

IICHE-MRC E-NEWSLETTER

MUMBAI REGIONAL CENTER



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IICHe-MRC Best
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Design Project Award

INDIAN INSTITUTE OF CHEMICAL ENGINEERS
Mumbai Regional Center, B-18 Vardhman Complex,
Gr Floor, Opposite Home Town & 247 Park, LBS Marg,
Vikhroli (West), Mumbai - 400 083

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2023-25

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FROM CHAIRMAN'S DESK

Prof. Sanjay Mahajani **Chairman IChE-MRC**



My Dear Friends, Greetings!

I am very happy of having this opportunity to address you all. I sincerely appreciate members for their time and effort in making MRC more vibrant. MRC has successfully conducted many online and offline events, EC meetings, as per IChE HQ Guidelines despite usual challenges and constraints.

The MRC hosted the Prof. N.R. Kamath Memorial Quiz on March 16th at Datta Meghe College of Engineering. Eight colleges participated. An interactive fireside chat with industry expert Shri Sandeep Gujrathi, Director Business Development, Worley Institute of Chemical Technology, Mumbai preceded the quiz, offering students valuable industry insights.

IICHE-MRC is dedicated to strong industry-academia collaborations for sustainable progress. On May 27, 2024, we hosted a seminar on “Sustainable Chemical Manufacturing” at IIT Bombay, focusing on technology, circular economy, and policies. Key topics included environmental stewardship, sustainable fertilizers, biomass utilization, waste polymer management, and future chemical manufacturing. Recommendations emphasized India-specific sustainability metrics, bio-inspired solutions, and stronger industry-academia partnerships.

IChE fosters industry-academia interactions for professional growth. Chemical engineering spans from plant design to new materials development. Engineers use advanced computing to create sustainable materials and optimize processes, reducing waste and emissions. MRC supports these objectives through ongoing interactions.

Industry-academia partnerships are essential for driving innovation and addressing real-world challenges. IICHE-MRC aims to bridge this gap by fostering collaboration. Industry insights guide academic research, while universities provide talent and expertise. MRC is developing a framework to facilitate interactions, including seminars, brainstorming sessions, and industry visits. We seek broader industry engagement and collaboration with other regional centers. Effective communication through digital and traditional channels will keep members informed of our initiatives.

I wish this issue proves beneficial to the member community to encourage them to collaborate and rededicate for sustainable development. Looking forward to interesting interactions.

Prof. Sanjay Mahajani

EDITOR'S CORNER



Dear Fellow IICHE-MRC Members,
Warm Greetings!

We are delighted to present another edition of the IICHE-MRC E-Newsletter, showcasing recent developments and initiatives. Your valuable feedback on previous issues has been instrumental in shaping our efforts.

IICHE-MRC remains committed to fostering robust industry-academia collaborations for sustainable progress. Under the dynamic leadership of Prof. Sanjay Mahajani, MRC has successfully organized several events, including a noteworthy seminar on "Sustainable Chemical Manufacturing." Held on May 27, 2024, at IIT Bombay, the seminar brought together industry and academia to address critical sustainability challenges. The event underscored the imperative for a comprehensive approach, emphasizing technology, circular economy, and supportive policies. Key discussions covered environmental stewardship, sustainable fertilizer production, biomass utilization, waste polymer management, and the future of chemical manufacturing. Recommendations were development of India-specific sustainability metrics, exploration of bio-inspired solutions, and strengthening industry-academia partnerships.

We encourage your active participation in shaping the future of chemical engineering. The Industry Institute Interaction platform offers an excellent avenue to showcase your achievements. Your suggestions and constructive feedback are invaluable as we navigate the evolving landscape.

Chemical engineers are at the forefront of redefining the industry. Our collective goal is to embark on this transformative journey with minimal challenges. I extend my sincere gratitude to the editorial team and the IICHE-MRC Chairman for their unwavering support in producing this newsletter.

Let us continue to grow and evolve together.

Happy Reading! Take Care, Stay Safe!!

Jagdish Nageshri
Chief Editor, IICHE-MRC e-Newsletter

IChE-MRC recent events / participation at a glance

Seminar Series

Sustainable Chemical Manufacturing - 1

May 27th 2024
Venue: VMCC, IIT Bombay

IIT BOMBAY
Research Hub for Green Energy and Sustainability (GESH)

Jointly with
Indian Institute of Chemical Engineers
Mumbai Chapter



Sustainability Partners:



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Prof. N.R. Kamath Memorial Quiz ChEQ'2024

