

DR. H. L. ROY BUILDING

# News Letter-2018



## INDIAN INSTITUTE OF CHEMICAL ENGINEERS

Dr. H. L. Roy Building, Raja S. C. Mullick Road, Kolkata 700 032  
E-mail : [iichehq@gmail.com](mailto:iichehq@gmail.com), Telephones : (033) 2412 9314, 2414 6670

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### IICChE Council Members (2018)

1	Prof Vinay K Srivastava	vksriv1954@gmail.com
2	Prof P De	parameswar_de@rediffmail.com,
3	Prof S P Chaurasia	chch1962@gmail.com
4	Prof Ajay Bansal	drajaybansal@gmail.com
5	Prof Sudip K Das	drsudipkdas@vsnl.net
6	Mr M Ranga Rao	ranga.nfc@gmail.com
7	Prof M Srinivasa Rao	msrao@ddu.ac.in
8	Mr Dhawal Saxena	dhawal_saxena@hotmail.com
9	Dr M Rajasimman	simms@rediffmail.com
10	Prof Suddhasatwa Basu	drsbasu@gmail.com
11	Prof N Balasubramanian	nbs.bala@gmail.com
12	Prof Amitava Bandyopadhyay	amitava.iiche@gmail.com
13	Dr S K Gupta	skjee@yahoo.com
14	Prof Bishnupada Mandal	bpmandal@iitg.ernet.in
15	Prof (Dr) S C Naik	rkl_sчнаik@bsnl.in
16	Mr Shashikant S Pokale	sspokale@yahoo.co.in
17	Dr T L Prasad	tlprasad63@gmail.com
18	Dr K B Radhakrishnan	drkbrnair20@gmail.com
19	Prof K S Rajanandam	ksrajanandam@gmail.com
20	Prof V V Basava Rao	profbasavarao_1964@yahoo.com
21	Prof R Shyam Sundar	rachamallass@yahoo.co.in
22	Dr Gaurav Rattan	grattan@pu.ac.in
23	Mr S I Thakar	sunilthakar59@gmail.com
24	Prof S S Sambi	Sambi1950@yahoo.co.in
25	Dr V S Sapkal	vssapkal@gmail.com





# INDIAN INSTITUTE OF CHEMICAL ENGINEERS

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My Season's Greetings to all IIChE Members & Colleagues!



This will be the third address through this IIChE News Letter from me and I really feel it as a great privilege and honour for me to be able to write in this 'President's Corner'.

I did try to share the history of the growth, strength and the vastness of this great institute. It has lived a glorious past, maintaining good health through decades. However, the challenges ahead are plenty in its path. It is but natural that in the present working system and in the new environment, even the **Constitution** needs fresh and new thoughts to keep pace with the present. In continuation of my previous piece, I would like to discuss about a few more challenges facing our Institute presently.

**AMIChE Examination:** The institute has been conducting this examination twice a year during March and September for more than six decades and more effectively since 1960 onwards. It is meant for the practising industry personnel, who have diploma in Chemical Engineering. It has been very popular among Chemical Engineering professionals in the country. Hundreds of candidates have passed in the past, who are now holding responsible positions in industries. The Controllers of Examination in the IIChE Council, who had executed this responsibility over the years, deserve all praise and appreciation for their dedicated and professional approach in smooth conduct of the examinations.

Increasing number of private coaching / training centres offering technical and management certificates courses in various disciplines are, however, posing direct and tough options challenges to the AMIChE examinations on the one hand. On the other hand, a number of government departments questioning quality of courses, conducted by Institutes like us and thereby imposing various restrictions, are also posing hurdles. The details of facts and documents have been submitted to AICTE / MHRD and the ministry notifications are expected any time soon.

**Financial & Administrative Management:** With the growth of the Institute, the volume of financial complexities has also grown due to increase in number of regional centres and Students Chapters. The implications of GST, Income Tax liabilities, TDS on FDs and issues regarding exemptions on donations, received from individuals / Government / private companies, are some of the important matters that need serious attention in addition to that of timely submissions of audited reports from all the Regional Centres.

The manpower management at HQ / RCs with the changes happening on the digital front in matters related to Communications, Finance, Publications, Membership, Awards, SCHEMCON, and CHEMCON, etc., are creating lots of constraints towards new recruitments and balancing with the retirements.

**Constitutional Amendments:** The constitutional amendments are a necessity in every democratic system and it is more so when an institute has grown many times in its stature during the last seven decades. The **Election Process of IIChE**, both at the national and the regional levels, needs reforms for attracting **new faces** from Academia, Industry, Government Departments, Research centres, etc. Many candidates are contesting elections at the Regional Centres as well as for the Council at the same time, which may not be very productive, and, hence, constitutional reforms are needed. A **proper coordination** is a must for smooth functioning of Students Chapters vs Regional centres vs National Council. Most of the jobs are done as honorary services from

PRESIDENT'S CORNER

dedicated professionals all over the country, which need to be governed by ethical and moral standards in addition to the rules and regulations, laid down for a smooth functioning of the official machineries. **Your suggestions in this regard are welcome.**

Election process for the Regional Centres and the Council are almost over this year. **SCHEMCON 2018 is scheduled to be held at ICT, Matunga, Mumbai during October 26, 27, 2018 and CHEMCON 2018 is scheduled to be held at Jalandhar during December 27 – 30, 2018.** Hope, you all have your tickets booked for participation in these events. The Organizing Committee of both the events must have been doing the follow-ups for the **Memorial / CDS** lectures while also doing their best to host such big and important events for IICChE by making timely communications with the Delegates, Invitees, Awardees and certainly the likely Chief Guest and the Guests of honour for the occasion.

With one big festival (Ganpati), coming to an end and other festivals around the corner, I convey my **Best Wishes** to you and your family.

With Kind and Warmest regards,

Prof. Vinay Kumar Srivastava

vkstriv1954@gmail.com

MGM CET, Kamothe, Navi Mumbai

### **Obituary**

**With profound grief, we announce the sad demise of our following member:**

**\* Prof. B.R. Saha (LM 6423).** The late Prof. Saha was a member of IICChE since 1981. He made valuable contribution to the Institute during his tenure as the Honorary Secretary and as the Treasurer of the national Council during 2009 - 2011. The late Prof. Saha also held the office of Secretary and Chairman of Calcutta Regional Centre during 2001 – 2003 and 2008 – 2010, respectively.

**We offer our heartfelt condolence to the bereaved family of the late Prof. Saha.**



**Student Program in APCCHE 2019**  
**Call for Research Proposals from Youth:**  
**Contribution of Chemical Engineering to SDGs**

The SDGs (Sustainable Development Goals) have been adopted at the United Nations Summit in 2015 with their 17 goals and 169 targets to be achieved by 2030. 18th Asian Pacific Confederation of Chemical Engineering Congress (APCCHE 2019) will be held on 23-27 September 2019 with the theme: *Chemical Engineering for SDGs*. To encourage students' challenge to this initiative, the Student Program will be held on 23 September. This calls for research proposals that are not constrained by conventional practice to further applications of chemical engineering to achieve the SDGs. Experienced researchers and engineers with knowledge and skills who could help conduct proposed research, research and governmental institutions promoting technology transfer, socially responsible investors considering the environment, society, governance will be invited as audience in an interactive session. The expected result of this program is collaboration and actions in the region and beyond. Please submit a proposal by March 2019.

