Conference proceedings

SCHEMCON-2020

16th Annual session of Students Chemical Engineering Congress

October 9-10, 2020
Virtual mode

Organized by
Indian Institute of Chemical Engineers
Dr. H. L. Roy Building, Jadavpur University Campus,
Kolkata - 700032
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IIChE Council Members

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<thead>
<tr>
<th>Prof. V. V. Basava Rao</th>
<th>Prof. S. V. Satyanarayana</th>
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<tbody>
<tr>
<td>(President)</td>
<td>(Immediate President)</td>
</tr>
<tr>
<td>Mr. Praveen Saxena</td>
<td>Dr. M. Venkateswara Rao</td>
</tr>
<tr>
<td>(Vice President)</td>
<td>(Vice President)</td>
</tr>
<tr>
<td>Dr. Avijit Ghosh</td>
<td>Dr. Madhu Agarwal</td>
</tr>
<tr>
<td>(Honorary Secretary &amp; Organizing Secretary SCHEMCON-2020)</td>
<td>(Honorary Jt Secretary)</td>
</tr>
<tr>
<td>Dr. M. K. Jha</td>
<td>Dr. Gaurav Rattan</td>
</tr>
<tr>
<td>(Honorary Treasurer)</td>
<td>(Honorary Registrar)</td>
</tr>
<tr>
<td>Dr N Balasubramanian</td>
<td>Prof. Sudhhasatwa Basu</td>
</tr>
<tr>
<td>(Honorary COE)</td>
<td>(Ex-Officio Member &amp; Honorary Editor,)</td>
</tr>
<tr>
<td>Mr D M Butala</td>
<td>Prof. C. Karthikeyan</td>
</tr>
<tr>
<td>Prof. S. C. Naik</td>
<td>Dr M P Jain</td>
</tr>
<tr>
<td>Prof. Sudip K Das</td>
<td>Prof. Alpana Mahapatra</td>
</tr>
<tr>
<td>Dr. G. S. V. Ratnam</td>
<td>Dr. T. L. Prasad</td>
</tr>
<tr>
<td>Prof. K. B. Radhakrishnan</td>
<td>Prof. Anil Kumar Saroha</td>
</tr>
<tr>
<td>Prof. Narendra M Surana</td>
<td>Mr. Kalyan Kumar Basu</td>
</tr>
<tr>
<td>Prof. V S Sapkal</td>
<td>AICTE Nominee</td>
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<tr>
<td>AICTE Nominee</td>
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Members from the IIChE Headquarters

Ms. Nandani Roy
Ms. Piyali Chakraborty
Ms. Subha Samajdar

Organizing Secretary
Dr. Avijit Ghosh, Honorary Secretary, IIChE
Assistant Professor, Heritage Institute of Technology, Kolkata
# Inaugural Program: SCHEMCON-2020

<table>
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<tr>
<td>9:00-9:05</td>
<td>Welcome address by The President: Prof. V. V. Basava Rao</td>
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<tr>
<td>9:05-9:10</td>
<td>Address by Guest of Honour: Prof. Basab Chaudhuri, Vice Chancellor, West Bengal State University</td>
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<tr>
<td>9:10-9:20</td>
<td>Address by Guest of Honour: Mr. Biswanath Chattopadhyay, CEO IVL Dhunseri Petrochem Industries Limited</td>
</tr>
<tr>
<td>9:20-9:25</td>
<td>Address by Guest of Honour: Prof. G. D. Yadav, Past President, IIChE &amp; Former Vice Chancellor ICT Mumbai</td>
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<td>9:25-9:30</td>
<td>Inauguration of IIChE App</td>
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<tr>
<td>9:30-9:35</td>
<td>Address by Vice President Prof. M. V. Rao</td>
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<tr>
<td>9:35-9:40</td>
<td>Address by Vice President Mr. P.K. Saxena</td>
</tr>
<tr>
<td>9:40-9:55</td>
<td>Address by Chief Guest: Shri C.P. Gurnani, Chief Executive Officer and Managing Director, Tech Mahindra</td>
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<tr>
<td>9:55-10:00</td>
<td>Vote of Thanks by Dr. Avijit Ghosh, Organizing Secretary, SCHEMCON-2020</td>
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| 9:00-10:00 | Inauguration Chief Guest:  
Shri C.P. Gurnani, Chief Executive Officer and Managing Director, Tech Mahindra  
**Guest of Honours:**  
Prof. V. V. Basava Rao, President, IIChE Prof. Basab Chaudhuri, Vice Chancellor, West Bengal State University  
Mr. Biswanath Chattopadhyay, CEO IVL Dhunseri Petrochem Industries Limited Prof. G. D. Yadav, Past President, IIChE & Former Vice Chancellor ICT  
Mumbai Prof. M. V. Rao, Vice President, IIChE  
P.K. Saxena, Vice President, IIChE  
Organizing Secretary  
Dr. Avijit Ghosh  
**Inaugural Song:** Mrs. Sumana Mandal, Assistant Professor, Haldia Institute of Technology | Subha Samajdar, IIChE Headquarters                                                                 | Time: Oct 9, 2020 09:00 AM  
India Join Zoom Meeting  
https://us02web.zoom.us/j/85228187246  
Meeting ID: 852 2818 7246  
YouTube Link:  
https://youtu.be/tBLegA14R3c |
| 10:30-11:30 | Special session I- Covid 19  
**Session Chairpersons:**  
Dr. T. I. Prasad, BARC  
Mobile: 9869879214  
tlprasad63@gmail.com  
Dr. C. Karthikeyan, Anamalai University  
Mobile: 9171474175  
drcktech@rediffmail.com  
Dr. M. P. Jain, Redt. Scientist, BARC  
Mobile: 9867262250  
mpjain2000@yahoo.com | Anwesha Pandit  
anweshapandit12@gmail.com  
08610710 |  
https://global.gotomeeting.com/join/148500029 |
| 11:30-13:30 | NN- I  
**Prof.(Dr) Alpana Mahapatra, D J Sanghvi College of Engineering, Mumbai**  
Mobile: 9920832421  
alpana.mahapatra@djsce.ac.in | Aishika Mitra  
aishikamitra1008@gmail.com  
7998453643 |  
https://www.gotomeet.me/IIChE-HQ/schemcon-2020-nn-1  
Access Code: 894-763-797 |
|           | NN- II  
**Prof. Biswajit Mandal, HITH**  
Mobile: 9732961156  
bmandal1977@rediffmail.com | Aniruddha  
Mondal  
8013292565  
aniruddha0266@gmail.com |  
https://global.gotomeeting.com/join/394490813 |
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<thead>
<tr>
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<tr>
<td>13:30-16:30</td>
<td>GSE I</td>
<td>Prof. Sunil Baran Kuila, HITH Mobile: 8972960394</td>
<td><a href="mailto:sunilbarankuila@gmail.com">sunilbarankuila@gmail.com</a></td>
<td><a href="https://global.gotomeeting.com/join/238357325">https://global.gotomeeting.com/join/238357325</a></td>
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<tr>
<td></td>
<td>Prof. S. K Gupta</td>
<td>HBTU Kanpur Mobile: 7081300512</td>
<td><a href="mailto:sgupta@hbtu.ac.in">sgupta@hbtu.ac.in</a></td>
<td><a href="https://global.gotomeeting.com/join/695624509">https://global.gotomeeting.com/join/695624509</a></td>
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<tr>
<td></td>
<td>Prof. Monal Dutta</td>
<td>CIT. Uluberia Mobile: 8334822119</td>
<td><a href="mailto:soniairin@gmail.com">soniairin@gmail.com</a></td>
<td><a href="https://global.gotomeeting.com/join/943167085">https://global.gotomeeting.com/join/943167085</a></td>
</tr>
<tr>
<td></td>
<td>Prof. N. Balasubramaniam</td>
<td>Anna University Mobile: 9444954151</td>
<td><a href="mailto:nbs.bala@gmail.com">nbs.bala@gmail.com</a></td>
<td></td>
</tr>
<tr>
<td>14:30-16:30</td>
<td>WM-I</td>
<td>Prof. Amitava Bandopadhy, Calcutta University Mobile: 9073507941</td>
<td><a href="mailto:amitava.iiche@gmail.com">amitava.iiche@gmail.com</a></td>
<td><a href="https://global.gotomeeting.com/join/581596565">https://global.gotomeeting.com/join/581596565</a></td>
</tr>
<tr>
<td></td>
<td>Prof. Madhu Agarwal</td>
<td>MNIT Jaipur Mobile: 9413349429</td>
<td><a href="mailto:madhunaresh@gmail.com">madhunaresh@gmail.com</a></td>
<td></td>
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<tr>
<td></td>
<td>Prof. R. Parthiban</td>
<td>SSN College of Engineering Mobile: 9884488302</td>
<td><a href="mailto:partibanr@ssn.edu.in">partibanr@ssn.edu.in</a></td>
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<tr>
<td>16:30-17:30</td>
<td>Keynote address</td>
<td>Keynote Address by: Prof. Jayant Kr. Singh, IIT, Kanpur</td>
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<td>Join Zoom Meeting</td>
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**Note:** Attendees can join the sessions using the links provided. For the Keynote address, please join the Zoom Meeting provided.
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<th>Contact Details</th>
<th>Meeting Link</th>
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<tr>
<td>8.15-</td>
<td>Invited</td>
<td>Dr. Sonal Majumdar, FDA, USA</td>
<td><a href="mailto:sonal.mazumder@gmail.com">sonal.mazumder@gmail.com</a>&lt;br&gt;<a href="mailto:sonal.mazumder@fda.hhs.gov">sonal.mazumder@fda.hhs.gov</a></td>
<td>[Join Zoom Meeting](<a href="https://us02web.zoom.us/j/4249611133">https://us02web.zoom.us/j/4249611133</a>&lt;br&gt;Meeting ID: 424 961 1133)</td>
</tr>
<tr>
<td>8.35-</td>
<td>PMS- I</td>
<td>Dr. Somak Jyoti Sahu, HITH</td>
<td><a href="mailto:somaksahu@gmail.com">somaksahu@gmail.com</a></td>
<td><a href="https://global.gotomeeting.com/join/880607693">https://global.gotomeeting.com/join/880607693</a></td>
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<tr>
<td>8:35</td>
<td>PMS II</td>
<td>Dr. Dwaipayan Sen, HITK Prof.</td>
<td><a href="mailto:dwaipayan.sen@heritageit.edu">dwaipayan.sen@heritageit.edu</a>&lt;br&gt;<a href="mailto:jyothithati@ouct.ac.in">jyothithati@ouct.ac.in</a>&lt;br&gt;<a href="mailto:sreetamapandit@gmail.com">sreetamapandit@gmail.com</a></td>
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<td>8:35-</td>
<td>PMS- III</td>
<td>Prof. Abhhuday Mallick, HITK</td>
<td><a href="mailto:abhyuday.mallick@heritageit.edu">abhyuday.mallick@heritageit.edu</a>&lt;br&gt;Mr. Dhawal Saxena, Blast Carboblocks Pvt. Ltd</td>
<td><a href="https://global.gotomeeting.com/join/167471141">https://global.gotomeeting.com/join/167471141</a></td>
</tr>
<tr>
<td>8:35</td>
<td>OCE- I</td>
<td>Prof. Bimal Das, NIT, Durgapur</td>
<td><a href="mailto:bimal_30@yahoo.com">bimal_30@yahoo.com</a></td>
<td><a href="https://global.gotomeeting.com/join/528703821">https://global.gotomeeting.com/join/528703821</a></td>
</tr>
<tr>
<td>8:35</td>
<td>OCE- II</td>
<td>Prof. Rajashimman, Annamalai</td>
<td><a href="mailto:simms@rediffmail.com">simms@rediffmail.com</a></td>
<td><a href="https://global.gotomeeting.com/join/912300877">https://global.gotomeeting.com/join/912300877</a></td>
</tr>
<tr>
<td>8:35</td>
<td>OCE- III</td>
<td>Prof. Tarun Kumar Naiya, IIT,</td>
<td><a href="mailto:trm2711@yahoo.com">trm2711@yahoo.com</a></td>
<td><a href="https://global.gotomeeting.com/join/906522717">https://global.gotomeeting.com/join/906522717</a></td>
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Day 2: OCTOBER 10, 2020 (Saturday)
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<tbody>
<tr>
<td>10.00-12.00</td>
<td>Keynote address</td>
<td>Prof. J. B. Joshi, Emeritus Professor-J.C. Bose fellow, <a href="mailto:jbjoshi@gmail.com">jbjoshi@gmail.com</a></td>
<td><a href="https://global.gotomeeting.com/join/513966589">https://global.gotomeeting.com/join/513966589</a></td>
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<tr>
<td>12.00-13.30</td>
<td>Special Session II - Emerging</td>
<td>Chief Guest: Prof. Saikat Maitra, Vice Chancellor, MAKAUT, WB</td>
<td>Join Zoom Meeting</td>
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<tr>
<td>Time</td>
<td>Session</td>
<td>Speaker(s)</td>
<td>Contact Information</td>
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<tr>
<td>14:00-15:00</td>
<td>Panel Discussion on Manufacturing up-gradation by Artificial Intelligence</td>
<td>Prof. V. K. Rattan, VC, GNA University</td>
<td>E-mail- <a href="mailto:vkrattanpu@yahoo.com">vkrattanpu@yahoo.com</a> Mob. 9815334198 Dr. Sanjeev Katti, Director General Energy Center ONC E-mail - <a href="mailto:sanjeev_katti@onc.co.in">sanjeev_katti@onc.co.in</a> Mob. 8451919270 Sh. Sushil Kumar, Past President IICHE, Ex unit Head RIL Dahej E-mail - <a href="mailto:sushilkumar.ril@gmail.com">sushilkumar.ril@gmail.com</a> Mob. 8454840176 Sh. R G Rajan, Ex CMD Rashtriya Chemical &amp; fertilizer E-mail - <a href="mailto:rgragan1957@gmail.com">rgragan1957@gmail.com</a> Mob. 9819991155 Mr. Saurabh Srivastava, Google Research Center <a href="mailto:saurabh.ixd@gmail.com">saurabh.ixd@gmail.com</a> Mob. 9945055966 Dr. U Kamachi Mudali, Ex. CMD Heavy Water Board <a href="mailto:ukmudali1@gmail.com">ukmudali1@gmail.com</a> Mob. 9969034515 Moderator: Prof. Praveen Saxena, Vice President, IICHE, Director &amp; CEO Blast Carboblocks Pvt, Ltd <a href="mailto:praveensaxena1951@gmail.com">praveensaxena1951@gmail.com</a></td>
</tr>
<tr>
<td>17:00-18:00</td>
<td>Award Ceremony and Valedictory Session</td>
<td>Chief Guest: Mr. Dileep Thatte, National Institute of Standards and Technology (NIST), USA Guest of Honours: Prof. S.V. Satyanarayana, Immediate Past President, IICHE Prof. V. S. R. K. Prasad, Director, IIPE, Visakhapatnam Mr. Shyam Bang, Past President, IICHE Chairpersons: Prof. V.V. Basava Rao, President IICHE Prof. M. V. Rao, VP IICHE Mr. Praven Saxena, VP IICHE Organizing Secretary Dr. Avijit Ghosh</td>
<td>Piyali Chakraborty, IICHE Headquarters</td>
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It is a matter of great pleasure to greet the IIChE fraternity on the occasion of the 16th SCHEMCON, being held at the IIChE Headquarters in Kolkata. The unprecedented crisis and distress, arising out the Covid-19 pandemic, forced us to cancel our original plan for this important event. Instead, for the first time in the annals of SCHEMCON, it is being digitally organised at the Institute Headquarters. One does not need much explanation to appreciate that it took considerable effort, energy and endeavour on the part of the organisers, particularly, the Organising Secretary, Dr. Avijit Ghosh, to plan the event with utmost care and coordination in the time of great difficulties.

Over the years, SCHEMCON has gained impressive popularity among the Chemical Engineering student communities and the faculty members across the country. It is a rewarding platform where the students can discover new ideas and learn new skills as well as share their out of the box thinking. It is their enthusiasm that has largely motivated us to go ahead with the event this year despite many hurdles.

The underlying theme for this year’s SCHEMCON – ‘Intensified Industrial Chemical Engineering – Operations, Practices and Techniques for Sustainable Development’ is highly appropriate in the new normal world that is unfolding before us. The mankind has been grossly abusing and exploiting Planet Earth over the decades for trivial gains. The Covid-19 pandemic has forced the humanity to stall and reflect upon building a new world, where mankind would hopefully respect the Nature and not destroy it mercilessly. In this changed world, Sustainable Development will be the new Mantra.

I look forward to many engaging sessions in SCHEMCON this year, with renowned academics and industry experts offering stimulating ideas and sparking off engaging interactions among the participants. It will indeed be a rewarding experience for all of us.
It is my pleasure to associate with virtual Student Chemical Engineers Congress 2020 and the specifically with the young Budding Chemical Engineers.

SCHEMCON is a global platform for the students to showcase their capabilities and capacities in the field of chemical engineering & technologies.

I wish grand success of virtual SCHEMCON 2020 held by HQ Kolkata. As previous years, I hope we continue our tradition of enthusiastic participation by students and knowledgeable sessions in this online edition this year.
It is my great pleasure to greet the IIChE community, specially its collective of Student Members, on the occasion of the 16th SCHEMCON, being hosted digitally by the IIChE Headquarters in Kolkata on 9 and 10 October 2020. This year, organising SCHEMCON was a challenging task with all of us still fighting a formidable battle against Covid-19 pandemic. But, as a matter of fact, all the hardships and obstacles in our path motivated the team IIChE to close ranks and plan the event in a manner, befitting the occasion.

Ever since its inception in 1947, IIChE has been committed to empowering students and practitioners of Chemical Engineering in its pursuits for knowledge and skill enhancement in Chemical Engineering and the allied fields. More particularly, in recent years, IIChE has been coming up with various ways and means to reach out to the students and to make them an integral partner in the Institute’s endeavour for attaining excellence. Towards that direction, SCHEMCON has evolved as an ideal portal, enabling the students to imbue with knowledge from the fast evolving field of Chemical Engineering and helping them to translate the knowledge into innovative practices for sustainable growth of the society and the economy.

I am confident that with the presence and participation of esteemed academics and industry experts, SCHEMCON 2020 will offer impressive opportunities to the students to update themselves with the changing scenario in the arena of Chemical Engineering. Although unlike any previous year, this year’s SCHEMCON is being held on virtual mode, nonetheless, I strongly believe that it will not dampen the high level of enthusiasm and energy among the students. I look forward to many engaging sessions ahead.
With the countdown beginning for SCHEMCON 2020, it gives me great pleasure as the Organising Secretary for this year’s Students Chemical Engineering Congress to look forward to a memorable and rewarding event ahead, notwithstanding the surrounding gloom arising out of the Covid-19 pandemic situation. This year’s SCHEMCON is going to be unique for more than one reasons. Firstly, this is the maiden time that the IIChE Headquarters in Kolkata is organising the event. Moreover, for the first time, the event is being hosted entirely on the virtual platform amidst the Covid-19 crisis.

The idea behind initiating SCHEMCON back in 2005 was to create a platform for the young minds to initiate them to the latest developments and discoveries in the fast evolving field of Chemical Engineering. Another objective was to enable the students spell out their innovative ideas and perceptions while enabling them absorb valuable inputs from acclaimed academics and seasoned professionals. It is a matter of great satisfaction for IIChE that over the years the Institute has been able to steadily establish popularity of the event among the academic fraternity in the Chemical Engineering field all across the country.

For the present year, it was a great challenge for the Institute Headquarters to organize the event with a short notice following the change in the original plans due to the unabated pandemic crisis. I am, indeed, very thankful to the IIChE President, Prof. V.V. Basava Rao, and several of my other colleagues in the IIChE Council and in other academic institutions whose strong support and suggestions smoothened out many difficulties and eased many logistic bottlenecks. I also appreciate the cooperation of the IIChE Headquarters team, providing me all the necessary assistance.

The central theme for this year’s SCHEMCON – ‘Intensified Industrial Chemical Engineering – Operations, Practices and Techniques for Sustainable Development (IIChE-OPTSD)’ is very apt for the present situation. As the world struggles to get back to a normal life that we all knew before the onset of the pandemic, the need of the hour is to search for ways and means to ensure Sustainable Development for the future of the humanity.

I keep my fingers crossed wishing that SCHEMCON 2020 turns out to be highly successful in every aspect. I also look forward to many invigorating sessions of academic empowerment and insightful interactions under the umbrella of SCHEMCON 2020.
I am very grateful to the organizing team of ONLINE SCHEMCON-2020 extending the horizons in Intensified Industrial Chemical Engineering-Operations, Practices and Techniques for Sustainable Development. It is particularly meaningful for me not only as a Joint Secretary to be here, in the organization like Indian Institute of Chemical Engineers but being a teacher the importance of shared values and common policies, as a basis for sustainable development and sustaining peace. I would like to take this opportunity to thank IIChE for providing the excellent platform for students in the Conference to adapt advances, specially in the field of Chemical Engineering and the interdisciplinary areas. For the recent scenarios, it has become imperative to explore the new horizons developing hybrid systems. Such platform is the plethora for exchange of ideas, knowledge, and creativity. Therefore, considering the participation of accomplished individuals from industries, research institutes, laboratories, academia, and students, I am once again obliged to be a part of event.
Technology has changed many folds in last decades. To keep a pace with the changing times, teaching learning ecosystem has to work on solving real time problems. We believe that with every technological breakthrough, new avenues for doing active research open up.

On behalf of the IIChe 2020 organizing committee, I am honored and delighted to welcome you to the Online SCHEMCON 2020, October 9-10, Theme: Intensified Industrial Chemical Engineering Operations, Practices and Techniques for Sustainable development a virtual mode from IIChe Headquarters. I believe we have chosen an online virtual conference platform that guarantees a successful technical conference to offer best way to allow researchers to share their scientific work and interact with collaborators.

This conference is conceptualized keeping in view the needs of current times. Having said so, I believe this conference would serve as an excellent springboard for various stakeholders to set and achieve higher goals in making the world a better place to live.

I cordially welcome all the academicians, researchers, industrialists and engineers who are taking part in this noble endeavor. Your presence at this conference and valuable scientific contribution will no doubt set the standard for future conferences of this nature.

I am sure that this conference will add more laurels in the years to come.
Invited Talks
Continuous Manufacturing -- A Key to Sustainable Manufacturing

Dr. Sonal Mazumder
*Corresponding Author Email: sonal.mazumder@gmail.com
Regulatory Reviewer (Chemical Engineering), US Food & Drug Administration, USA

Abstract

Continuous Manufacturing is achieving extensive consideration as a way of producing fine chemicals, active pharmaceutical ingredients, and finished dosage forms. Although potential benefits over traditional batch-wise production have been discussed at many occasions and appear evident, continuous processes are only slowly being implemented. The American Chemical Society Green Chemistry Institute Pharmaceutical Roundtable has defined “continuous processing” as one of its research priorities. Innovative continuous manufacturing (CM) technologies have a great potential to improve control over quality, reduce costs, enhance process safety, and significantly reduce the timelines currently involved across the medicines’ supply chain. When compared to traditional batch manufacturing, continuous manufacturing also has enhanced ability to control the process and product quality through knowledge of residence times and the implementation of process analytical technology (PAT) tools. The design and implementation of continuous processes for the manufacture of pharmaceutical intermediates, APIs, or even drug products are a truly multidisciplinary effort. It starts with defining a route which is most favorable among several possible routes to reach a target molecule. It requires a thorough understanding of each single-chemical transformation on molecular level, covers the knowledge of the kinetics of the desired and competing reaction pathways including factors such as activation enthalpy and entropy, and reaction enthalpy. This leads to performance requirements for the reactor in which the desired reaction is intended to run. This finally leads to required reactor features such as mixing speed, heat removal, residence time distribution, and others. It also leads to requirements regarding the control accuracy and speed of feedback loops. Consequently, stakeholders of very different disciplines are engaged in implementing a continuous process. The speaker will give an overview of the continuous manufacturing process related to development of pharmaceutical products along with Quality-by-design (QbD) paradigm for pharmaceutical development and the advancement of process analytical technology (PAT) for designing, analyzing, and controlling manufacturing using science and risk-based approaches.
Special Session II
Emerging Trends on E-Waste Management
Abstract

End of life electronic equipment, known as e-waste, is a threat to the whole world. The problem of e-waste disposal is a very well-known fact, and its generation is increasing exponentially every year. There are many factors that are associated with the end of life disposal of e-waste management. The complexity of the materials used, occurrence of hazardous substances, lack of awareness, legislative requirements, availability of technologies, supply chain uncertainty are some of the major issues pertaining with e-waste management. Aim of the talk would be to touch upon the various factors, issues and challenges of e-waste management.

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Abstract

Global energy demand is increasing exponentially, and the renewable energy sources are becoming promising and sustainable solutions. Solar power, which is the most abundant source of energy, is a big area of research as well as market analysis. Hence, there has been a sharp increase in global solar power investments leading to a high demand of solar panels. The solar panels, otherwise known as Photo-Voltaic (PV) panels, not only help in energy harvesting but also comes with the danger of end-of-life (EoL) disposal. It is expected that by 2030, there will be 1.7 – 8 million tonnes of solar panel waste which will reach 60-78 million tonnes by 2050. End of life solar panel is categorised as electronic waste (e-waste) which is hazardous in nature as it contains heavy metals e.g. lead (Pb), tin (Sn), cadmium (Cd) etc. It can be considered as an emerging e-waste. Since the lifespan of solar panels are quite high compared to other electronic devices, the volume of solar panel waste generation is low. This is one of the key issues for the commercial recycling plants. There are only a few dedicated solar panel recycling units around the world and the cost of recycling is quite high. There are existing technologies that includes physical disintegration, dry and wet mechanical process, thermal treatment, chemical etching, leaching, pyrolysis etc. However, the recycling line changes based on the type of the solar panels. Hence segregation of solar panels plays a role in this case. Additionally, the supply chain issues are also very important and needs to be addressed. In this article, the current status of solar panel recycling has been discussed in detail with a focus on the existing and upcoming technologies for resource recovery. The importance and the role of supply chain network has been discussed. Additionally, a generalised idea on circular economy aspects of solar panel recycling has been briefly stated. It is expected that the article will be helpful to the researchers and policymakers.

Keywords: Solar Panel Recycling, Circular Economy, Resource Recovery, E-waste, Supply Chain.
Emerging trends on E-waste management

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Emerging trends on E-waste management E-waste is the Toxic Legacy of our Digital Age. Setting new benchmarks in maintaining the confidentiality of the business data and offering highly efficient e-Waste management services is GreenWaves Environmental Solutions - the first authorized (by Pollution Control Board, Andhra Pradesh) e-Waste collection and handling unit of Andhra Pradesh. Interestingly, besides a data destruction certificate, GreenWaves sends a video of storage device disposal to its customers. We consider e-Waste not as a waste but as a multiple-resource. It's a tool for social transformation giving paramount importance to the trust factor;

Focused on collecting all types of recyclable e-Waste, GreenWaves has built an app called ReByte. The app within mere touches ensures safe & environment-friendly disposal of recyclable wastes collected from the user’s door-step, and also provides reverse-logistics. Additionally, clients are given a chart indexing the types of e-Waste and provided with assistance in custom clearance and filling of e-Waste’s annual returns.

Through continuous innovations and implementing cutting-edge recycling technologies, GreenWaves has created a niche for itself. It engages in end-to-end operations – right from collecting electronic waste from various functional areas to storing, and dismantling. The company collects e-Waste from Corporate, Government, SMEs, Educational Institutions, Retailers, and Individuals among other sources. The dismantling process (including manual semi-manual & automatic) involves physical segregation of particles such as plastics, glass, steel, non-ferrous materials, wires, gases & printed circuit boards, and hazardous e-Waste like tube lights, sodium vapors lamps, and cartridges. All along the process, safe handling of elements and safety of its employees are given the first priority. On the other hand, by passing-on the knowledge to its clients and the general public, GreenWaves is tirelessly creating public awareness. It regularly conducts workshops & several programs (E-Drives), in addition to framing creative portraits poised to inspiring people to utilize e-Waste in innovative ways. Furthermore, to impart the knowledge on the importance of proper e-Waste disposal and its ill-effects of mismanagement to every individual, the company has installed e-Bins in selected areas of Visakhapatnam for disposal & recycling of small electrical & electronic items.

Owing to such exquisite range of service offerings and delicate methodologies followed, GreenWaves has also won the National Awards for its excellence in e-Waste Recycling at Indian Industry Session (at 8th Regional 3R Forum in Asia and the Pacific). And yet another golden feather on its crown is the invitation it received from National Green Tribunal Conference to deliver a talk on e-Waste Management at Guwahati. On world environmental day we had been given Seva Puraskar award by Andhra Pradesh Pollution Control board for our great contribution towards sensitizing the people on Ewaste management and for.
effective recycling of e-waste. We aim to be the first company to provide an indigenous solution for e-Waste management to every individual. GreenWaves is well on its way to make this part of the world a better place to live in.

E - Waste Mukt Bharat - Swachh Bharat
Nanomaterial & Nanotechnology (NN)
Restrained Synthesis of 1D, 2D & 3D α-Fe2O3, Cu-O and their conglomerates for assessment of Photo-Induced & magnetic properties

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Abstract
Hematite was one of the extensively engineered materials premediated to study far-flung applications in material science. We paraphrase the template-based synthesis of controlled self-assembly α-Fe2O3 structures such as 1D (nanorods), 2D (hexagonal platelets), and 3-D (spheres) succored by hydrothermal technique. 3-D Cuprous Oxide structures were also synthesized. The combo of these oxides was mimicked as composites. All the synthesized materials including composites were characterized for phase purity and crystallographic properties through X-Ray Diffraction. Morphological studies of structured materials were performed with the aid of Scanning Electron Microscope. Pair Distribution Function (PDF) was performed to understand vacancy ordering in the materials. Comprehensive studies of bandgap properties were evaluated by Diffuse Reflectance Spectroscopy (DRS). Elemental analysis of the synthesized materials were conferred using Energy Dispersive X-Ray spectroscopy (EDAX). Systematic photo-catalytic of methylene blue dye with composites as catalysts using low power visible light were conferred which provided degradation up to 85%. UV-visible spectrophotometer was used to trace the degradation of organic dyes. Further, they were subjected to magnetic properties and photocurrent testing. The room temperature MH curve for 0-D Iron Oxide nanoparticles inherited soft magnetic behaviour with low coercive field and 3-D Iron Oxide sphere was a hard magnet with larger coercive field. Photocatalytic degradation; Coercive field.