Venue: DMCE, Airoli
Time: 9am to 5pm
Date: 16th March 2024

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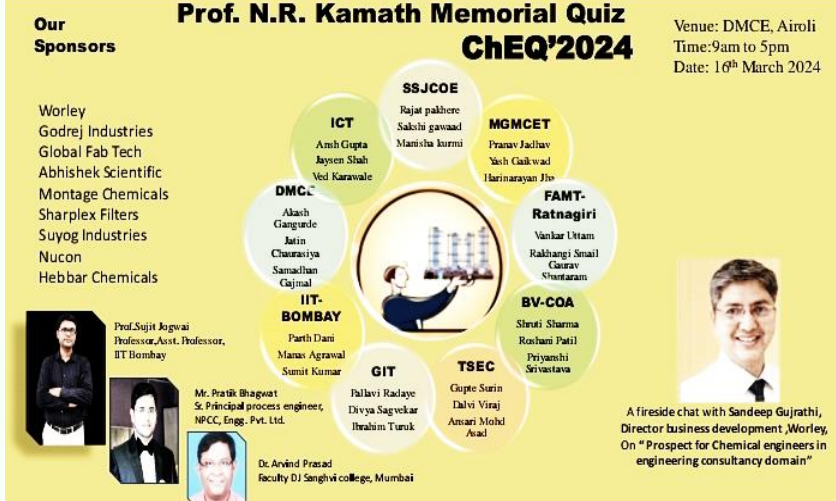
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Rakhsangi Smail
Gaurav Shantaram

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Shruti Sharma
Roshani Patil
Priyanshi Sureshtava



A fireside chat with Sandeep Gujrathi, Director business development, Worley, On "Prospect for Chemical engineers in engineering consultancy domain"

World Meet of the **CHEMICALS, PETROCHEMICALS, BIOPHARMA & PROCESS** Industry in India

31st International Exhibition & Conference



4-7 March 2024

Venue: Bombay Exhibition Center,
Goregaon (East), Mumbai, India

Continued ...

Prof. N.R. Kamath Memorial Quiz

16 March 2024

The Indian Institute of Chemical Engineers (IICChE) Mumbai Regional Chapter (MRC) hosted the prestigious Prof. N.R. Kamath Memorial Quiz (ChEQ 2024) on the morning of March 16, 2024.


The venue for this exciting event was the seminar hall of Datta Meghe College of Engineering (DMCE), which assembled anxious students from eight colleges under the IICChE MRC umbrella. These are Mahatma Gandhi Memorial College of Engineering, Indian Institute of Technology Bombay, Finolex Academy of Management and Technology, Thadomal Shahani College of Engineering, Gharda Institute of Technology, Shivajirao Jondhale College of Engineering, Institute of Chemical Technology (ICT), and Datta Meghe College of Engineering.

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Prof. N.R. Kamath Memorial Quiz ChEQ'2024


Venue: DMCE, Airoli
Time: 9am to 5pm
Date: 16th March 2024




Prof. Sujit Jagwai
Professor, Asst. Professor,
IIT Bombay



Mr. Pratik Bhagwat
Sr. Principal process engineer,
NPCC, Engg. Pvt. Ltd.



Dr. Anvnd Prasad
Faculty DJ Sanghvi college, Mumbai



A fireside chat with Sandeep Gujrathi,
Director business development, Worley,
On "Prospect for Chemical engineers in
engineering consultancy domain"

Continued ...

Prof. N.R. Kamath Memorial Quiz

16 March 2024

Shri Sandeep Gujrathi, Director Business Development, Worley Institute Of Chemical Technology and **Prof. Sanjay Mahajani**, IIT Bombay and Chairman IICHE-MRC through an interactive fireside chat, shared valuable insights from their industry experience. This provided students with a unique opportunity to ask questions and gain knowledge from these esteemed guests. The engaging session lasted for an hour, enriching not only the students but also the faculty and guests present.



Continued ...

Prof. N.R. Kamath Memorial Quiz

The event was commenced with welcoming remarks by Ms. Kirti Rajput, who introduced the prestigious N.R. Kamath Quiz. A distinguished gathering graced the occasion, including Mr. Sandeep Gujrathi, Director of Business Development, Worley Institute of Chemical Technology, Mumbai; Prof. Dr. Sanjay Mahajani, IIT Bombay and Chairman of IICHE-MRC; Shri Jagdish Nageshri, former DAE Executive and Vice-Chairman of IICHE-MRC; Shri Dhawal Saxena, CEO & CTO, Bhumistha Infra Services; Dr. Sujit Jogwar, IIT Bombay; Dr. Sunil Bhagwat, ICT Mumbai; Dr. Manish Yadav, ICT Mumbai; Dr. Sachin Jadhav, ICT Mumbai; Dr. (Mrs.) Neeta Mehta, HOD of TSEC Mumbai; Shri Mahendra Patel, former ONGC Executive; and Mr. Bejoy Menon. The formal inauguration marked by a lamp-lighting ceremony, followed by a Saraswati Vandana, commenced the program.



Continued ...

Glimpses of N.R. Kamath Quiz

The Quiz Competition

The afternoon commenced with the highly anticipated quiz competition. The format consisted of multiple rounds designed to test participants' knowledge and quick-thinking abilities. Rounds included rapid-fire questions, audio-visual challenges, and buzzer-based competitions. The final round focused on advanced chemical engineering concepts and current affairs.