**Application Guidelines:** We call for proposals for the following two categories (A) and (B).

(A) Technical research proposal to solve concrete problems

Please propose a concept to solve regionally specific issues, preliminarily examine literature surveys, interviews with stakeholders, etc., the anticipated technological and economic bottlenecks, measures necessary to solve them, etc.

Examples: *The essential cause of the plastic waste problems and how to solve it?*

*How do we balance low carbon and stable energy supply?*

*How will you prepare for the huge waste of mega solar to be disposed in 20 years?*

*How can we proceed with district cooling and air conditioning in tropical areas with low environmental impact?*

Any subjects related to chemical engineering could be proposed. Please freely set the proposal topic with reference to but not constrained by the above examples. Please explain concretely the expertise, technology, research equipment / information, research funds etc. needed for the execution of that proposal.

(B) Goals, targets and Indicators to measure the impact of chemical engineering on the SDGs

While the contribution to the SDGs is drawing attention, indicators to measure the impact of chemical engineering on the SDGs are needed. We refer to existing SDG indicators (eg <https://unstats.un.org/sdgs/indicators/indicators-list/>) which are macro-indicators and not necessarily can be aggregated from the bottom up. Please propose new indicators to measure the impact of chemical industry on the SDGs.

**Proposal Format:** A4 within 10 pages, English, Word or PDF. We recommend an outline as follows.

- |  |   |
|--|---|
| 1. Proposed category (A) or (B)  | 6. Literature survey / interview results              |
| 2. Abstract of 1 page (including proposal representative's affiliation and contact address, the abstract will be posted on APCCHE website) | 7. Research question and hypothesis                   |
| 3. Problem to be addressed   | 8. Research method / procedures                       |
| 4. SDGs targets and Indicators   | 9. Research plan for the next three years             |
| 5. Purpose and outlook of the proposal   | 10. Partner candidates, recruitment for collaborators |
|  | 11. Budget  |
|  | 12. References  |

**Peer Review and Financial Support:** Submitted proposals will be reviewed by the organizing committee members. Presentation slots will be allocated for accepted proposals, while financial support (up to JPY100,000 and the exemption from conference registration fees for 5 participants per group) will be granted for outstanding proposals.

**Impact Prize:** Based on the feedback of the organizing committee members and the audience on the presentations, some prizes will be awarded to excellent ones.

**Proposal Deadline:** March 31, 2019 tentatively. Details will be posted later at <http://apcche2019.org/>.

## REGIONAL CENTRE ACTIVITIES

### Ahmedabad Regional Centre

**Date:** 22 August 2018

**Event:** Workshop

**Topic:** Present Trend in Heat Exchanger Manufacturing and Design and Manufacturing

The workshop was organised jointly with the Institution of Engineers, Gujarat State Centre; Dept. of Chemical Engineering, Institute of Chemicals and Petrochemicals; and, L D College of Engineering, Ahmedabad. Mr. Navin B Vasoya, former President, Institution of Engineers, was the Chief Guest and Mr. Ashutosh Shukla, Founder, Aerotherm Products was the Guest of Honour. The inaugural session was followed by a Technical Session and post-lunch, there was an open house discussion. During the valedictory function, Chief Guest, Dr. G.P. Vadodaria, Principal, L.D. College of Engineering, and the Guest of Honour, Dr. Sachin Parikh gave away certificates. Both of them also delivered motivational speeches to the student participants. The workshop ended with vote of thanks.



### Ankleshwar Regional Centre

**Date:** 10 August 2018

**Event:** Talk

**Topic:** Energy Conservation through Steam Turbine

The talk was delivered by personnel from Chola Turbo Machinery Pvt. Ltd (CTMI), Bangalore. Chola has a state-of-the-art manufacturing facility for steam turbines with generating capacity from 5 KW to 30,000 KW. Attended by around 85 participants, the talk was followed by an interactive session.

**Date:** 23, 24 August 2018

**Event:** Industry Visit

A trip to GNFC Ltd-Bharuch was organised for 69 students along with faculty members from Dept. of Chemical Engineering, Shroff Rotary Institute of Chemical Technology (SRICT), Valia. Students in three batches were taken around manufacturing plants for Neem Soaps, Neem Oil, Neem Repellents, Neem Shampoo, etc., along with the DM plant utility system of GNFC. The students were shown the working of plant air and instrument air compressors (reciprocating and centrifugal).

**Coming Events:**

**5 October 2018:** A talk is planned by personnel from Steamlok Engineering Pvt. Ltd, Pune.

### Bangalore Regional Centre

**Date:** 26, 27 September 2018

**Event:** Conference

**Topic:** Recent Advances in Engineering Sciences

### Calcutta Regional Centre

**Date:** 22 September 2018

**Event:** Lecture

**Topic:** Waste Water Treatment – Recent Practices

This lecture was particularly designed to attract a large number of students from technical institutes.

**Coming Event:**

**6 October 2018:** A trip will be organised to the plant of MATIX Fertilizers Ltd., for the Student Members from Jadavpur University, Calcutta University and Heritage Institute of Technology.

### Mumbai Regional Centre

**Date:** 2 September 2018

**Event:** Networking Visit

A daylong programme was organised for MRC members and their families, who made a trip to Shangrila Water Park, Mumbai Nashik Highway, Bhiwandi.



#### **Coming Events:**

**26, 27 October 2018:** SCHEMCON 2018 will be organised by the Students Chapter of Institute of Chemical Technology (ICT), Mumbai under the aegis of MRC. The central theme of SCHEMCON 2018 will be 'Green & Sustainable Chemical Engineering'.

#### **Neyveli Regional Centre**

**Date:** 4 July 2018

**Event:** Lecture

**Topic:** Energy Management

Mr.B.Senthilkumar, Director, NIN Energy Private Ltd., Chennai, delivered the lecture.

**Date:** 7 August 2018

**Event:** Lecture

**Topic:** Chemical Engineer's Journey – Campus to Corporate

Mr. C. Sathya Murthi, Staff Engineer (Process), Faculties Engineering-STS, Sabah Technical Services Department-STS, PetronasCarigali Sdn Bhd–Sabah Assests-SBA, Malaysia delivered the lecture.

**Date:** 3 September 2018

**Event:** Lecture

**Topic:** How Chemical Engineers will drive the 21<sup>st</sup> Century? The Mega Possibilities Ahead Mr.Vaidyanathan Nagarajan, International ASU Expert, AIR LIQUIDE, Middle East, delivered the lecture.