Key Words: Template synthesis; hydrothermal technique; Pair Distribution Function;

Nano-biosensors for Advanced Packaging Systems and Food Safety
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Abstract

Nano-biosensors have emerged as a next-generation technology, opening new horizons in the field of food technology and food safety. These advanced sensing systems help to facilitate the monitoring of food quality by detecting the foodborne pathogens, foreign particles in processed food, controlling food additives concentration and analyzing the freshness by determining shelf life of the product. The devices can be easily integrated with the packaging material, giving rise to a novel Intelligent Packaging System. The working principle deals with the conversion of biological or chemical signals into electrical signals via transducer. Depending upon the type of information obtained from these nano-sensors, they are broadly categorized into Mechanical (based on changes in resonant frequency), electrochemical (involve chemical changes) and optical (output signal received is a light signal) sensor. This article mainly discusses the application of Iron based magnetic nanoparticles which proves to be a promising material for fabricating these biosensing devices. Also, a future perspective on the usage of biopolymer-based nanocomposite for enhancing the performance of sensing devices have been discussed.

Keywords: Nano-biosensors; Intelligent packaging system; Magnetic nanoparticles
Abstract

What if we could screen of thousand of diseases all at once...with just a single drop of blood. What if we could search out and destroy cancer cells without surgery or chemotherapy? What if we could restore eyesight by injecting tiny particles that help the body repair injured nerves. These scenarios may seem far-fetched that they are among the long term goals of researchers working in the field of medicine, but what is Nanomedicine? Nanomedicine is the application of nanotechnology to medicine. Its kind of like giant game of lego, only it is very small and the building blocks are molecules and atoms. So what doctors need our tiny tools that can work with fantastic precision at the nanoscale the size of the smallest working parts of our bodies. Nanomedicine refers to highly specific medical intervention at the molecular scale for curing disease or repairing damaged tissues, such as bone, muscle, or nerve.

Applications of nanotechnology for treatment, diagnosis, monitoring and control of biological systems is referred to as nanomedicine. It is a relatively new technology based on the uses of engineered nanomaterials like liposomes, carbon nanotubes, fullerenes, polymeric micelles, quantum dots. Nanomedicine gives great hope for better and faster treatment of many diseases and hope for better tomorrow. However, the creation of new "nanodrugs" requires a special understanding of the properties of nanoparticles. This review presents the work which determines and describes the way of creating new nanodrugs and molecular dynamic applications up to new medicinal products, as a proposal for the personalized nanomedicine in the early future.

Keywords: Nanomedicine, Fullerenes, Nanoparticles, Nanodrugs, Personalized nanomedicine.
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Ruthenium-bound Silica Nanoparticles coated onto Contact Lenses for Oxygen Sensing in the Tear Film

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Abstract

Oxygen tension (pO₂) in the tears is invariably affected by contact lens wear, especially in the post-lens tear film (PLTF). This negatively influences oxygen metabolism of cellular layers of the cornea and measuring pO₂ dynamics (in ns) underneath PLTF is an important tool to evaluate health of the cornea. Measurement of pO₂ dynamics in nano timescale in the PLTF is a major unmet clinical need. Hence, we propose to employ O₂-sensitive Ruthenium (Ru)phenanthroline bound to hollow silica nanoparticles (NPs) coated on contact lens for measuring pO₂ dynamics. Ru-SiO₂ NPs were prepared by microemulsion method and water etched to improve porosity. The average size of Ru-SiO₂ NPs was 150 ± 20 nm. XRD showed that Ru-SiO₂ NPs were amorphous in nature. FTIR results confirmed that Ru was bound to Si. Fluorescence emission at 590 nm confirmed the presence of Ru. To enhance binding of the NPs to the contact lens, they were functionalized with binders. The lifetime of Ru measured using spot-fluorometer was found to be 4-6 µs and fluorescence decay was seen, confirming oxygen selectivity of the NPs. Future work includes in vivo measurement of pO₂ dynamics in PLTF in a rabbit model using custom-built spot fluorometer.

Keywords: Post-lens tear film, oxygen dynamics, fluorescence quenching, ruthenium
Microwave assisted Nano-catalysis in water

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Abstract

Nowadays, Everyone is tending towards sustainable development by using renewable resources, implementing new techniques, efficient raw materials recoveries and by improving the reusability of products. A lot of pressure is present on all the chemistry-related industries to improve the overall efficiency and sustainability of industrial processes due to the rise in demand for chemical products and the quest for sustainable solutions. Among the greener approaches for sustainable development, a combination of Nano-catalyst in presence of benign water medium with non-conventional Microwave heating is one of them. Nanomaterials acts as both catalyst and susceptors and Microwaves with aqueous medium leads to homogeneous in-core heating, enhanced yields and selectivity. Microwave-assisted Nano-catalysis in water approach for a wide variety of organic reactions have shorter residence time, safeguard the catalyst from deactivation and decomposition and other benefits. It appears that this approach of integrating the Microwave heating with nano-catalysis and benign water (as a reaction medium) can provide an excellent synergistic effect with greater impact than these three individual components separately. Glutathione-based Nano-organocatalyst for aqueous microwave-assisted synthesis of heterocycles is one of the examples of this approach.

Keywords: Nano-Organocatalyst, microwave heating, polar aqueous medium.
Review on carbon materials, metal oxide, conducting polymers as electrode material for supercapacitors

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Abstract

There is a rising curiosity in the application of supercapacitors in energy storage systems because of their high specific power, fast charge/discharge rates and long cycle stability. Researchers have concentrated recently on building nanomaterials to boost their capacitive performance of supercapacitors. Predominantly, the utilisation of fibres as templates has led to theoretical and practical benefits owing to their increased specific surface area, which permits fast electrolyte-ion diffusion. Carbon and carbon derivatives are the most popular selection for the composite electrodes. Also, the inclusion of redox-active components, like transition metal oxides (TMOs) and conducting polymers (CPs), into the fibres is meant to play a significant role in enhancing the electrochemical behaviour of the fibre-based materials. On the other hand, supercapacitors comprising TMO- and CP-based fibres generally suffer from poorer ion transport kinetics and poor electronic conductivity, which can impact the rate capability and cycling stability of the electrodes. Therefore, the development of TMO/CP based fibres has achieved widespread consideration because they synergistically unite the benefits of both materials, enabling revolutionary applications in the electrochemical field. In this article, different carbon materials, metal oxides and conducting polymers used as working electrode materials are presented.

Keywords: Supercapacitor, Nanomaterials, Carbon, Conducting polymers, Metal oxides, Composites
Artificial Intelligence Driven Safe and Profitable Agriculture

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Abstract

Agriculture in India ranks second largest in the world with total arable land area of approximately 159.7 million hectares employing more than 50% of the Indian workforce and contributing about 17-18% to country’s GDP. Therefore, adopting more efficient agricultural practices using advance technologies to address the current bottlenecks is a must. The agriculture sector is always in search and increasingly look at ways to leverage technology for better yield and targeted agri-based solutions to benefit the farmers. With advancements in technology coupled with conducive policies, penetration of technologies like artificial intelligence (AI) is a great starting point for the agricultural sector. AI could act as the epitome of shift in conventional practices, enabling farmers to produce quality crops in the appropriate time and ensuring efficient market supply chains. The current paper highlights important applications of AI in Indian agriculture with utmost emphasis on three important applications, viz. monitoring of crop and soil, predictive agricultural analytics and supply chain efficiencies. AI comes as a great boon to the agricultural sector which is heavily dependent on climatic conditions which are often unpredictable. The future of farming largely depends on adapting cognitive solutions. AI solutions if become viable and offered in an open source platform to make it affordable, would result in faster adoption of the technology and greater insight among the agricultural producers and consumers.

Keywords: Artificial intelligence; agriculture; crop; technology
The role of nanotechnology in the treatment of viral infections

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Abstract

Infectious diseases are the leading cause of mortality worldwide, with viruses in particular making global impact on healthcare and socioeconomic development. In addition, the rapid development of drug resistance to currently available therapies and adverse side effects due to prolonged use is a serious public health concern. The development of novel treatment strategies is therefore required. The interaction of nanostructures with microorganisms is fast-revolutionizing the biomedical field by offering advantages in both diagnostic and therapeutic applications. Nanoparticles offer unique physical properties that have associated benefits for drug delivery. These are predominantly due to the particle size, large surface area to volume ratio, tunable surface charge of the particle with the possibility of encapsulation, and large drug payloads that can be accommodated. These properties, which are unlike bulk materials of the same compositions, make nanoparticulate drug delivery systems ideal candidates to explore in order to achieve and/or improve therapeutic effects. This review presents a broad overview of the application of nanosized materials for the treatment of common viral infections.

Keywords: advances, hepatitis, HIV, influenza, nanotechnology, vaccine, virus.
One Step Facile Synthesis of Tunable Core-shell Type Magnetic Ni/NiO Nanoparticles for Waste Water Applications

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Abstract

Here, we propose a facile synthesis of magnetic nickel-nickel oxide nanoparticles through polymer assisted route where the surface area of the nanoparticles can be tuned by manipulating the reaction parameters. To make the nanoparticles, oxalic acid and nickel precursor were thoroughly mixed into a PEG solution which was prepared in ethanol. Further addition of water led to the formation of nickel oxalate which was then calcined to get the Ni/NiO nanoparticles. Upon calcination, nickel oxalate converts into nickel oxide and polymer into carbon which acts as a reducing agent facilitating conversion of non-magnetic nickel oxide to magnetic nickel while oxidizing itself into carbon dioxide. Further oxidation of Ni to create a magnetic core-shell type nanoparticle having NiO on inner-core and Ni on outer-core is to be expected when the calcination time is for long duration. Effect of parameters such as precursor concentration, calcination temperature and time of calcination was studied on the morphology of particles. The synthesized nanoparticles were characterized through microscopic (FESEM and TEM), spectroscopic (XRD) and BET surface area analysis. Potential of the nanoparticles was evaluated through a series adsorption experiments which results a quick removal of Pd(II) from water having a capacity of ~300 mg/g.

Keywords: Magnetic nanoparticles, Heavy metals removal, Morphology Characteristics
Biogenic synthesis of Silver nanoparticles for their biomedical Applications

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Abstract

Among several noble metal nanoparticles, silver nanoparticles have attained a special focus in biomedical applications recently. Conventionally silver nanoparticles, which have excellent antimicrobial properties, are synthesized by chemical method using chemicals as reducing agents, which later on become accountable for various biological risks due to their general toxicity; engendering the serious concern to develop environment friendly processes. Biological approaches for instance green synthesis exhibits superiority over chemical and/or biological methods. Although among the various biological methods, microbe mediated synthesis is not of industrial feasibility due to the requirements of highly aseptic conditions and its maintenance. Therefore, the use of plant extracts for this purpose is advantageous over microorganisms due to the ease of improvement. Moreover, different plant extracts have proven to have wide range and strong antibacterial properties for both Gram positive and Gram Negative bacteria. In this research, we have discussed the potential of these NPs in biomedical applications. Increased risk of viral contamination has also prevailed in the human race, strong inhibiting character of silver can be used to make a disinfectant solution spray made with biogenic synthesis. Also several synthesis methods and plant extracts have been discussed and a comparison is drawn at the end for better understanding.
Synthesis and characterization of glass/copper and glass/silver core/shell particles

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Abstract

Core/shell structures consisting of silica or glass cores and metallic shells have attracted a lot of attention in the last two decades due to their unique properties and numerous potential applications. The present work deals with the synthesis and characterization of micron sized core/shell particles. The method that has been discussed here deals with the bottom-up (self-assembly) approach of synthesizing core/shell particles and hence can be easily scaled up to nano-scale and so the bulk synthesis of such particles can take place at the industrial scale. It is its application in the fabrication of micro and nano sized Janus beads that have driven the motivation to work on this project. In this work, the focus has been done on synthesizing glass/copper core/shell structures and glass/silver core/shell structures using electroless deposition. The core/shell composites were characterized using X-Ray Diffraction Pattern, UV-Visible Absorbance Spectra, FT-IR Analysis, SEM and EDS analysis techniques.

Keywords: core/shell structures; Janus beads; glass/copper core/shell particles; glass/silver core/shell particles; electroless deposition
Synthesis of NiO@Co$_3$O$_4$ core shell nanoparticles for photoelectrocatalytic applications

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Abstract

NiO@Co$_3$O$_4$ core shell nanoparticles were synthesised by a facile one pot co-precipitation method, wherein, Ni(OH)$_2$ was precipitated out first, followed by the precipitation the hydroxides of Co (II or III) on the surface of nucleated Ni(OH)$_2$. These nanoparticles were consequently calcined at 450°C, to ensure a porous Co$_3$O$_4$ shell structure with high surface area. Subsequent characterisation included SEM analysis to infer the morphology of the material, and XPS spectroscopy to determine the surface characterisation, as well as to qualitatively highlight the core electron spectra of Ni$^{2+}$ and Co$^{2+/3+}$. Since the core and shell both consist of p-type semiconductors, these were tested as photo-cathodes for photoelectrocatalytic water splitting, and suitable inferences were drawn to shed light on the synergy exhibited by the material.

Keywords: - Core shell nanoparticles; photoelectrocatalysis; water splitting; co-precipitation.
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Review on Nano Enhanced Phase Change Materials for Storage Applications

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Abstract

Thermal energy storage systems have received growing attention in recent years for various applications, such as thermal management, energy efficient operation and maintaining uniform supply of energy. The researchers worldwide are investigating the methods to utilize phase change materials (PCMs) based latent heat storage systems for various applications. PCMs offer promising thermal storage characteristics where they can absorb and release large amounts of latent heat and undergo phase transition. The major limiting factor of most PCMs is their poor thermal conductivity. One of the most common methods to increase the thermal conductivity is by adding nanoparticles to the PCM matrix and are referred to as nano-enhanced phase change materials (NEPCMs). This study provides a comprehensive review on the application of these nano-enhanced PCMs. It discusses the use of NEPCM for building application, heat exchanger, heat sink, heat pipe, solar water system, solar still, air conditioning, etc. The review of NEPCMs for various temperature ranges forms the part of this study. The main advantage of these NEPCMs is the reduced cooling load in buildings, passive cooling, heat recovery as well as improving the efficiency of solar thermal systems.

Keywords: Latent heat storage; nano enhanced phase change materials; thermal conductivity; thermal characterization.

A review on stability of nano-enhanced Phase Change Materials
Abstract

Phase Change Material (PCM) utilization for various applications is limited due to their low thermal conductivity. Thus, research has been carried out to enhance the thermal conductivity of these materials. The addition of high thermal conductivity nanoparticles is one such solution. Studies suggest that thermal conductivity of Nano-enhanced PCMs (NEPCMs) can be increased even multiple times of the base PCM, thereby increasing the dispatch ability of these NEPCMs. The increase in nanoparticle concentration results in their separation, which is a major concern and often not discussed in details. Another issue is the cyclic stability of these NEPCMs. This addition also affects other thermophysical properties such as the storage capacity of the PCMs. To overcome this, we add certain additives that stabilize the nanoparticles within the PCM, enhancing their thermal conductivity and stability. These materials (surfactants) decrease the surface tension through creation of ionic environment and improve the dispersion of nanoparticles effectively. The stability of nanoparticles in PCMs is studied using thermal cycling analyses. The present study provides a comprehensive review on studies carried out to improve the stability of nanoparticles in the PCMs using surfactants and their impact on thermal conductivity and stability characteristics.

Keywords: Phase Change Materials (PCMs); Thermal Energy Storage; Thermophysical properties; Surfactants.

Synthesis of nitrogen doped TiO2 nanosheet photocatalyst
**Abstract**

TiO$_2$ nanosheets have recently gained interest due to their enhanced photocatalytic activity owing to their defect-free surfaces and high specific surface area. Three modifications of TiO$_2$ nanosheets with silver, copper and with Graphene oxide for performance enhancement have been reported. The modification with metal will result in loss of photoactivity due to ion leaching and the composite with Graphene oxide results in large particle size of the resulting composite photocatalyst. Nitrogen doping has successfully been reported in nanoparticles and is advantageous as it doesn’t involve ion leaching and size increase issues. In the present work, TiO$_2$ nanosheets were synthesized using the hydrothermal method. The obtained TiO$_2$ nanosheets were treated with a nitrogen precursor ammonia and heat-treated to facilitate nitrogen doping. The prepared nanosheets were characterized using X-ray diffraction and Field emission scanning electron microscopy. The photocatalytic activity was accessed using dyedegradation studies. The N-doped nanosheets synthesized using ammonia showed enhanced photocatalytic activity.

**Keywords:** TiO$_2$ nanosheets; Nitrogen doping; photocatalyst

**TiO2 nanosheet/cellulose acetate nanocomposite floating photocatalyst for solar degradation of pollutants**
Abstract

Floating photocatalyst are viable options for degradation of pollutants using solar radiation. The presence of photocatalyst floating on top of water body can enable better exposure to Sunlight and also better air contact for photodegradation. Direct use of powder photocatalyst in water bodies is impracticable. In the present work TiO2 nanosheets were immobilized in cellulose acetate matrix and provided supports using Ethylene Vinyl Acetate to develop a floating photocatalyst. The performance of the floating photocatalyst for degrading pollutants under solar radiation was evaluated using Congo red dye as a model pollutant. The TiO2 nanosheet based floating photocatalyst showed good performance in degradation Congo red dye. X-ray diffraction and Field emission scanning electron microscopy were used to characterize the photocatalyst.

Keywords- TiO2 nanosheets; Cellulose acetate; nanocomposite; floating photocatalyst

Synthesis of Cu/Co3O4 nanomaterials and its application for CO oxidation
Abstract

In this study, Cu substituted cobalt oxide (Co$_3$O$_4$) nanoparticles were synthesized using sonochemical method. Cobalt oxide nanoparticles were chosen as catalysts due to its excellent absorption properties towards gases such as CH$_4$ and CO, and also because of its abundant lattice oxygen. Cobalt’s half-filled d-orbitals also contribute to good catalytic activity. Further, Cu was doped in the lattice of cobalt oxide and Cu was chosen due to its low work function and high chemisorption ability. The synthesized Cu/Co$_3$O$_4$ via sonochemical protocol offered narrow particle size distribution indicating the homogenous particle size. All these factors led to the hypothesis that Cu/Co$_3$O$_4$ would be an excellent catalyst for reactions such as CO oxidation. Cu/Co$_3$O$_4$ nanoparticles were characterized with XRF, XPS, SEM analysis, TGA and tested its activity for CO oxidation reaction using a packed bed reactor with GHSV of 47760 h$^{-1}$. Cu/Co$_3$O$_4$ offered excellent catalytic activity for CO oxidation and showed 100% conversion of CO below 275°C. This study shows that Cu/Co$_3$O$_4$ can be a promising catalyst to mitigate harmful CO emissions.

Keywords: Cu/Co$_3$O$_4$; Sonochemical Synthesis; CO Oxidation.
Abstract

With the rapid outbreak of the COVID-19 pandemic, there is an urgent requirement of technology which can aid humans to prevent getting in contact with the virus pathogen. For this, the personal protective clothing (PPC) has to be engineered in a way that the virus pathogen neither enters the human system nor gets transmitted to the environment on disposal. Silver, copper, and zinc nanoparticles demonstrate significant antimicrobial and antiviral activity with a wide therapeutic index. Moreover, recently it has been discovered that the zeolite formulations could be combined with various materials used in manufacturing medical devices, surfaces, textiles, or household items where antimicrobial properties are required. The synthetic zeolites facilitate the ion exchange mechanism to exhibit antiviral and antimicrobial properties. With recent developments in electrospinning, both synthetic and natural polymers, impregnated with nanoparticles, can be produced as nanofibers with diameters ranging from tens to hundreds of nanometers with controlled morphology and function. In this work, we discuss the feasibility of the existing technology to be scaled-up and commercialized for public use which can lead to increased preparedness for averting future pandemics.

Keywords: Anti-viral mask, COVID-19; PPEs; electrospun nanofiber.
A Review on synthesis of TiO2 nanoparticles

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Abstract

TiO2 nanoparticles widely studied for its photocatalytic and oxidative applications. Nanoparticles are particles between 1 to 100 nm scales. Nanoparticles possess a unique physical, chemical and biological properties at nanoscale than bulk materials. Titanium dioxide can be prepared in different forms such as powders, crystals, thin films. Titanium dioxide (TiO2) nanoparticles are one kind of important and promising photocatalysts because of their oxidizing power. TiO2 belongs to the family of transition metals. There are three polymorphs of TiO2 found in nature, anatase, rutile, brookite. The size and geometry of semiconductor materials depend on the motion of electrons and holes. Titanium dioxide has been widely used in photovoltaic environmental applications such as renewable energy sources, CO2 conversion, water treatment, air pollution control and many applications in a vast range of industrial and consumer goods including paints, coatings, adhesives, paper and paperboard, plastics and rubber, printing inks, water treatment agents.

The anatase phase has a band gap of 3.2 eV and is able to absorb light only of wavelengths shorter than 388 nm. There are many methods of the synthesis of TiO2 nanoparticles, sol–gel technique, solvothermal, hydrothermal, electrochemical process, precipitation method etc. The sol-gel method is a versatile process used for synthesizing various oxidematerials. In this review paper, different preparation methods that can be used to synthesize TiO2 nanoparticles and the photocatalytic environmental applications are proposed very well.

Keywords- Titanium dioxide nanoparticles, band gap, photocatalyst.
Applications and properties of graphene and its composites

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Abstract

Graphene is the thinnest material known to mankind of about one atom thick (around 0.34 nm), and is also incredibly strong – about 200 times stronger than steel. Graphene consists of a sheet of single carbon atoms arranged in a honeycomb structure. Graphene and its composites can be synthesized through various methods such as exfoliation, chemical vapor decomposition, nano tube slicing, carbon dioxide reduction, spin coating, supersonic spray, microwave assisted oxidation, ion implantation. However, it is found that the production of graphene for commercial application is still under research for improvement of its quality, size and amount. Alongside being incredibly strong, graphene also conducts heat and electricity remarkably well, resists rust and has excellent optical and mechanical properties. Graphene is an extremely diverse material, and can be alloyed with other elements to produce materials with superior properties. The extraordinary properties of graphene show some promising applications such as optical electronic, photovoltaic systems, bio fields, hydrogen storage, sensors, catalysis, super capacitors, DNA sequencing, water filters, solar cells and others. In this paper, we have concentrated on some applications and properties of graphene and its composites. Applications of graphene as bullet proof vests, membrane for fuel, hydrogen ion filters.

Keywords: Graphene; nano tube slicing; applications; properties
Green & Sustainable Energy (GSE)
Investigation of Nanoparticles-polysaccharides based porous membrane for Hydrogen separation

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Abstract

A growing interest in the hydrogen-based economy as an energy carrier has placed a high demand for hydrogen separation and purification techniques. The palladium material has a high affinity to adsorb hydrogen. Therefore it is a relevant material used in the membrane for improving selectivity and permeability of hydrogen gas. In this work, MWCNTs and polysaccharide-based guar gum material has been using to the developed membrane and Pd-nanoparticles dispersed in the polymeric matrix. For increasing the performance of the membrane, functionalized MWCNTs with Pd nanoparticles were dispersed in it. The MWCNTs with Pd nanoparticles found high selective towards the hydrogen gas as compare to other gases due to the adsorption of hydrogen molecules in Pd nanoparticles. These composite membranes were characterized by Fourier transform infrared spectroscopy (FTIR), Scanning Electron Microscope (SEM) for confirming the distribution and functionalization of MWCNTs in guar gum membrane.

Keywords: Hydrogen separation; Guar gum membrane; Pd-nanoparticles
Microbial fuel cells (MFC) represents a very promising technology for generating electrical energy from organic and inorganic matter in wastewater using microorganisms as biocatalysts. MFCs provide a suitable, eco-friendly alternative to produce energy and to treat wastewater simultaneously. Various types of wastewater can be used as feedstock for the microbial fuel cells in which the exoelectrogenic bacteria produce electrons under anaerobic conditions. Compared with conventional aeration technologies for wastewater treatment, MFCs produce less sludge with net energy production. Now a days electricity play a major role in daily life. It is one of the method of electricity production.
Hydrogen Storage using Carbon based Nanomaterials

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Abstract

With an increase in the global population, the depletion of fossil fuels is much anticipated. This will eventually lead to global energy crisis. Hydrogen is seen as a potential candidate to meet the future demands of the energy carrier. But, the only difficulty arises is in its storage. Hydrogen has the highest gravimetric density and lightest volumetric density among all gases. This makes it difficult to store hydrogen at ambient conditions. Hence, storage has become a major topic of discussion since the past few years. Hydrogen can be stored either by adsorption (carbon material) or by absorption (complex metal hydrides). When compared, the adsorption principle displayed high storage capacities at favorable operating conditions. Following the same, the present article discusses the different allotropes of carbon i.e. graphite, C-nanofibers and C-Nanotubes for their hydrogen storage capacities. These materials have been critically discussed on the basis of kinetic, thermodynamic, and operating conditions. Also, the methods to improve the storage capacity of carbon-based materials have been intensively reviewed.

Keywords: Hydrogen storage, Carbon Nanotubes, Physisorption, Adsorption, Absorption
Microalgal Biofuel: A Potent Green Energy Source

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Abstract

The alarming depletion of fossil fuels and the pollution caused by their usage has led to the discovery of alternative sources—biofuels being one of them. Biofuels can be obtained from different sources by using different processes. Microalgae has emerged as a sustainable feedstock, upon which various researches are being done. The production of biofuels from microalgae involves a vital enhancement of accumulated lipids in microalgal cells. TAGs is the primary form of energy storage in microalgal cells, comprising of 60-70% of dry cell weight. Each TAG molecule consists of a glycerol backbone to which three fatty acids moieties are connected which can be enhanced to increase the lipid content incells, leading to increased production of oil/fuel.

Biofuel is not only a cleaner, greener and safer alternative, but also it will curb the energy crisis. Using microalgae as the primary feedstock, replacing the food crops that are being used will help reduce the food and water shortage as well as get the saline water and barrenlands in use. Unlike fossil fuels, it only emits CO₂ rather than emitting gases like CO, SO₂, etc. Thus, production of biofuels from microalgae will lead to a better environment in the future.

Keywords: Triacylglycerol-TAG ; Feedstock-fd. ; Alternative- alt.
Syngas Fermentation: Current Studies and Future Outlook

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Abstract

The increase in population and energy demand has led to unsustainable utilisation of fossil fuels. With depleting fossil fuel resources and increasing concern about climate change, the demand for cleaner fuels is rising. Many countries are making policy interventions to promote cleaner fuels like bioethanol and biodiesel. First-generation biofuels are already commercially available, but these are being criticised due to “food vs energy” debates. Second-generation biofuels are thus getting much more attention by researchers. Syngas fermentation is the conversion of syngas to bioethanol and other products like acetic acid, 2,3-butanediol etc. using biocatalysts. It is the second step in the production of biofuel after biomass gasification. Biomass gasification integrated with syngas fermentation can be a sustainable source for biofuel production. Although many studies are being conducted on the syngas fermentation, the process is still far from commercialisation due to low yield and mass transfer limitations. In this study, the various benefits, limitations of syngas fermentation and recent developments for improving the process have been reviewed. The paper discusses the process from a bioethanol production point of view. The review also discusses the opportunities for commercialisation of the process from an Indian outlook. The study also provides some recommendations for future studies.

Keywords: Syngas fermentation; Second-generation biofuels; Bioethanol
Abstract

Energy and Water are indispensable elements of our lives. Harnessing energy in an efficient and environmentally sustainable manner is almost as troublesome as purifying contaminated water to its completely potable form. Solar Photocatalysis, a relatively nascent field of research, shows great potential in addressing these inherent problems. An analysis of this novel process and the technologies employed therein forms the basis of this review paper. The fundament of Solar Photocatalysis rests upon the simultaneous oxidation-reduction reactions occurring due to the photon-induced electron-hole pairs formed in a semi-conducting nanocatalyst. The catalyst in use needs to have a characteristic energy profile that complements the process for the given reactant. TiO$_2$, one such semiconducting oxide, has been extensively researched for the heterogeneous splitting of water due to its suitably positioned energy bands with respect to the oxidation and reduction potentials of water. Major advancements in the development of catalysts, critical engineering strategies to overcome various shortcomings and vigorous comparative performance assessment of the prominent catalysts (CdS, ZnO, ZnS, Fe$_2$O$_3$) form the crux of this review paper. It also intends to emphasise on the extent of untapped potential associated with this groundbreaking process.

**Keywords:** Integrated Energy Generation; Wastewater Treatment; Solar Photocatalysis; Semiconducting nano-catalyst
Organic Photovoltaics - An Enhancement in Green Technology

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Abstract

Dye-Sensitized Solar Cells (DSSCs) represent a relatively new photovoltaic technology (PVT) with great potential and is a low-cost solar cell belonging to the group of organic photovoltaics. It also offers the possibility of various colours and attractive designs, such as semi-transparent modules. Dye-sensitized solar cells have been investigated intensely during the last three decades. It works using electrochemical principles in which sensitive dyes are absorbed in the TiO2 photo-electrode layer. Organic Photovoltaics (OPV) is a rapidly emerging PVT. We have developed and applied new high-performance absorber materials with improved performance and lifetime, focusing on the growth of photovoltage and provide stability to photo-oxidation. The building-integrated PVT market may find OPV especially attractive because of the availability of absorbers in different colors and their ability to make efficient transparent devices.

Keywords: Dye-Sensitized Solar Cell; Photovoltaic Technology; Organic Photovoltaics; Photo voltage.
Integrated System of Biodiesel and Power Cogeneration Using a Solar Thermal Energy System

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Abstract

Biodiesel plays an important role to diminish the consumption of fossil fuels and their subsequent pollution in the transportation sector and can be used in diesel engines without significant changes. But biodiesel needs energy to be produced. A renewable energy source such as solar energy is a promising source for this aim, reducing the carbon dioxide production and cost. Biodiesel production processes can be coupled with solar energy sources to achieve higher efficiency and renewability. Employing a subsystem to produce power simultaneously increases the process performance. An integrated process including Parabolic Trough Solar Collector (PTSC), Biodiesel Production Unit (BPU) and Organic Rankine Cycle (ORC) is proposed for this purpose. Methanol, fresh oil and sodium hydroxide enter the BPU as a feed.

Biodiesel is produced in BPU by transesterification reaction in which plant and animal feed stock is converted to a mixture of monoalkyl esters of long chain fatty acids. PTSCs are employed to supply required thermal energy for BPU and ORC subsystems. The ORC provides the needed power of the system. Not only does the ORC provide the internal required power of the plant but also the integration of ORC with BPU and PTSC subsystems form a biodiesel-power cogeneration process.