Eight teams of three students each battled it out in the first round, moderated by Mr. Pratik Bhagwat. ICT, IIT-Bombay, DMCE, GIT, TSEC, and MGMCET advanced to the next stage. Dr. Sujit Jogwar hosted the second round, which saw intense competition, including two tie-breakers between DMCE and IIT-Bombay.

Continued ...



Glimpses of N.R. Kamath Quiz

The Quiz Results:

The final showdown featured IIT-Bombay, ICT, Thadomal Shahani College of Engineering, and Gharda Institute of Technology. A fast-paced rapid-fire round concluded the competition. After a nail-biting score tally, IIT-Bombay emerged as the champion, with Thadomal Shahani College of Engineering and Gharda Institute of Technology securing the second and third positions, respectively.



Winners in one frame ...



Valedictory Ceremony and Closing Remarks: The exhilarating competition culminated in a grand valedictory ceremony. A photoshoot session captured the joyous and memorable moments from the event. The ceremony was graced by the presence of dignitaries such as Dr. Sandeep Gujrathi, Dr. S.D. Sawarkar, Dr. D.J Pete, Dr. S.M Deshmukh, Dr. Sanjay Mahajani, Shri Jagdish Nageshri, Shri Pravin Saxena, and Dr. Prashant Ingole. The winning teams were acknowledged for their exceptional performance and awarded certificates of merit along with cash.

Prof. N.R. Kamath

The Prof. N. R. Kamath Chemical Engineering Quiz Competition in Mumbai honors his legacy. The Quiz is a prestigious event held annually in Mumbai to honor the memory of Professor N. R. Kamath, a founding figure in the city's chemical engineering education. Organized by the Indian Institute of Chemical Engineers (IIChE), the competition brings together students from colleges to test their knowledge and passion for the field. The competition is an one day event, typically featuring a talk on advancements in chemical and environmental engineering on the first half. This provides a platform for industry experts and academicians to share their knowledge with the students. The second half is dedicated to the quiz itself, with teams battling it out in a series of challenging question rounds. The event not only tests the students' knowledge but also fosters a spirit of camaraderie and healthy competition.



Prof. Kamath welcoming His Excellency Shri V.V. Giri, President of India at the All India Plastics Manufacturers' Association Silver Jubilee Celebration on 31st January 1972.



The Prof. N. R. Kamath Quiz Competition serves as a testament to Professor Kamath's lasting impact on the field of chemical engineering. It inspires students to excel in their studies and pursue careers that contribute to the advancement of this vital field. Students from the Chemical Engineering Department of IIT Bombay won the prestigious Prof. N R Kamath Annual Intercollege Chemical Engineering Quiz, held on 16th March 2024 at DMCE, Mumbai. Eight different teams nominated by the respective colleges across the MRC participated in the event. This is the third time IIT Bombay has won this competition in the last 18 years. The students who got the trophy for IIT Bombay are: Sumit Kumar, Manas Agarwal and Parth Dani.

Congratulations !

Glimpses of Seminar on Sustainable Chemical Manufacturing 27 May 2024

Seminar Series

Sustainable Chemical Manufacturing - 1

May 27th 2024

Venue: VMCC, IIT Bombay



IIT BOMBAY

Research Hub for Green Energy and Sustainability (GESH)

Jointly with

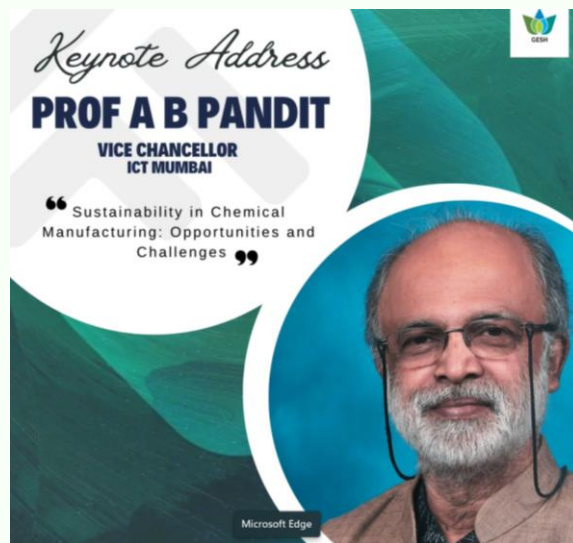
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Mumbai Chapter



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Continued ...

Glimpses of Seminar on Sustainable Chemical Manufacturing

Seminar on Sustainable Chemical Manufacturing was held on 27 May 2024 at VMCC, IIT, Bombay, in collaboration with IICHE. The event aimed to brainstorm ideas for sustainability and initiate a series of one-day seminars to culminate in a white paper.

Key Themes and Discussions

The seminar covered a wide range of topics related to sustainable chemical manufacturing. Key themes included:

- **The need:** Speakers emphasized criticality of addressing sustainability challenges through holistic approach involving industry, academia, and government.
- **The role of technology:** The seminar highlighted the potential of technology, such as biomimicry, green chemistry, and advanced materials, in driving sustainability.
- **Circular economy:** Participants discussed the importance of adopting circular economy principles to minimize waste and optimize resource utilization.
- **Industry-academia collaboration:** The need for collaborative research and development was emphasized to address complex sustainability challenges.
- **Policy and regulatory framework:** The seminar touched upon the role of government policies and regulations in fostering sustainable practices.