#### **Northern Regional Centre**

##### **Coming Events:**

**6 October 2018:** As a part of the Lecture Series, 'Learning with the Leaders', Mr. P.L. Kaul, Managing Director, Mariental India Pvt.. Ltd. will speak on 'Chemical Engineering Applications to Food Processing Industry'.

**10 – 15 October 2018:** Northern Regional Centre will conduct a short term course on 'Chemical Reaction Engineering'.

#### **Pune Regional Centre**

**Date:** 8 – 11 September 2018

**Event:** Workshop

**Topic:** On Aspen technology

The workshop was held at the Department of Chemical Engineering, VIT Pune in association with Chemsys, Pune.

**Date:** 24 September 2018

**Event:** Lecture

**Topic:** Continuous Flow Reactors

The lecture was delivered by Dr. Amol Kulkarni, Scientist NCL, Pune at School of Chemical Engineering, MIT Academy of Engineering, Alandi, Pune.

**Date:** September 2018

**Event:** Lecture

**Topic:** Reaction Engineering

Prof. Ashwin Patwardhan, Institute of Chemical Technology, Mumbai delivered the lecture at Department of Chemical Engineering, VIT, Pune.

##### **Coming Event:**

**26, 27 October 2018:** A workshop on 'Analytical Instruments' will be held for academics and industry personnel at NCL, Pune.

#### **STUDENT CHAPTER ACTIVITIES**

##### **Hindustan Institute of Technology and Science, Chennai**

**3 September 2018:** Students Chapter at the Department of Chemical Engineering was inaugurated under the aegis of the Chennai Regional Centre. Following the welcome



address by Prof. Anitha, Head of the Department, Mr. D. Gokul, Treasurer, Chennai Regional Centre of IChE gave an introductory speech about IChE and its membership benefits. On the occasion, an exhaustive lecture on 'Safety and Hazop In Process Industries' was delivered by Dr. G. S. Venkata Ratnam, Chairman, Chennai Regional Centre.

#### **National Institute of Technology Karnataka, Surathkal**

**10 August 2018:** Dr. Smita Srivastava, IIT, Madras delivered a lecture on 'Plant Cell Culture Bioprocess and Scale-up'.

#### **Manipal Institute of Technology, Manipal**

##### **Coming Event:**

**29, 30 October, 2018:** A national symposium, CHEMIGNITE 2K18, will be held on 'Carbon Capturing and Sequestration Technology'.

#### **BITS, Pilani**

**12 September 2018:** Selected third-year students from the Chemical Engineering department presented industrial projects (based on their summer time industrial training) before the faculty members and students. The event was held with a view to giving the second year students an idea of what kind of work is being done in industries and research labs in the country in Chemical Engineering and allied fields.

**17, 18 September 2018:** Mr. Kabidas Mandal, former Chief General Manager, IOCL visited the BITS Pilani campus and delivered lectures on the following three topics:

- i. Hydro-cracker Unit Operation and Catalyst Activity,
- ii. Oil Scenario of India (Present and Future) and Fundamentals of Refinery Planning, and,
- iii. Latest Refinery Configuration and Best Technologies

#### **MIT Academy of Engineering, Pune**

**28, 29 September 2018:** The 14<sup>th</sup> National Chemical Engineering Students Conference, PRAKALP-2018, was organized.

#### **Deenbandhu Chhotu Ram University of Science and Technology, Murthal**

**1 August 2018:** An interactive session was organised with Mr. Neeraj Kumar, Senior Engineer, Abu Dhabi Polymer Company, Borouge, UAE for the students.

#### **Galgotias University, Noida**



**5 September 2018:** On the occasion of Teachers Day, an interactive session was organised for the 1st year students of the Chemical Engineering Department. The primary objective of this interaction was to introduce the first year students to their faculty, seniors and the department as a whole as well as about the IChE. In course of the lively interaction, the students were also asked about their interests in chemical engineering. All the faculty members from the department and co-ordinators of IICHE participated in the event.

#### **KLE Dr. M. S. Sheshgiri College of Engineering and Technology, Belagavi**

**14 August 2018:** An orientation programme was organised for the first year students of the Department of Chemical Engineering.



**7 September 2018:** An industry visit to Shashi Sidnal Foods Pvt. Ltd. Bailhomgal was organised for the third semester students.

**8 September 2018:** Two lectures were delivered. The first one was on 'Life Skills required for successful career in Chemical Engineering', delivered by Mr. Sudhindra Hegde, Technical Leader, Baker Hughes General Electric, Bengaluru and the second one was on 'Roles and responsibilities of a process engineer in Aerospace industry' by Ms. Ambika Parab, Lead – Engineering Aerospace Processing India, Belagavi.

### **Manipal University Jaipur, Jaipur**

#### **Coming Event:**

**October 2018:** A talk on 'The Secret of Selling Ideas' has been planned, to be presented by Dr. Gaurav Bhaduri, Asst. Professor, Department of Chemical Engineering, Manipal University Jaipur for engineering students of all branches.

**October 2018: 'The Secret of Selling Ideas',** A two-hour session on effective presentation skill development for the final year students of all branches of engineering will be organized by the Student Chapter, Manipal University Jaipur (MUJ). Dr. Gaurav Bhaduri, Assistant Professor, Chemical Engineering, MUJ will be the speaker on the occasion.

### **S. N. Patel Institute of Technology And Research Centre, Umrakh-Bardoli**

**7, 8 July 2018:** A National workshop was held on 'Utilities of Process Simulators in Chemical Engineering' for 3<sup>rd</sup> and 4<sup>th</sup> year students. It was sponsored by Gujarat Council on Science and Technology (GUJCOST).

A national seminar on 'Recent Trends in Novel Separation Processes' was organized as well, sponsored by GUJCOST.

**26 July 2018:** An intercollegiate essay writing competition was held for the batch of 2017, Department of Chemical Engineering on the topic 'The Goal of My Life'.



**3 August 2018:** Talks were presented on the following four topics for the 2<sup>nd</sup> and 3<sup>rd</sup> year students.

- i. Green Environment & Green Chemistry
- ii. Liquid-Liquid Extraction
- iii. Supercritical Separation
- iv. Separation Operation

**23 August & 4 September 2018:** Industry visits were arranged to Schemitten Factory, Mahuvej, Kosamba and Nuclear Power corporation of India limited, Kakrapar, respectively, for the batch of 2017, Department of Chemical Engineering.

### **Delhi Technological University, Delhi**

**17 September 2018:** An orientation course was held for B.Tech 1<sup>st</sup> year and 2<sup>nd</sup> year students pursuing Polymer Science, Chemical Technology, Bio-technology and Environmental Engineering. It was followed by an interactive session.