KEYWORDS: biodiesel; cogeneration; organic rankine cycle; parabolic trough solar collector; transesterification
Organic photovoltaics - an enhancement in green Technology

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Abstract

Dye-Sensitized Solar Cells (DSSCs) represent a relatively new photovoltaic technology (PVT) with great potential and is a low-cost solar cell belonging to the group of organic photovoltaics. It also offers the possibility of various colours and attractive designs, such as semi-transparent modules. Dye-sensitized solar cells have been investigated intensely during the last three decades. It works using electrochemical principles in which sensitive dyes are absorbed in the TiO2 photo-electrode layer. Organic Photovoltaics (OPV) is a rapidly emerging PVT. We have developed and applied new high-performance absorber materials with improved performance and lifetime, focusing on the growth of photovoltage and provide stability to photo-oxidation. The building-integrated PVT market may find OPV especially attractive because of the availability of absorbers in different colors and their ability to make efficient transparent devices.

Keywords: Dye-Sensitized Solar Cell; Photovoltaic Technology; Organic Photovoltaics; Photo voltage.
Study of Upgrading Biogas by Biological Hydrogen Methanation

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Abstract

Biogas production is an established sustainable process for simultaneous generation of renewable energy and treatment of organic wastes. The increasing interest of utilizing biogas as substitute to natural gas or its exploitation as vehicles fuel opened new avenues in the development of biogas upgrading techniques. This study on biological biogas upgrading by utilizing hydrogen to obtain biomethane, the aim of all upgrading biogas technologies is to achieve high methane purity and low methanol losses with low energy consumption. Based on a review of the literature on the technologies for biogas upgrading and enhancement with attention to the emerging biological methanation processes, the review includes comprehensive description of the main principles of various biogas upgrading methodologies, scientific and technical outcomes related to their bio-methanation efficiency, challenges that have to be addressed for further development and incentives and feasibility of the upgrading concepts.

The experiment demonstrated that biological methanation in continuous stirred tank reactor is well feasible for biogas upgrading under the prerequisite that an adequate H\textsubscript{2} source is available, and observed that (the production of bio-methane was 90% of the produced gases, reduction of greenhouse gases and reduction 10% of ammonia losses as well as 50% nitrogen oxide emission).

Key Words: Green Energy; Renewable Energy; Upgrading Biogas; Anaerobic Digestion; Hydrogen Solubility.
Recent Developments in All Solid State Lithium Ion Batteries: A Review

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Abstract

Battery development is imperative to shift the focus of energy consumption towards renewable energy sources and promote green technology. Today, lithium ion batteries (LIBs) are considered as a promising candidate for its application in electrochemical storage devices mainly because of the high energy density offered, due to the lowest redox potential of lithium metal. However, they suffer from several drawbacks and safety issues because of the flammable behaviour of liquid electrolytes. Thus, researchers around the globe are paving their research focus towards solid state battery technology due to its better safety, high energy density and better mechanical and thermal stability. This review exhaustively studies and compares development and challenges faced by three main solid lithium electrolytes which are sulfides, oxides and polymers. The review also brings out the major issues such as interfacial as well as the mechanical and electrochemical stabilities associated with these solid electrolytes, along with the projected strategies. Unique characteristics of solid state batteries and their capacity to occupy a niche in the alternative energy sector are discussed.

Keywords: Solid State Batteries; energy density; lithium ion conductivity; sulfides; oxides; polymers.
Perovskite Solar Cell for Energy Harvesting: A Review

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Abstract

Keywords: Organometallic Halides ; Thin Film PV Cell ; Ecological Footprint

Perovskite solar cell is based on ABX3 type organometallic halides (also known asperovskite) is one of the most promising photovoltaic thin-film solar cell technologies. Thedesign of the perovskite solar cell is inspired by the 3rd generation DSSC - Dye SensitisedSolar Cell. DSSC is a thin-film type solar cell that converts the visible light into a photocurrent using methylammonium lead halide (naturally occurring dye in barriers) absorbed on nanocrystalline TiO2 surface. Even the easy construction of DSSC using recycled e-waste did not get much attention because of its too low chemical stability when exposed to harsh environments. But (naturally occurring or engineered in a lab) Perovskitesolar cells in comparison to conventional silicon cells have higher potential to give better efficiencies in different working conditions. Perovskite has low bandgap, hence requires 20 times less materials to manufacture thin film, reducing 50% of manufacturing cost in comparison to silicon cell. Though perovskite solar cells can drastically reduce ecological footprints of the manufacturing of PV cells, it also includes the use of toxic heavy metal lead as central atom of ABX3 structure. In this review, the optoelectronic properties, ramifications on the environment, recent progress, and future challenges for perovskite solar cells are discussed.
Epoxidation of karanja oil (KO): a nondrying vegetable oil, was carried out with peroxyacetic acid that was generated in situ from aqueous hydrogen peroxide and glacial acetic acid. KO contained 61.65% oleic acid and 18.52% linoleic acid, respectively, and had an iodine value of 89 g/100 g. Unsaturated bonds in the oil were converted to oxirane by epoxidation. Almost complete epoxidation of ethylenic unsaturation was achieved. The effects of temperature, hydrogen peroxide-to-ethylenic unsaturation ratio, acetic acid-to-ethylenic unsaturation ratio, and stirring speed on the epoxidation rate and on oxirane ring stability were studied. The rate constant and activation energy for epoxidation of KO were $10^{-6}$ L·mol$^{-1}$·s$^{-1}$ and 14.9 kcal·mol$^{-1}$, respectively. Enthalpy, entropy, and free energy of activation were 14.2 kcal·mol$^{-1}$, $-51.2$ cal·mol$^{-1}$·K$^{-1}$, and 31.1 kcal·mol$^{-1}$, respectively. The present study revealed that epoxides can be developed from locally available natural renewable resources such as KO.

**Keywords**: Karanja Oil, Epoxidation
Optimization of biodiesel production from Cucurbita pepo L.

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Abstract

In the last decade, the demand for fatty acid methyl esters as a substitute to petroleum diesel has considerably risen. The raw materials for biodiesel production in India mainly include non-edible traditional seed oils. Our study focuses on the evaluation of pumpkin seed oil as a feedstock for biodiesel production. The oil content of pumpkin seeds was found to be considerably high of around 45%. The fatty acid profile of the oil showed that it is composed majorly of linoleic, oleic, palmitic and stearic acids. The oil was chemically converted via an alkaline transesterification reaction with methanol to methyl esters, with a remarkable yield. All of the measured properties of the produced biodiesel met the current quality requirements. Although our study proved that pumpkin oil could be a promising feedstock for biodiesel production, scale-up methods are still require further evaluation. Parametric optimization was performed to maximize the yield. They can therefore be commercialized for large-scale utilization as biodiesel fuels or as blends with existing feedstocks which would be more environmentally friendly.

Keywords: fatty acid, transesterification, fuels, feedstock.
Abstract

Green hydrocarbon production from second generation biomass is a powerful fuel to increase the sustainable energy in the future. The ultimate aim is to redesign second generation biomass into stable and dense bio crude based on the derivative of sugar ketal, since the properties of biomass are not suitable for refinery condition. Biomass was first converted into a dense and stable bio crude composed mainly of ketal-sugar derivatives by using acetone in diluted acid. The conversion of a representative compound of this biocrude, 1,2:3,5-di-O-isopropylidene-α-D xylofuranose (DX), by two processes; usually carried out in oil refinery. Mixtures of DX of up to 70 wt% in n-hexane were converted by fluidized catalytic cracking (FCC) and 14.3 wt% of DX in n-hexane was converted by the hydroconversion process (HDC). HDC yielded mainly saturated and naphthenic hydrocarbons containing more than seven carbons, whereas FCC produced mainly mono-aromatics. The efficiency of DX for the production of green hydrocarbon by FCC and HDC process are 66% and 85% (approx) respectively. These green hydrocarbons could be used as gasoline, diesel and jet fuel. Therefore, this ketalization approach builds a bridge that has not existed until now between the refinery and the biomass.

Keywords: Green hydrocarbon; Fluidized catalytic cracking; hydroconversion process.

Biofuel synthesis through Microalgae- Opportunities and Challenges
Abstract

Rising dependence on natural fuel resources is an increasing concern for the global environment and society. Biofuel is an alternative source of energy which assures environmental concerns and energy security. Following the same, microalgae can deliver a sustainable and complementary biofuel platform with some important advantages. They are featured with distinct ability to provide ecological services and response to the sustainability challenges. The present study revolves around the identification of microalgae as a potential candidate for an alternative source of energy. The optimal use of light energy through photosynthesis is the most efficient pathway executed by microalgae. They possess higher photosynthetic levels and can produce oil more efficiently (i.e. >300 times) than other existing resources such as terrestrial plants. The added advantage of microalgae includes the use of non-cultivable soil and wastewater for its operations which renders the process more efficiently from the economic perspective. Hence, the usage of microalgae for biofuel production doesn’t affect the agricultural land and drinking water balance in the environment. This review critically discusses the use of algal biomass conversion methods into various biofuel products i.e. biodiesel, syngas, biogas, and bioethanol. Moreover, the techno-economic and commercial viability of microalgae-led bio-refinery is intensively reviewed to drive this technology towards practicality.

Keywords: Biofuel; Microalgae; Sustainability; Energy; Wastewater; Biomass.
The Recent Advances in Carbon Based Aerogel Materials for Hydrogen Storage

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Abstract

Safe and efficient Hydrogen storage is considered to be one of the main challenges associated with using it as fuel. Porous Carbon materials can be used as Hydrogen sorbents. The hierarchical 3D morphology of Carbon aerogels and the fact that its structural parameters can be systematically controlled, make Carbon aerogels attractive materials for Hydrogen storage. They can be used for Hydrogen storage by direct adsorption or they can be used as scaffolds for the incorporation of metal hydrides. Conventional aerogels, such as R-F aerogel, have a Hydrogen binding energy of the order of 3-6 kJ / mol and can only store Hydrogen at cryogenic temperatures. However, thermodynamic studies indicate that the binding energy should be 10-25 kJ / mol for ambient temperature, pressure operation. Numerous approaches have thus been employed to improve the thermodynamics of Hydrogen binding in porous Carbons. For example, the incorporation of metal species into the aerogel frameworks has drawn much attention for the purpose of structure modification and improvements in catalytic activity due to the Hydrogen spillover effect, the use of scaffolds of light metal hydrides have improved the reaction kinetics significantly. This review summarizes such latest developments in the carbon-based aerogels for Hydrogen storage and the associated future challenges.

Keywords: Carbon aerogels; Hydrogen storage; Hydrogen binding energy; Advanced materials.
Cellulose-based hydrogel materials: Chemistry, Preparation, and their Properties

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Abstract

Recently, efforts have been made to produce organic chemicals by using biomass as feedstock. The current work deals with the development of a biodegradable superabsorbent hydrogel by using waste biomass as feedstock. Hydrogels are macromolecular networks that can hold and reversibly release large amounts of water. The cellulose-based hydrogel was prepared by using wheat straw and peanut shells. These lignocellulosic agricultural by-products are a cheap source for cellulose fibers. Isolation of cellulose was confirmed by Fourier-transform infrared spectroscopy (FTIR) analysis. Super absorbent hydrogel has been synthesized through copolymerization of acrylic acid and cellulose. N,N-methylenebisacrylamide (MBA) was used as a cross-linker and ammonium persulfate (APS) was used as an initiator. Dynamic swelling tests were conducted at different temperatures to investigate the swelling properties of the cellulose hydrogel. Increasing salinity decreased swelling, indicating that sorption capability was affected by the salinity present in the water. The sorption capability at different concentrations of cellulose was evaluated. The soil amendment with hydrogel enhances water holding capacity, reducing infiltration rate and cumulative evaporation compared to the untreated soils. These results show that cellulose-based hydrogel seems to be of great promise in the field of agriculture.

Keywords: Cellulose, hydrogel, water content capacity, water retention
Abstract

Fusion powers the sun and the stars, where gravity compresses hydrogen gas to the temperatures required for fusion. The challenge for fusion energy is how to create those conditions on Earth in a controlled way that can be used to provide power. The most practical fusion reaction uses isotopes of hydrogen named “deuterium” and “tritium”. These can be extracted from seawater and derived from lithium, both in abundant supply. There is enough fusion fuel on earth to power the planet for hundreds of millions of years. The challenge that scientists face is to achieve the required temperature to ignite the fusion reaction. To keep the plasma together at this temperature long enough to get useful amounts of energy out of the thermonuclear fusion reactions. To obtain more energy from the thermonuclear reactions than the amount of energy used to for the ignition temperature of the plasma.
Sodium Borohydride Activated Hydrogen Generation through Water Splitting Reaction

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Abstract

The energy requirement is fulfill by fossil fuel, Energy based on the fossil fuel are notsustainable for future generation. Considering current scenario necessity to find alternateenergy source. Hydrogen gas as energy source has the capability to replace fossil fuel. Ournstudy focus on the generation of hydrogen gas through water splitting reaction with NaBH4 .In our process water NaBH 4 ,NaOH,catalyst are reactant. The reaction is carried out at ambienttemperature condition. To increase rate of hydrogen gas catalyst is introduced, the catalystCo/Al 2 O 3 is prepared by CO(II) Schiff base Complex which shows higher catalyticperformances. The reusability of catalyst in the process is up to 8 times. The objective of ourstudy to provide economical on-site hydrogen gas with desired rate. We will be also deal withoperating parameter of our reaction which make reaction more feasible.

Keywords: Cobalt complex Catalyst, Hydrogen generation, Sodium borohydride.
Studies in Hydrogen Generation using Waste Aluminum and Water

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Abstract

The dependency on conventional sources of energy and its rapid depletion in upcoming times intensified the search for non-conventional, perpetual and economical sources of energy. Hydrogen is one such promising alternative source of energy. Our study focuses on the generation of hydrogen by water splitting reaction using waste aluminium. The water splitting reaction accompanied by the metal aluminium for producing hydrogen gas is one of the ideal methods of in-situ hydrogen generation. The process involves materials such as water, aluminium, sodium hydroxide, gallium as a reactant and the obtained product is pure hydrogen gas. The gallium used in the reaction is used for the activation of aluminium metal and is recovered back and can be used again. This process of hydrogen generation has various advantages like mild conditions required for the reaction, controlled and pure hydrogen generation, and useful by-products. The objective of our study is to achieve on-demand, in-situ, local, continuous, economical production of hydrogen. The experimental setup proposed in our study effectively addresses the aim of our study. We will be also be studying various operating parameters of our reaction in this study to make the reaction more efficient.

Keywords: Hydrogen Generation; Water Splitting Reaction; Continuous Process
Sustainable energy generation using Rice Straw

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Abstract

India produces over 100 million tons of agricultural waste in the form of paddy straw annually. The process of cleaning of land for future use involves a lot of manual work. More than 80% of it is burnt away due to lack of sufficient resources. The resulting smoke creates a cloud of hazardous gases. This degrades the air quality to such an extent that can cause several health issues. To overcome this problem, the government and some industries are working to create a technology that converts paddy straw into usable products. Paddy straw simply undergoes anaerobic digestion for the production of methane that is used as a feed for the generator to produce electricity. The process of anaerobic digestion produces biogas that can be used directly as feed for generator or as a fuel in combined heat and power gas engines. The nutrient-rich digestate can be used as a fertilizer. There can be some reduction in greenhouse gases too. The concept of this technology is to generate power from paddy straw and to also create additional revenues for farmers.

Keywords: paddy straw, agricultural waste management, energy generation, biofuel
Abstract

Green Energy is energy resources that are renewable, can be naturally replenished. Green Energy is Clean, Safe and not harmful to the environment. It is also called as mother earth. Types of Green Energy are Biomass, Solar, Geothermal, Water and Wind. Green energy technologies turn these fuels into usable forms of energy like electricity, heat, chemical or mechanical power. Biomass is biological material derived from living organisms. Biomass is highly diverse in nature and classified on the basis of site of origin as follows Field and plantation biomass, Industrial biomass. Solar Energy is produced by using photovoltaic cells, which capture sunlight and turns that into energy. Giant pinwheels spin from strong winds which spins a turbine of generator to produce Wind Energy. Large space areas required for Winding areas. The advantages of Green Energy is Negative impact to the environment is zero, make Pollution Free Environment, Green energy solutions and more efficient. So the Conclusion on Green Energy is that to make sure we have plenty of energy in the future, it’s up to all of us to use energy wisely. The future is ours, but we need energy to get there. The Major Renewable Energy Sources Solar Energy and Wind Energy. Any sustainable source that comes from natural environment is Renewable Energy. Sustainable Energy is the sustainable provision of energy that meets the needs of present. Technologies that promote sustainable energy include renewable energy sources such as solar energy and wind energy. Energy which is replenishable within a human lifetime and causes no long-term damage to the environment. The importance of Sustainable energy are Environmental, Energy for future generations and Energy security. “THE FUTURE IS GREEN ENERGY, SUSTAINABILITY, RENEWABLE ENERGY.”

Keywords: Green Energy; Renewable energy; Sustainable Energy
Novel Techniques for Conversion of carbon dioxide to methanol: A Review

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Abstract

Global warming is adversely affecting human health, the environment, as well as social and economic factors, and as we all know CO2 also plays a major role in global warming. So, if CO2 is evolved to value-added chemicals like methanol, ethanol, or formic acid, can lessen energy crisis, global warming, and storage issues. Coupling the reduction of CO2 with renewable energy and converting it into methanol can be a promising solution. This CO2 should not be considered as an unwanted product, but as an asset that, with human ingenuity, could be used sustainably. Methanol is a renewable energy source and has advantageousness like can be made from any raw material, a clean source of energy, sustainable, used by most production companies as a raw material to produce different products, major organic feedstock, used in producing solvents like acetic acid which represents 10% of global demand and direct methanol fuel cells (DMFC) for the conversion of chemical energy in methanol directly to electrical power under ambient conditions. Methanol is produced conventionally from natural gas using steam reforming which requires a high-pressure loop and the other is from syngas by coal gasification which also requires high pressure and range of temperatures. The major drawback of the above techniques is the utilization of a huge amount of natural resources i.e., fossil fuel, and the production of large amounts of CO2. Varying novel technologies like heterogeneous catalysis, homogeneous catalysis, the electrochemical, photochemical, and photoelectrochemical conversions have captured the attention in converting CO2 to value-added products like methanol that has the potential that it can contribute to economic growth as well as to attenuate hazardous emissions for a better environment. This review focuses on the current trend for the application of such novel techniques to minimize the amount of CO2 by converting it into methanol over the conventional method. Also, a detailed comparison between these techniques is portrayed on the basis of environment friendly, cost, efficiency, industrial-scale feasibility, approach, and recycling.

Keywords: heterogeneous catalysis; homogeneous catalysis; electrochemical conversion; photochemical conversion; photoelectrochemical conversion.
Estimation of Bio-butanol production from plantain pseudostem fibers of Musaceae paradisiaca as a substrate using a metabolically altered strain of Saccharomyces sp

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Abstract

Production of higher alcohols utilizing microbial activity has been a topic of wide interest since higher alcohols address the shortcomings of bio-ethanol and present scope for application as an alternative biofuel. Our work is focused on the production of Bio-butanol from pretreated plantain pseudostem fibers (PSF) using an engineered strain of Saccharomyces cerevisiae which is subjected to metabolic alterations. The PSF samples are tested for various alkali pretreatment conditions and their delignification and cellulose recovery showed that the optimum alkali concentration is 15-20% (w/v) at 50°C. Enzymatic saccharification is carried out by cellulase supplemented with β-glucosidase and the glucose yield of pretreated PSF(al) was found to be 2.4 times untreated PSF(ut) sample. Sugar fermentation of hydrolysate sample PSF-EH is carried out for 5 days using metabolically engineered Saccharomyces sp for butanol production. Following the metabolite measurement, gives the maximum ethanol and butanol production of 4.72 g/L and 11.07 g/L respectively at 72hr. A comparison of SEM images showed PSF(al) has more pores than PSF(ut) and also hydrolysis residue PSF-EH(rd) showed greater pores due to the complete rupture of the cell-wall.

Keywords: pseudostem fibers; bio-butanol; delignification; enzyme saccharification.
Pyrolysis of Agricultural Biomass

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Abstract

Pyrolysis is a thermochemical technique that converts biomass into solid (biochar), liquid (bio-oil) and gaseous fractions at moderate temperatures, either in the absence of air or in stoichiometric quantities of oxygen. Pyrolysis could be a suitable method for the enhancement of this agricultural biomass, cashew nutshells (CNS). India is the largest producer, processor and exporter of cashews, Anacardium occidentale. Cashew nut shells are a residue obtained from cashew shelling. The Cashew nut has a shell of about 1/8-inch thickness, with a soft honeycomb structure inside, containing a dark brown viscous liquid. It is called Cashew Nut Shell Liquid (CNSL). The CNSL is reported to be 15 –20% by weight of the unshelled nut in Africa, 25 –30% by weight in India and 25% overall. CNSL forms the basic raw materials for vast number of chemicals and intermediates including bactericides, germicides, insecticides, disinfectants, emulsifying and surface-active agents. Cashew nutshell (CNS)–based biochar is obtained as a by-product which can be used as activated charcoal. In this study we have seen Biooil (40wt%), Biochar (30wt%), gas products (30wt%) in the temperature range of 400-600°C. The residue generation is negligible.

Keywords: Pyrolysis; biochar; bio-oil; agricultural biomass; Anacardium occidentale;
Abstract

Water electrolysis has the advantage to produce hydrogen at an improved efficiency under external fields. Among overall world technologies for hydrogen production today, only 5% is produced by electrolysis. The reason for such low contribution is due to the efficiency of the process. Electrolysis of water under external fields enhances the electrolyser efficiency by influencing the process parameters like magnetic field effect on electrolyte properties, mass transport, magneto hydrodynamic convection (MHD), IR-drop, electrolyte concentration, ion diffusivity, electrode kinetics, and more. Industrial high pressure electrolyser systems operated at high current densities which require external magnetic field to impart magneto hydrodynamic (MHD) convection to reduce IR-drop that improve the void fraction and the surface coverage as well as forced convection of gas bubbles which contributes to the high energy consumption. To expand the use of water electrolysis, it is mandatory to reduce energy consumption, cost of electrodes, and maintenance of current electrolyser systems. High current densities have to be maintained at reduced cell voltage, and to increase their efficiency, durability, and safety. Hereby the paper elucidates the magnetic field effects on electrolyser efficiency and studies the insights of magnetoelectrolysis.

Keywords: Electrolyser, Magneto hydrodynamic convection, Efficiency, Magnetic field
Developing Aluminum-Air Cells as A Sustainable Energy Source And Proposing Optimizations

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Abstract

Batteries and Fuel Cells happen to be a potential answer to the society’s energy problems. However, they are still limited by issues such as low energy density, high material costs, short lifetime etc. The Metal-Air technology that uses O2 from air as cathode seems to be an fitting solution. The paper discusses the advantageous use of Aluminum as the metal anode owing to reasons like low cost & abundance, high energy density, easy recyclability etc. Various challenges faced while designing Al-air cells are discussed and some viabilitiesolutions in the form of optimizations are proposed. An account of an inexpensive, self-designed Al-air cell that can serve as a scalable primary source of energy is provided. The self fabricated cathode was based on multiple carbon mixtures. Activated Carbon + Graphite Mixture was applied onto SS 316 Mesh (120 Mesh size) via a novel procedure. 15% (w/v) NaOH provided best output with controlled anode corrosion (Open Circuit Voltage: 1.44 V, Current Output: 132 miliAmperes for a 4cm x 5cm cell). Two Al-air cells were able to run 5 LEDs (0.75 Watt lamp) for 11+ hours in full brightness before electrolyte refill. Four cells were able to charge a mobile phone via USB. Cells lasted for ~72 hours in full use (3 days) before the anode was replaced. Cost effective synthesis of novel materials like multi-doped graphite and possible engineering optimizations are being explored for developing a bigger cell stack and overcoming present challenges as discussed.

Keywords: Sustainable Energy; Metal-Air; Battery Chemistry; Engineering Optimizations; Electrochemistry
Abstract

Electricity consumption is going to comprise an increasing share of global energy demand during the next few decades. In recent years the increases in the price of fossil fuels and concerns about the environmental consequences of greenhouse gas emissions have increased the interest in the development of alternative energy resources all over the world. For developing countries such as India renewable energy sources and technologies are the solution to energy related problems. Renewable energy sources such as wind energy, solar energy, geothermal energy, ocean energy, biomass energy, and fuel cell technology can be used to solve the energy shortage in India. For a country like India whose economy is growing fast, energy requirement will increase 3 to 4 times the current requirement. In the last two decades, a lot of research, development, demonstration, production, and application has been done in the renewable energy sector in India. This paper assesses the availability, current status, major achievements and future potential of renewable energy in India.

Keywords: Renewable energy, solar, wind, biomass, geothermal, hydro.
Conversion of Co₂ Into Methanol

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Abstract

The global warming, mainly sourced from the human induced emission of CO₂, is one of the major environmental threats we are facing in the 21st century. Methanol (MeOH) can be synthesized from CO₂ hydrogenation and is one of the most celebrated and widely suggested alternatives for chemical energy carrier. Methanol is widely regarded as a promising alternate to automobile fuel. Some of the positive effects for developing world-wide market for methanol as a fuel are (a) Decrease in dependency on foreign energy resources, (b) conservation of existing petroleum based energy reserves, (c) Increase competition among energy providers resulting in lower cost and (d) environmental benefits from improved emission inherent in the combustion of methanol as compared to petroleum based fuels. The dominant method of producing methanol is a two step process but this step is very energy intensive and represent the major expense in the methanol production. Instead of using two step method, one step method seems to be beneficial. There many one step methods but Catalytic hydrogenation of CO₂ with renewable H₂ to methanol represents a promising pathway for reducing anthropogenic CO₂ emission. Catalyst play a key role in enhancing both the hydrogenation rate and methanol selectivity. For this process, sources are easily available for e.g. CO₂ can be obtained from blast furnaces, cement plant, power station and Hydrogen from electrolytic splitting of water by using renewable energy sources. Hence, we can say that this method is high efficient considering all environmental aspects.

Keyword : Sustainable, Catalytic Hydrogenation, Blended Methanol.
Waste Management: Land/ Water/ Environment (WM)
Adsorptive Removal of Nickel from Aqueous Solution Using a Red Algae

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Abstract

The adsorption of nickel was studied by using a red algae Gracilariachangii. The influence of different operating parameters viz. pH (2 - 6.5), temperature (20-40 o C), sorbent dosages (0.5-10 g/L), initial concentrations of nickel in solution (0.01-5.0 g/L), and contact time. The maximum removal of nickel occurred at pH 5.2 and temperature - 38.1 o C for a sorbent dosage of 5.0 g/L. The results were modeled by response surface methodology (RSM), which determines the maximum sorption of nickel as a function of the above five independent variables, and the optimum values for the efficient sorption of nickel were obtained. A coefficient of determination R 2 value 0.96 shows the fitness of RSM in this work.

Keywords: Optimization, Nickel, Gracilariachangii, Sorption, Response surface methodology, Algae
Effective Utility of Waste Cashew Nut Shell Liquid in the synthesis of resins-A valuable pre-polymer resin in Industry

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Abstract

Today, polymers are used as replacements for wood, glass and metals and for a variety of applications in industries such as packaging, automobiles, building constructions, electronics, aerospace, electric equipments etc. The decline of petroleum-based resources for the polymer industry has forced to explore the naturally available renewable resources as alternate raw material, which hold beneficial characteristics for being non-toxic, bio-degradable and environmentally friendly. Cashew Tree is an important tropical tree crop, well known agro-forestry species, a crop of high economy and commercial value. The waste cashew nut shell liquid (CNSL) is a versatile by-product of cashew industry, is unique natural source, unsaturated long chain phenol.4-chloroaniline has been diazotized and coupled with cardanol, the main ingredient of CNSL to prepare dye (bio-monomer). The dye has been condensed with formaldehyde to form homopolymer resin. The homopolymer resin has been further condensed with thiourea to form a copolymer resin. The resin has been characterized by spectral studies. Thermal behavior of resins has also been studied.

Keywords: Cashew Nut Shell Liquid (CNSL), Cardanol, Formaldehyde.
Abstract

The recent development in wastewater treatment is the use of biosurfactants produced from yeast orbacteria. This review paper illustrates the nature of effluents from four of the most common industries and their methods of treatment using biosurfactants. The effluents are from the distilleries, dairies and slaughterhouses, petroleum and oil refineries and industries that process metals. Each of these employ the use of bacteria and fungi systems for the biodegradation process. The distillery spent wash is treated using the reactor systems involving biomethanation in addition to fungal and bacterial systems. Lipases obtained from fungi of certain genera have been used to treat wastewater from dairies, slaughterhouses, restaurants and the like. Some novel processes such as the ion floatation method and micellar-enhanced ultrafiltration have been employed to treat water containing metals such as copper, cadmium and lead. Enzymatic biodegradation process have been used to treat the effluents from petroleum industries. Rhamnolipids are the most commonly used class of biosurfactants to remove a multitude of pollutants. As industries are moving towards sustainability and biodegradability in all realms, this review article focuses on potential application of biosurfactants to treat the effluents.

Keywords: biosurfactants; sustainability; effluent; rhamnolipids
**Abstract**

Burgeoning population, scarce financial resources and limited capacity to manage environmental issues are some of the common problems faced by most developing countries. With growing populations and changing lifestyles, the quantum of waste generated is growing apace. Inadequate awareness and willingness to responsibly dispose waste results in steep increase in amount and costs of garbage that the countries will be required to deal with by 2025. This enormous amount of waste generated in developing countries and the significant potential for resource recovery are primary triggers for waste-to-value based models. In addition to generating high valued products and minimizing pressure on landfills, these models provide an opportunity for informal waste workers to enhance their quality of life and earn higher income. It is estimated that a country generates nearly 100,000 metric tons of solid waste per day of which 40% is recyclable. Ironically, much of this waste has value and can be recycled and reused if segregated and collected in sufficient quantities. This is where the Waste-to-Value models come into play for a better perspective. These models help minimize the amount of waste lying on street and in open dumps. They aim to build a sustainable business around recycling and reuse of waste that are either difficult to treat or harmful if left untreated.
Manufacturing of Alcohol from Whey

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Abstract

Introduction to the formation of alcohol from whey, with the use of different yeast.

The whey is a raw material carried out from the dairy industries, which is the waste material collected from the upper liquid part of the cheese, butter, buttermilk etc. The specific gravity of the whey is firstly measured and with the use of “HYDROMETER” the measured specific gravity of the whey lies between 0.9921 to 0.9999.