Continued ...



MEET the SPEAKERS

		
Mr. R G Rajan Ex CMD, Rashtriya Chemicals and Fertilizers Ltd.	Prof. Haresh Manyar Queens University Belfast, Ireland	Prof. Yogendra Shastri IIT Bombay



MEET the SPEAKERS

		
Dr. DK Tuli Ex Executive Director IOC R&D Visiting Chair Professor IIT	Dr. Sangeeta Srivastava Executive Director Gadhavari Biorefineries Ltd	Dr. Pramod Kumbhar President & CTO Praj Matrix



MEET the SPEAKERS

		
Dr. Mritunjay Chaubey Global VP & Head Environment & Sustainability, UPL Pvt. Ltd	Ms Jyothi Palekar Founder and MD Sustainable Technosolutions for Environmental Protection (STEP) Private Ltd	Dr Debabrata Rautaray VP Chief Product Dev. & Innovation Officer, DCM Shriram



MEET the SPEAKERS

		
Dr. Sateesh Daggupati AVP & Group Lead Reliance Industries Ltd	Mr. Rajendra Gandhi MD GRP Ltd	Prof. Guruswamy K IIT Bombay

Glimpses of Seminar on Sustainable Chemical Manufacturing

Specific Topics and Recommendations:

- **Environmental management:** Dr. AB Pandit emphasized the importance of considering long-term sustainability, linking it to human well-being, and conserving natural capital. He advocated for eco-efficiency, life cycle assessment, and biomimicry as key approaches.
- **Fertilizer manufacturing:** Challenges related to greenhouse gas emissions, water usage, energy consumption and opportunities for reducing environmental impact through green ammonia, nano-fertilizers, carbon capture were discussed.
- **Biomass as feedstock:** The potential of biomass as a sustainable feedstock for biorefineries was highlighted. Challenges related to feedstock quality, processing efficiency, and economic viability were discussed.
- **Waste polymers:** The seminar addressed the issue of waste plastic and rubber, emphasizing the need for efficient recycling technologies, supply chain improvements, and value-added product development.
- **Future of chemical manufacturing:** Prof. Haresh outlined the importance of CO₂ utilization, green chemistry, and advanced manufacturing technologies for sustainable chemical production.

[Continued ...](#)



Glimpses of Seminar on Sustainable Chemical Manufacturing

Recommendations for Future Action:

Based on the discussions, the following areas were identified as potential focus areas for future research and development:

- Develop India-specific LCA and emissions databases.
- Explore the potential of biomimicry for sustainable process design.
- Investigate the use of waste as a valuable resource for chemical production.
- Develop advanced technologies for CO₂ capture and utilization.
- Promote industry-academia collaboration to accelerate the development and implementation of sustainable solutions.

Conclusion:

The seminar provided a valuable platform for knowledge sharing and collaboration among academia and industry stakeholders. The discussions generated a rich set of ideas and recommendations for advancing sustainable chemical manufacturing. It is recommended to continue the series of seminars to delve deeper into the identified areas and develop actionable strategies.



CHEMTECH 2024

India's Premier Chemical Industry Event

CHEMTECH 2024 was a significant platform for the chemicals, petrochemicals, biopharma, and process industries in India. Held from March 4-7, 2024, in Mumbai, it marked the 50th anniversary of this renowned event. The IICHE MRC EC exhibition stall at CHEMTECH 2024 was a bustling hub of activity, attracting a steady stream of industry professionals and enthusiastic students.

World Meet of the **CHEMICALS, PETROCHEMICALS, BIOPHARMA & PROCESS** Industry in India
31st International Exhibition & Conference



4-7 March 2024

Venue: Bombay Exhibition Center,
Goregaon (East), Mumbai, India



Continued ...

CHEMTECH 2024

India's Premier Chemical Industry Event

CHEMTECH 2024: A massive exhibition: Showcasing the latest technologies, equipment, and services from over 750 exhibitors across 20 countries. **Concurrent conferences:** Covering diverse topics like EPC, specialty chemicals, refining, petrochemicals, biopharma, water treatment, and more. **Networking opportunities:** Bringing together industry leaders, experts, and professionals for knowledge sharing and business collaborations. **Focus on sustainability:** Addressing environmental concerns and promoting sustainable practices within the chemical industry. **Student outreach program:** Encouraging young talent and fostering future leaders in the chemical sector. Overall, CHEMTECH 2024 served as a catalyst for innovation, growth, and collaboration within the Indian chemical industry.