## **Elements and Guidelines of Process Safety Management- I**

**Joy M. Shah<sup>1</sup>**

*“For a long time, people were saying that most accidents were due to human error and this is true in a sense but it’s not very helpful. It’s a bit like saying that falls are due to gravity.”—Dr Trevor Kletz*

After the Bhopal gas tragedy on 3 December 1984, a lot has been said about Safety Management system so that human errors could be taken care of. Almost every developed country has risen to the occasion and developed fail-proof guidelines for Safety Management system. Occupational Safety and Health Administration (OSHA) was the leader in providing such guideline and offering vision to all industry leaders on how to make safety system reliable by involving all employees. OSHA issued its first guideline in July 1990, which was finalised in February 1992. Since then, it is regularly updated, based on feedbacks from professionals. Today, all information on Process Safety Management is freely available. However, to implement the guideline in an effective way, a strategy and a systematic approach as well as hand-holding is required. The objective of this series of articles is to initiate a thinking process on how to develop safety and risk culture for incident-free and sustainable operation in highly hazardous chemical industries.

Dictionary meaning of culture is a set of shared attitudes, values, goals and practices that characterises an institution or organisation. In process industries, we define it by how we behave when no one is watching. Process Improvement Institute has given a very good graphic definition as follows.



<sup>1</sup> The author is Founder and Chief Consultant, Innov8 ProTech Solutions, Sustainability and Management Consultant. Formerly, he was Sr. Vice President – Technical at Reliance Industries Ltd.

Email: shahjoyim@hotmail.com; Mob: +919374715109



Every organisation defines core principles of safety culture in its own way. However, four aspects are very common.

1. It has to start with Leadership and visible Management Commitment,
2. It involves and empower employees,
3. It has to ensure development of capabilities and position right resources, and,
4. It has to ensure incorporation of process safety into the management's decision making process.

Process safety culture must be a real, finite and tangible concept.

The following can be the 21 best practices (or elements) for Behavioural and Process safety management.

1. Strong and visible leadership commitment. Personal involvement of management and leaders in all safety activities.
2. Laying down of an explicit safety policy, which would be used and followed on a daily basis. Policy must spell out the principles that will govern decision making in safety.
3. Setting challenging targets and objectives for the organisation and encouraging people to make their personal safety action plan.
4. Demanding high standard of performance. Ensuring that rules, standard and procedures are written down and are understood by workers. Verification checks and authorisation for non-routine work is defined.
5. Ensuring accountability for safety and implementation of safety policies in the line organisation. Supportive safety personnel have to facilitate participation and audit of the system and work practices and analyse safety performance.
6. Integrating the safety aspect with an organisation's management system from the top level to the shop floor level. Every employee needs to feel responsible for safety and must be involved in decision making related to safety.
7. Ensuring progressive motivation for safety which comes through positive reinforcement by recognising and rewarding individuals for their skills, efforts, ideas, suggestions and safety performance. It involves each employee as well as necessitates managing the consequence of unacceptable employee behaviour with consistent and fair disciplinary policy.
8. Introducing effective two-way communication as an integral part of enforcing discipline. World class performance can be achieved only if a message is developed with true content, conveyed in formal and informal way as well as ensuring that it is received and understood by audit, test, feedback mechanism as well as honoured by effective observations.
9. Ensuring continuous safety training for employees at all levels, viz., freshers, transferees, supervisors and contractors, are essential. Refresher course is required for long time employees.
10. Ensuring that all injuries as well as incidents are reported and their underlying causes are identified. Lessons from accident investigations must be classified and communicated to the concerned group of employees.
11. Working out a good safety management system that must include two distinct types of verification, evaluation and audit processes – the first one to evaluate people and their behaviours and the other one to evaluate the management system in terms of suitability and compliance.
12. Setting criteria for maintaining a minimum level of knowledge, training of new entrants and their field demonstrations as well as introducing annual review of capability for every position that has to be integrated to Personnel change management system.
13. Contractors and employees play very critical role as they are exposed to same or greater risk. Employees and contractors must pass through same level of training and identical qualification procedures.

14. Emergency response and contingency plan must be logical, complete and based on all emergency situations. It must be published and well understood by an employee. It involves consequence analysis, notification to employee, notification of affected personnel, notification of regulatory authority, escape and evacuation route, personal accounting for employees and contractors, rescue operation and medical assistance as well as designation assembly points, and primary as well as secondary control centres.
15. Process safety information should describe material hazards, process design basis as well as equipment and installation design basis. These are the first step in safety management system and provides basis for identifying and understanding the risk involved.
16. Process risk analysis is used to identify, evaluate and control process risk. It has two legs, viz., consequence analysis or hazards assessment and other process hazards review, which involves an organised and systematic analysis of facilities segmented into manageable process blocks. Every five year, it must be evaluated.
17. Every technology change brings new risk. It can be related to material or process design basis or to equipment design basis. Every technology change must be analysed in advance and authorised before its implementation.
18. Quality assurance procedures must be applied to all process equipment to ensure that these equipment are manufactured, assembled and installed as per the project specification and are safe to operate.
19. Pre-start-up safety review ensures final checks for new and modified equipment to confirm that all appropriate guidelines of process safety are addressed appropriately and that a facility is truly safe to operate and maintain. It ensures that process safety management systems are in place before the start-up.
20. A comprehensive mechanical integrity program is required, including written maintenance procedure; training protocol for mechanical personnel; quality control procedure for maintenance; spare parts and equipment; reliability analysis for critical equipment; and predictive and preventive maintenance program.
21. Anything which is not exactly replacement in 'kind' is a change and must be reviewed as well as approved by qualified personnel prior to alteration.

All these essential practices are covered in a 14-point guideline of Process Safety Management, divided in to three categories, viz. Technology, Assets and Human.

#### 1. Technology

- 1.1. Process technology or process safety information
- 1.2. Standard operating procedure and safe practices
- 1.3. Management of change related to technology
- 1.4. Process hazards analysis

#### 2. Assets

- 2.1. Quality assurance
- 2.2. Pre-start-up safety reviews
- 2.3. Mechanical integrity
- 2.4. Management of subtle change

#### 3. Human

- 3.1. Training and performance of an employee
- 3.2. Contractor safety and performance
- 3.3. Incident investigation and reporting

- 3.4. Management of personnel change
- 3.5. Emergency planning and response
- 3.6. Audit and assessment

Although these guidelines are well documented and resources are available for their implementation, it is essential to develop a road map for every industry with a goal for Zero accident through the following five tenets.

- 1. Committed culture
- 2. Vibrant management systems
- 3. Disciplined adherence to standards
- 4. Intentional competency development
- 5. Enhance application of lessons learned.

#### **SCHEMCON 2018**

The 14<sup>th</sup> Annual Session of Students' Chemical Engineering Congress, SCHEMCON 2018 will be held on 26 and 27 October 2018 in Mumbai. It will be organised by the Students Chapter, Department of Chemical Engineering, Institute of Chemical Technology, Mumbai under the aegis of Mumbai Regional Centre. The central theme of SCHEMCON 2018 will be 'Green & Sustainable Chemical Engineering'.

Local Organising Secretary: Dr. P. R. Gogate. Email: [pr.gogate@ictmumbai.edu.in](mailto:pr.gogate@ictmumbai.edu.in).