After measuring the specific gravity of whey, the whey is collected in a round bottom flask, with the use of yeast, the whey is kept under observation for fermentation at a moderate room temperature for 72hrs. At a time interval of 8hrs, the specific gravity of whey is measured.

After the fermentation of whey, the whey is collected for the distillation setup, where the fermented whey is filtered, and proceed to the distillation column. The process carries out the fermented whey into alcohol. The fermented alcohol is separately collected and passed for further tests such as specific gravity, (ABV) Alcohol by volume.

Keywords- whey, fermentation, yeast
Investigation of Carbon nanotubes as efficient electrode material
deionizing the RO reject

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Abstract
Deionizing the reject stream from reverse osmosis (RO) system has been one of the major limitations of RO which needs greater attention due to water scarcity. Treatment of stream till date has not been commercial adapted due to pros and cons of technology as well as the location specific characteristics of stream. Carbon nanotubes (CNT) is well known member of carbon family but with higher specific surface area (3000 m²/g) and acceptable to the field of ion sorption or any other waste stream. Henceforth, focusing the capabilities CNT possess, a successful fabrication of CNT electrode (2.5 * 2.5 cm²) was attempted in the investigation and it was found that it had a specific capacitance of 23 F/g. Further, the electrodes were applied with electric potential of 1.0 V for 1000-1500 ppm revealing a maximum electro sorption capacity 6.9 mg/g.

Keywords: RO reject; capacitive deionization; Carbon nanotubes
Degradation of Atrazine in Water Using on Photocatalytic Ozonation

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Abstract

The present work investigates the degradation of pesticide atrazine in water using advanced oxidation processes based on photocatalysis and ozone. The degradation of atrazine was done using UV light and ozone alone and the combined processes such as UV+TiO₂, UV+TiO₂+H₂O₂ and UV+TiO₂+H₂O₂+O₃. The effect of various parameters such as initial atrazine concentration, initial solution pH, concentration of photocatalyst TiO₂, concentration of H₂O₂, concentration of ozone on degradation rate were studied. The optimum parameter established are 20 ppm of initial atrazine concentration, initial pH of 7, TiO₂ concentration as 80 ppm, H₂O₂ concentration as 80 ppm, ozone flow rate as 50 mg/h. The degradation was lowest using UV light alone (31.5%). Near complete degradation (99.8%) was obtained using combined photocatalytic ozonation (UV+TiO₂+H₂O₂+O₃). The BOD and COD removal obtained were 16.51% and 16.25% respectively.

Keywords: Advance oxidation process; photocatalysis; photocatalytic ozonation.
Textile dye removal using Coriolus versicolor from aqueous solution

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Abstract

Decolourization potential of white rot fungal organism, coriolus versicolor, was investigated in a batch reactor, for reactive red 120 dye from aqueous solution. The influence of process parameters like pH, temperature, agitation speed and dye wastewater concentration on the decolourization of textile dye wastewater was examined by using Response surface methodology (RSM). The maximum decolourization was attained at: pH- 6.2, temperature – 28.6°C, agitation speed – 155 rpm and dye wastewater concentration – 1:2. From the analysis of variance (ANOVA) results it was found that, the linear effect of agitation speed and dye wastewater concentration were significant for the decolourization of textile dye wastewater. At these optimized condition, the maximum decolourization and chemical oxygen demand (COD) reduction was found to be 76.9% and 87.5% respectively. Kinetics of textile dye degradation process was studied by first order and diffusional model. From the results it was found that the degradation follows first order model with R2 value of 0.9330.

Keywords: Wastewater ; COD ; White rot fungi
A novel activated sludge-graphene oxide composites for photocatalytic application

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Abstract

With the continuous development of society, energy depletion and environmental pollution get worse. It has no doubt that increasing demands for clean energy. The demand for energy is proportionately increased with the growing global economy. These forced the researchers to work towards sustainable and renewable resources for energy production, energy storage devices. The renewable energy power generation requires its energy storage components to have fast response characteristic, high reliability and flexible energy management. Batteries, capacitors, and fuel cells are commonly available energy storage devices. The continued increase in the energy demand, forced to improve the performance of these energy storage devices to meet the power requirement systems. This gap can be bridged with the incorporation of novel material in energy storage device applications. Electrode materials, generally as the crucial components of flexible energy storage devices, should endow themselves with outstanding conductivity, good mechanical properties as well as high electro-chemical stabilities. In recent years, researchers focusing on to incorporate the carbon materials as they contribute to enhance the conductivity to enhance the specific capacitance values. Among various carbon materials such as activated carbon, graphene, carbon fibers, and carbon nanotubes (CNT), have been investigated as electrode material for energy storage device applications. To date, large number of energy storage such as lead acid-batteries and Li-ion batteries have been developed and utilized. The scientific community has shown interest in recent years to develop high power and energy density storage devices. Graphene, a two-dimensional (2D) monolayer of carbon atoms with packed honeycomb lattices, displays abundant fascinating properties, such as large surface area, good thermal and chemical stability, high conductivity, and mechanical flexibility. However, most of the multi-doped carbon nanomaterials were developed by using multiple hazardous chemicals as precursors.

In is known fact that the conventional disposal methods of sewage sludge causes environmental risk in addition to covering a large area, resulting conversion of into useful resources. Pyrolysis of solid sludge produces carbon material, which further synthesized for graphene. It is attempted in this study to convert sewage sludge into the graphene and the synthesized graphene is used as electrode material for energy storage.
Abstract

India is developing country and the agriculture sector is an inseparable part of our economy. Phosphorus is essential mineral for the growth of plant which is supplied in the form of fertilizers. Typically the runoff rainwater takes the phosphorus from the fields to the waterbodies. The excess amount of phosphorus in the water bodies cause eutrophication and have adverse effect on aquatic life. Phosphate removal is essential to control the eutrophication of water bodies and adsorption is one of the promising approaches for this purpose. This paper presents a comparative review of the literature on different methods of removal and recovery of phosphorous. Adsorption stands out among the processes and has many fold advantages. Herein we discuss different adsorbents, there behaviors, mechanisms, and ways to the regeneration of materials. The adsorbents are categorized under different heads; iron-based, silica-aluminabased, calcium based, natural or manmade clays and metal oxides that are employed in phosphorous removal. The adsorption capacities of the adsorbent varies widely between 10mg/g to 300 mg/g. The attractive feature of adsorption is the usage of nutrient-loaded adsorbents, which can be used as a phosphate fertilizer and a soil conditioner in agriculture. Metal oxides are promising materials for the effective adsorption as well as for recoveryprospective. Analysis of recovery technology to generate effective fertilizer is there as well asregeneration of sorbents for reuse using acids, bases, and salts, are critically examined.
Fish-Hydroxyapatite/Shrimp Chitosan/PES Membrane for Industrial Effluents Treatment

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Abstract

This study was designed to short out the problem of wastewater treatment using Fish-shrimp chitosan (CS) based cross linked polyethersulfone (PES) based membrane. Herein, chitosan was prepared by deacetylation of fish shrimp, whereas PES was prepared by phase inversion method. The prepared 18% polyethersulphonewas dissolved in dimethylformamide (DMF) in which 2gm of polyvinylpyrrolidone (PVP) was added as a pore performing agent. The (1gm/1gm) fish shrimp chitosan solution was prepared with dilute acetic acid and cast on the top of PES membrane and then cross-linked with 2% glutaraldehyde. The resulting Fish Shrimp composite membrane was extensively characterized using several methods such as X-ray powder diffraction (XRD), scanning electron microscope (SEM), thermogravimetric analysis (TGA) and Fourier transform infrared spectroscopy (FTIR). The 18% fish shrimp membrane and 18% commercial membrane molecular weight cutoff was found to be 9180 and 9022 Da respectively. The pure water flux for fish shrimp membrane with thickness of 0.2 mm was 62 L/m 2 h.

Keywords: Membrane, Chitosan, Fish, Shrimp and Polyethersulfone.
An overview of challenges and solutions of Plastic Waste Management in New Delhi and Chandigarh

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Abstract

This study aims to compare the mechanisms of disposal, collection, segregation, recycling and disposal of plastic waste in two large metro cities namely, New Delhi and Chandigarh. It further highlights the impact of increasing plastic waste in both the cities. In an attempt to do so, we highlight the role of authorities and citizens in facilitating the mechanism of plastic recycling. The analysis also highlights differences in approach used by both the cities and chalk out what can be learned from them. It was observed that the lack of segregation of waste in both the cities posed to be a major deterrent to the increase in percentage of recycled plastic waste. The study further offers insights on possible solutions to increase this percentage.

Keywords: Plastic Waste Management, Solid Waste Management, Plastic Recycling
Development of low cost water purifier for simultaneous arsenic and fluoride removal

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Abstract

Fluoride and Arsenic are the two main contaminants in groundwater present naturally in India, China and Bangladesh in South Asia, causing a set of health symptoms known commonly as Fluorosis and Arsenicosis respectively. For many rural areas where hand-pumps and tube-wells are the only source of safe drinking water, these two contaminants have emerged to cause a serious crisis threatening public health. High Fluoride concentrations in groundwater present in the western states of Rajasthan and Gujarat and in the southern states of Andhra Pradesh, Karnataka and Tamil Nadu, while the ground water in northeastern India contains arsenic concentration above the statutory limitation.

As compared with Fluorosis, the skin afflictions of Arsenicosis carry greater social stigma and incur higher costs on patients. In Nadia district in West Bengal, the impacts of Arsenic contamination are more severe with increasing age. Cumulatively over the entire afflicted population, both Fluoride and Arsenic contamination have a high cost on society and addressing the problem would require more attention from government agencies and society apart from individual awareness.

Many technologies have been developed for removing arsenic or fluoride from groundwater. However, only few studies have been carried out to investigate the simultaneous removal of arsenic and fluoride, although both contaminants can co-present in groundwater in many cases. However, none of these studies considered the simultaneous removal of arsenic and fluoride.

Further a portable cartridge for effective removal of arsenic and fluoride will be very much beneficial for our societal need. Thus, the objectives of the present study to develop a portable cartridge using activated alumina/carbon filter for simultaneous removal of arsenic and fluoride.
Investigative Study on Waste foodstuff – Adsorbent Preparation

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Abstract

Chitosan is amino polysaccharide and it is one of the most promising and applicable materials in adsorption applications. Chitosan is commercially obtained by deacetylation of chitin produced from crustaceans and waste food stuffs like eggshells as the most abundant natural sources. The existence of amino and hydroxyl groups in its molecules contributes many adsorption interactions between chitosan and pollutants. In this experimental study, Chitosan was first prepared by proper treatment of eggshells and adsorption is compared of commercially available chitosan with the prepared chitosan from eggshell. Adsorption capacity of chitosan was also checked by use of Langmuir and Freundlich adsorption isotherms. This research work reveals that information that chitosan prepared by waste foodstuff can be used as potential adsorbent for wastewater treatment.

Keywords: Chitosan; Marine creature; Eggshell; Wastewater treatment.
Abstract

In these crucial times, health is a major concern, hence we are bound to have a dramatic increase in demand of vegetables and fruits of superior quality, but there is a limit to which conventional farming techniques can scale their produce. This can be resolved by hydroponic type of farming. Hydroponics means growing plants directly in water, not in soil, and providing it a balance of nutrients, hence increasing its rate of growth, getting more nutritious vegetables and fruits, reducing man work and catalysing the production of exotic vegetables and fruits at a cheaper rate as well as all year round. Apart from this, it occupies relatively lesser space which can help cultivate more number of plants per area and reduces the possibility of plants being infected by soil and water borned diseases since water is Reverse Osmosis purified and Ultraviolet treated. This paper has covered types and technology for hydroponic farming, aspects that affect produce, increase in profitability and decrease in the price borne by the consumers. Moreover, this method helps in soil management as exhausted land can be utilised for farming purpose because it doesn’t concern with soil. This also helps water management as the remaining water, after absorption by the plants, is recirculated through the system.

Keywords: Hydroponic Farming; Soil management; Water based plants; Water Management
Recent Trends in Recovery of Gold from E-wastes

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Abstract

The rapid global development in technology along with pressures for upgrade infunctorality and design has generated advanced electrical and electronic equipment with shorter life span. Waste electronic and electrical equipments releases variety of toxic substances which can contaminate the environment and threaten human health, if disposal protocols are not meticulously managed. According to the UN’s Global E-waste Monitor 2020, a record of 53.6 MT of E-waste was generated worldwide in 2019 and by 2030 the number would reach 74 MT. The latest data from Ericsson estimates that 74% of the world’s population uses mobile phones and also the survey by Consumentenboard, non-profit organization recorded an average life span of a smartphone as 2.5 years, thus producing a large amount of wastes. A study showed that the recycling of one tonne of mobile phones would yield 0.34 kg of gold which is 18000USD today. This review highlights the various challenges and opportunities in the recovery of gold from E-wastes using metallurgical techniques like Pyrometallurgy, Hydrometallurgy and Biohydrometallurgy from PCBs. In addition to that, a special focus has been given on the technique developed by the Indian researchers on recovery of gold using the leaf extracts of Lagerstroemia speciosa.

Keywords: E-waste; Mobile phones; Gold recovery; PCBs; Metallurgical techniques.
SCHEMCON-2020

Selective production of aromatic compound from the waste plastics by catalytic pyrolysis

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Abstract

Today waste plastics become an important threat to plant and animal on land mass. It becoming an increasingly challenging to manage and control the use of plastics due to their adverse environmental effects. The landfill deposition of municipal waste plastics (MWP) may cause environmental problems and is becoming more expensive. Due to increasing volume of MWP and decreasing landfill capacity for disposal, landfill becomes more challenging. In addition, landfill can release hazardous sub-stances and plastic wastes take long time to degrade. Thermochemical conversion of plastic wastes is a promising approach to produce alternative energy-based fuels. Herein, we conducted two stage thermal pyrolysis by utilizing the porous waste carbonaceous material as catalyst Study the effect of catalytic temperature, residence time and plastic waste component on the production of Aromatic compound. The entire process is undertaken in closed reactor vessel followed by condensation, if required. Waste plastics while heating up to 500 to 900 o C convert into liquid-vapour state, which is collected in condensation chamber in the form of liquid fuel.

Keywords: Waste plastics; Aromatic production; Catalytic thermochemical conversion
Biosorption of Heavy Metals By Activated Sludge And Their Desorption Behaviours

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Abstract

The biosorption of five metals (Cu2+, Cd2+, Zn2+, Ni2+ and Pb2+) was tested using activated sludge. The most favorable pH was 4 for Cd, Cu and Pb sorption and 5 for Ni and Zn. Biomass metal uptake clearly competed with protons present in the aqueous medium, which made pH an important variable in the process. Protons consumed by biomass in control tests vs protons exchange in biosorption tests proved that a maximum exchange of metal cations and anions is seen at pH 2. This study tells that the amount of protons that are released from biomass have increased with biomass concentration. The maximum sorption uptake of the five metals by the activated sludge exhibited the following decreasing order: Pb>Cu>Cd>Zn>Ni. Desorption experiments were conducted using HCl and it was found to be a good eluent for the five metals tested, especially at low pH values (1 and 2). At pH 3 or 4 the desorption yield was comparatively lower. Although its use did not allow the reuse of biomass. EDTA was also a good desorption agent which completely recovered the five metals that were tested at a concentration of 1mM with the advantage that biomass could be reused for three sorption–desorption cycles. This study focuses specifically on removal of heavy metals from industrial effluents in an eco-friendly way.

Keywords: Activated sludge; Biomass; HCl; EDTA; pH; Metals; Eluent
Economical Sustainable Way for De-fluoridation of Water

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Abstract

In 2019, Central Ground Water Board (CGWB) of India had cautioned that the levels of fluoride are beyond the acceptable limits in various states. Across the country, 370 districts are facing the problem of excess fluoride. World Health Organization (WHO) has set the upper limits of drinking water standards at 1.5 mg/l, and the Bureau of Indian Standards (BIS), has therefore, laid down Indian drinking water standards as 1.0 mg/l as maximum permissible limit of fluoride. Excess exposure of fluoride may lead to dental fluorosis or crippling skeletal fluorosis, which is associated with osteosclerosis, calcification of tendons and ligaments, and bone deformities. In this project, We have done an analytical examination on different methods for fluoride removal from drinking waters such as coagulation-precipitation, membrane separation process, ion exchange, adsorption techniques, Fluoride Nilogon and so on. Fluoride Nilogon is found to be an unique low cost effective water treatment technology that has been developed recently. Our aim is to find a sustainable economically feasible process to minimize the amount of fluoride to it's permissible limits. We have also studied some under-developed projects like graphene based filtration system for the effective removal of ions from the water.

Keywords : Fluorosis; Ion Exchange; Adsorption; Fluoride Nilogon
Abstract

Waste management is becoming more hot topic in our country. Municipal governments, which are largely responsible for building & maintaining waste disposal networks, are desirous to find ways of reducing the waste & final disposal. This includes the collection, transport, treatment, disposal of waste. Waste can be solid, liquid or gas. Waste management deals with all types of waste including industrial, biological and household.

Municipal solid waste management (MSWM) is one of the major issue in policy circles. Municipal solid waste (MSW) is known as waste consisting of furniture, plastic products, food waste, paper left over. There is a rapid increase in MSW due to the urbanization and population growth.

This paper gives current situation of India with respect to MSW. We have presented the overview of MSW in major cities and we have included quality, quantity and its management.
We have also presented the outcomes on MSW small-scale and large-scale.

Keywords: Municipal solid waste; transportation; collections.
A Review on Hydrothermal Liquefaction of wastewater to bio-oil

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Abstract

UN Sustainable development goals SDG 11.6 aiming at reducing per capita environmental impact of cities by better way of municipal and other waste management and SDG 7, at providing access to clean, affordable and sustainable energy by 2030 can be achieved together by developing appropriate Waste to Energy (WTE) technologies. Anaerobic digestion (AD) a WTE employing biochemical process, produces biogas containing nearly 50% of CO 2 and inherently slow. Microbial Electrolysis cell (MEC) process produces hydrogen by breaking down the organic matter in the wastewater bi-electrochemically butirates and yields of hydrogen needs to be increased to make it a viable WTE. Hydrothermal liquefaction (HTL), the only WTE technology among thermochemical conversions to produce bio-oil, which upon hydrotreating will be a substitute for diesel, kerosene and gasoline. Pacific Northwest National Laboratory, USA converted sewage Sludge to bio-crude as energy product of 44% yield using HTL. HTL of synthetic wastewater in the presence of iron-molybdenum oxide and hierarchical Fe-Co-ZSM-5 have resulted in bio-oil yield of 36.5 and 34.7% respectively, thus making it a more promising WTE technology. Detailed comparison of AD, MEC and HTL as WTE technologies will be reviewed and presented.

Keywords: HTL; Anaerobic Digestion; Wastewater; bio-oil.
Optimization of Emulsion Liquid Membranes for the removal of harmful dyes from industrial wastewater

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Abstract

In the present study, various harmful dyes like methylene blue, malachite green, crystal violet, and rhodamine 6G which were drained in the water from industrial waste having a certain adverse effects on the human body, aquatic life have been studied and optimized. The majority of dyes were basic which were removed using emulsion liquid membranes (ELM). Since emulsion liquid membranes have a high mass transfer rate, extraction and stripping in a single-stage make this membrane very efficient. Various parameters like carrier concentration, surfactant concentration, oil phase to stripping phase ratio, internal phase, emulsification time, emulsification speed, and others were studied and optimized. The model has been developed for the extraction yield with the help of Minitab 17 software.

Keywords: emulsion liquid membrane, surfactant, carrier, wastewater
Waste Minimization Challenges Post COVID-19

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Abstract

The COVID-19 pandemic has expanded all over the globe. It has created an enormous impact on the environment leading to severe consequences. The waste sector is one such which is in trouble and ensuring for its safe disposal. Research studies have revealed that waste materials like plastics, cardboards, steel, etc are carriers of COVID-19 virus and it can stay on these for up to 72 hours. Thus, there is a need to look for health situations of waste stream workers and recyclers and to deal with growing challenges in waste minimization practices. On the other hand, a rapid increase in biomedical waste has become an issue due to the need for proper destruction of the residual virus. In India, biomedical waste generation has increased from 94 tonnes to 761 tonnes as reported by the Central pollution control board (CPCB) and thus creating a dilemma on the establishment of new facilities to handle the increased waste volume. The emerging changes in composition and quantity of waste highlight the need for optimum changes in waste management systems. The public authorities and municipal waste operators had to rapidly adopt effective measures for careful handling and disposal of such waste to overcome the long-term dangers. The paper gives the outlook on how during and post-pandemic the waste management practices are adversely affected. Wastemanagement recommendations regarding COVID-19 waste are also discussed. The increase in the percentage of plastic and biomedical waste from pandemic threatens to dominate existing waste management practices.

Keywords: Biomedical; pandemic; waste minimization; waste management
Sustainable Biomedical Waste Management amidst the Pandemic

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Abstract

Environmentally sound management of biomedical waste is a key challenge faced by us today. The emergency declared in the response to COVID-19 has resulted in individuals producing more waste than usual, including masks, gloves, and other protective equipment that could be infected with the virus. This has led to an increase in the production of single-use plastics. When not managed properly this biomedical waste could be subjected to uncontrolled dumping (in oceans and land) or incineration, leading to the release of toxins and increasing our carbon footprint in the environment.

The idea is to disinfect the used Personal Protective Equipment and the masks made of polymer (generally polypropylene) by physical as well as chemical means, using a virucidal solvent such as ethyl alcohol and ultraviolet radiation (to eliminate the risk towards public health which is a prime concern in these unprecedented times). This disinfected biowaste is then transferred to a pyrolysis chamber where polymers are broken into hydrocarbons which are segregated by fractional distillation method. The hydrocarbons obtained as products are combustible and can be used as fuels. This process will help in reducing adverse effects on the environment while promoting the recycling of polymers.

Keywords: Biomedical Waste; Pyrolysis; Fractional Distillation
Plastic Waste Management under COVID-19 Pandemic – A Review

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Abstract

The corporeal attributes of plastics like durability, low density, tensile strength and minimal cost, make them useful in various sectors. Regardless of their degree of operation and utilization, plastics deteriorate the environment and thus its disposal has gained critical attention. In addition to the already existing challenges, the COVID-19 scenario has made conditions worse. This paper provides an overview of different plastic disposal policies and discusses the readjustments of these policies amidst the COVID-19 pandemic along with their potential environmental implications. This paper has also emphasized the issue of plastic waste management policies, sustainable and green plastic solutions and development of dynamic and responsive waste management system followed by recycling of the plastic waste. Advances in technologies and systems for the collection, sorting and reprocessing of recyclable plastics are creating new opportunities for recycling, and with the combined actions of the public, industry and governments it may be possible to divert the majority of plastic waste from landfills to recycling over the next decades.

Keywords: Plastic Waste Management; Covid-19; Sustainable and green solutions.
Biosaviours of environment from oil spills

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Abstract

The oil spills are posing a great threat as seen in the latest "mauritius oil spill and deepwater horizon oil spill". The reason for oil spills are oils leaking from tankers, offshore platforms, drilling rigs and wells and spills of refined petroleum products etc. The oil spills adversely effect the marine ecosystem, thus resulting in loss of biodiversity. The oil spill treatment depends on various factors and the treatment of oil spills originally consumes a lot of time which results in emulsification of oil and water. There have been various methods to treat oil spills like using oil booms, skimmers, usage of surfactants, burning, sorbents etc. Few have been used effectively for spills in the middle of the sea but the major threat is at the shores due to accumulation of the floating oil. For past few decades research has been done for remediation of environmental contaminants, because of the high economic cost of physicochemical strategies, the biological tools for remediation of these persistent pollutants is the better option. Major have been considered on organic chemicals i.e. polyaromatic hydrocarbons (PAHs) due to their occurrence, bioaccumulation potential and carcinogenic activity. Rhizoremediation, a specific type of phyto remediation that involves both plants and their associated rhizospheric microbes. We found that Pseudomonas aeruginosa, Pseudomonas fluorescens, Mycobacterium spp., Haemophilus spp., Rhodococcus spp are some of the commonly studied PAH-degrading bacteria. We first used dispersants to break up the complex oil molecules and then the microbes feed on the dispersant and thus dispersant not causing any environmental contamination as well. We researched on how to treat oil spills effectively, economically and within the time bounds. Thus the methods of natural bio augmentation and bio stimulation proved to be effective methods in the treatment of oil spills. The rate of degradation can be increased by the use of fertilizers like nitrogen and phosphorus.

Key words: PAH; Bioremediation; Rhizoremediation
Composite material from Tannery wastes

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Abstract

The leather processing industry produces large amount of solid organic wastes in the form of un-tanned and tanned waste from raw hides and skins are heavily polluted containing appreciable amount of inorganic substances like chromium, sulphide, chloride etc. So it is incompatible and harmful for direct biological treatment. Though there is various methods are applicable for disposal have been practised, there is a huge leftover of these wastes to be managed. It poses serious issue on these case. These study is aimed at providing additional method of managing tannery solid wastes generated in the leather industry into a useful composite material. The tanned leather shavings were collected, cleaned, dried and ground to particle size and used as reinforcement in the matrix (HDPE). Then it is compounding by the roll mill and subjected to the compression moulding at the compression temperature and pressure. Stabilizers and compatibilizers are used to maintain long term properties and to enhance the mechanical properties of polymeric mixtures. The reinforcement fibres from the animals, leaves, grasses and other source for the composites had used in the vast applications like automotives, shipping etc. This natural fibre reinforced composites have numerous advantages in automotives and other industries.

Keywords: Tannery solid wastes, compression moulding, Natural fibre reinforced composites.
Preparation and Estimation of characteristics of Partially Replaced Cement with prosopis Juliflora ash

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Abstract

Cement is a binder, substance used for construction that sets, hardens and adheres to other materials to bind them together. Rise in price of cement leads to rise in construction cost. Replacement of cement with another material which completely satisfies all the required properties is difficult. Partial Replacement of cement with a substitute material is an efficacious solution. Prosopis Juliflora is a shrub belonging to fabaceae family, a kind of mesquite having roots which are capable to grow at a greater depth in search of water which is challenging to remove. Partial Replacement of cement with ash of prosopis Juliflora will be a good strategy for solving both of the troubles. This study focuses on investigating the characteristics of partially replaced cement with prosopis Juliflora ash. The main objective of the study lies on combining different proportions of ash say 0, 20, 40, 60, 80 with cement and estimating the effectiveness of different combinations by evaluating physical and strength properties such as workability, setting time, density, compressive strength and comparing it with ordinary Portland cement.

Keywords: Partially Replaced cement; Prosopis Juliflora; Ash; Initial setting time
Abstract

In this study, we report the thermal decomposition kinetics of agricultural residues wheat straw using thermogravimetric analysis (TGA). TGA was carried out at different heating rates (5, 10, 30 and 50 °C /min) under inert conditions in the temperature range of 303 – 1173 K. The kinetics of thermal degradation was separately studied in the active zone of pyrolysis (120-600 °C). The results show that the nth order reaction model is applicable for in all heating rates with order of reaction in the active zone ~3.0, activation energy ~100 kJ/mol and pre-exponential factor ~10^5 sec^-1.
Abstract

In an ever growing industrialized world the natural resources are depleting at an unprecedented rate, and one of the most crucial resource is water. Water scarcity and water treatment is a global concern. This paper discusses about an integrated system for waste water treatment that combines the existing industrial waste water treatments with a cost effective and environment friendly biological treatments that work on the principles of bio-mimicry by using plants like ‘canna indica’ which absorb nitrates, phosphates. A plant ‘cyprus papyrus’ can be used for better removal of ammonical nitrogen demand, chemical oxygen demand, and latifolia breed of plants for removal of heavy metals etc. Apart from this, the paper has laid emphasis on major industries that generate maximum waste water i.e. the textile industry and the sugar industry. This paper has also emphasized on reuse and safe disposal of waste water which is often neglected due to high cost. It is an attempt to encourage water reuse and treatment to help in conservation of water resources.

Keywords: Industrial waste water treatment, Economics, Bio-mimicry, Water resources.
Waste to energy conversion in India

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Abstract

Previously, wastes were considered as the products formed by a process those have no value (use) and were simply discarded. But, now people have come to know that wastes are not really ‘waste’ and are extremely valuable in energy production. As a country develops, its energy requirement and waste generation increases. So, we need to increase energy production and manage the increasing wastes (waste management). Waste to energy technologies (WTE) can serve both these purposes. The first WTE plant was commissioned long back in 1987. But, these WTE plants are not very successful in India. Moreover, many plants have been shutdown due to their inability to handle mixed, unsegregated municipal solid wastes (MSW), pollution caused and high cost of electricity produced by them that renders it unattractive to power companies. This paper discusses different WTE technologies like incineration, gasification, pyrolysis and anaerobic digestion and their present situation in India. Advantages, disadvantages and challenges faced due to these technologies. Paper also suggests solutions for some problems. Deep research must be done in WTE area for bringing down the cost of power production and reduce emissions from these plants.

**Keywords:** WTE; Waste management; Incineration; Anaerobic digestion; Unsegregated waste.
Multi-Mix-Bed Adsorbents for Simultaneous Multi-Pollutant Removal

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Abstract

With this industrialization time, when more and more heavy metals are utilized for better manufacturing finally leads to more and more pollution one or another way. These will be primarily discharged in the outer water environment adding up the pollutant content of the water body. More the number of heavy metals and other chemicals utilized lies the presence of multiple chemical and heavy metals to be present in the effluents as the pollutants. This shows a greater requirement of an effective method for the removal of the multiple pollutants available in the effluent before it's mixing to the outer world. Adsorption is one of the most basic methods which have been proven to be effective for the removal of different pollutants whether it is heavy metal, dyes and other phenolic compounds. Therefore, there is a lot of possibility for the utilization of the adsorption for the removal of multiple pollutants at the same time. To enhance its capability, this paper is dealing with utilization of the multiple adsorbents to prepare a multi-adsorbent bed for the removal of multiple metal ions.

Keywords: Environmental Sustainability, Wastewater, Multi-metal removal, Adsorption
SCHEMCON-2020

Process of Decomposition Of Plastic By Nano Clay

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Abstract

Plastics have woven their way into our daily lives and now pose tremendous threat to the environment. Over 100 millions tons of plastics are produced annually worldwide, and the used products have become a common feature at over flowing bins and landfills. For example, normal plastic items take up to 1000 years to decompose in landfills, while plastic bottles take 450 years to decompose in the earth to overcome this problem government made a discussion that avoid usage of plastic (more than 35 microns) in that place we are using biodegradable plastic could decompose much faster than existing ones, safely breaking down in the environment instead of polluting the world for centuries.