CHEMTECH 2024

India's Premier Chemical Industry Event

More than **400 Exhibitors** already confirmed



World Meet of the **CHEMICALS, PETROCHEMICALS, BIOPHARMA & PROCESS** Industry in India

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4-7 March 2024

Venue: Bombay Exhibition Center, Goregaon (East), Mumbai, India

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Chemicals, Petrochemicals, BIOPHARMA & Process Industry Exhibition & Conferences, 2024 in Mumbai, India

Chemtech will organize 31st edition of **ChemTECH World Expo 2024** from **4th - 7th March, 2024** in Bombay Exhibition Centre, Goregaon (East), Mumbai, India. This edition will also mark 50 years of ChemTECH's journey of creating B2B platforms for downstream chemical processing and allied industries. Co-located events will include focused exhibitions & conferences for EPC, Refining & Petrochemicals, Specialty Chemicals, BioPharma, Industry Automation & Process Control, Water & Environment Services, Lab & Analytics and Surface Engineering & Corrosion Control.

ChemTECH World Expo since its inception in 1974 has been enabling stakeholders of Chemicals & Process Plant Technologies globally to engage at common platforms to explore technology partnerships and build business networks.

Industry Leaders who are guiding force of ChemTECH World Expo 2024



Maulik Jasubhai
Chairman & Chief Executive
Jasubhai Group & ChemTECH Foundation
Honorary Consul General of Austria in Mumbai



Patron & Brand Ambassador
ChemTECH World Expo 2024
Shri Suresh Prabhu
Former Member of Parliament
Government of India



Jury Chairman, Chemtech Leadership & Excellence Awards 2024
Dr. R.A. Mashalkar
Scientist, Former Director General, Council of Scientific and Industrial Research (CSIR)



Chairman
BioPharma World Expo 2024
Dr. Rajesh Gokhale
Secretary, DBT, Ministry of Science & Technology Govt. of India



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Group President Projects & Procurement, Reliance Industries Ltd.



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Whole time Director & Sr. EVP Energy
Larsan & Toubro Limited



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Director (Refineries)
Indian Oil Corporation Ltd.



Co-Chairman, Refining & Petrochemicals World Expo 2024
Mr. Sanjay Khanna
Director (Refineries)
Bharat Petroleum Corporation Ltd.



Chairman,
Specialty Chemicals World Expo 2024
Mr. Nadir Godrej
Chairman & Managing Director
Godrej Industries Ltd.

International Conferences 2024



4th-5th March 2024

Theme: Roadmap to EPC Leadership - A Paradigm Shift
Tel: +91-22-4037 3617
Email: afrah_shalkh@jasubhai.com



4th-5th March 2024

Theme: 'Role of Specialty Chemicals for Catalysing Sustainable Future'
Tel: +91-22-4037 3614
Email: shikha_pandey@asubhai.com

Chlor-Alkali World Expo & Conference 2024

6th-7th March 2024

Tel: +91-9870822621
Email: shikha_pandey@asubhai.com



5th March 2024

Theme: Sustainable Energy Landscape: Future Downstream
Tel: +91-22-4037 3617
Email: afrah_shalkh@jasubhai.com



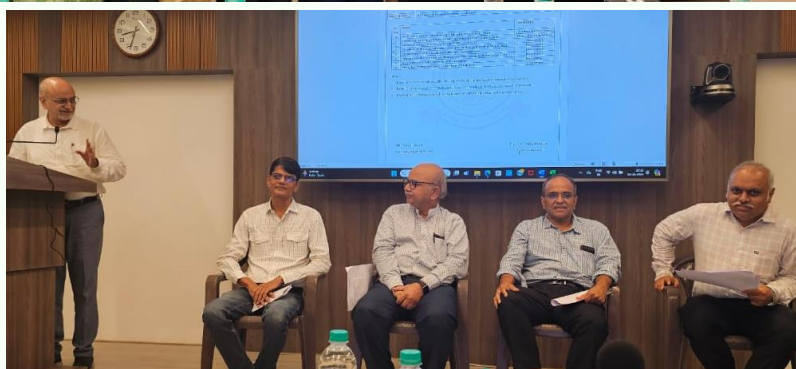
5th March 2024

64th Annual General Meeting 2023-24

2nd August 2024

Warm welcome filled the air as the Chairman Prof. Sanjay Mahajani graciously received MRC members and esteemed guests alike. The proceedings commenced with a comprehensive overview of the organization's accomplishments throughout the year, highlighting the remarkable success of various events and providing an exciting glimpse into the promising initiatives on the horizon.