Website: [schemcon2018.ictmumbai.edu.in](http://schemcon2018.ictmumbai.edu.in)



## **Novel Design Concepts of Fermentors to Cut Down Fermentation Time for Production of Anhydrous Ethanol**

Amalesh Sarkar<sup>1</sup>

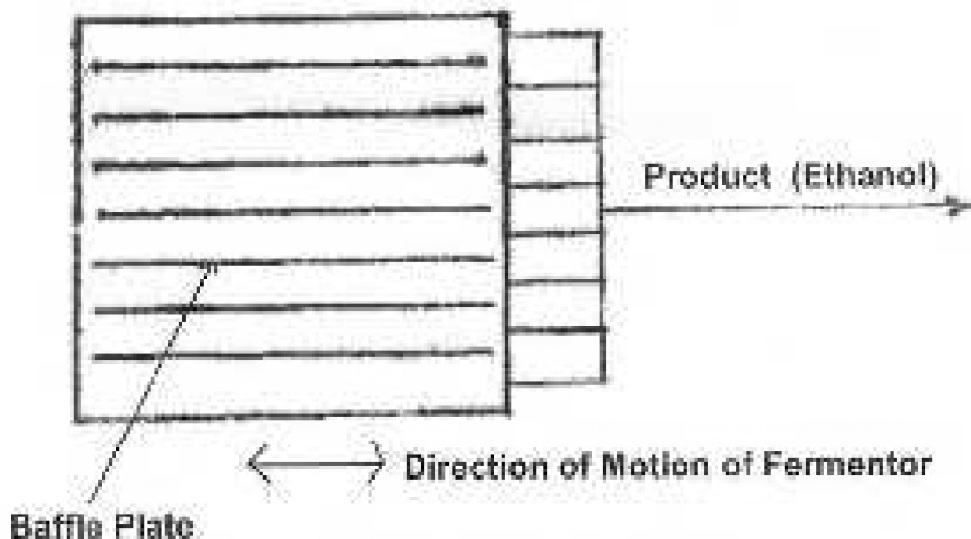
### **Introduction**

Demand for production of anhydrous ethanol in India is increasing rapidly due to the Government policy to blend petrol with 10% by volume of ethanol to cut down import bill of crude oil. There are several ways to make anhydrous ethanol (1) from the ethanol water azeotrope:

- (1) Using a third chemical constituent (benzene) to break the azeotrope coupled with distillation.
- (2) Membrane separation.
- (3) Solid desiccant, e.g., CaO, cracked corn

However, hardly any research work has been carried out to cut down the fermentation time (which is about 30 hrs.) either to increase production of a given size of fermentor or for reduction of fermentor size for a given capacity. With such steps, cost of ethanol production can be cut down as well. In this article, different designs have been suggested, based on a particular technique, to cut down the fermentation time. These designs have been verified experimentally on spot-check basis. Detailed experimental studies are necessary to develop foolproof designs so that the concepts can be utilised on commercial scale.

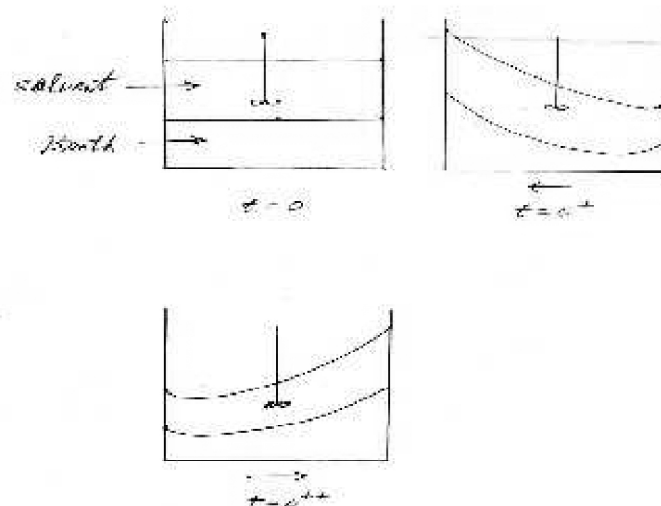
### **1. Baffle Plate Fermentor (2, 3) (Batch Operation) (Figures 1 & 2)**



**Figure 1: Baffle Plate Fermentor**

The author has done extensive research in the area of ethanol production in laboratory. He has also developed several conceptual designs of fermentors in India and has Indian Patents in the area: #173212, #201474, #278004. He was Dean, School of Chemical Engineering, Food Technology & Biotechnology at Haldia Institute of Technology (Haldia, West Bengal) and prior to that, he was Professor and HOD, Chemical Engineering at the same Institute.

## Batch Operation Using Organic Solvent



**Figure 2: Schematic Diagram of Fermentor**

### Mechanism of Enhanced Fermentation Rate

In the fermentation broth, glucose concentration around the yeast floc surface drops due to its consumption by yeast cells for their growth and conversion to ethanol. Therefore, glucose has to diffuse from bulk in order to supply more of it to the cells and to continue the process. To achieve higher fermentation rate, one can reduce the film thickness of liquid through which glucose diffuses from bulk to floc surface by allowing adjacent flocs to move at different speed. This would then generate shearing effect of one on the other. Thus, a velocity gradient inside the fermentor has to be created.

Velocity gradient is created in the fermentation broth due to back and forth movement of the fermentor. For instance, when a thrust is given to the fermentor, the liquid inside moves, and, due to a wall on the other side, the liquid rises against the wall, as shown in Figure 2. Also, a velocity gradient develops in the liquid layer next to the baffle plate with zero velocity at the wall and the maximum midway between the two baffle plates due to the thrust. The fermentor is pushed a little bit due to the thrust and is held at this position for a short time when a boundary layer develops and the liquid rises at the opposite wall. Next, the fermentor is pulled back to the original position and is held there for a short time as before and this continues till fermentation is complete.

In order to achieve a large velocity gradient, different designs of fermentor can be conceived and one such design is Baffle Plate Fermentor.

Based on pure biochemical reaction (4), for 90% conversion of glucose, fermentation time is 2.3 hours. Therefore, in presence of mass transfer resistance, fermentation time will be more than 2 hrs.

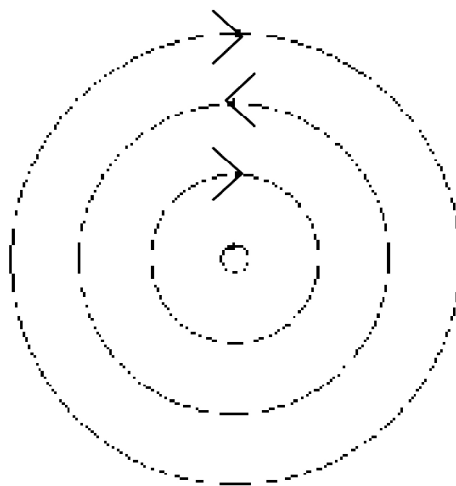
### Experimental Verification

It has been found from spot checking that the fermentation time taken during this process is much less than 30 hrs. Detail experiments by varying different parameters have to be carried out to optimize the design of such fermentor. The parameters are as follows:

1. Velocity gradient
2. Solvent/broth ratio (5)
3. Speed of stirrer in organic phase (5)
4. Spacing of baffle plates
5. Height of baffle plates

After fermentation is complete, the organic phase is distilled to get anhydrous ethanol and the aqueous phase is distilled to get rectified spirit. This can be converted to more of anhydrous ethanol by one of the techniques mentioned under 'Introduction'.