Since in 1980s, it has seen limited use because of its brittleness and unpredictable rates of biodegradation now scientists at cornell university in New York have designed a new form of the plastic that at first glance is paradoxically both stronger and decomposes faster the key is additional of plastic of particles of clay only nano meter-billionths of a meter - in diameter. these nano clays help the PHB crystalise, enhancing its strength at the same time, the nano clays act as catalysis, eventually helping the plastic decomposes fastly.

India consumes an estimated 16.5 million tonnes, about 1.6 million truckfull, plastic annually, India generates nearly 26,000 tones of plastic waste every day, making in the 15 the biggest plastic polluter globally, discard plastic waste litter the country’s roads, rivers and also form huge mods in garbage dumps across the country. As we know that in 1976 congress passed the resource conservation and recovery act to increase recycling and conservation efforts as waste become a bigger problem. It is estimated that the slogan “reduce, reuse, recycle” was born at that time so people are making an increasing efforts to recycle, reuse items that have another purpose, and reduce our waste. Soon enough, to sing an aluminum can will have you running to the nearest recycling bin.

KEYWORDS: NANOCLAY, PLASTIC CONSUMPTION, SAFETY MEASUREMENTS
Technical approaches towards waste minimization

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Abstract

Waste management is nothing but the activities and actions required to manage the waste. It includes collection, transport, treatment, disposal and monitoring of wastematerials. Sources of waste can be broadly classified into four types i.e. Industrial waste, Domestic waste, Commercial waste, Agricultural waste. In India a large number of WMP deals with Municipal Solid Waste (MSW). One of the most important principals of waste management is The Waste Hierarchy which refers to the “3 Rs”; ‘Reduce’, ‘Reuse’, ‘Recycle’. It classifies waste according to their desirability and extracts the maximum principal benefits from product in terms of waste minimisation. There are many companies in India which served waste management facilities like, Antony Waste Handling Cell Private Limited, AtteroElectronics, Let’s recycle etc. Some major initiatives and activities such as SwachhBharat Abhiyan, Mahatma Gandhi Swachhata Mission, SwachhataSurvekshan etc. Has been taken by Government for the welfare of the society and human being. The main purpose of writing this paper is to spread awareness among the people and to provide some suggestions and recommendations to improve the waste management practices in India.

Keywords: Waste Hierarchy, Reduce, Reuse, Recycle, MSW
Combined hydrodynamic cavitation and advanced oxidation processes for industrial effluent treatment

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Abstract

Industrial effluent is a major source of water pollution which imposes severe effects in the environment and ecosystems. The industrially processed water may contain complex organic pollutants such as heavy metals, pesticides, dye intermediates, pigments, solvents, pharmaceutical drugs, etc. which must be completely removed before being discharged to natural resources. In recent years, various advanced oxidation processes (AOPs) have been used for treatment of both simulated and real industrial wastewaters. AOPs include the use of ozone (O3), hydrogen peroxide (H2O2), persulphate, UV irradiations, etc. Cavitation leads to generation of free radicals, local hot spots, and release of large amount of energy associated with intense turbulence are helpful for breakage of complex refractory materials and also partial conversion into simple biodegradable molecules. Hence, the current work focuses on the implementation of hybrid strategies using hydrodynamic cavitation (HC) combined with oxidants followed by biological oxidation using oxidants such as ozone, Fenton’s reagent, hydrogen peroxide, etc. to increase the treatment efficiency. It was reported that COD reduction by such hybrid techniques is up to 85% using a HC reactor. Therefore, there is an urgent need to develop such efficient processes to degrade compounds present in industrial effluent in a proper manner and bring the concentration to a certain minimum level so as to comply with the environmental laws.

Keywords: Industrial Effluent; Advanced Oxidation Process (AOP); Hydrodynamic Cavitation (HC)
Biochemical Engineering: Bioreactor,
biomedical engineering (BE)
Silver Nanoparticles-doped Gel-MA and Alg-MA Antimicrobial Bio-composite as Potential Wound Dressing

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Abstract

Skin is the largest organ in human body and the first line of defence to protect us from external harmful factors. Once the skin is injured, its function as a barrier to disease causing microorganisms is lost. So, development of novel wound dressing with potent antibacterial activity is crucial for wound healing and tissue regeneration. As a natural biocompatible polysaccharide, Alginate is extensively used in the pharmaceutical and biomedical fields. Alginate chains are modified with functional groups (i.e., methacrylates) followed by the free-radical polymerization in the presence of a UV light irradiation. Gelatine possesses good biocompatibility and excellent haemostatic function. Gelatin is modified into GelMA by introducing methacrylates exposing to ultraviolet (UV) light. Meanwhile, Gel-MA and Alg-MA composite possessed significant water uptake behaviour and mechanical properties, which support local tissue and promote cell adhesion and growth. Then introducing Ag-nanoparticles due to its higher toxicity to microorganisms, results in excellent antibacterial activity. In this research, we discussed the green synthesis of silver nanoparticles (Ag-NP’s)-doped Gel-MA and Alg-MA bio-composite, which possess antibacterial activity and be used as wound dressing.

Keywords: Ag NPs; Gel-MA; Alg-MA; Wound Dressing
Efficient uptake of paclitaxel-loaded nanoparticles by donor corneal endothelium towards prophylactic drug delivery

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Abstract

The standard care for treating corneal disorders is corneal transplantation. The barrier function of corneal endothelium (CE) maintains corneal transparency. During storage, donor CE is inevitably exposed to hypothermia and challenged by cytokines after transplantation. They both induce microtubule disassembly and subvert barrier function of CE. Therefore, the objective of this project is to develop a nanoparticle (NP)-based strategy for delivering microtubule stabilizing drug paclitaxel sustainably to donor CE during storage and after transplantation to enhance the success of corneal transplantation.

In this direction, CE cells were isolated from fresh porcine cornea and grown using a defined medium. Paclitaxel was mixed with biodegradable poly-L-lactic-co-glycolic acid (PLGA) polymer and nanoparticles (PNPs) were prepared using nanoprecipitation technique. PNPs were spherical and homogeneously sized with an average size and zeta potential of 95 ± 10 nm and -25 ± 2 mV, respectively. Drug entrapment efficiency of PNPs was 91% and drug release sustained up to 3 weeks and followed zero order kinetics at 4 °C and first order kinetics at 37 °C. The surface charge of PNPs was increased to +25 ± 4 mV by coating poly-L-lysine, which resulted in a better uptake of PNPs by CE cells, confirmed by confocal fluorescence imaging.

Keywords: Paclitaxel, microtubules, barrier function, corneal endothelium, nanoparticles, controlled drug delivery
**Biodiesel and its production**

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**Abstract**

Made from an increasingly diverse mix of resources such as recycled cooking oil, soybean oil and animal fats, biodiesel is a renewable, clean-burning diesel replacement that can be used in existing diesel engines without modification. The chemical name for biodiesel is methyl ester. Biodiesel is a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated as B100. Biodiesel Blend is a blend of biodiesel fuel designated BXX, where XX represents the volume percentage of biodiesel fuel in the blend. Although being functionally similar, biodiesel is chemically different than petrodiesel because it contains oxygen atoms and as a result, has different chemical and physical properties and has higher cetane number, contains no aromatics, and is non-toxic and biodegradable. The major steps required to synthesize biodiesel are feedstock pretreatment, process reactions and product purification. Biodiesel is made through a chemical process called transesterification, which involves reacting vegetable oils or animal fats catalytically with a short-chained aliphatic alcohol (typically methanol or ethanol). The process leaves behind two products – methyl esters (product, biodiesel) and glycerin (byproduct). Overall, despite many achievements, the industrial production of biodiesel using homogeneous catalysts encounters major challenges such as requiring longer residence time, resulting in increasing reactor volume, high capital cost, and a large footprint, and are difficult to control. Sustainability and environmental benefits include: Reduction in lifecycle greenhouse gases by 86 percent, particulate matter by 47 percent, hydrocarbon emissions by 67 percent. For every unit of fossil energy it takes to produce biodiesel, 3.5 units of renewable energy are returned, the best of any fuel.

**Keywords:** Cetane Number; Feedstock pretreatment; Transesterification; Product purification; Blending
Plastic Eating Bacteria

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Abstract

Plastic is a synthetic material made from a wide range of organic polymers such, polyethylene, PVC, nylon, PET, can be moulded into shape while soft and then set into a rigid or slightly elastic form. PET-polyethylene terephthalate 1, IUPAC name is poly(ethyl benzene -1,4-dicarboxylate. About 311 million tons of plastics are produced annually worldwide, mostly used for packaging such as drinking water. Most plastics degrade extremely slowly, constituting a major environmental hazard, especially in oceans, where micro plastics are matter of major concern. To resolve this problem many scientists in the world had tried many ways. A scientist named Kohei Oda and his team from Kyoto institute of technology first identified a bacteria named Idonellasakensis 2after collecting a sample of PET-contaminated sediment near a plastic bottle recycling facility in Japan. This bacterium uses two hydrolytic enzymes 3 to degrade the common plastic polymer PET. These enzymes converts the PET into its monomers. Idonellasakensis is a gram negative 4, aerobic beta proterobacteria. It first adheres to the PET material and secrete enzyme which generate mono(2-hydroxyethyl) terephthalic acid. Then MHET taken up by the cell and hydrolyzed by second enzyme MHETase to furnish the two starting monomers. These monomers are then catabolized by the bacterium as its sole carbon source.

Keywords: 1-PET- polyethylene teryphthalate; 2-Idonella sakensis-plastic eating bacteria; 3- PETase and MHETase; 4-Dangerous bacteria.
Cloaking of nanoparticles with stem cell membranes to render stealth and tumor targeting properties for targeted drug delivery

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Abstract

Anticancer drugs loaded into biodegradable polymer-based nanoparticles possess enhanced bioavailability. However, the host immune system can recognize these nanoparticles and phagocytose them, thus reducing the efficiency of treatment. In addition, the nanoparticles do not possess active tumor targeting properties. Thus, the drug released can cause toxicity to normal cells as well. Mesenchymal Stem Cells (MSCs) are immuneprivileged cells possessing innate tumor-targeting abilities primarily due to their unique membrane biochemistry. Hence, we hypothesize that by cloaking the nanoparticles with MSC membranes, phagocytosis can be avoided and active cancer targeting may be achieved. In this direction, MSC membrane vesicles were derived using a simple spin-cup centrifugation method. Poly-l-lactic-co-glycolic acid (PLGA) nanoparticles (NPs) were synthesised by nanoprecipitation method. Fusion of the membrane vesicles with NPs was achieved by extrusion through polycarbonate membranes. The average size of NPs was 90 ± 10 nm with high monodispersity. The size of the MSC membrane vesicles was reduced from 5500 nm ± 500 nm to 700 ± 100 nm during spin-cup centrifugation. Upon fusion, the average size of the membrane vesicle-cloaked NPs was 120 ± 20 nm. Cryo-TEM imaging with uranyl acetate dye confirmed the structure and integrity of the membrane vesicles and the cloaking process.

Keywords: Nanoparticles; Mesenchymal Stem Cell; membrane vesicles; targeted drug delivery.
Hydrothermal liquefaction of algae into bio-crude: Comparative study on different species and operating parameters

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Abstract

The macroalgae species of Gracilariacorticata, Turbinariaconoides, Sargassum wightii and microalgae Nannochloropsis sp., Chlorella vulgaris species are collected from Gulf of Mannar for bio-crude production under Hydrothermal Liquefaction (HTL) condition. The effect of influencing parameters on the yield of bio-crude have been investigated. All the 5 algae species were processed under HTL in the temperature range between 300 and 350 °C, residence time 15-60 min has been studied. It is found that the bio-crude yield for Nannochloropsissp. and Chlorella vulgaris was 38.2 and 36.2 wt.%, respectively with higher heating value (HHV) of 35.92 and 34.3 MJ/kg while Gracilariacorticata, Turbinariaconoides, Sargassum wightii yields about 29.63, 18.46, 16.33 wt.%, with higher heating value (HHV) of 16.9, 20.3 and 33.63 MJ/kg. Based on the suggested reaction pathway, the identification of existing components in their respective source of bio-crude was done using GC-MS. The composition of triglyceride and fatty acids in individual species are responsible for the formation of bio-crude. The results from GC-MS showed the occurrence of amides and heterocyclic groups due to protein presence. Moreover, the aqueous solution can be recycled as a loading solvent to enhance the bio-crude yield significantly.

Keywords: hydrothermal liquefaction; bio-crude; algal biomass; high heating value; thermochemical conversion.
Ultraviolet light (UV-C): An effective tool to Mitigate Pandemic Spread

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Abstract

Ultraviolet light is divided into three wavelength ranges UV-A (315-400nm), UV-B(280-315nm) and UV-C (100-280nm). Among these, the short- UV (UV-C) is found to have germicidal properties and at the same time is harmless to humans. UV-C light can be produced using tube-lights, smartphone flashlights, torches or any light source by incorporating a biochemical reaction using a fused amorphous silica (SiO2) based dichroic mirror filter accompanied by Ultraviolet Germicidal Irradiation and DiffractionGrating splitting of white beams. This arrangement allows UV-C rays (wavelength 222nm) to pass while blocking other higher wavelengths. When such light falls on surfaces, it gets absorbed by nucleic acids of micro-organisms. The absorbed energy can result in defects like formation of pyrimidine dimers via a photochemical reaction. Dimerization prevents replication by forming covalent bonds between adjacent bases in the DNA, resulting in the inactivation of the organism. Such apparatus can be used to disinfect hands, groceries, electronic equipment, closed rooms and public places. This review work is intended to analyze this cutting-edge technology and its lucid implementation in everyday life, which is most relevant in today’s time. This paper has also scrutinized its potency to eliminate bacteria and novel viruses like SARS CoV-2.

Keywords: Biochemical Reaction; Photochemical Reaction; Ultraviolet Germicidal Irradiation and Diffraction; UV-C, 222 nm.
Removal of copper (as heavy metal) from aqueous solution using popaya seed by adsorption

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**Abstract**

Papaya seed was evaluated as a new biosorbent of heavy metals. On contacting 10 mg copper(II), cadmium(II) and zinc(II) solutions with 5g papaya seed, during shake flask contact time of 60 min, the respective metal removal was noted to be 97.8, 94.9 and 66.8%. Sorption was most efficient at pH 5. Metal ion biosorption increased as the ratio of metal solution to the biomass quantity decreased. Conversely, biosorption/g biosorbent decreased as the quantity of biomass increased. The increase in initial metal ion concentration was associated with steep increase in biosorption at lower concentrations, progressively reaching towards plateau at higher metal concentrations. At equilibrium, the affinity of papaya wood to biosorb metals was in the order of copper(II) > cadmium(II) > zinc(II), which remained the same during the testing of variables of different factors. The biosorption data perfectly fit the Langmuir adsorption isotherms model with 0.99 regression coefficient ($r^2$) for all the metals.

**Keywords**: Bioabsorbant, copper removal, adsorption
Extraction of Azadirachtin (A Biopesticide) From Neem Kernels

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Abstract

Despite the harmful implications involved in the use of synthetic chemicals to control pests, still they are extensively used in all countries all over the world. The increased social pressure to replace them gradually with other alternatives that are safe to humans and non-target organisms has led to increased development of compounds based on the models of naturally occurring active ingredients of biological origin, having various biological activities known as "biopesticides". The use of biopesticides for pest control today is an evolving field in pest management. Azadirachtin is one of the biopesticide which is extracted from the neem kernels. It is the perfect replacement for harmful, chemical pesticide used worldwide. Being natural and organic bio-pesticide it does not harm the crops, environment, soil and human beings who are handling it. There are few units in India which are producing azadirachtin. The overall aim of our project is to make these azadirachtin products available at farm level at an affordable price, and this would become a possible tool in the integrated pest management strategy.

Key words: Biopesticide, Azadirachtin, Neem
Is hydroxychloroquine effective in the treatment of COVID-19

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Abstract

Corona Virus Disease was first registered on 17th November 2019. Ever since the pandemic started, the researchers and scientists started working for developing vaccine for the treatment of COVID-19. In spite of research being done by scientists and researchers currently no treatment specifically approved for COVID-19. Some of the researchers have suggested to use quinine derivatives i.e. hydroxychloroquine (HCQ) and chloroquine as temporary vaccines. Use of hydroxychloroquine for treatment of COVID-19 has several issues however its positive effect outweigh the negative effect that the patient will have. Another issue is if it can be used then whether the world is equipped with so much of stock to cure the rising COVID-19 victims. Many researchers have been working on the efficaciousness of hydroxychloroquine however the effect of hydroxychloroquine is yet to be seen. Also there has been no clinical evidence for hydroxychloroquine as of now. Efforts are being made to support universal decision of clinic and laboratories for the faster attainment of a vaccine. This work is a thorough study on experimental ideas and finding out whether hydroxychloroquine is an effective method of treating corona virus patients.
Process Modeling, Simulation & Optimization (PMS)
Novel process modelling and optimization methodology for design of a tubular reactor

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Abstract

The present work developed an Aspen model of a tubular reactor to produce methyl lactate from lactic acid and methanol. Reaction is carried out at very high temperature (340 K) to promote auto-catalysis. Operating conditions like the temperature and pressure of the reactor, the mole flow rate of two raw materials- lactic acid and ethanol and reactor design parameters like length and diameter has a profound effect on product purity i.e. reactor conversion. The effect of those parameters on reactor conversion is calculated by sensitivity analysis in Aspen. A large number of data is generated by sensitivity analysis of Aspen Simulation. These data are used to develop an Artificial Neural Networking model to predict product purity from reactor operating and design parameters. Genetic Algorithm is used to optimize reactor dimensions and operating parameters so that reaction conversion is maximized. ANN model is generated because Aspen simulation has limitation for optimizing large number of parameters. This Aspen Plus and ANN model along with GA optimization framework developed in this study is generic and can be used to optimize equipment design and operating parameters in any other process also.

Keywords: simulation, lactic acid, methanol, Artificial Neural Network, Genetic Algorithm, purity, conversion.
First principle and ANN modelling and multi-objective optimization of vinyl chloride monomer (VCM) plant

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Abstract

In this work, an Aspen Plus simulation was done for a full commercial vinyl chloride monomer plant from ethylene dichloride (EDC) which consists of EDC cracking unit, cooler, first multi-component distillation tower (to separate out hydrogen chloride), second distillation tower (to separate pure VCM). Unconverted EDC is recycled back from second tower bottom to the cracking unit. A complete sensitivity analysis is done to find out the impact of temperature and pressure of the cracking reactor, degree of sub-cooling of the cooler, reflux ratio of both distillation towers on product flowrate, heat duty of reboiler and HCl vent flow. Artificial Neural Networking model is also made from the sensitivity data. Multi-objective Genetic Algorithm optimization was done to simultaneously minimize heat duty of reboilers, vent flow of HCl and maximize the product flowrate. The developed methodology can be deployed in the plant for optimization in real time. Pareto optimal solutions are generated to represent the trade-off between three contradictory objectives. The developed modelling and optimization methodology is generic and can be used in any other process also.

Keywords: simulation, vent flow, heat duty, Genetic Algorithm, sensitivity analysis, Pareto.
Design optimization of heat exchanger by old and new generations metaheuristic optimization algorithms: Insights and comparisons

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Abstract

This study compares the performance of 3 old generation algorithms namely Genetic Algorithm, Particle Swarm Optimization and Differential Evolution with two new generation algorithms namely Firefly Algorithm and Symbiotic Organism Search in optimization of heat exchanger.

The optimization procedure involves the selection of the major geometric parameters such as tube diameters, tube length, baffle spacing, number of tube passes, tube layout, head type, baffle cut, etc., as per TEMA standard and minimization of total annual cost is considered as the design target. The methodology takes into account the geometric and operational constraints typically recommended by design codes. Three different case studies are presented to demonstrate the comparative effectiveness and accuracy of proposed five algorithms. From the results of all the three case studies, it is concluded that DE performed the best in terms of capturing the lowest value of total cost and minimum execution time. The new generation algorithm, SOS performed the second-best as it captures the lowest values of total cost every time, honours the constraints every time in reasonably low execution time. The final optimized heat exchanger comply TEMA standard, having lowest cost and obey all geometry, velocity and service constraints.

Keywords: Heat Transfer; Mathematical Modelling; Heat Exchanger Design; Firefly Algorithm (FA); Symbiotic Organism Search (SOS); Differential Evolution (DE); Constrained Optimization
Modelling and multi-objective optimization of commercial ethylene oxide reactor

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Abstract

In this work, a commercial ethylene oxide reactor was modelled by Artificial Neural Network algorithm with actual plant data as no reliable first principle based phenomenological model is available. In commercial plant, ethylene oxide is produced by reacting ethylene and oxygen at high temperature (225-275°C) and pressure (19-21 bar) with silver catalyst. The function of catalyst is to promote the desired ethylene oxide reaction (Ethylene + oxygen → ethylene oxide) and suppress the undesired reaction which produces CO₂ (Ethylene + oxygen → CO₂ + H₂O). A promoter is also added in small quantity (2-10 ppm) to enhance the catalyst selectivity. In commercial plant maintaining the optimum concentration of promoter is very crucial as it has large impact on selectivity. Our developed ANN model finds a relation of catalyst selectivity and catalyst temperature with other reactor operating parameters like promoter concentration, raw material concentration, CO₂ concentration etc. in reactor inlet gas. A multi-objective genetic algorithm (MOGA) is used to find the optimum reactor conditions to simultaneously maximize the catalyst selectivity and minimize the temperature. Pareto optimal solutions are generated to represent the trade-off between two contradictory objectives. Our developed modelling and optimization framework is deployed in running commercial plant for real time optimization of reactor conditions.
Exploiting and comparing metaheuristic optimization algorithms for design optimization of Plate and Frame Heat Exchanger

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Abstract

The area of optimisation has seen a boom of various metaheuristic algorithms with each claiming to be superior to others. This diversity in algorithms added with the intensified industrial requirements lead to a need for a systematic comparative analysis of these algorithms ensuring that an efficient algorithm is put in use in industries. This paper focuses on evaluating the performance of some of the old generation metaheuristic algorithms which have proven their calibre with some novel metaheuristic algorithms based on the global minimum and their respective execution time. The study involves comparing old generation algorithms like genetic algorithm (GA), particle swarm optimization (PSO), and differential evolution (DE) with new generation algorithms like Firefly algorithm (FA) and symbiotic organism search (SOS).

For evaluation a benchmark problem of optimising the design of plate and frame heat exchanger for a popularly found case is used. The methodology involved using major geometric and operational parameters as optimization variables namely hot and cold flow length, number of hot-side layers, fin frequency, fin thickness, fin height and fin strip length.

It was found that differential evolution (DE) performed best followed by symbiotic organism search (SOS) when analysed based on the global minimum and the execution time.

Keywords: Symbiotic Organisms Search (SOS); Firefly Algorithm (FA); Heat exchanger design; metaheuristic algorithms; mathematical modeling
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Insights into the optimal design of plate and frame heat exchangers through comparative study of old and new generation meta-heuristics optimization algorithm

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Abstract

The conventional design of a heat exchanger is a rigorous task including a complex trial and error process where the possibility of results may not be optimum. The diversification and intensification characteristics of meta-heuristics algorithms benchmarked the global optimisation. The novelty of this paper is that it uses Satin Bower Bird (SBO) and Biogeography Based Krill Herd (BBKH) algorithm for design optimization of Plate and Frame Heat Exchanger (PFHE) and simultaneously compares the performance with three well established old generation algorithms: genetic algorithm, particle swarm optimization, and differential evolution by analyzing a case study taken from the literature in order to have a reliable reference.

This procedure involves seven geometric and operational parameters as optimization variables like hot and cold flow length, number of hot-side layers, fin frequency, fin thickness, fin height, and fin strip length. All variables are continuous except the number of hot-side layers. From the result, the comparative study shows that Differential Evolution (DE) predicts a lower annual cost and faster converging rate than other algorithms followed by the new generation algorithm-Satin Bower Bird (SBO). In regard to case study, the comparative study justifies as a beneficial guide for sustainable, efficient and economic method for optimal design of PFHEs.

Keywords: Satin Bower Bird (SBO); Biogeography Based Krill Herd (BBKH); PFHE; optimal design
Combining Column Targeting & Exergy Analysis for Energy Efficient Distillation Column Configuration

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Abstract

To achieve better energy efficiency in distillation system, the column targeting tools needs to be complemented by thermodynamic tool like exergy analysis. The strength of both approaches facilitate modifications for energy target improvement of a base-case design of distillation column. This combined approach facilitates to identify process sections that are thermodynamically inefficient. The combination of process options like feed stage location, reflux ratio modification, feed conditioning, side-reboiler and side-condenser etc greatly enhances the separation and reduces exergy loss throughout the column. In this work, the thermodynamic analysis of distillation column was studied for propane-propylene binary system. The converged simulation of distillation column obtained from Aspen Plus were assessed with column targeting tools and exergy loss distribution. The energy efficient column targeting by both CGCC and exergy analysis achieves \textasciitilde29\% and \textasciitilde15\% reduction in reboiler and condenser duties respectively. This resulted in improvement in the distillation column energy efficiency in the range of 33\% as compared to base-case design due to reduction in total exergy losses. The combined approach of column targeting and exergy analysis resulted in reduction in thermodynamic imperfections.

\textbf{Keywords:} Column targeting, CGCC, Exergy Analysis, Pinch Point, Distillation, Thermodynamic Efficiency
A Comparative study of old and new metaheuristic optimization algorithm for design of Plate and Frame Heat Exchangers

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Abstract

In this paper, we present few results of old meta-heuristic optimization algorithms like genetic algorithm (GA), differential evolution (DE), particles swarm optimization (PSO) and new generation algorithms like migrating bird’s optimization (MBO) and intelligent water drops optimization (IWD) algorithm for design of plate and frame heat exchanger(PFHEs). Optimization was solely done to reduce the total cost. The optimization procedure involves the selection of the major geometric parameters such as hot and cold flow length, numbers of hot-side layers, fin frequency, fin thickness etc.

MBO is based on V-shaped flight formation of migrating birds. It starts with a number of initial solutions corresponding to the leader bird in a V-shape formation. Whereas intelligent water drops algorithm (IWD) works on new swarm-based optimization algorithm. It is inspired from observing the water droplet flowing in the river. The results of these algorithms revealed that old generation algorithm, namely, Genetic algorithm (GA), differential evolution (DE) gave the best results among all five algorithms in term of execution time and lowest cost. Whereas the new generation algorithms namely MBO and IWD performed third best every time.

Keywords: meta-heuristic algorithms; plate and frame heat exchanger (PFHE); migrating bird’s algorithm (MBO); intelligent water drops algorithm (IWD)
Abstract

In this study a methodology to design the lowest cost plate and frame heat exchanger was carried out. The procedure involves major geometric and operational parameters of heat exchangers including hot side flow length, cold side flow length, fin height, fin thickness, fin frequency, fin offset length, number of hot side layers, etc. are considered as the optimization variables and the minimization of total cost of the PFHE is taken as design target. This study applies three old generation metaheuristic algorithms, namely genetic algorithm, particle swarm optimization and differential evolution along-with two promising new generation algorithms, Intelligent Water Drop (IWD) and Big Bang Big Crunch (BBBC) for optimization of heat exchanger. The effectiveness and validity of the proposed five algorithms for optimization is investigated by analyzing a case study taken from the literature. Optimization of plate and frame heat exchangers considering the minimization of total annual cost under specified constraints has been conducted. From the results, it is concluded that particle swarm optimization (PSO) performed the best among all algorithms in terms of achieving the lowest total cost. Among the new generation algorithm, Big Bang Big Crunch able to achieve the third-best low values of total cost but its execution time is considerably low.

Keywords: Intelligent Water Drop (IWD); Big Bang Big Crunch (BBBC)); Metaheuristic algorithm; Heat exchanger design; Constrained optimization; Mathematical modelling.
Application of AI-based Genetic Programming (GP) to develop a Melt Flow Index (MFI) model for commercial High-density polyethylene (HDPE) plant

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Abstract

In commercial HDPE plant, Melt Flow Index (MFI) is the most important quality parameter of the final polymer product. Usually, inside a plant, MFI is measured by lab analysis which takes 4 - 6 hours before the results are available to plant operation engineers. Based on the results, production engineers change the operating parameters like polymer reactor temp, pressure, ethylene to hydrogen ratio, etc, to improve the MFI. Due to this time lag, when the product goes off-spec tons of undesired MFI polymer is produced and industry incurs huge losses. In the present work, a data-driven Genetic Programming (GP) model is developed which can predict the MFI on a real-time basis. GP is an AI-based modeling methodology and the GP algorithm has been improvised to make it effective for accommodating plant data. Commercial plant data and plant operating experience is utilized to identify the input parameters and train the model. The developed model is very accurate as evident from very high R^2 value and very low prediction error percentage, on unseen data. This model can be deployed in plant PCS to indicate MFI. The developed soft sensor helps the production engineer to avoid huge losses from the off-spec polymer product.

Keywords: Soft Sensor; Melt Flow Index; Genetic Programming; High-density polyethylene
Abstract

In commercial HDPE plants, MFI is the most important quality parameter of the final polymer product. Usually, MFI is measured by lab analysis which takes 4 - 6 hours before the results are available to plant operation engineers. Based on the results, production engineers change the operating parameters like polymer reactor temperature, pressure, ratio of ethylene to hydrogen etc., to improve the MFI. Due to this time lag, when product goes off-spec, tons of polymer is produced with undesired MFI value and industry incurs huge losses. In the present work, a data driven ANN model is developed which can predict the MFI on real-time basis. ANN is an AI-based modelling methodology. Commercial plant data and plant operating experience has been utilised to identify the input parameters and train the model. The developed model is very accurate and reliable as evident from very high R2 value and very low prediction error percentage on unseen data (test data). This model can be deployed in plant DCS to indicate MFI of HDPE product in real-time basis. The developed soft sensor helps the production engineer to take easy corrective and preventive action and avoid huge losses from off-spec polymer product.