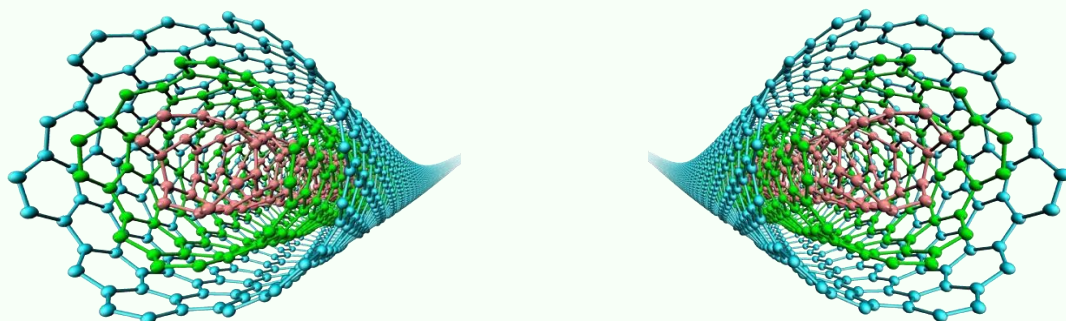
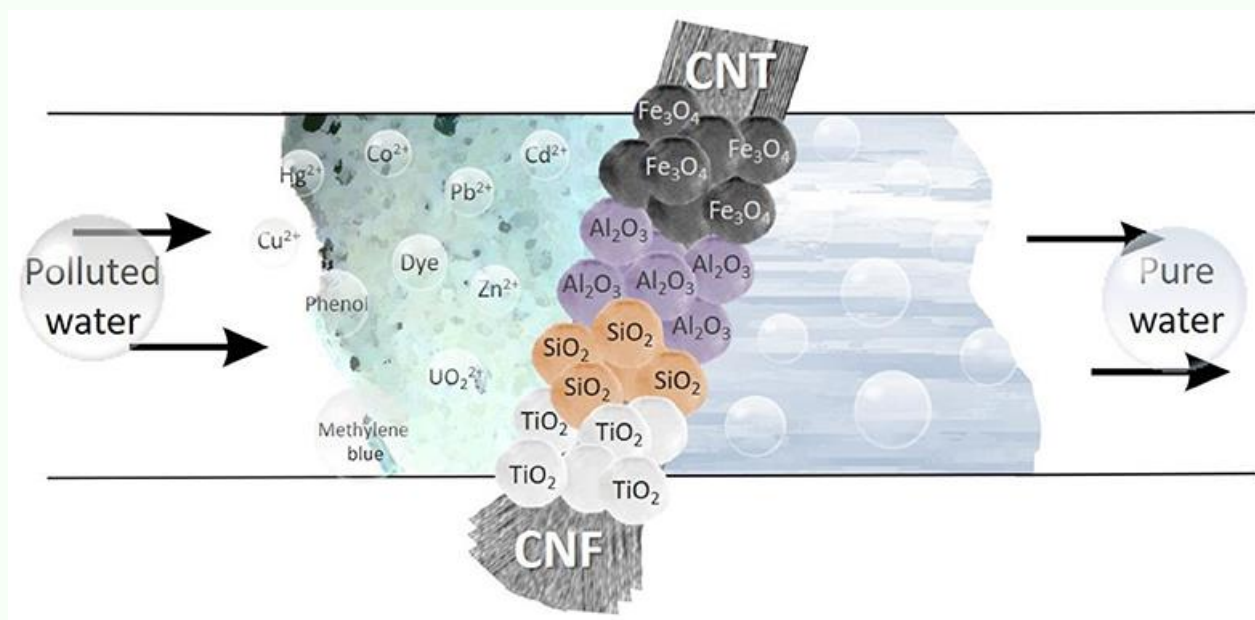
The subsequent presentation by the Member Secretary Shri Dhawal Saxena offered a detailed chronicle of the organization's endeavors, inviting insightful questions and valuable suggestions from the attentive audience. A transparent financial overview was presented by the Treasurer Shri Mahendra Patel and Joint Treasurer Shri Rajesh Jain, who unveiled the audited accounts for the fiscal year 2023-2024. As the evening drew to a close, the Vice Chairman Jagdish Nageshri expressed sincere gratitude to all members for their unwavering support and contributions, culminating in a delightful invitation to share a convivial dinner.



Carbon Nanomaterials in Desalination Processes

Unnati Rao (unnatir@ucla.edu)

Dr Unnati Rao is a Senior Research Engineer at Membrion. Her research focuses on the development and testing of membrane materials for water treatment. She has also extensively worked in the application of electrochemistry for water treatment processes. Unnati has completed her PhD at UCLA and has postdoctoral experience at UCLA and Stanford University. At Membrion, she tests operational limits and investigates optimum operating conditions of Membrion's electro ceramic desalination modules. She also uses her extensive background in membrane science, electrochemistry and water chemistry to treat challenging acidic industrial wastewater streams. She has numerous publications and books as well as a patent.



Note: We would like to thank Dr. TL Prasad for his help in arranging Dr. Unnati Rao's interesting and up-to-date article on Carbon Nanomaterial in desalination processes.

Carbon Nanomaterials in Desalination Processes

The global desalination market has been increasing at a rapid rate due to growing population and changing climate. While thermally driven desalination techniques are the most widely used in Gulf countries, pressure driven processes such as reverse osmosis (RO) are the fastest growing market segment and contribute to most of the global desalination capacity today.