## 2. Cylindrical Concentric Rotating Fermentor (Continuous Operation) (Figure 3)



**Figure 3: Multiple coaxial cylinders**

The fermentor consists of multiple coaxial cylinders rotating in opposite directions. The broth travels vertically down through the space between two adjacent cylinders and the organic solvent flows as bubbles upward. The organic solvent picks up a definite amount of ethanol continuously from the broth. Thus, a constant composition of ethanol containing solvent continuously goes directly to distillation column for separation of ethanol from the solvent. This is continuously recycled to the fermentor-cum-extractor.

As per the concept of increasing the velocity gradient to increase mass transfer rate of glucose, in this design, two velocity gradients (in radial direction) are important. These are  $dv_r/dr$  and  $dv_\theta/dr$  and the combined effect of these two at a particular radial position is important for the overall increase in the rate of mass transfer. Thus, in comparison to the size of the conventional continuous fermentor, the size of the present fermentor can be reduced by using the above design for the same ethanol production capacity. However, the rotational speed of the coaxial cylinders should not be too high because in that case the magnitude of shear stress on the floc surface would be very high, causing microorganisms to become inactive, being a living being, and, eventually, it may result in their death.

### Engineering & Design Aspects of Improvised Fermentors

1. For scaling up Baffle Plate Fermentor with back and forth movement, there may have to be multiple connections to the vessel through crank- shafts, driven by separate motors, so that the vessel can move through multiple linkages. It will ensure that the momentum of impact on the contents of fermentor is distributed and not localized as with a single linkage, in which case, high momentum of impact may not be evenly distributed among all the little fermentors.
2. For coaxial cylindrical fermentor, scale up can be done by adding extra cylinders in radial direction. However, for maximum enhancement of fermentation rate due to velocity gradient in radial direction, spacing between the added cylinders may have to be changed because of an increase in radii of the cylinders.
3. For feeding the aqueous phase continuously into the coaxial cylindrical fermentor, there could be provision of concentric rings with perforations at the bottom. Moreover, the assembly of rings could be placed in the aqueous phase, just below the organic phase. Each ring diameter should be as per the outer diameter of the coaxial cylinders



for full coverage of the annular space in the aqueous phase. The coil diameter should also be equal to the clearance between two cylinders which would vary from the innermost to the outer one due to the reason described above. (Please refer to the previous point)

### **Conclusions**

Detailed experimentations and a study on economic viability need to be carried out on the proposed designs of fermentor.

### **References**

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2. Sirkar, A. ‘Advancement in Design of Fermentor for Ethanol Production’, presented at one day seminar organized by West Bengal State Centre’s Chemical Engineering Division of IEI on 10<sup>th</sup> November, 2017.
3. Indian Patent # 278004 by A. Sirkar, P. Bhattacharya & S.R. Roy, 2016.
4. Sirkar, A., ‘An Experimental Study and Mathematical Modeling of Ethanol Production from Banana Peels by Hydrolysis and Fermentation’, Journal of the Institution of Engineers (India), Vol 88 March 2008.
5. Roy S.R., Bhattacharya P., Sirkar A., “Studies on Solvent Extraction of Ethanol during Fermentation under Agitated condition”, Indian Chemical Engineer, vol 54,no.4, December 2012

### **CHEMCON 2018**

Indian Chemical Engineering Congress, CHEMCON 2018, will be held during 27 - 30 December 2018 at Dr. B.R. Ambedkar National Institute of Technology, Jalandhar, to be organised by Doaba Regional Centre, IICChE. The central theme of CHEMCON 2018 will be ‘Seamless Chemical Engineering in Service of Humanity: Innovations, Opportunities & Challenges’.

For further details, please contact: Organising Secretary, CHEMCON 2018, Department of Chemical Engineering, NIT Jalandhar, Punjab. Emails: chemcon2018@yahoo.com and chemcon2018@gmail.com. Website: [www.chemcon2018.co](http://www.chemcon2018.co)

## CHEMITRENDS

### New Catalyst with Dual Functions

A team of chemists at Ruhr-Universität Bochum (RUB), Germany, led by Prof. Martin Muhler, has developed a new, low-cost catalyst for plastic production. It turns a bio-refinery product into a starting material for the synthesis of plastics, which could turn out to be a sustainable alternative to widely used PET. At the same time, the potential energy source hydrogen can also be formed during the reaction.

In their study, the Bochum-based researchers have presented a nickel boride catalyst. It is readily available and does not contain any precious metal. It can turn the biorefinery product HMF (5-hydroxymethyl-furfural) into FDCA (2,5-furandicarboxylic acid). "FDCA is interesting for the industry because it can be processed into polyesters," said Stefan Barwe, one of the team members. "PEF, an alternative to PET, can thus be produced and all of this is based on renewable raw materials, i.e. plants," he added. The researchers have also designed the catalyst in such a way that it is effective under the same conditions under which hydrogen production is also successful. They were, thus, also able to use the starting material to synthesise hydrogen as a potential energy source.

Meanwhile, in another development, scientists at Sandia National Laboratories, USA claim to have engineered a platinum-gold alloy that may be the most wear-resistant metal in the world. It is 100 times more durable than high-strength steel, making it the first alloy in the same class as diamond and sapphire, which are nature's most wear-resistant materials.

*Angewandte Chemie*, Vol. 57, No. 28, 9 July 2018; *Science Daily*, 24 July 2018 & 16 August 2018

### Bacteria-powered Solar Cell Developed

Researchers at the University of British Columbia (UBC) have developed a cheap and sustainable way to build a solar cell using bacteria that convert light to energy. This cell generates current, which is stronger than what has previously been recorded from such a device. Moreover, it works as efficiently in dim light as in bright light. This innovation could be particularly helpful in that part of the world where for greater part of the year, sky remains

overcast. With further development, these solar cells, which are called 'biogenic' because they are made of living organisms, could become as efficient as the synthetic cells used in conventional solar panels. It is the solar cells that convert light into electrical current. Previous efforts to build biogenic solar cells relied on extracting natural dye that bacteria use for photosynthesis. This process has proved to be expensive as well as complex, involving toxic solvents. Moreover, the dye could degrade.