Keywords: Soft Sensor; Melt Flow Index; Artificial Neural Network; High Density Poly Ethylene
Process Development for the Production of 1000 TPD of Ethylbenzene

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Abstract

Ethylbenzene is a colourless and flammable liquid. Ethylbenzene is used primarily in the production of styrene and synthetic polymers. Production of ethylbenzene can be accomplished by different routes such as, from mixed xylenes by isomer separation and catalytic isomerization, 1,3-butadiene in a two-step process, the zeolite-based process using vapor/liquid/mixed phase alkylation, etc. To begin with, literature study was done to document all the routes for the production of ethylbenzene. Based on raw material, product price, thermodynamic feasibility, safety, and selectivity considerations, and many other criteria, an appropriate process for the production of ethylbenzene was adopted in the work. Material balance calculations was performed in a spreadsheet for the chosen route. The entire process flow sheet for once-through process and recycle was simulated in DWSIM (v5.8). Stream-wise comparison of results with spreadsheet and DWSIM (v5.8) was done to check the correctness. Major equipment such as heat exchanger, reboiler and distillation column were designed. The economics of the process was determined based on the available data to ascertain the viability of the process. Furthermore, appropriate effluent treatment was done. E-Factor was determined in order to quantify the environmental friendliness of the process. Safety and hazard assessment for the process was done in order to analyze the risks involved in the process. The work demonstrate use of free & open source simulation tool for process development of a key petrochemical derivative.

Keywords: Ethylbenzene; Alkylation; Process Development; DWSIM
Process development for the production of liquid carbon dioxide from 2 TPH of raw gas

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Abstract

Liquid carbon dioxide is used in softening drinks, refrigeration and freezing in food processing, shield gas in welding, fire suppression systems, enhanced oil recovery of oil and gas wells, etc. Liquefaction is the major route used for large scale production of liquid carbon dioxide. It is a process in which gas is compressed and cooled to produce liquid. The present work focuses on development of flow sheet for production of liquid carbon dioxide from 2 TPH of raw gas. In this process, raw gas composition is taken from available industrial data. Operating conditions for the equipment are obtained by simulation in DWSIM (v5.8). Thermodynamic analysis is performed to know the feasibility of sequencing equipment in the flow sheet. Various types of heat exchanger are designed and results are compared with available data. The entire flow sheet is simulated in DWSIM (v5.8). A case study is done to determine the effect of increase in moisture content in the raw gas in the overall liquefaction efficiency. Economic analysis and safety analysis are also documented as a part of the work.

Keywords: Liquid carbon dioxide; Liquefaction; Simulation; DWSIM
Neolamarckia cadamba is one of the important medicinal plant belongs to the family Rubiaceae. Various parts of Cadamba tree has got Antivenom, Antioxidant, Antifungal, Antifilarial, Antimalarial, Antidiabetic, Antitumor activity. The motivation behind this project lies to extract oil by standard solvent extraction method using a modified Soxhlet apparatus. The effects of the various operating parameters such as temperature, solvent ratio and solvent type on the extraction yield of the oil have been investigated. The maximum extraction yield was obtained in water and ethanol. The maximum yield of the product (after processing) turned up to a feasible value of 33.2 percent. Effects of different process parameters are Optimized using Response Surface Methodology (RSM) through the central composite design (CCD). Three parameters (Extraction Time, Seed to solvent ratio and Separation Speed) are used to obtain the response surface.

This study definitively provides a thorough procedure to obtain the valuable extraction from the seeds of Cadamba to get maximum yield considering time and cost of the process and Optimization of the results. It gives an idea about how to optimally surpass the loopholes in the methodology working behind this objective.

**Keywords:** Soxhlet Extracti;, Cadamba seed; yield; Solvent to seed ratio; Oil; RSM
Simulation Studies for Production of Levulinate Esters by Reactive Distillation

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Abstract

With the diminishing fossil fuel resources and the trepidation of them exhausting in a few decades has led to escalating studies in the field of renewable energy, especially biofuels. Levulinic acid is produced abundantly from biomass processing; it serves as an eminent precursor for the synthesis of a variety of levulinate esters as fuel additives. The excellent fuel blending properties of levulimates has led to research in this field. Various catalysts have already been studied for manufacturing levulinate based value added products, experiments have also been carried out in this area to optimize the operating conditions. Conventional esterification reactions are seriously affected by equilibrium limitations thereby reducing their efficiency. Reactive distillation (RD) has shown to achieve almost qualitative conversion for most equilibrium reactions. Simulation of the production of levulinic acid derived compounds using RD column are studied for their yield. Also, the optimization of the RD column design is done for economic feasibility. The increased conversions will mark a great step in the production of fuel additives.

Keywords: renewable energy; biofuels; fuel additive; levulinic acid; reactive distillation
Process Development for the Production of 150 TPD 1,4-Butanediol

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Abstract

1,4-Butanediol (BDO) is a primary bi-functional organic compound used as an intermediate for the production of tetrahydrofuran (THF) and polybutylene terephthalate (PBT). THF and PBT form the key ingredients for producing spandex fibers, resins (THF), plastics and elastomers (PBT). The first commercial production of BDO was based on Reppe process that involves the reaction of formaldehyde with acetylene and subsequent stages of hydrogenation to produce BDO. Other processes use maleic anhydride (Davy process) and allyl alcohol (Dairen process) and 1,3-Butadiene (Mitsubishi process) as raw material. Based on factors such as capacity, thermodynamic feasibility, cost and availability of raw materials and product purity, Reppe process for the production of 150 TPD BDO was chosen and process flowsheet was developed. Material balance based on first principles was developed and the flowsheet was simulated in DWSIM (v.5.8). Major equipment (Distillation column and Heat exchanger) is designed as part of the work. Economic analysis for the process was done as part of the work. Effluent treatment guidelines for the given process were established as part of the work. This work focuses on the process development for the production of BDO using key chemical engineering principles and demonstrates the use of free & open source simulation tool.

Keywords: Butanediol; Reppe process; DWSIM
Study of Blast Furnace in Simplified Model: Experimental & CFD Study

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Abstract

The blast furnace is highly efficient but energy-intensive chemical reactor for iron production. Typical temperature in the blast furnace is around 1300-1400°C. Experimental and live operation measurements can be extremely difficult to perform on blast furnace due to extremely harsh environment generated by the operational process. In this project experiment will carried out in simplified model of Blast furnace (2D system). Computational Fluid Dynamics (CFD) modelling has been applied to simulate and validate for all experimental data, simulation.

Keywords: Blast furnace; CFD;
Rating of Shell and U-tube Heat Exchanger Using PRO/II Simulation Software

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Abstract

Rating of the heat exchanger is done when it is desired to know whether the Heat Exchanger sent by the vendor fulfils the required load or not. Sometimes, periodically there is a need to check the performance of the existing heat exchanger for a given operation. The current work is aimed at the determination of the rating parameters such as heat transfer and pressure drop for a Shell and U-tube heat exchanger. In this work, the extent to which the existing heat exchanger can be utilized for preheating the toluene using hot water as utility is assessed. To perform rating calculations, the steady-state process simulator PRO/II was used. Parametric studies were also performed using PRO/II case study feature to understand the dependence of heat transfer coefficient and the toluene outlet temperature on flow rates. Manual calculations were also performed using certain empirical convective heat transfer correlations. The results calculated, using PRO/II, are in excellent agreement with the manual calculations with an absolute error of less than 5%.

Keywords: PRO/II simulator, Heat Exchanger, Rating
Abstract

In this work, a commercial ethylene oxide reactor was modelled by Artificial Neural Network algorithm with actual plant data as no reliable first principle based phenomenological model is available. In commercial plant, ethylene oxide is produced by reacting ethylene and oxygen at high temperature (225-275°C) and pressure (19-21 bar) with silver catalyst. The function of catalyst is to promote the desired ethylene oxide reaction (Ethylene + oxygen $\rightarrow$ ethylene oxide) and suppress the undesired reaction which produces CO2 (Ethylene + oxygen $\rightarrow$ CO2 + H2O). A promoter is also added in small quantity (2-10 ppm) to enhance the catalyst selectivity. In commercial plant maintaining the optimum concentration of promoter is very crucial as it has large impact on selectivity. Our developed ANN model finds a relation of catalyst selectivity and catalyst temperature with other reactor operating parameters like promoter concentration, raw material concentration, CO2 concentration etc. in reactor inlet gas. A multi-objective genetic algorithm (MOGA) is used to find the optimum reactor conditions to simultaneously maximize the catalyst selectivity and minimize the temperature. Pareto optimal solutions are generated to represent the trade-off between two contradictory objectives. Our developed modelling and optimization framework is deployed in running commercial plant for real time optimization of reactor conditions.
“Model predictions of SARS-CoV-2 infection using chemical kinetics in batch reactor dynamics”

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Abstract

Nowadays, the pandemic infection of SARS-CoV-2 has been spreading in a huge number. Therefore, future prediction of this spreading behavior by using chemical reaction is often demanded in straightforward model. This will give the importance of the disease spreading and its behavior. In the present work, we considered one series parallel irreversible chemical reaction which is carried out in a hypothetical reactor (batch type reactor). A healthy population (A), active infected population (B), recovered population (C) and, deceased people (D), are to be assumed as molecules of chemical compounds and its dynamics seem well in accordance with those of composition and conversions in chemical syntheses. Due to these analogies, we are able to generate predictive pandemic model taking into consideration its chemical and physical properties and retrograde their kinetic parameters in order to anticipate peak time, entity and end of the infection with some credibility. Ordinary differential equation is adopted to analyze the infection data by given source. These predictions can surely help in emergency plans decision making.

Keywords: SARS-CoV-2; Infection dynamics; Chemical kinetics; Batch Chemical Reactor; Predictive model; Regression; Pandemic Mathematical Model.
Study of Heat Transfer through Rectangular Fins in Circular Conduit

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Abstract

Heat dissipation is a main challenge in process industries, electronic equipment, powerplants, etc. There have been numerous investigations to improve the heat dissipation by incorporating fins on the external surface of a body. The current study is focus on the use of rectangular fins in a circular conduit and the CFD analysis of various factors that affect the performance of these fins. In the current work, the effect of thickness of the fins, length of the fins and the number of fins on a given circular conduit is studied. A 3D steady state computational model is built on ANSYS (Student version, Ansys Inc., USA). Simulations are performed with water as test fluid. The inlet mass flowrate was varied over the range from 2kg/s to 6kg/s. The study shows that increasing the thickness of the fins result in increased heat flux to a threshold value and beyond which the heat flux remained constant. Also, with the increasing length of the fins, thermal resistance of the material increases, thereby decreasing the heat flux. Further simulation studies are in process. This study demonstrates the use of computational models for better understanding of concepts of heat transfer.

Keywords: heat dissipation; computational fluid dynamics; thermal resistance

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Extraction of Acetic Acid Using Green Solvents

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Abstract

Acetic acid being widely used in food and pharmaceutical industries is also used for the synthesis of organic compounds. After synthesizing acetic acid need to be separated from aqueous phase and from the literature it is found that various solvents such as benzene, tri octyl amine were used for extraction. These are harmful and cannot be used in food and pharmacy industry where acid produced (ex., vinegar, drugs) which is directly related to human consumption. Looking at the alternative, to choose green solvents, which are inert in nature and considers SHE(Safety Health And Environment) factors. Selected seven of these solvents namely MIBK, MEK, t-butanol, n-butanol, n-butyl acetate, iso-butyl acetate, ethyl acetate for further studies.

Ternary data was generated for Acetic acid water and with each of above solvent using titration method by comparing the solubility curve area suitable solvent was selected and found to be n-butyl acetate which has highest 2-phase area. Also generated tie line data using simulation software PRO 2 and calculated the distribution coefficients along with separation factors. And also studied temperature effects on solubility curve (26 °C, 30 °C, 35°C) and found out that lower temperatures (26 °C) are favorable. Similarly, generated distribution coefficient and separation factor for a particular concentration for all the solvents and found that n-butyl acetate has highest value of separation factor. Recovery of acetic acid from solvents using equilibrium data for flash calculations of P-X-Y and T-X-Y studied using Pro 2 software and is found that ethyl acetate and MEK, both are good for recovery.
Analysis of Two-Stage Membrane-Based Carbon Dioxide Capture Process Using Pro/Ii Steady State Simulator

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Abstract
Coal supplies over one-third of the global electricity generation and the flue gas from coal-fired power plants is a major source of CO₂ emissions. Membrane-based carbon capture technology has the following merits - the absence of moving parts and corrosive chemicals, absence of phase, and temperature change phenomena, leading to lower energy requirements, easy scale-up because of a modular design. Recent improvements in the permeability and selectivity of membrane materials have made the separation process more viable. Membrane process design involves the determination of the membrane unit size i.e., membrane area requirements. In this simulation study, a two-stage membrane separation and liquefaction assembly for a 600 MW coal-fired power plant is analyzed. The capture process was designed to meet the following specifications: 90% CO₂ recovery and 99% CO₂ purity in the CO₂ rich stream. The compression pressure for captured CO₂ is specified to 110 bar at a temperature of 25°C. The variation of the total membrane area and net energy consumption as a result of changes in permeation pressure and feed pressure have been studied.

Keywords: Membrane separation; CO₂ capture; Process simulation
abstract

The use of certain chlorofluorocarbon-based refrigerants in the conventional vapor compression refrigeration cycle has been causing ozone layer depletion and global warming. Due to this, there has been an increased interest in the refrigerants with zero ODP (ozone depletion potential) such as carbon dioxide, ammonia, and hydrocarbons. The refrigerant currently being used in cold storage for the storage of frozen products is R404a. Efforts are being made to upgrade to carbon dioxide. It is well known that for the conventional subcritical system the coefficient of performance (COP) increases with the decrease of the heat rejection (condensation) pressure. For the transcritical carbon dioxide cycle, however, the variation of the COP with the heat rejection pressure exhibits a non-monotonic change since the heat rejection temperature is independent of the heat rejection pressure in the supercritical region. This work is aimed at understanding, how the gas cooler exit temperature, the degree of superheat in the evaporator will affect the COP, and to determine the optimum compressor outlet pressure which maximizes the coefficient of performance. PRO/II steady state process simulator has been used along with manual calculations and a comparative study for various thermodynamic methods have been presented.

Keywords: Refrigeration; transcritical cycle; process simulation.
Reaction Model for Predicting Oxidative Degradation of Ortho – Xylene

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Abstract

Understanding degradation behaviour of chemical products is important not only for finding suitable stabilizers and predicting their shelf-life while stored in inventories, but also for safety and economic concerns. In this work, an oxidative degradation mechanism for ortho-xylene is studied. Long term degradation of liquid phase ortho-xylene is complex and can be initiated by generation of oxygen radicals caused by UV radiations followed by a set of liquid phase radical reactions. The oxygen radicals can react with o-xylene molecules to give benzene and toluene. Hydrogen donation and beta-scission of o-xylene produce o-xylylene which can rearrange to give styrene. Hydrogen donation of o-xylene followed by oxidation can give tolyl-methoxyl radical which can react further generating tolualdehyde. Termination reaction can occur between any two free-radicals in proximity to each other. Mass balance on various reacting species is performed to obtain the model equations required for predicting their concentration evolution. The rate constants of different reactions are either obtained from literature or estimated. Rates of reactions are compared in order to study the rate determining step. A parametric study is also utilized to find the key parameters governing the overall degradation.

Keywords: - Oxidation, Xylene, Parametric Research. Degradation, Reaction Mode
Multi-Objective Optimal Control of Otto-William Reactor

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Abstract

Optimization is essential for reducing material and energy requirements as well as the harmful environmental impact of chemical processes. Model-based process optimization has garnered particular interest and one such process is the Otto William plant which act as a test bed for various non-linear programming (NLP) algorithms and their relative efficacy. Generating optimal policies for this reactor is a challenging task, so a systematic and computationally tractable approach is developed for generating optimal operating policies for production of the desired product using Otto William reactor. Considering the issues in the field of optimization, this work develops a comprehensive and computationally tractable framework to maximize profits and minimize energy requirements using a multi objective optimization approach i.e., Non dominated sorting Genetic Algorithm II (NSGA-II). Further, the results generated are shown to give a set of trade off solutions to satisfy both the objectives. The optimization results indicate that NSGA-II is able to generate the global optimal solutions within reasonable number of cycles.

Key words: Model-based optimization; Williams- Otto Reactor; Genetic Algorithm II
Modelling and Simulation of Gas Engines Using Aspen HYSYS

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Abstract

In this paper gas engine model was developed in Aspen HYSYS. The rising cost of energy and emissions has necessitated the interest in an alternative economical, cost effective and least polluting means of power production. Fuel flexibility, fuel types and part load performance of the gas engine were investigated. The design variability revealed that the gas engine can operate on poor fuel with low lower heating value (LHV) such as landfill gas, sewage gas and biogas with biogas offering potential integration with bottoming cycles when compared to natural gas. The efficiency and power output were calculated.

Keywords: Gas engine, Aspen HYSYS, lower heating value
Abstract

In today’s world, major developments are happening in the field of optimization. Microfluidics is the concept that is highly used to optimise the expense in the field of research. Microfluidics considers treatment of fluid with volumes commonly in the scope of nano-to microliters (10^{-9} to 10^{-6} L) or smaller. Hence, the cost of raw materials, lab, operation, fabrication etc. is relatively less when working with them to establish the mechanism. Also, there are properties (for ex. surface tension, viscosity and diffusivity) which have more effect at micro level (can be known from scaling analysis). To study these properties and to understand the working of various processes in living beings and its applicability in industrial processes, research in the microfluidics area is required. As a part of the project, photocatalytic dye and bacterial degradation were simulated on different types of microchannels using finite element methods (FEM). Further, diffusion limitations of photocatalysis and reaction kinetics within the boundary layer of a catalyst surface are investigated. The insights obtained from this study would elaborate the understanding of the surface mechanisms of miniature devices and sensors.

Keywords: Microfluidics, FEM, Tubular Reactor, Photocatalytic Degradation.
Handling Styrene Effectively Through LG Polymers Ltd. Case Study

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ABSTRACT

In this growing age of industrialization, safety and design are the most important aspects to be considered during construction and commissioning of any industry. Any mishap in a chemical plant has two-fold effects - the immediate effect of the blast and the after effects of the chemical that spreads throughout the surroundings. There have been numerous accidents in industries reported till date owing to human errors and faulty designs leading to heavy toll of the human race both personally and financially.

One such incident reported during COVID-19 pandemic happened to occur at L.G. Polymers Ltd. in Visakhapatnam due to leakage of styrene gas. This study discusses in detail about the major reasons causing the incident with special emphasis on the safety and design aspect. The operational and maintenance errors which led to the accident have been enlisted. The study also includes an effective design of storage tank for styrene monomer that eliminates polymerization of styrene, excessive temperatures, contamination of polymer residue left in infrequently used pumps and pipes. Additional features like inhibitor addition, tank content sampling, tank breathing etc are also discussed as well in the preventive standpoint of such incidents.

Keywords: Styrene Gas Leak; Faulty Storage Tank; Polymerisation; Excessive Temperature; Tank Design.
Mathematical modelling approach for nodes selection in HAZOP

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Abstract

A Typical chemical process plant is best studied by the information such as process flow diagram’s (PFD) and piping & instrumentation diagram(P&ID). HAZOP study for a chemical process is very critical to operate the process to the desired level and safely. P&ID’s are the necessary diagrams for this study arbitrary selection of nodes by the HAZOP team. This is highly challenging to the team as this might consume lot of time in selection and study of the nodes. The primary focus of this study is to present a mathematical modelling approach for effective study. Many researchers Dunjo et al (2011, 2012), Khan and Abbasi (1997) have given models for node selection as a function of P&ID diagrams and number of Major Equipment (ME) and time for node selection. The reported model for node selection is in the form of:

Nd = a(P&ID’s) +b(ME)

This mathematical modelling approach if applied for chemical plants can ease the efforts of team.

Keywords: P&ID; HAZOP team; Mathematical Model; Nodes selection; Time of node selection
Zero Liquid Discharge Strategy And Related Energetics: A Study Of Thermal Desalination Integrated With Crystallization

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Abstract

Presently, desalination is carried out throughout the world with State of Art technology. The present study is focussed on the MLD (Minimum Liquid Discharge) or ZLD (Zero Liquid Discharge) by integrating Crystallizer with MSF-OT (Multi-Stage Flash Once-Through) consisting of 15 stages. The author has considered different combinations of crystallizer with MSF-OT to observe the maximum percentage of water recovery and thermal efficiency of the system. Additionally, the thermal efficiency of seawater was calculated for different salinities with MSF-OT. The simulation was carried out using Aspen Plus, ELECNRTL property method to recover potable water and precious salts (NaCl, KCl, MgCl\textsubscript{2}) that would add benefits to the plant. The simulations revealed that with an increase in salinity, thermal energy increased while water recovery decreased. The thermal energy of seawater (35000 ppm) turned out to be 69.763 kWh/m\textsuperscript{3} with 47.92\% of water recovered while for 2,15000 ppm, the water recovered and thermal energy of the plant was 38.984\% and 72.355 kWh/m\textsuperscript{3} respectively. Also, when crystallizer was integrated with MSF-OT, the best possible case revealed the solid fraction of precious minerals to be 1 with 57.25\% of the recovery of water. Yet, the thermal energy requirement turned out to be extremely high (349.264kWh/m\textsuperscript{3}).

Keywords: Desalination; Multi-stage flash; Zero Liquid Discharge; Minimal Liquid Discharge
Other Areas of Chemical Engineering (OCE)
Estimation of solubility of NH3 in Deep Eutectic Solvents using Artificial Neural Network

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Abstract

After the discovery of deep eutectic solvents (DES’s) with its unbelievable chemical and thermodynamic properties, research on green solvents paced up. Recent studies highlighted the use of deep eutectic solvents in the absorption of harmful gases released in the industries. In this work solubility of NH3 in nine deep eutectic solvents is studied using artificial neural network. A neural network is trained using Bayesian-Regularization algorithm. The resultant solubility is then compared with the solubility data available in literatures. The overall absolute deviation was found around 5.13%. Henry’s constant for each isothermal dataset is also calculated using estimated solubility and the average absolute deviation was found around 3.51% which indicates that our neural network is trained properly.

Keywords: Ammonia; Deep eutectic solvents; solubility; artificial neural network; Henry’s constant
Effect of green additive in cold finger apparatus to measure the performance in wax deposition studies

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Abstract

Chemical inhibition method is one of the most economic method to mitigate the wax deposition in pipelines. Before going into field study, it was recommended to check the efficiency of additives in laboratory scale. Cold finger apparatus is one of the most common wax deposition measurement apparatus in which probes are fitted into sample carrying glass bottle. In this experiment, 1h, 2h and 3h time interval wax deposition thickness was measured in between 30 - 50℃ temperature range.

The green additives were synthesized with Sesame oil. Transesterification reaction was performed between Sesame oil and Pentanol. Sesame oil contains triglycerides which turned into sesame oil pentyl ester after transesterification reaction. The functional groups were characterized by FTIR instrument and physical properties like wax, water, pour point and SARA analysis of crude oil was measured by ASTM procedure. Pour point measurement were done after treating with 0-2000 ppm additives with crude oil. Maximum 11℃ pour point reduction was observed after crude oil treated with 1500ppm additives.

After addition of 2000 ppm green additives, the wax deposition thickness was reduced 47% with Indian crude oil. The result suggested that hydroxyl (-OH) and Carbonyl (-CO) are responsible for interaction with asphaltene and resin to reduce the van der waals interaction force between the molecules.

Keywords: Wax deposition; Green additives; Transesterification ; Pour point
Permeability Study of dye wastewater using Nanofiltration membrane

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Abstract

Accumulation of hazardous species in aquatic environment becomes a threat to water supply for human, agriculture and recreational purposes. Because of low biodegradability of most dyes and chemicals used in dye industry, biological treatment does not always meet with expected success. Membrane separation technologies are reported to be a practical and competitive alternative for removal of a variety of dyes from aqueous solutions. In this work, wastewater from a dye manufacturing unit was treated by NF membrane using a flat sheet membrane module. Variation of permeate flux (PF) and dye retention with time were analyzed for different transmembrane pressure (TMP). Extent of dye retention, COD, conductivity and total dissolved salts (TDS) were determined to monitor membrane’s separation efficiency.

Keywords: COD, Concentration polarization, Permeability, Pressure drop, Retention
Online Course on Advanced Process Control with Industrial Exposure

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Abstract

Reduced profit margin and nerve-racking global competition has forced the process industries to switch focus upon yield and profit maximization, energy efficiency, waste minimization. Over two decades, implementation of Advanced Process Control (APC) in chemical companies, refineries, and petrochemicals industries, proved as an efficient controlling and optimizing tool to achieve above targets in real time. However, profit increasing opportunities, energy reduction and raw material consumption vary from plant to plant. Identifying those opportunities and exploiting them to enhance plant efficiency and capacity is an art; contemplated during functional design of APC.

Present work studied and gathered knowledge on different aspects like preliminary cost-benefit analysis, functional design, step testing, offline simulation and deployment of robust APC application, based on large refineries and petrochemicals plants. The practical knowledge of building APC applications are poles apart compared to theoretical/textbooks details of APC to date. This exposure is presented in an Online Course covering implementation steps, successful evaluation techniques and monitoring performance, once installed. Additionally, APC application failure along with its root cause and safeguards and corrective measures are incorporated too. This Course primarily bridges the gap between academic knowledge and industrial practice, beneficial to practicing chemical engineers, control engineers and process control students.

Keywords: online course; advance process control; cost-benefit analysis; monitoring performance
Long Term Structure Evolution in Electrorheological Fluids under Shear Flow

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Abstract

A two-phase flow continuum model is employed to obtain the long-time evolution of the structures in electrorheological fluids under constant shear and electric field. To this end, a temporal study of the ER fluid structures is performed using the continuum model. While columns get formed in the absence of shear flow, stripe formation takes place when a shear flow is imposed in the presence of an electric field. Our temporal study shows that stripes evolve and thicken after a sufficiently long-time for high shear rates. The results from our simulations are in line with the experimentally observed phenomena of thickening of stripes with time.

Keywords: electrorheological; shear; field; fluid; columns; stripes;
Fault distillation with Neo4j in Food Industry

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Abstract:
Customers are key stakeholders of a product of any company. Customer satisfaction is directly proportional to the progress of the company. For a company, it is not possible to deliver every product undamaged. It is crucial for any company to solve every complaint and improve its standards to satisfy their customers. When it comes to food products, every food product has its flavour, texture, and feel which attracts the consumer to have it repeatedly. An unpalatable product leaves an unsatisfied customer, when the customer raises a complaint to the respective company, it might take few weeks or months to get response. Every day, number of batches are produced in a factory. Even though sample checks are done, it’s not possible to check each and every product’s compatibility. To increase the complaint solving efficiency, the model called Fault Distillation with Neo4j (graph database platform) is developed wherein with a batch number, the data of the quality parameters, time of delivery of ingredients, and any other parameters that have observed on the day of processing can be acquired within a few minutes. Tracing the problem becomes uncomplicated with this method. This helps to improve the company’s products and provide a better profitable atmosphere too.

Keywords: Tracing data; quality parameters; complaint solving.
Challenges and Prospective for Carbon dioxide Removal

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Abstract

In the present scenario of climate change, greenhouse gases including carbon dioxide as one of the largest contributors, play a major role to intensify it. Major sources for carbon dioxide include burning of fossil fuels like coal, oil and natural gas. With the fast developing world, the need for energy is increasing day by day and so is the use of fossil fuels which might eventually lead to increase in global warming. Thus, there is a dire need to remove carbon dioxide from gaseous mixtures like natural gas, biogas etc. There are various technologies being employed for the removal of carbon dioxide out of which membrane-based technology is efficient, cost effective and environmentally friendly. Polymeric and inorganic membranes are the most studied having their own pros and cons. But now a days, a new class of mixed matrix membranes with metal organic frameworks (MOFs) as fillers offer combined advantages of the other classes of membranes. In this review, our key focus is highlighting the recent advances in metal organic frameworks based membranes with a detailed study of the permeability and selectivity data for different membrane bases and fillers. We will also draw a comparison between metal organic frameworks (MOFs) and polymeric membranes, thus providing a clear insight for the best possible kinds of membranes for different applications.

Keywords: Metal Organic Frameworks (MOFs); Mixed Matrix Membranes; Gas Separation.
Ionic Liquid Supported Membranes Form CO2 Separation

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Abstract

Separation of gaseous mixtures, involving carbon dioxide (CO2), is not only of scientific interest but also a social issue for environmental protection, due to its implications on global warming. Carbon dioxide is constantly being exchanged among the atmosphere, ocean, and land surface as it is produced and absorbed by many microorganisms, plants, and animals. Ionic liquids (ILs) have been proposed as potentially good solvents for CO2 capture and separation. They are formed by a combination of organic cations and organic or inorganic anions. ILs have attracted extensive attention in recent years due to their appealing properties: excellent thermal and electrochemical stability, very low vapor pressure, relatively high ionic conductivity. In this review we focus on the applications of ILs in separation processes. Thus, an extensive study is presented of various ionic liquids impregnated into the polymeric membrane to test the separation performance with pure as well as mixture of gases containing carbon dioxide.

Keywords: Ionic Liquids [ILs], Polymeric membrane, Membrane separation
Impact of lockdown and the trends after unlock on air quality of Delhi, Chennai and Mumbai during COVID-19

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Abstract

COVID-19 lead to a nationwide lockdown in India starting from 25th March, 2020 after a Public Curfew held on 22nd March, 2020. COVID-19 outbreak showed some positive impact on the natural environment. In the present work, the effect of lockdown on air quality of three major Indian metropolitan cities namely Delhi, Chennai and Mumbai is evaluated using MATLAB. The variations in concentration of key air pollutants including PM$_{2.5}$, NO$_2$, SO$_2$, CO and O$_3$ during three phases- pre-lockdown, during lockdown and post-lockdown phases, was analyzed. There was a reduction in concentrations of PM$_{2.5}$, CO and NO$_2$ of 70%, 66% and 54%, and 55%, 29% and 41%, and 56%, 65% and 80% for Delhi, Chennai and Mumbai respectively. However the improvement in the air quality was only a temporary lockdown benefit and the air quality is already degrading post lockdown as a result of revitalizing the economy which is evident on comparing the data during the same period in the years 2018 and 2019. Overall, this study gives confidence to the regulatory bodies that a significant improvement in air quality could be expected provided strict execution of air quality control plans is implemented.

Keywords: COVID-19; India; Air Quality; Lockdown; Air Pollution; Environment
Study and analysis of physical and thermal properties of biopolymeric composites and the effects of composition change on the properties of the biopolymeric composites.

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Abstract

Composites are the macroscopic scaled mixture of two different types of materials which produces materials with enhanced properties. Composites constituting of polysaccharide, polypeptide and plasticiser have shown significant improvement in the thermal, chemical and physical properties closely or equally matching plastics. Introduction of the biopolymers (polysaccharides, polypeptides) into the composite synthesis have shown a great potential of reducing the utilisation of synthetic plastics, from the existing procedure of composite manufacturing. This has also shown potential in reducing the existing solid waste management problems by recovering the biopolymeric matrices from the municipal and agricultural wastes. Due to the inclusion of various biopolymers, the properties of composites can be modulated according to the need by changing the composition (starch/cellulose/keratin presence) of the matrix which is not possible in the case of synthetic plastics. Furthermore, the composites unlike synthetic plastics are exceptionally biodegradable which is one of the main problems while dealing plastics. This paper focuses on the study of the effects on the physical properties of the biopolymeric composites due to composition changes and noting down the factors which induces the changes. Furthermore, producing the characterisation results obtained from FTIR, SEM, TEM etc to cement the study with proofs.