Desalination can be differentiated into two categories: thermal-based, and membrane-based processes. Thermal based processes remove salt by facilitating a phase change. The most widely used technologies are multi-stage flash and multi-effect distillation. These are highly efficient and utilize changes in temperature and pressure to cause phase change of water. Over the years, little research has been conducted in using carbon-based nanomaterials for these thermal desalination processes. The rest of this article will focus on membrane-based desalination processes.

Membrane based desalination processes can further be divided into three categories:

1. Thermally driven: Separation of water from feed due to phase change, facilitated by a membrane. The primary thermally driven membrane separation process is membrane distillation (MD). In this process, a hydrophobic polymeric membrane separates the contaminated (feed) phase from the pure (permeate) phase. The feed stream is heated, and vapor generated passes through this hydrophobic membrane, while liquid is retained on the feed side.
2. Pressure driven: Separation of water from feed due to pressure difference. In the pressure driven process, water preferentially permeates through a semi-permeable polymeric membrane resulting in a purified permeate stream and a concentrated brine stream. The most widely used pressure driven techniques for desalination are reverse osmosis (RO) and nanofiltration (NF). NF membranes have pore sizes in the sub-nanometer range and can reject hydrated divalent ions, while RO membranes can reject monovalent ions, making them extremely effective for desalination.
3. Electrically driven: Separation of salt from water due to movement of ions under an applied electric field. Under applied electrical potential, ions migrate towards oppositely charged electrodes. These ions can be absorbed on the electrodes or transported through selective membranes. In electrodialysis (ED), feed water is passed through alternating anion exchange membranes (AEM) and cation exchange membranes (CEM) which are alternately placed in a sandwich like structure. There are two different independent flow loops- concentrate and dilute. The concentration of ions is enriched in the concentrate loop, making it saltier and the concentration of ions is depleted in the dilute loop, making it purer.

[Continued ...](#)

All membrane-based processes suffer from some common challenges such as membrane scaling, fouling and durability. Scaling and fouling are caused by precipitation and deposition of inorganic or organic matter on membrane surfaces or within the structure. These phenomena can reduce flux and rejection and increase energy demand. By incorporating carbon-based nanomaterials in membrane synthesis, or by coating nanoparticles on membrane surfaces, the properties of membranes can be tuned to make them resistant to scaling and fouling. Membrane distillation also suffers from wetting, which provides hydrophilic pathways for contaminants to seep into the permeate. Several advances have been made by incorporating carbon-based nanomaterials in MD membrane synthesis to mitigate wetting. RO and NF membranes are usually made up of polyamide, which are susceptible to free chlorine attack. As a result, these membranes are sensitive to chlorine. Certain enhancements with carbon nanomaterials can make these membranes chlorine resistant.

Below are the main carbon-based nanomaterials and their recent advances in membrane-based desalination processes.

Nanomaterials used in desalination:

1. Carbon nanotubes (CNTs): CNTs are thin graphene sheets rolled into cylinders. They can either be single walled or multi-walled depending on the number of graphene sheets rolled. CNTs can be functionalized to impart desired properties.

The main pathways through which CNTs enhance membrane processes are:

- Enhanced flux in MD through alternative pathways for vapor transport along with imparting anti-wetting properties. Several studies have shown that the polar nature of CNTs provided higher water vapor sorption, thus enhancing flux. The presence of CNTs can cause MD membranes to have superhydrophobic pore walls. This reduces the boundary layer effect for viscous flow, assisted surface diffusion and facilitated Knudsen and molecular diffusion by repelling water vapor molecules, leading to superior anti-wetting properties and enhanced flux.
- Enhanced energy efficiency can be achieved by CNT due to the Joule heating effect. CNT coated polypropylene membrane was able to achieve 100% single-pass recovery by applying alternating current to the membrane surface, causing joule heating effect. This eliminated the need for bulk heating of the liquid. A composite Fe-CNT/PTFE membrane was directly heated using a high frequency magnetic field resulting in increased thermal efficiency as well as high salt rejection. MD process with induction heating by radio frequency at the CNT coated membrane surface

[Continued ...](#)

enhanced flux by nearly 400% and showed sustained high fluxes for up to 6 hours during the treatment of a CaSO_4 solution. A membrane distillation system consisting of a CNT membrane as solar absorption layer achieved thermal efficiency of nearly 85%.