Instead of using the dye in bacteria, the UBC researchers genetically engineered *coli* to produce large amounts of lycopene, which is particularly effective in harvesting light for conversion into energy. The researchers coated the bacteria with a mineral that could act as a semiconductor and applied the mixture to a glass surface. With the coated glass acting as an anode at one end of their cell, they generated a current density of 0.686 milliamps per square centimetre. This is the highest current density for a biogenic solar cell, according to leader of the project, Prof. Vikramaditya Yadav, Department of Chemical and Biological Engineering, UBC. These hybrid materials can be manufactured economically and sustainably, and, with sufficient optimization, could perform at comparable efficiencies as conventional solar cells, Prof. Yadav claimed. Other potential applications for these biogenic materials are in mining, deep-sea exploration and other low-light environments.

*Science Daily*, 5 July 2018; *Renewable Energy Magazine*, 10 July 2018

### 'Apsara-upgraded' Unveiled at BARC

Nearly 62 years after Apsara, India's and Asia's first nuclear research reactor, produced by Bhabha Atomic Research Centre (BARC), Trombay became operational in August 1956, scientists at BARC unveiled 'Apsara-upgraded' on 10 September 2018. It is a high-capacity research reactor, made indigenously, using plate-type dispersion fuel elements, made of low enriched uranium (LEU). By virtue of higher neutron flux, this reactor will increase indigenous production of radio-isotopes for medical application by about 50%. It will also be extensively used for research in nuclear physics, material science and radiation shielding.

Press Release by Government of India, Department of Atomic Energy, 11 September 2018

## **SAFETY, HEALTH AND ENVIRONMENT**

### **Rising CO<sub>2</sub> Level Making Staples Less Nutritious: Study**

Millions of Indians are at the risk of becoming nutrient-deficient by 2050 as rising levels of CO<sub>2</sub> are making staple crops, such as, rice and wheat, less nutritious, according to researchers at Harvard TH Chan School of Public Health, USA. Their study has found that rising CO<sub>2</sub> levels from human activity could result in 175 million people worldwide becoming zinc deficient and 122 million people becoming protein-deficient by the middle of this century. Moreover, over one billion women and children could lose a large amount of their dietary iron intake, putting them at increased risk of anaemia and other diseases. India, the researchers predict, would bear the greatest burden with an estimated 50 million people becoming zinc-deficient. As many as 38 million people in India are at the risk of becoming protein-deficient in 502 million women as well as children becoming susceptible to diseases, associated with iron deficiency, the study emphasised. Other countries in South Asia, Southeast Asia, Africa and West Asia will also be significantly affected.

Humans tend to get a majority of key nutrients from plants. For instance, 63% of dietary protein comes from vegetal sources, as well as, 81% of iron and 68% of zinc. It has been shown that higher atmospheric levels of CO<sub>2</sub> result in less nutritious crop yields, the researchers asserted.

<https://www.hsph.harvard.edu/news/hsph-in-the-news/crops-nutrients-carbon-dioxide/>; *The Times of India*, 29 August 2018

### **Crayons, Markers may be Toxic for Children: Study**

A public interest group in the USA, namely, the United States Public Interest Research Group Education Fund, has found toxic substance, including asbestos, in Playskool crayon and another carcinogen, benzene, in a dry-erase marker. They also found phthalates in certain brands of binders. The group had independent laboratory test of 27 back-to-school products. Four tested positive for dangerous chemicals. They tested crayons, markers, binders, water bottles, lunchboxes, notebooks, rulers and glue.

<https://www.nytimes.com/2018/08/08/education/asbestos-crayons-school-supplies.html>; *The Times of India*, 10 August 2018

### **Molecule Developed for TB Vaccine**

A six-member team from the Indian Institute of Chemical Biology (IICB), Kolkata and the Bose Institute, Kolkata, claims to have successfully altered protein to develop a 'stable and active' protein-based molecule that will provide immunity against TB, which can spread through coughing or sneezing.

Besides malnutrition, which is the principal trigger for TB, a large number of tuberculosis patients get the bacteria

through transmission, especially in crowded public places. The researchers led by Krishnananda Chattopadhyay, Head of IICB's Structural Biology and Bioinformatics Division, started working on the MPT 63 protein, well-known for its anti-TB characteristics, about a year-and-a-half ago. They soon realized that even though it could effectively fight the disease, the protein was unstable and couldn't be made into a stable formulation in its original form. To overcome this, they attempted to tag the protein to a nanoparticle and altered its genetic sequence to give it a structure suitable for a stable vaccine. The research has been published in the American Chemical Society's *Langmuir* journal.

<http://indianews.worldnewsnetwork.co.in/2018/08/kolkata-researchers-develop-molecule-for-tb-vaccine/>

### **New Wireless Device for Light Therapy against Cancer**

Toshinori Fujie at Waseda University, Japan, and his colleagues have developed a new light-emitting device that can be implanted in the body for using in treatment of cancer. This device is sandwiched between two thin and sticky sheets and is to be attached to body. The sheets are covered in a sticky polymer, based on proteins that are found in mussel's feet. The device consists of an LED chip, powered wirelessly. As a result, there is no need for batteries to be implanted in the body. During trial with mice that had tumours, this device was found to be helpful in significantly reducing size of tumour. According to Fujie, the device could be particularly useful for treating cancer in delicate organs such as the brain and pancreas, where surgery or radiotherapy is risky. The conventional photodynamic therapy, which is used to treat some forms of cancer, has a disadvantage in case the tumour is located in an organ that moves, such as, the oesophagus or the lung. The illumination during therapy in such case becomes irregular, which makes it hard to control the dose of medicine. The research team has overcome such problem in the device as during therapy as it is held in place by the sticky nanosheets.

*New Scientist*, 16 July 2018

### **Germany Launches 1st H-powered Train**

Germany has rolled out the world's first hydrogen-powered train, signalling the start of a push to challenge the might of polluting diesel trains with costlier but more eco-friendly technology. Two trains, built by French TGV-maker Alstom, have started running a 62 mile (100km) route between the

towns and cities of Cuxhaven, Bremerhaven, Bremervorde and Buxtehude in northern Germany. This stretch is normally plied by diesel trains. Alstom is said to have plans to deliver another 14 of the zero-emissions trains by 2021. Hydrogen trains are equipped with fuel cells that produce electricity through a combination of hydrogen and oxygen, a process that leaves steam and water as the only emissions. Excess energy is stored in ion lithium batteries on board the train.

These trains can run for about 600 miles (1,000km) on a single tank of hydrogen, similar to the range of diesel

trains. Alstom is betting on the technology as a greener, quieter alternative to diesel on non-electrified railway lines. While buying a hydrogen train is somewhat more expensive than a diesel train, it is cheaper to run, claim Alstom authorities. Other countries are also looking into hydrogen trains, according to Alstom sources, including Britain, the Netherlands, Denmark, Norway, Italy and Canada. In France, the government has already said it wants the first hydrogen train to be on the rails by 2022.