Keywords: Composite; biopolymer; biodegradable; synthetic; polymers
Effect of particle size and concentration of fly ash on the properties of polymer composite matrix.

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Abstract

Particulate filled polymer composite is growing by the years because of its wide application and low cost. Numerous particulates also known as fillers such as Mica, Rice straw, Calcium Carbonate, fly ash and so on has been used to enhance the various properties of polymer composites. Fly ash is a fine-grained powder, which is mainly composed of spherical glassy particles, produced during the combustion of coal at thermal power stations. It has been used in various industry due to its low density, strong filling ability, smooth spherical surface and it is easily available at low cost. It is a waste by product material that must be recycled or disposed properly otherwise it may give rise to several environmental issues such as atmosphere contamination and huge area for dumping. Utilizing fly-ash as a filler material in polymer composites is considered important in improving the properties of composites and also in reducing the production cost. The main aim of this work is to determine the effects of particle size and concentration of fly-ash on polymer matrix and its properties. The concentration of fly-ash and its particle size plays an important role in the enhancement of physical and mechanical properties of polymer matrix. The mechanical properties of polymer filled composites are strongly dependent on size, shape and distribution of filler particles in the polymer matrix. Scanning electron microscopy (SEM) is used to characterize the morphology of the polymer/fly-ash composite. Mechanical properties such as tensile strength, elongation of break, impact strength is analyzed as per the ASTM standards.

Keywords: Polymer Composite, Fly ash, Particle Size, Concentration.
Influence of Temperature on the Reactive Crystallisation of Oxalic Acid

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ABSTRACT

Reactive separation is a chemical process in which the synthesis of a substance (reaction) and the separation of products proceed simultaneously in one unit. It involves the reaction between the reactants to form a solute which crystallizes into a product. When chemical reaction is the reason for supersaturation of a crystallizing compound, the operation is known as reactive crystallization. In reactive crystallization, because of high local supersaturation reactions can be very fast compared to the mass transfer rates and growth rates to the crystals. The high level of supersaturation results in high nucleation rates and small size crystal in micron range. Production the small sized crystals in the pharmaceutical compounds manufacturing is important to improve properties such as dissolution rate, bioavailability, and tableting of the drugs, and to avoid additional downstream operations such as milling to reduce the particle size.

In this work oxalic acid was prepared by oxidizing sucrose using nitric acid and obtained the product in one step without further steps of purification. Influence of temperature on reactive crystallisation of oxalic acid was investigated. It was observed that in the sample which was cooled to 7 °C the nucleation has been just initiated but the crystal growth did not happened. Whereas the sample which was heated to 85 °C it was observed that white colour oxalic acid crystals were formed. So in reactive crystallization by lowering the temperature there was no considerable crystal growth. Hence evaporative crystallization shall be preferred for this process.

KEYWORDS: Reactive Crystallization; Oxalic acid; Super- saturation.
Application of extreme learning machine (ELM) method for recently developed process intensification (PI) techniques for biodiesel production

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Abstract

The fast depletion of fossil fuels and environmental pollution are the main concerns for mankind. Being a biodegradable and sustainable biofuels, biodiesel has potential to substitute gasoline diesel due to its similar phyco-chemical properties. Biodiesel produced through conventional mechanical stirring has several drawbacks, such as higher oil to alcohol ratio and catalyst loading, energy intensive, lower yield and excess time consumption. Recent studies suggest that process intensification techniques have potential to replace conventional mechanical stirring method with favorable process parameters. The developed techniques reported in the literature included microwave (MW), ultrasound (US), sequential or hybrid MW+US, hydrodynamic cavitation (HC), shock wave power reactor (SWPR) etc. The main process parameters of these techniques are: molar ratio, catalyst (%), reaction time, and reaction temperature and system specific geometric/operating parameters. Till recently, RSM based tools have been popularly used by researchers to optimize the process parameters to maximize the yield. The RSM based BB design, Taguchi and CCD methods are widely used to save time, effort, material and cost. Recent optimization studies related to biodiesel production reported that ELM method is superior modeling method as compared to RSM based method due to its unique features. The present study summarizes the feature of various PI techniques for biodiesel production process and the application of ELM method for optimization of process parameters.

Keywords: Biofuels; production techniques; optimization and analysis:
Process Intensification for Production of Bioethanol using Extractive Fermentation in Sugar Industry-A Review

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Abstract

Conventional fuels have a deleterious impact on our environment and the need of the hour is to promote the use of biofuels and Bioethanol is one such green fuel. India, the second largest producer of sugarcane can economically convert sugarcane wastes like bagasse and molasses into bioethanol. Fermentation is the key process which needs to be intensified in order to attain energy efficiency, higher yield of bioethanol and economy while considering the impact on the environment. Extractive fermentation is a strategy which involves product recovery by introducing a biocompatible organic solvent in the fermenter to selectively extract ethanol in a single step. The solvent is effectively recycled in a closed loop back to the fermenter. This process is characterized by high productivity, continuous operation, significantly reduced water consumption and lower product recovery costs. This paper has reviewed the process intensification in the system and analysed it in terms of cost of production, eco-friendliness, flexibility, consumption of energy and material, profitability, efficiency and overall sustainability.

Keywords: Bioethanol; Process Intensification; Extractive Fermentation; Sugarcane wastes; Sugar Industry
Dimethyl Ether from Syngas – Standpoint on Catalyst and Reactor Configurations

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Abstract

Dimethyl Ether (DME), additive to diesel, a clean fuel with high octane number makes it favourable to use it as a substitute for diesel and also for LPG as a cooking fuel. Catalytic synthesis of dimethyl ether is performed by two methods, direct method, a route wherein syngas is converted to DME in one step & indirect method, wherein first syngas to methanol synthesis takes place which is followed by dehydration of methanol to DME. DME synthesis if influenced by the the nature of the catalyst and also on the types of reactors and separators and their configuration dictating the process economics. This paper presents a review on the innovative strategies which have been reported for the production of DME from standpoint of catalysts and influence of operational parameters on DME selectivity, conversion and yield. Coupled and dual type reactors are industrial employed in the direct method, one such reactor is reactive distillation column with dividing wall column (R-DWC). The dual type reactor applies exothermic reactions as heat source and works on counter current configuration with increase the rate of production at low cost. Different reactors and configurations in practice are also compared here and a critical analysis is presented to provide future prospects in the field.

Keywords: Dimethyl Ether (DME), Syngas, Methanol, Bi Functional Catalysts, Dual Type Reactors.
Energy Saving Opportunity by suitable Variable Speed Drive to a Pump

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ABSTRACT

Energy plays an integral role in industrial development process. In Chemical Industry, Pumping system accounts for nearly 25% to 50% of total energy usage and as much as 75% of Pump's total cost of ownership. Many pumping systems require a variation of flow or pressure. When a single pump is installed for multiple range of duties, it should be sized to fulfil the greatest output demand, therefore it will usually be oversized, and will be operating inefficiently for other duties. Hence, there is always an opportunity to achieve an energy cost saving in pumping systems. There are various flow control methods for pumps such as throttle, bypass, on/off and VSD control. Out of which flow control by speed regulation of pumps, is one of today's best methods of varying the output. It serves advantages like energy cost savings, Simplified pipe systems by elimination of control valves & by-pass lines, Soft start & stop and reduced maintenance. This Paper compares the energy consumption for all flow control schemes, discusses various aspects of system curves for different process scenarios and also sets some process guidelines or rules of thumb for the installation of VSD for a new or existing pump.

Keywords:
Energy consumption, pump & system curves, comparison of energy cost savings.
Nutraceuticals is a word which has been derived from 'nutrients' and 'pharmaceuticals' that are available in the form of isolated nutrients, herbal products, processed foods and dietary supplements in various different forms such as capsules, tablets, etc. Nowadays, nutraceuticals have received considerable interest due to potential nutritional, safety and therapeutic effects. An analysis of its development, efficacy, current trends and challenges forms the basis of this paper. Recent studies have shown promising results for these compounds in various complications with increasing potential in its efficacy pertaining to target and using apt pathways. The explosive growth of health consciousness, research developments, burgeoning trends and satisfactory standards make it a high demand product along with its myriad benefits and minimal side effects. The nutraceutical industry has grown alongside the expansion and exploration of modern technology and is advancing at a paced rate with new processes, namely, various nano systems and advanced biotechnology systems which have been introduced to improve the therapeutic efficacy of products with varied applications which in turn promotes new researches for new prospects and trials to strive each day to enhance its activity and safety. Alongside of this booming success, the incipient industry faces various challenges such as developing a viable product with a background in scientific evidence and regulation in market without altering the nutritional supplement it provides.

Keywords: Nutraceuticals; Novel formulations; Efficacy; Regulation
Abstract

Water scarcity, insufficient freshwater resources to meet the human and environmental demands of a given area and increase in water pollution would be the major threat to the human society, nature and this planet in near future. As a solution to this problem, Membrane technology is widely accepted as a means of producing various qualities of water from surface water, well water, brackish water and seawater. In the present age, polymers and plastics dominate our rapidly developing daily needs and show enormous potential for the development of new technologies as they are the important building materials in the making of membrane. It is therefore obvious that the future of polymer chemistry will be influenced by the elaboration of new functional polymers. They are also widely used for membranes and in the solid phase synthesis of peptides and oligonucleotides. Membrane-based processes, with their inherent advantages, emerges as a highly competitive candidate for reclamation and reuse of water, owing to its efficiency, ease of implementation, cost, and low environmental impact. A major problem in membrane technology for applications such as waste water treatment or desalination is often the loss of membrane performance due to organic and bio-fouling. This review provides a comprehensive overview on the development of polymeric membranes having advanced or novel functions in the various membrane separation processes for liquid mixtures.
Photocatalytic Process for CO2 Emission Reduction in Chemical Industries

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Abstract

Reducing the impact of greenhouse gases (CO2) on climate change in an attempt to tackle global warming issues is a challenge many companies and businesses are trying to undertake. Businesses across the globe need to take a leadership role in reducing their carbon footprint. This paper proposes carbon sustainability framework that provides a comprehensive strategy to reduce the emission of greenhouse gases (CO2) from data centers in order to reduce the effects of global warming. This contribution describes a novel process systems engineering framework that couples advanced control with sustainability evaluation for the optimization of process operations to minimize environmental impacts associated with products, materials and energy. The sustainability assessment of process operating points is carried out by using the U.S. EPA’s Gauging Reaction Effectiveness for the Environmental be Sustainability of Chemistries with a multi-Objective Process Evaluator (GREENSCOPE) tool that provides scores for the selected indicators in the economic, material efficiency, environmental and energy areas. At present, carbon dioxide (CO2) is the largest contributor among greenhouse gases. This article addresses the potential application of photo catalysis to the reduction of CO2 emissions from industrial flue gas streams. Not only does this process remove CO2, but it can also convert CO2 into other chemical commodities such as methane, methanol, and ethanol. In addition, the photo catalytic process can consume less energy than conventional methods by harnessing solar energy. Given these advantages, photo catalysis is an attractive alternative for CO2 capture. This article reviews the principle of photo catalysis; existing literature related to photo catalytic CO2 reduction; and the effects of important parameters on process performance, including light wavelength and intensity, type of reductant, metal-modified surface, temperature, and pressure. Finally, we discuss various system configurations for UV and solar photo catalytic reactors. The advances in photo catalysis technology indicate a promising application potential for significant reductions of CO2 emissions and a positive impact on climate change effects.

Keywords: Sustainability, Process control, Reduction of CO2, Process performance, GREENSCOPE
Performance analysis of pulsating-gas-jet mixer based on volumetric mass transfer coefficient

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Abstract

Mixing is one of the important industrial treatments in order to attain and maintain the concentration homogeneity of the process streams. Care must be taken to achieve effective mixing at an industrial scale as the process is more energy intensive in nature. Literature reveals that research works have been carried out in order to improve the mixing index and to reduce the energy requirement. Jet mixing has been reported as one of the alternative methods for mixing of gas-liquid and liquid-liquid systems. Literature shows that jet mixing has its own merits and demerits. In order to improve the performance of mixer and to minimize the energy requirement for mixing, a novel method called ‘pulsating-gas-jet’ mixing was developed. This project deals with the performance analysis of pulsating-gas-jet-mixer based on volumetric mass transfer coefficient by passing the compressed air through the nozzles and recording the dissolved oxygen content of the working fluid (water). From the results of the study, it was observed that the mixing time was reduced on the usage of pulsating input on comparison with conventional mixers and it was also noticed that the pulsating gas jet mixer found to give good results in both mixing and mass transfer.

Keywords: Gas jet mixer; Pulsating input; mixing time; dissolved oxygen transfer.
Abstract

The amount of greenhouse gases in the atmosphere are continuously increasing and as the demand for energy increases in the coming years the amount is going to rise further. There are various methods to separate and reduce the amount of greenhouse gases which are pressure swing adsorption, water adsorption and cryogenic distillation which are well established. Nowadays, membrane technology is a promising and widely studied field. It is being widely used in selective separation of various gases which can be further utilized. It is also an economic and energy efficient process as it doesn’t require much energy to carry out the separation processes. Another promising technology is the ionic liquids (IL) which are also efficient in the gas separation processes. The conventional membrane technology is not effective in separation of various gases and has some drawbacks. For effective separation of the gases an efficient membrane is required. In this review, we are going to mainly focus on the effectiveness of membrane when combined with ionic liquid whose intrinsic property will help in effective separation of various gases. Moreover, future prospects and commercial viability of the supported ionic liquid membranes will also be evaluated.

Keywords: adsorption; cryogenic; membranes; ionic liquid
Modification of Polymeric Membrane using Graphene Oxide for Water Treatment

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Abstract

Water is getting highly contaminated from the effluents of industries, domestic sewage and other polluting agents. Treatment of such polluted water is a very challenging task. Various practically enhanced technologies are there for water/wastewater treatment in a very effective and efficient way. Among all those methods, membrane technology is a very novel, efficient, cost-effective and easy-to-go process. Unmodified membranes are not that much helpful in treating the water, so addition of some materials such as silica nanomaterials and carbon-based inorganic materials to the membrane coating enhances its permeability, mechanical strength, flux and rejection as well. Graphene oxide (GO) and functionalized GO intercalated with any type of membrane (PES, PVDF etc.) shows very promising results due to its extraordinary properties such as high specific surface area, thermal and mechanical stabilities, easy functionalization of surface, 2D nanostructures can also be prepared. GO's abundant functional groups, including epoxy, carboxyl, carbonyl and hydroxyl provide functional reactive sites and hydrophilic properties and increase the membrane performance. In this paper, functionalization of GO with various amines, polyamines, porous oxide materials such as Al₂O₃, alkylation with PEG and so more which helps in better permeance and selectivity of the membrane. It describes the methodology of preparation of GO layered hybrid membrane along with its characterization and removal of various pollutants from wastewater. At last, the mechanism behind the separation has been discussed in detail to get an insight into the process and future scopes in this area.

Keywords: Wastewater Treatment; Membrane Technology; Graphene Oxide; Functionalised GO
Highly stable M/NiO-MgO (M = Co, Cu and Fe) catalysts towards CO2 methanation

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Abstract

NiO-MgO nanocomposites are synthesized using solution combustion, sonochemical, and coprecipitation synthesis to understand the catalytic activity of CO2 methanation. Excellent particle size distribution was noticed with the sonochemical routed synthesis method, and the CO2 conversions are found to be better with the same synthesis protocol. Surface modifications in NiO-MgO composite were incorporated by doping M (M = Co, Fe, and Cu). The active catalysts are characterized by X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM) and transmission electron microscopy (TEM) to understand physical, structural properties and surface morphology of the nanocomposites. All catalysts showed excellent catalytic activity for the conversion of CO2 to methane and selectivity towards methane to be higher than 85%. However, 2%Co/NiO-MgO showed the lowest activation energy of about 43 ± 2 kJ mol⁻¹ among other synthesized catalysts. The mechanism of CO2 methanation was investigated with the inputs from temperature programming reduction with H2 (H2-TPR), and temperature programming desorption with CO2 (CO2-TPD) studies. Detailed reaction mechanism and kinetics are investigated for all doped catalysts. M/NiO-MgO offered excellent stability up to 50 h reaction time with high CO2 conversions and CH4 selectivities.

Keywords: NiO-MgO nanocomposites; Sonochemical synthesis; Reaction mechanism; CO2 methanation; Co, Fe, and Cu doping
Sterically hindered C-2 Substituted Benzimidazolium cation containing adamantane group as highly stable anion exchange membrane: Theoretical and experimental approach.

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Abstract

A Fuel Cell is a device that converts chemical potential energy (energy stored in molecular bonds) to electrical energy. Among various types of fuel cells that have been developed, the Alkaline Exchange Membrane Fuel Cell (AEMFC) is considered to be one of the most promising energy conversion devices for stationary and mobile applications due to enhanced oxygen reduction and fuel oxidation kinetics. In AEMFC, Anion Exchange Membrane (AEM) i.e. OH\(^-\), should possess high ionic conductivity, low degree of swelling and high chemical stability. Over the years, AEM’s suffers from poor alkaline stability, largely due to nucleophilic attack on the fixed cation species. Hence, in the present study covers synthesis of poly (arylene ether sulfone) copolymers containing benzimidazolium cations, determination of the effects of the C-2 substitution on alkaline stability of benzimidazolium salt by \(^1\)H-NMR spectroscopic analysis. Further, results indicate C-2 substituted benzimidazolium salt displayed enhanced stability at elevated temperatures in comparison to C-2 unsubstituted benzimidazolium salt, which may be due to the steric hindrance of the substituent. Further, details about the synthetic route, spectral analysis, and thermomechanical, physical and electrochemical properties have been discussed in detail.

Keywords: Benzimidazolium; Anion exchange membrane; Alkaline fuel cell
Study of Hydrodynamic Cavitation based hybrid advanced oxidation technology: A case study for degradation of Sodium dodecyl sulphate

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Abstract
dodecyl sulphate (SDS) is an anionic surfactant commonly used in detergents for laundry, personal care products and has potential application in industrial cleaning applications. However, removal of surfactant from wastewater is a challenging problem due to its low biodegradability. Hence in this work, the authors have reported the possibility of treating SDS laden wastewater using hydrodynamic cavitation (HC) technology for the first time. The authors have carried out a systematic study by optimizing the geometry of the cavitating device followed by studying the effect of process parameters like pH, inlet pressure, treatment time on the degradation rate of SDS.

Under optimized conditions of pH 2 and 5 bar of inlet pressure, % degradation of SDS was found to be 64.93 % in 120 min by HC process alone. Coupling HC with oxidizing agents such as H$_2$O$_2$ and Fenton’s reagent further accelerated the rate of degradation and improved the performance of the process and the maximum degradation was observed to be 99.96%. Additionally, the degradation mechanism of SDS at optimized conditions were evaluated using liquid chromatography–mass spectra (LC–MS) study. Further studies were carried out based on the energetics and economics for standalone technologies as well as hybrid process for implementation of the technology from lab scale to industrial scale.

Keywords: Surfactant degradation; Hydrodynamic Cavitation; Advanced Oxidation Process; Synergist Co-efficient.
Functionalization of PVA-CA membranes with nanoparticles for surface enhancement

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Abstract

In the current study, Polyvinyl Alcohol (PVA) and Cellulose Acetate (CA) composite membrane is doped with nanoparticles for surface enhancement. PVA hydrogel was prepared using the solvent Dimethyl sulfoxide (DMSO) with varied compositions of CA added in known quantities to get a homogeneous polymeric solution. The PCD-Ti, PCD-Zr, PCD-Cd flat sheet composite membranes were prepared using phase inversion method combined with gentle doping of nanoparticles like ZrO, TiO$_2$ and CdO. The synthesised PVA-CA membranes were examined using SEM, TGA, FTIR and XRD. The basic characteristics like pure water flux, membrane porosity, langelier saturation index, contact angle, dye rejection rate, and water uptake capacity were tabulated. The effects of different type of solvents involved during the preparation of PVA-CA membranes were also studied. The high-resolution SEM image analysis showed the homogeneous dispersion of ZrO, TiO$_2$ and CdO nanoparticles over PVA, and TGA analysis showed improved thermal stability of the membrane. The nanoparticle doped PVA-CA membranes showed improved mechanical strength and good chemical oxidation stability during Fenton test. PCD-Ti (6.4% wt) showed high thermal stability and oxidation stability at elevated temperatures of 290°C compared to PCD-Zr, PCD-Cd.

Keywords: surface enhancement; PVA-CA; composites; nanoparticles; membrane stability
Abstract

Imagine if your company is able to reduce the number of mundane, repetitive tasks that are completed manually by staff. Tasks that can often hold up sales, delay delivery, frustrate customers or, even worse, be completed incorrectly. This can be done by RPA. Robotic Process Automation (RPA) is transforming the way organizations across different industries do business. It allows organizations to automate work processes to reduce the time spent on costly manual tasks and increase efforts to deliver mission critical work. In the past few years, RPA has grown rapidly in many sectors. Manufacturers can get up to 40% cost savings using RPA. It can even increase employee productivity. Teams can provide quicker resolution to customer queries with RPA, automating searches across system into a single action by users bringing necessary data to resultant queries. RPA enables order placement with suppliers tracking shipped and delivered orders main inventory stock level. To stay competitive and to optimize manual process, RPA streamlines operational processes. If any error happens, this could lead to a massive loss in the industry. RPA allows the companies to create the product better because of data accuracy.
Advances in Steam Cracking

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Abstract

Petrochemical sector in India is a key pillar of the economy and one of the fastest growing, at a CAGR of about 10%. Despite the healthy growth, the per capita consumption stands at 10kg compared to the global average of 30kg, indicating significant headroom for growth. The steam naphtha cracking is the cornerstone of the petrochemical industry for the production of lower olefins. But, the present thermal process requires high energy, with significant down time for coke removal moreover, we have a little control over product selectivity, producing mainly ethylene. But, the demand for C3&C4 olefins is increasing at higher rate than the production levels. The capacity of on-purpose production technologies are still at very low levels and have a major concern on feed availability. The recent advances in the steam cracking involves a catalytic approach by which the reaction temperature can be decreased significantly and can also obtain higher yields of C3&C4 olefins apart from the ethylene. Here, we explore the catalytic steam naphtha cracking in terms of advantages over conventional steam cracking and also study the effect of various operating conditions on the product yields and the process kinetics.

Keywords: Catalytic steam cracking; Kinetics; Catalysts; Petroleum
Leak Detection in Heat Exchangers and Underground Pipelines Using Radiotracer

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ABSTRACT

In a large scaled industry, it is very common to have a little amount of leaks. But these small malfunctions can become threat to whole plants in real soon if undetected. This leaks are suspected if there is any abnormal behavior of a system, such as loss of pressure contamination of product or loss of process efficiency. Leaks create serious problems in process plants or in pipelines, spoiling the quality of the final product or reducing the transportation capacity of the water, oil and gas pipelines. A pipeline section leaking few liters of oil per hour to the environment has the potential to contaminate tens of thousands of cubic meters of groundwater per day. So the basic functions of leak detection are the location and size measurement of leaks in sealed systems. Radiotracer techniques are very sensitive, effective and competitive for on line leak detection, especially in heat exchangers and underground pipelines. Radiotracers allow an early detection of small leakages before these develop into major pollution incidents. Radiotracer can achieve the detection limits up to 0.1% of stream flow by emitting radiations.

KEYWORDS: LEAKS, HEAT EXCHANGER, PIPELINES, RADIOTRACERS.
Emission control by catalytic convertor: Present scenario

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Abstract

The increasing number of mode of transportation resulted in uncontrolled emissions to pollute air. Emissions from diesel vehicles are the main concern of air pollution related deaths worldwide. Its impacts are growing in most of the developing nations especially India, inspite of the regulatory limits. In 2016, the Indian government declared that the nation would skip the Bharat Stage(BS) V norms completely and adopt progressively stringent BS VI norms by 2020 in which the level of nitrogen oxide(NOx) and particulate matter (PM) emissions will be reduced by 89% and 50%, respectively, from BS-IV norms. The major pollutants emitted through vehicular sources are carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NOx), particulate matter (PM) and lead (Pb) which can be reduced by improving fuel quality and by improving the catalytic converter design or catalyst used in the convertor. In present study we have reported the various types of catalytic convertors used and the new research going on in Indian automotive industry.

Key words: Air emissions; Catalyst; Catalytic convertor
An Investigation into Phenomenal Characteristics of Rotating Packed Bed Reactor

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Abstract

Rotating Packed Bed reactor (RPB) is a novel equipment which holds a packed bed fixed within a hollow tubular casing. It uses centrifugal force in addition to other conventional principles of packed bed reactor to increase mass transfer and heat transfer. RPB reactor has been in research for its efficient usage/application in several industries. RPB is ideal for process intensification which aims to integrate multiple process/operations to enhance internal mass, heat transfer and kinetics at micro-level and thereby improve mixing. Rotating Packed Bed reactors significantly reduce the equipment volume and improves selectivity. These merits can effect intense micro mixing and internal mass, heat transfer. It can also provide more contact between reactant and catalyst and thus resulting in more product formation. Desired products can also be produced by adjusting the variable speed of rotation. RBP reactors also have come up with some disadvantages like channeling of inlet stream, side reactions, tedious heat transfer to/from the reactor and control of temperature gradient.

Keywords: Packed bed reactor; Rotating Packed Bed reactor; Mass and Heat transfer; Process intensification; Mixing
The world is moving towards sustainable development with focus on attaining the Sustainable Development Goals in the coming years. In this context the role of food industry is extremely important to attain the sustainability.

Sustainable development is the development that meets the needs of the present, without compromising the ability of future generations to meet their own needs. Making sustainability strategies operational is itself a big task, feeding a planet of 7.7 billion people is no easy matter. Every person on the planet needs, expects, and has the right to a healthy diet, every farmer needs, expects, and has the right to a decent livelihood.

A ‘food system’ involves the infrastructure and processes that go into feeding the population, such as growing, harvesting and transportation. Despite the increase in food production, the Food Sustainability Index ranks India 33rd among 67 countries in 2018. Many foods related conditions and diseases, including poor diet, under-nutrition, over-weight and obesity as well as general food safety risks are all interlinked. This study focuses on sustainable food production and policies that comply with international food safety standards and promote good health from the farmer’s field to the dinner plate.

Keywords: Sustainable development; Food safety; Health and Nutrition
Recent developments in printing technologies for electrochemical energy storage devices

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Abstract

Electrical energy storage (EES) devices play an important part in the development of sustainable energy technologies. Electrical energy generated from renewable resources such as solar radiation or wind have proven to be sustainable if not continuous in the quest for energy. Thus, these renewable energy technologies which generate electricity intermittently require efficient and reliable electrical energy storage methods. Ever since the development of Electrochemical Energy storage devices, scope for advancements in the fabrication methods and materials of these devices has been increasing. Massive research interest has been sparked among scientists in this field. Conventional methods like spray coating and vapour deposition, to name a few, have not been as flexible and low cost as one expects them to be. Recently developed printing technologies like 2D and 3D printing are well equipped to become more promising fabrication methods. This review provides an insight into some of the more commonly used printing technologies for the fabrication of EES devices emphasizing mainly on the 2D and 3D printing techniques employing graphene and graphene – based materials. The fabrication and performance of current graphene based batteries and supercapacitors have been reviewed. Challenges faced in the field of 2D and 3D printing have also been discussed.

Keywords :Printing techniques ; Graphene ; Electrochemical Energy storage devices
Effect of inorganic salt on the structure and dynamics of stereoregular isomers of poly (methacrylaic) acid (PMA) in dilute aqueous solutions-A molecular dynamics simulations study

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Abstract

The effect of monovalent salt i.e. NaCl on the structure and dynamic properties of stereoregular water soluble polymer polyelectrolyte poly(methacrylic acid) (PMA) was studied by atomistic molecular dynamics (MD) simulations with explicit solvent description. The stereoisomers studied in this work are isotactic-PMA (i-PMA) and syndiotactic-PMA (s-PMA). Results pertaining to salt concentration dependence on structural properties viz. radius of gyration, conformations, end-to-end-distance, h-bonds, intermolecular structure and scattering structure factor and, dynamic properties viz. chain relaxation, h-bond dynamics and self-diffusion coefficient of i-PMA and s-PMA and counterions will be presented. The PMA radius of gyration decreases with increase in NaCl concentration in corroboration with experimental and simulation works reported in the literature. The number of intermolecular h-bonds between PMA-water decreases with salt concentration for both isomers (i-PMA and s-PMA). The intermolecular structure and counterion condensation are studied via. radial distribution functions and quantified by computing coordination number values.

Keywords: poly(methacrylic acid); molecular dynamics; stereoisomers; intermolecular structure; counterion; radial distribution functions
Developing Hydrophobic - Oleophilic absorbent material by synthesizing composites of Ceiba pentandra (Kapok) for Oil Spill Clean-up

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Abstract

Oil spill clean-up is an expensive and complicated process harming marine life and further damaging the environment. Recently used methodologies include in-situ burning of oil, using chemical dispersants to breakdown oil into very small droplets, skimming oil floating on top of the water, and/or absorbing it with expensive, unrecyclable sorbents. Oleophilic and hydrophobic absorbent materials have received growing attention in recent years for promising applications in accidental oil spills. The porous structure and high lumen content enable Ceiba pentandra having excellent oil absorbency and retention capacity. The proposed model is a sandwich-like structure that has an innermost oleophilic layer of reinforced Ceiba pentandra and similar materials which is bounded by the hydrophilic sponge layer. The whole structure provides rigidity using a coated metal net. The hydrophobic sponge layer is obtained by a metal-ion-induced hydrophobic melamine sponge (MII-HMS) prepared by a one-step solution immersion process. The sponge is immersed in an aqueous solution of transition metal ions (e.g., FeCl₃) for a short period, followed by drying. This simple process renders the transition of the super hydrophilic melamine sponge to become highly hydrophobic. Ocean surface is simulated using surface wave generating device. Spinning the wheel of time and technology has led us to dive deep into the future possibilities of the advanced engineering and material science techniques for mitigating with oil spill clean-up.

Keywords: Oleophilic; Hydrophobic; Ceiba pentandra; Absorption
The increasing worldwide demand for energy is pushing oil and gas industries to look for heavy and inferior fuel resources as low sulfur-containing crudes are rapidly being depleted. Sulfur has deleterious impacts on the environment as well as human health. Removal of sulfur, especially below 10 ppm, from various types of fuels is an important area of research and countries worldwide mandate these low sulfur levels and the norms have become increasingly stricter in recent years. India also poses strict standard for fuel quality and vehicle emissions standards. Liquid petroleum fuels contain verities of sulfur compounds such as, thiols, sulfides, disulfides and thiophenes which cause severe environmental pollution by generating SO\textsubscript{X} and airborne particulate emissions during combustion, poison the catalysts of downstream processes as well as cause corrosion in refinery equipment.

Hydrodesulfurization (HDS) is the most widely used industrial process for removing sulfur compounds from petroleum fuel. But the severe operating conditions and the use of costly hydrogen make the process expensive. Hence, research is underway to develop alternative desulfurization processes. Alternative or non-conventional desulfurization processes such as oxidative desulfurization, adsorptive desulfurisation, extractive desulfurization etc are the upcoming techniques to take the position of HDS. Mild operating conditions such as requirement of temperatures less than 100˚C and atmospheric pressure make these processes more appealing over hydrotreatment. The oxidative desulfurisation takes place in the presence of oxidising agents such as hydrogen peroxide, tert-butyl hydrogen peroxide or in some instances, in the presence of molecular oxygen and ozone as well and the oxidised products are removed from the oil by adsorption or extraction with polar solvents. Adsorptive and extractive desulfurizations are non-catalytic, low-severity process, which need a suitable adsorbent and solvent respectively to remove sulfur compounds from petroleum fuels economically without changing the chemical nature of the fuel cut.

Esterification of Acrylic Acid with Ethanol

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Abstract
Esterification of acrylic acid with ethanol, The catalysed by sulphuric acid has been carried out in stirred batch reactor under atmospheric pressure. Different parameters such as effect of initial molar ratio, effect of catalytic loading, effect of reactant temperature has been studied in the batch reactor. Differed catalyst loading system (1-3%), initial molar ratio (1:1-1:2), reaction temperature(50-70°C) was used in the reaction system. The temperature dependence is exponential and expressed by Arrhenius type of relationship. Kinetics parameter such as equilibrium constant, rate constants, activation energy and reaction enthalpy and entropy were estimated by experimental data. The rate equation has remarkable fit to the data and was able to describe the behavior of the system of various reaction temperature. Sulphuric acid was found to be more efficient catalyst for esterification it induces the maximum conversion pf acrylic acid. ester, which are desired product out of esterification reaction, have varied applications. we want to developed optimum condition for the production of ethyl acrylic.

Keywords: acrylic acid, ethanol, kinetics, esterification.
Estimation of Material Accumulation, Temperature, Humidity and Generation Using IoT in Industry

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Abstract

Internet of things (IoT) has bounded itself into our lives and its wide application embedded into almost every gadget which we use. If such technology brought into the chemical industry it brings a huge difference in the work and also creates safe workplace. In industry during a certain reaction a person must completely monitor the reactor for amount of materials present in the equipment, temperature and humidity. We worked out a successful project in which we applied IoT to laboratory chemical apparatus. We had built a device which is used to measure the parameters like height of the materials present inside the equipment, temperature, humidity and generation which will be displayed on the monitor with more accurate values. Three major equipments are employed in the construction of our device includes an ultrasonic sensor, Arduino Uno and a DHT-11 sensor. Arduino Uno is programmed as per reactants and used to do the material balance. This device easily measures the distance and information is displayed on a monitor which runs a GUI (Graphical User Interface) which displays the various conditions in the reactor.

Keywords: Internet of Things; Easy measurement; Safe; Time saving; GUI
A Novel Integrated Approach for the Enhancement of Yield of Biogas from Cow Dung

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Abstract:

Present study deals with an integrated approach for the production of biogas from Cow dung to fulfill the growing demand of Indian market of the gas fuel. The ratio of Cow dung to water was optimized 1.5:1 (w/w) for the dilution. The effect of pre-treatment of cow dung with cavitation is checked and synergetic effect of this integrated system is obtained. It was also observed that the glucose concentration in the Cow dung increases after UC treatment which means depolymerisation of polysaccharides of glucose (cellulose) occurs. Effect of ultrasonic cavitation was checked with UV spectroscopic analysis in terms of Total Reducing Sugar (TRS). pH was maintained in between 4.5-5.0 during Anaerobic digestion using buffer solution. The outstanding enhancement in TRS in the pretreated biogas dilution with UC+Acid is obtained up to 34% due to synergetic effects of integrated pretreatment process. It is helpful to reduce the digestion time as well as increase in glucose concentration for the Biogas production. This would be breakthrough for the India as well as agricultural based countries to become self-reliance for fuel.

Keywords: Biogas Production, Total Reducing Sugar, Cow Dung, Ultrasonic Cavitation bath.
The shape memory polyurethane in chemical release and diffusion

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Abstract

Shape memory polyurethane are mechanically active and smart materials, which can be formed and fixed in a temporary shape and are able to deform to their original shape when exposed to a suitable circumstances such as the temperature change. In this the mechanism of pH responsiveness of pyridine compound and urethane is used, which acts as a switch to control shape memory and this functionality only depends on the change in the pH and not with the variation in the temperature. Where this is applied in the controlled release and diffusion mechanisms of engineering equipments as an automatic chemical release in process equipment and also can be used as a control for chemical reaction.

Keywords: shape memory polyurethane ; change in shape; pH responsiveness ; chemical release ; controlling reactions
Abstract

The present study focuses on medicinal plants which are used for the treatment of Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Aegle marmelos (Bael), Colocasia esculenta (Arbi), Curcuma longa (Haldi) and Tinospora cordifolia (Giloy) is use to check the herbal medicinal activity to see the immunity boost effect against SARS-CoV-2. Extraction studies for given plants has been carried out to investigate & confirm the presence of chemical compounds like alkaloids, coumarins, alkaloids, flavonoids and tannins. It confirms from reported data that Leaf and fruit extract of these plants shows anti-diabetic, anti-ulcer, anti-oxidant, anti-malarial, anti-inflammatory, anti-cancer, anti-fungal, antibacterial and anti-viral activities. Survey study to check the Socioeconomical effect of such plants also carried out and it shows that, medicinal plants show comprehensive results along with the traditional reports.

Keywords: Immunity Booster; CoV-2; Soxhlet Extraction; Chemical constituents; Bioactivity; Soxhlet extraction.
Development of Ceramic Membranes From Industrial Solid Waste Material and Their Application in Water Recovery from Aqueous Effluents.

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Abstract

The study proposes to develop ceramic membranes from industrial solid waste. The current industrial method of filtration uses diatomaceous materials as adsorbents, which adsorb impurities, colour, etc. After a certain number of filtration cycles, the filter bed has to be replaced with fresh one. This leads to a solid waste chiefly containing the diatomaceous material. Such industrial spent material is abundant with silica and other metal oxides. This either goes to incineration or land filling. This study proposes to develop ceramic membranes from such industrial spent material, because of their chemical inertness, rigidity, and high temperature stability, as compared to polymeric membranes. Ceramic membranes were been synthesized in-house based on the previously reported methods using fully characterized industrial spent material. Synthesized ceramic membranes were tested for water recovery from industrial aqueous effluents. The overall objective of the project is to develop a technology for the reuse of industrial solid spent material for water recovery and effluent treatment purposes.

Keywords: Membrane; Industrial Spent Material; Ceramic; Filtration; Effluent.
Role of PSM Critical Elements in Engineering Control

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Abstract

The approach to controlling the chemical risk from a process is rarely straightforward as there will always be a choice of control options – some easier to apply than others. The present work emphasizes on the engineering controls, a part of hierarchy of control. This consists of a variety of methods for minimizing hazards, including process control. Well-designed engineering controls can be highly effective in protecting workers from accidents. Accident has become a huge issue in the world which has been recurring in the process industries today though there are a number of safeguarding elements. For example, in the LG Polymers accident elements like MI, PSI, OP, PHA, and PSSR should have been thoroughly considered post lockdown in pandemic situation COVID-19 which could have prevented the release of styrene. Poor maintenance of the storage tank has resulted in polymerisation of styrene due to presence of iron oxide in the tank. As higher temperatures are bound to cause styrene vaporization and subsequent build-up of polymer, maintenance of lower temperature in the tank was preferred in the range of 10–18°C. Well established interlocking system between the tank temperature and refrigeration system could have prevented the onset of reactive hazard. Elements mentioned above of PSM mainly address the safe operation of the process equipment to prevent loss of containment. Present work suggests that these elements are critical.

Keywords: Engineering control, PSM critical elements, Interlocking system,
Ameliorating economic sustainability of Enhanced Oil Recovery (EOR) by Polymer flooding method

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Abstract

With Industrial Revolution 2.0 the energy demand is more than obvious. Among the non-renewable energy solutions, about 5.1 million barrels of oil was consumed per day only in India (2019). Keeping that in eye we need to rethink the production strategies and expenses of oil production. In this project, we have performed an analytical examination on Ameliorating economic sustainability of Enhanced Oil Recovery (EOR) by Polymer flooding method. Polymer flooding is a non-thermal and only proven chemical enhanced oil recovery (EOR) method in which a non-Newtonian polymer gel like Polysaccharide derivative and polyacrylamide derivatives are used to decrease the water-oil mobility ratio by increasing the viscosity of displacing water. Polymer flooding has considerably higher oil recovery potentials than waterflooding, which is typically on the order of 6%–12% higher, which gives a 40%–50% recovery factor of initial oil in place (IOIP) after application. So our main objective is to improve the efficiency of oil recovery process in an economical and sustainable way by using an advanced form of polymer flooding method by blending it with alkali and surfactant flood. We have also explored on Fractional flow and diverting injected water from zones for more efficacious recovery.

Keywords: Polymer ratio; Mobility ratio; Recovery factor; Fractional flow
Various Aspects of Production of Ethylene Glycol

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Abstract

Ethylene glycol, also called ethane-1,2-diol or monoethylene glycol (MEG), is the simplest member of the glycol family of organic compounds. It is an odourless, colourless, sweet-tasting viscous liquid. It is an important industrial compound used in a large number of commercial applications mainly in manufacture of polyester fibre and for antifreeze and coolant formulations. Owing to its versatile applications, a variety of methodologies have been explored for the synthesis of ethylene glycol, and great efforts have been undertaken in order to improve these processes. The commercial route to ethylene glycol in use today involves hydrolysis of ethylene oxide. Although hydrolysis with both acid and base catalysts are proven methods for ethylene glycol production, neutral non-catalysed hydrolysis has been shown to be equally popular. The descriptive study of these methods has been done and distinction between these processes has been made.
Rosemary Essential Oil Extraction and Its Components from Microwave Hydrodistillation Method

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Abstract

The main focus of this review project is to study the advantages and properties of the rosemary essential oils and to study its components. The major part of this paper also focuses on the impact of the extraction process for the essential oil of rosemary. Microwave Assisted Hydro Distillation (MAHD) process is proven to be one of the finest methods among the already existing one for the isolation of essential oils from rosemary plants. The process is based totally on the principle of classical hydro distillation method. The study of the extraction of essential oil and its components of rosemary oil, is characterized by the Gas Chromatography coupled with mass spectroscopy (GC-MS). The study of the methods (MAHD, HYDRODISTILLATION (HD)) has been done from the available literature on the basis of cost, energy, time and cleanliness or the environmental safety and is effectively compared with each other. The results according to the literature reviewed suggest that the yield of the rosemary essential oil is much likely the same as other methods quantitatively (yield) and qualitatively (aroma). Based on the research and when compared on the basis of mentioned aspects MAHD process stands out to be the most efficient method among the traditional one (HD). Microwave heating appears to be very versatile and safe. For example, the total time of the extraction of essential oil for 100 gm of plant was calculated to be 30 mins for MAHD and 90 mins for SD. Moreover, this review also covers the general components of essential oils and their properties and other general advantages of essential oils from other plants. In the conclusion, MAHD has more advantages over the traditional methods and therefore it can successfully replace the traditional industrial methods on a pilot and industrial scale for extracting essential oil from rosemary and other aromatic and medicinal plants after comparing.
Abstract

Concern about the environmental pollution increased due to enrichment of civilization, globalization and countless falls down in ecosystem. Among the different kind of environmental pollution, water related pollution has taken the attention of scientists and researcher. Different pollutants, for example dyes, phenols, heavy metals, organic compounds, etc. can be removed productively by using rice husk (RH) and rice husk ash (RHA) in the form of adsorbent. An attractive adsorbent which need not require any additional pre-treatment and is inexpensive provides alternative for pollutants removal from waste water. The utilization of RH and its RHA due to its different properties such as insoluble in water, upper mechanical strength, chemical stability & granular structure, makes it desired adsorbent substance. This article shows brief reviews on the contribution of RH and RHA in the elimination of several toxins through contaminated water. Studies on the adsorption of different toxins by RH material are looked into & the mechanism of adsorption, appreciative conditions, influencing factors etc, examined in this article. It is noticeable from the review that in the field of adsorption science, the expansion of rice husk and their ash represents a valuable and powerful tool which has led to great improvements in pollution control and environmental protection.

Keywords: Rice husk, Dyes, Inexpensive, Adsorbent, Pollution
Abstract

Sulphuric acid, also known as the Oil of Vitriol, is a mineral acid composed of the elements sulfur, oxygen and hydrogen. It is a colourless, odourless, and viscous liquid that is soluble in water. It is a basic raw material used in a wide range of industrial processes and manufacturing operations. Due to the continuous expansion and variation in the market and to meet the increase in demand of Sulphuric Acid, the sulphuric acid industry has been adopting new methods and technology for improving plant reliability, operability, environmental and safety services. The paper deals on this aspect of the acid industry and describes the production process which is the contact process along with the transition brought about in the production sector. The paper also describes the recent advancements made in the production process including air pollution control, minimising the emissions using scrubbers and improving efficiency.

Keywords: Sulphuric acid; Oil of Vitriol; Sulphur
Abstract

Anisole synthesis by vapour phase methylation of phenol and methanol is carried out in presence of gamma-alumina catalyst in fixed bed reactor. The vapors of phenol and methanol are reacted over gamma- Alumina catalyst with mole ratio of 1:5 respectively. Keep the catalyst at 6000 C for 4 hrs for calcination. Silica balls are used for packing with 2 grams catalyst at middle of the reactor and fed the solution with the flowrate of 0.3 ml/min. The Anisole selectivity is maximum at 250 0c and selectivity decreases in between 275 0c – 300 0c therefore 250 0c is optimum temperature hence selectivity inversely proportional to temperature .The reaction follows first order reaction according to kinetics study by plotting graph of concentration vs time .The rate of a first-order reaction is proportional to the concentration of one reactants rate .The purity of anisole is further increased by distillation process.

Keywords: methylation,calcination,kinetics, gamma-alumina,selectivity.
M.P Chary Awards 2020
Synthesis of 2, 5-Dimethyl Furan (DMF) from Renewable Lignocellulosic Biomass

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Abstract

Renewable biomass resources could reduce the dependency on the fossil fuels by conversion of its lignocellulose into bio-fuels and other valuable chemicals. Depolymerisation of lignocellulose, hydrolysis of cellulose to monomer glucose and its subsequent dehydration results 5-hydroxymethylfurfural (HMF). HMF is an important platform chemical for fuels and various other applications. The hydrogenation of HMF results 2, 5-dimethylfuran (DMF), which may be a biofuel with 40 % greater energy density than that of ethanol. The homogeneous catalytic method is preferred for lignocellulosic biomass conversion to cellulose, its hydrolysis and further dehydration to HMF. This review is an attempt to summarise the current research and developments in the field of lignocellulose derived HMF and further conversion to DMF as a potential biofuel using conventional homogeneous and heterogeneous catalyst as well as using deep eutectic solvents as green solvent.

Keywords: Biofuels, Biomass, Chemicals, Dimethyl furan, Lignocellulose.
**Synthesis and Characterization of Aromatic Polymer Blend Membranes for Fuel Cell Applications**

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**Abstract**

The energy crisis has been one of the globe’s foremost concerns because of rapid industrialization and depletion of fossil fuel resources. Consequently, there is an urgent necessity to develop energy efficient machinery that is ecologically friendly. Under these circumstances, membrane-based fuel cells (FCs) appears to be potential by having membranes one of the foremost components. Nafion membrane manufactured by Du-Pont, USA, is widely used, but owing to its high production cost, temperature limitations and high methanol permeability, restricts its widespread commercialization. Therefore, the present work focuses on the synthesis of more affordable alternatives that overcome the limitations of Nafion. To control the problem of methanol crossover or hydrogen (H2) fuel bypass without sacrificing their proton conductivity, chemical crosslinking and physical blending of polymers have been investigated in this work. Different polymeric blend compositions made up of sulfonated polyethersulfone (SPES) with polyetherimide (PEI) and polyamide-imide (Torlon) were synthesized by solution casting and solvent evaporation method to obtain dense (nonporous) membrane. Apart from blending, nanocomposite membranes prepared from polyaniline (PANI) were also studied. The structural and surface modifications of membranes after blending and doping of nanoparticles were confirmed by FTIR, XRD, TGA, and SEM analysis for comparison with their pristine membrane. Furthermore, the combination of the biodegradable and synthetic polymeric membrane was also studied. The synthesized blend and nanocomposite membrane exhibit low fuel crossover without sacrificing proton conductivity along with maximum performance of 0.13 W/cm2 shows that the indigenously synthesized membranes exhibit a strong potential for membrane-based FC applications by demonstrating all the desired properties.

**Keywords:** Membrane; Fuel cell; Molecular Dynamics; Polarization curve; Proton conductivity
Modeling and Simulation of Biodegradation of Scaffolds for Bone Tissue Engineering

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Abstract

Tissue engineering is a promising field of research which offers reconstruction or regeneration of a particular tissue and organs. Scaffold plays an important role in tissue engineering and an optimum degradation rate and enough mechanical strength are required during the regeneration of tissue. 3D printing technology attracts researchers and clinicians to fabricate biodegradable scaffolds. Mathematical modeling and simulation of scaffold degradation, mechanical stimuli and bone regeneration can provide an optimal design of 3D scaffold using computational methods. The present work is to model the degradation of polymeric scaffold which occurs due to diffusion. The reduction in molecular weight over the time is modeled by understanding the concentration of functional groups remain inside the polymer matrix and Fick’s law of diffusion using Matlab. Simulation resulted, 80 percentage of polymer gets degraded at the end of 14 week. Young’s modulus calculated using the porosity of scaffold reveal that, up to 4 week the degradation rate is slower and after which undergoes faster degradation and scaffold is capable of withstanding for a minimum period of 14 weeks and ensures regeneration of tissue in the defected bone. Another attempt of 3D geometry of scaffold with four layer is developed with the following dimensions diameter – 4 mm, Height – 5 cm and spacing – 2 mm in Comsol. Concentration drop during the degradation process is captured for the entire geometry and it is observed that for 10 hours of simulation edges of the scaffold begin to degrade thus ensures the complete degradation of entire polymer matrix. Simulation time and step size are to be increased to predict the complete degradation of polymer matrix.

Keywords: Scaffold; Degradation; Concentration
Inkjet-printed nanostructured electrocatalyst for Fuel Cell application

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Abstract

Proton exchange membrane fuel cells (PEMFCs) are an energy-efficient alternative to combustion engines for automotive applications but are on the cusp of mass-adoption, mainly due to higher costs. Significant advances have been made in PEMFC design over the time concerning cost-reduction and structural redesign. The membrane electrode assembly (MEA), especially the electrocatalyst, is considered as ‘the heart’ of a PEMFC and is designed to accommodate constraints imposed by the cost of platinum used for electrocatalysis, as well as the need for efficient transport of electrons, reactants, and heat. The current design of Pt/C electrocatalyst is prone to carbon support corrosion followed by deactivation under PEMFC working conditions and has led to renewed interest in carbon-free nanostructured electrodes (NSTFs). Contextually, the Print-Expose-Develop technique developed in our group was used to fabricate porously and conducting silver nanostructures on the Nafion membrane. Preliminary results confirm successful electrodeposition of Pt on metallic nanostructures via the self-terminating process having <10μgPt/cm² loading. The ease of printing silver nanostructures using a simple inkjet printer and the ability to coat them with atomic layers of Pt via cycling of electrode potential can pave the way for a cost-effective, additive process for manufacturing of MEAs for PEMFCs.

Keywords: Inkjet printing, Print-Expose-Develop; Self-terminating electrodeposition, Pt atomic layers
CLeONs: Contact Lens-based Oxygen Nanosensors for Rapid pO₂ Sensing in the Post Lens-Tear Film

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Abstract

Contact lens wear affects oxygen tension (pO₂) in the post-lens tear film (PLTF), and thereby, influence oxidative metabolism of the cornea. pO₂ measurement underneath the tear film is important to assess corneal health. However, rapid measurement of pO₂ dynamics in the PLTF is still an unmet need. Thus, we propose to employ contact lenses coated with silicon nanoparticles (NPs) containing O₂ sensitive Ruthenium phenanthroline to measure pO₂ dynamics.

Ru-SiO₂ NPs were prepared by microemulsion method. To enhance binding to the contact lens, they were surface functionalized and coated on the posterior surface of contact lenses using dropcoating method. The average size of functionalized Ru-SiO₂ NPs was 190 ± 50 nm. Photoluminescence analysis showed fluorescence at 590 nm confirming the presence of Ru complex. SEM imaging and AFM confirmed the deposition of nanoparticles on the lens surface.

Furthermore, Ru did not leach out from CLeONs. Fluorescence lifetime of Ru complex was 60100 ns. Fluorescence quenching was observed in the presence of oxygen and significant increase when exposed to N₂, demonstrating its oxygen selectivity. Based on these findings, we presume that CLeONs can be used as a sensor for measuring pO₂ dynamics rapidly and selectively in the PLTF.

Keywords: Oxygen, post lens tear film, Ruthenium silica nanoparticles, fluorescence quenching.
Aqueous Calcium Amended - Hydroxyapatite Defluoridation Method: A Step towards Mitigation of Crippling Fluorosis for Rural Areas

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Abstract

In India, around 11.5 million people are at high risk due to an unappreciated and debilitating disease, fluorosis, which is mostly caused by the drinking of fluoride-contaminated water. Researchers had made efforts to alleviate fluorosis, which given some relief from this widespread disease. However, they fail to provide a permanent solution for this crippling disease due to adverse health effects on the consumers. Defluoridation using synthetic hydroxyapatite found to be a cost-effective and efficient method due to its propensity to uptake fluoride ion. However, hydroxyapatite dissolution during defluoridation was an unattempted problem. Hence, this water was unfit for drinking due to the higher residual values of pH and phosphate, and no calcium even hydroxyapatite could effectively remove fluoride. A modified method was proposed to overcome this issue which suggested that amending aqueous calcium to the fluoride water before contact with the hydroxyapatite successfully prevented its dissolution and also enhanced defluoridation capacity. Further, the treated water was calcium-enriched and alkaline. A field study done using this proposed method reported that it was free from hydroxyapatite dissolution and also fluoride-removal was effective. Further, it reported that there was an improvement in the health of fluorosis-affected patients after drinking this water. In conclusion, “aqueous calcium amended-HAP defluoridation method” would be a promising method not only for fluorosis prevention but also it helps in the fluorosis reversal in the already affected population.

Keywords: Drinking water; Fluoride contamination; Fluorosis; Fluoride removal; Hydroxyapatite; Household water filtration.
Ultrasound-Assisted Hybrid Techniques for Developing a Sustainable Environment

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Abstract

The present investigation provides the information to understand the mechanism of sono-hybrid techniques including validation of experimental results with simulations of cavitation bubble dynamics model for identifying the links between the physics and the chemistry of ultrasound and cavitation. The study also reports the ultrasound-assisted green synthesis of alternative fuels, nanomaterials using plant extracts and its application for oxidation processes towards developing sustainable environment. The effects of different process parameters such as intensity, frequency, system temperature and pressure, properties of the solvent, oxidant dosages etc. have also been extensively investigated. The results of his study have shaded light on the intricacies of the ultrasonic processes and have helped to identify the relative contributions of different parameters in the process to the overall outcome of the process (in terms of either kinetics or yield).

Keywords: Green Synthesis; Advanced Oxidation; Modeling; Cavitation
Abstract

Herein, the synthesis of most sought-after chemicals such as 5-ethoxymethylfurfural (EMF), 5-hydroxymethylfurfural (HMF), and ethyl levulinate (EL) from different feedstocks is studied. Obtained compounds serve as a precursor to producing a variety of commodity chemicals as well as fuel both. In this regard, synthesis of EL from HMF in the presence of inexpensive metal salts have been demonstrated. The reaction mechanism illustrated the overall EL synthesis from HMF proceeds via EMF formation. Therefore, another novel process has been developed and patented for the selective synthesis of EMF from carbohydrates in the presence of dichalcogenides. Alternatively, EL synthesis from the biomass-derived and commercially available levulinic acid have been explored. For this purpose, novel heterogeneous catalysts have been prepared via wet impregnation method using Keggin type silicotungstic acid and zirconium dioxide support. Subsequently, synthesized catalyst has been characterized using XRD, FT-IR, Raman spectroscopy, BET surface area analyzer, Ammonia TPD, FESEM, TEM, and HR-TEM. After that, production of ethyl levulinate in a microwave reactor using synthesized catalyst have been explored. Eventually, a suitable kinetic model has been developed to calculate the activation barrier for EL formation from the levulinic acid in the presence of zirconia supported Keggin type silicotungstic acid.

Keywords: Green Catalysis, Biofuel, Biomass Conversion
Prospect of biopolymer derived hydrogel for controlled environment agriculture

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Abstract

Hydrogel derived from naturally occurring biopolymers (e.g. cellulose, lignin, alginate) can be widely deployed for agriculture applications. The waterabsorbing quality and water retention property of hydrogel makes it a suitable candidate in arid and semi-arid conditions. The presence of the biopolymer promotes the plant growth and it can act as a possible growth medium for controlled environment agriculture. Biopolymer derived hydrogels can help to regulate the water content, flow of nutrient according to various other dependent variable like ambient temperature, pH of the soil and presence of nutrients. The effectiveness of the hydrogel largely depends upon the porosity, toxicity and other chemical properties. Thus hydrogel can act as a proper management tool to develop physico-chemical and biological properties in controlled environment agriculture. The choice of the biopolymer as the precursor of hydrogel is also crucial and thorough examination should be carried out prior to the application. The optimum concentration of biopolymer in hydrogel should be analyzed in the plant growth for a particular plant subjected to environmental condition.

Keywords: Biopolymer; Hydrogel; Controlled environment agriculture; Growth medium
Integrated Membrane Processes (IMP) play a crucial role in implementing process intensification practices in the industry to meet the demand for effective separation with less energy consumption, cost-effective design, and safe practices. Different membrane processes with varying configurations serve the multipurpose need in improving quality, quantity, and capacity with effluent treatment and recovery of valuables. In the nuclear industry, large volumes of medium level (10 kBq/l), and low level (0.1 kBq/l) radioactive waste that consists of alpha (Np, Pu) and beta (I, Zr, Se, Cs, Sr) emitters need to be treated and separated before its disposal. Conventional separation methods can be replaced with IMPs such as, Liquid Membranes (LM), Ultrafiltration (UF), Reverse Osmosis (RO), Membrane Distillation (MD), etc. that require less chemicals, offer better volume reduction, and with high selectivity. Application of MF+RO was used for treating radioactive waste with 95% of water recovery. Hybrid processes of RO+MD, evaporation+RO that use waste heat from the nuclear plant, and are reliable for small scale operation. IMPs offer improvement in the techno-economical, energetic analysis of various case studies. This study gives a brief review on the applicability of IMPs in the nuclear industry with a framework for the futuristic aspect of them.

**Keywords:** membrane processes; nuclear industry; radioactive effluent treatment
Cavitation induced treatment of wastewater: The current state of knowledge

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Abstract

Tremendous stress on water sources has led to a situation where there will be a 55% upsurge of water demand, globally, by 2050. Sustenance of limited water availability can be addressed by focusing on recycling and reuse of wastewater. In this regard, this is the need of the hour for a sustainable, cost-effective and safe solution for water management. Thus, the current work explores hydrodynamic cavitation (HC) as a promising treatment technology coupled with other advanced oxidation processes for effective degradation of emerging water pollutants. The authors have focused on treatment of surfactants, dyes, antibiotics and real life greywater streams discharged from kitchen sinks. A systematic approach has been adopted for all the treatment schemes whereby the following modus operandi were taken: (i) selection of a cavitating device for HC treatment (ii) optimization of operating parameters (iii) influence of oxidizing agents on treatment efficiency (iv) energetics and economics of the treatment scheme. The results indicate that HC induced advanced oxidation process is efficient in reduction of more than 75% organic content, around 60% dye degradation, more than 90% antibiotic degradation and almost 100% surfactant degradation. Encouraging results at laboratory scales can help in providing scaled up solutions both for domestic and industrial applications.

Keywords: Hydrodynamic cavitation; Advanced oxidation process; Surfactants; Antibiotics; Dyes; Greywater
Development of Capacitive Graphene Oxide Flow Electrode for Salt Recovery

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Abstract

Capacitive Deionization (CDI) is an emerging new technology for removal of ionic as well as polarizable species from water/wastewater. This CDI is an alternative to flask evaporation for recovery of salts from RO reject with low operational cost and enhanced energy efficiency. In recent time, Flow Capacitive Deionization, FCDI has been considered one of the emerging and alternative techniques for conventional salt removal. We have developed a graphene oxide flow electrodes, flow Capacitive Deionization unit. The FCDI has been tested for salt recovery from domestic RO reject. The results are quite encouraging. The process operating parameters such as initial salt (NaCl) concentrations, effect of permeate flow rate, effect of flow electrode weight have been extensively varied to study the efficiency of salt recovery. The efficiency, optimal wt%, optimal flow rate, water recovery for activated carbon and graphene oxide flow electrodes was found to be 85, 7%, 0.7 ml/min, 73% and 97, 5%, 0.7 ml/min, 73% respectively. The result shows the better performance efficiency of graphene oxide flow electrodes and the further application of desalination in industrial scale.

Keywords: FCDI; Graphene oxide; Desalination
Power of Graphite for Green Chemical Process Industry

Processes

1. Dry HCl Gas Generation System
2. Acid Regeneration System
3. HCl Synthesis Unit
4. Methanol Recovery System
5. Distillation Column
6. Packed bed Scrubber System
7. Line Pipes & Fittings
8. Vacuum System

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