*The Guardian International Edition*, 17 September 2018

## INDUSTRY NEWS

### **GAIL in Major Expansion Drive**

GAIL India has announced its plans to expand its pipeline network capacity about 50 per cent in three years by constructing 5,500-kilometers of new lines. It is also exploring the possibilities of setting up 400 CNG stations and giving 10 lakh piped natural gas (PNG) connections to households, according to Mr. B.C. Tripathi, CMD of GAIL. GAIL operates 11,000-km of pipeline network and markets two-thirds of all natural gas, sold in the country. The company is building a 2,655-km gas pipeline from Jagdishpur in Uttar Pradesh to Bengal and Odisha. The first phase of the process is set to be completed ahead of the December target. This pipeline network will be extended to Guwahati, which will interconnect with the upcoming 1,500-km Indradhanush pipeline network, which has been conceived to operate in the North-east.

*The Telegraph*, 12 September 2018

### **HPCL to Invest Rs. 75,000 Cr in 5 Years**

Hindustan Petroleum Corp. Ltd (HPCL) will invest Rs. 75,000 crore over the next five years across its business segments to grow, according to M.K. Surana, its Chairman, and Managing Director. The company is expanding its Visakhapatnam refinery in Andhra Pradesh under the Visakh Refinery Modernization Project for enhancing the refinery capacity from the present 8.33 million metric tonnes per annum (mmtpa) to 15 mmtpa at a cost of ₹ 20,928 crore. The project includes bottom

grow its lubricants business across Asia, West Asia and Africa. To execute its plans, HPCL has formed HPCL Middle East FZCO, in the Dubai Airport Free Zone Area in the United Arab Emirates.

*Live Mint*, 30 August 2018

### **India to Triple Ethanol Output by 2022**

India will triple its ethanol production from 141 crore litres at present to 450 crore litres over the next four years till 2022. This will save the country Rs. 12,000 crore in its oil import bill, Prime Minister Narendra Modi has said. The government has also planned to set up 12 biofuel refineries in the country at an investment of Rs. 10,000 crore, according to the Prime Minister. The government will attain 10% ethanol blending in petrol by 2022 and is aiming to double it to 20%. Ethanol blending in petrol has increased from 38 crore litres in 2013-14 to an estimated 141 crore litres in 2017-18. The Indian government reports that the bio-diesel blending that had commenced from August 2015 had inspired the oil marketing companies to allocate 7.6 crore litres of biodiesel in 2018-19.

*The Hindu*, 11 August 2018

### **Emami to Set Up Rs. 2000-cr Paper Plant in Gujarat**

Emami Paper Mills (EPML), the paper and packaging board arm of the Emami group of companies, will invest Rs. 2,000 crore in Bharuch, Gujarat to set up its first



upgradation facilities and will make the refinery capable of producing Bharat Stage VI (BSVI) compliant motor fuels and enhance its complexity and profitability. Its Mumbai refinery is also being expanded from 7.5 mmtpa to 9.5 mmtpa at a cost of Rs. 5,060 crore. HPCL is also setting up a 9 mmtpa greenfield refinery in Barmer, Rajasthan and is a partner in the 60 mmtpa Ratnagiri Refinery and Petrochemicals Ltd in Maharashtra. At Chhara, Gujarat a well, the company is investing Rs. 5,555 crore in expanding its pipeline network and is also a partner in a 5 mmtpa liquefied natural gas regasification terminal. Moreover, HPCL is exploring opportunities to

manufacturing plant in Gujarat. The foundation stone for the plant has recently been laid. Spread over around 103 acres of area, the upcoming multi-layer coated packaging board manufacturing plant will have a total capacity of 2.25 lakh tonnes per annum. It will also have an 18 MW captive power plant in the first phase. The initial investment will be Rs. 1,000 crore. In the second phase of the project, the company will double its capacity with an equal additional investment towards installation of a new machine. The project has already received the necessary environment clearance from the state government.

*The Times of India, 22 September 2018*

#### **Letter to the Editor:**

In the news item 'New Catalyst Turns Ammonia into Clean Fuel', published in Newsletter (Vol. 10, Issue 2, 2018) in the Section Chemitrends, Dr. Satoshi Hinokuma of IROAST, Japan, while explaining about their research, claims that the new crystal developed by his team does not emit carbon dioxide ( $\text{CO}_2$ ).

However,  $\text{CO}_2$  is actually not much of a GHG (Green House Gas) since it is the basic food for all plants. It increases the green cover and all the excess  $\text{CO}_2$  can be consumed by plants (carbon cycle).  $\text{CO}_2$  is taken as a basic 'Unit of Measure' for GHGs, just as any other unit nomenclature.  $\text{CH}_4$  (methane) is 20 times more powerful GHG than  $\text{CO}_2$ .  $\text{NO}_x$  is 310 times powerful GHG than  $\text{CO}_2$ . In fact, the combined effect of all GHGs is expressed in terms of  $\text{CO}_2$ .

Therefore, in his article, Dr. Satoshi Hinokuma of IROAST should have mentioned that his catalyst shall prevent emission of  $\text{NO}_x$  and not  $\text{CO}_2$  as Dr. Hinokuma claims.

I K Bhalla  
LM – 10065

***The Editorial Team of the IChE Newsletter does not assume any responsibility for the opinion expressed by Mr. I.K. Bhalla in the above letter.***

## COMING EVENTS

### **ICCP 2018 - 8<sup>th</sup> International Conference on Catalysis and Pyrolysis**

Date: 31 October, 1 November 2018

Venue: Colimbus, Ohio, USA

Organiser: Conference Series LLCÊ

Contact: Lisa Brown

Phone: +1-702-508-5200

Email: Massspectrometry@chemistryconference.org

### **Biologics World MEA 2018**

Date: 12 - 14 November 2018

Organiser: IMAPAC

Venue: Dubai, UAE

Contact: Sumukhi Sreevatsan

Phone: +65-3109-0126

Email: sumukhi.Sreevatsan@imapac.com

### **BioSD 2018 CSIR-Indian Institute of Chemical Technology/ The Biotech Research Society, India**

Date: 22 – 25 November 2018

Venue: Hyderabad, India

Contact: Dr. S. Venkata Mohan

Phone: +91-40 -27191765/1679

### **HPTLC Asia 2018**

Date: 28 - 30 November 2018

Venue: Bangkok, Thailand

Organiser: HPTLC

Contact: Prof. Wanchai De-Eknamkul

Email: committee@hptlc.com

Website: www.hptlc.com

### **13<sup>th</sup> International Conference on Biofuels and Bioenergy**

Date: 18, 19 February, 2019

Venue: Amsterdam, Netherlands

Organiser: Conferenceseries LLC Ltd

Email: biofuels@europemeet.com

Website: <https://biofuels.conferenceseries.com/>

### **ieeeforum-International Conference on Nanotechnology, Renewable Materials Engineering & Environmental Engineering (ICNRMEEE)**

Date: 4 November 2018

Venue: Pune, India

Organiser: ieeeforum

Contact: Conference Coordinator

Email: ncriset.2014@gmail.com

Website: <http://ieeeforum.com/Conference2018/11/Pune/ICNRMEEE/>

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