- Enhanced flux in RO and NF by incorporating into the active layer. The embedded CNTs provide a low-resistance pathway to the water molecules and improve the mechanical properties of the polymer composites which helped to reduce the compression of the membrane, all of which contribute to higher water flux. When incorporated as the intermediate layer between the active layer and support layer, the higher flux exhibited by the CNT membranes was attributed to the robust CNT layer providing a strong mechanical support and preventing the active layer crumpling when exposed to high operation pressure. The pore size distribution of the CNT membrane has also been very similar to that of a pure polymer membrane, and the flux improvement is due to the reduced tortuosity and increased interconnectivity of the water transport channels created by the inclusion of CNTs.
- Enhanced permeance by incorporating CNTs in the support membrane matrix. CNTs serve as pore forming additives that increase the porosity of the material. Therefore, the resulting TFC membranes with CNT-polymer supports showed significantly enhanced water permeance.
-
- Increased chlorine tolerance in RO/NF membranes. Most commercial RO/NF membranes are vulnerable to chlorine exposure, but some nanocomposite CNT-TFC membranes exhibit high chlorine resistance due to the CNT incorporation. The presence of CNT within the polyamide active layer matrix in composite membranes acts as anti-chlorination stabilizers: the interactions between polyamide and carbon networks increased the activation energy for chlorination. Moreover, the addition of CNT to a polymer matrix reduced chlorine uptake within the matrix, therefore protecting the polymer from chlorine oxidative degradation. The potential mechanism for the enhanced chlorine resistance of composite membranes may also lie in the protection of active site in m-phenylenediamine (one monomer that is widely used to form polyamide active layer) residual by the electron-rich CNTs from being attacked by the free chlorine.
- Anti-fouling properties. Research has shown that CNTs are inherently toxic towards bacteria. The toxicity is attributed to the physical disruption of the bacterial membrane, and/or the CNTs serving as an electron shuttle which oxidizes bacterial cellular machinery. In addition, reactive oxygen species generated from bacteria-CNT interaction can induce in vitro apoptosis and cell oxidative stress that encourage biofilm-free conditions during membrane desalination.

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- Mitigating scale formation due to their electrical properties. CNT nanocomposites have been demonstrated to mitigate scaling by electrostatic repulsion and proton/hydroxide production from water splitting when an external potential was applied to the electrically conducting membrane surface, which effectively dissolved the accumulated minerals and restored membrane performance. Electrostatic repulsion and electro-responsive surface morphology changes of CNT membranes also contribute to organic fouling reduction. When cathodic potential was applied to the CNT coated membrane, calcium carbonate scaling was successfully dissolved by local pH modification. An alternating current applied to the CNT coated membrane resulted in reduced scaling, and enhanced flux by nearly 80% during treatment of calcium sulfate and silicate rich streams.
 - Anti-fouling properties due to electrical conductivity. CNT membranes also showed reduced fouling during oil/water separation due to field-induced redistribution of surfactants at the oil/water interface; importantly, the anti-fouling effects were independent of salt concentrations, indicating that this method is potentially applicable under a wider range of environmental conditions. In addition, the electrochemical effects of electroactive CNT membranes have been harnessed for biofouling control by driving reactions such as hydrogen evolution (i.e., in-situ bubble formation) and oxygen reduction/H₂O₂ evolution or affecting the redox potential across the cell membrane and the coupling of electrochemical degradation reactions with filtration.
2. Graphene or graphene oxide: Graphene and graphene oxide (GO) have outstanding mechanical, chemical, thermal, optical, and electrical properties. Their thin 2D nanostructure allows for pore engineering. Graphene and graphene oxide can improve membrane-based processes in the following ways:
- Modification with graphene oxide increases surface roughness, which imparts anti-wetting properties to MD membranes. A graphene oxide-based membrane modified with SiO₂ particles showed excellent salt rejection over a period of 170 hours, along with a stable flux due to enhanced surface roughness and hydrophobicity by grafting of long alkyl chains. A PVDF/graphene composite membrane fabricated by phase inversion showed >99.9% rejection even after 35 hours, at which time the non-modified membrane showed a drop in salt rejection.
 - Enhanced thermal efficiency. Graphene is also an excellent thermal conductor. A graphene array was grown on a nickel foam. When this membrane was heated using solar energy, energy efficiency of nearly 75% was achieved.

Continued ...

- Enhanced mechanical properties. Functionalized graphene nanoparticles have also been shown to possess superior mechanical properties. n-Butylamine graphene oxide was incorporated in PVDF hollow fiber membranes and used for seawater desalination. This increased the maximum tensile stress, maximum tensile strain, and Young's modulus by 32%, 63% and 71%, respectively, while the liquid entry pressure (LEP) and burst pressure increased by 67% and 15%, respectively. While this modification reduced the water flux by 7%, it maintained high salt rejection.
- Superior anti-fouling. Graphene oxide dispersed on PVDF membranes was used in a DCMD system and showed superior anti-fouling performance. This was hypothesized to be due to the presence of oxygen containing functional groups in graphene oxide. Moreover, owing to the several oxygen containing functional groups on its surface, GO imparts superior hydrophilicity to the membrane. Hydrophilic surfaces form a hydration layer that prevent hydrophobic interactions between the foulants and the membrane surface, thereby inhibiting initial attachment and decreasing fouling propensity.
- Increased chlorine resistance. Graphene oxide and reduce graphene oxide (rGO) provide an excellent platform for exploring size selective membranes. GO incorporated into PA-TFC membranes improves its anti-fouling capacity and acts as a protective layer for the PA structure, offering increased chemical resistance to chlorine. The GO flakes impeded dissolved chlorine from contacting the surface, increasing its chlorine resistance.
- Enhanced permeability. Embedding GO can also improve water permeability, surface hydrophilicity and negatively charged surface properties. By incorporating GO into a PA-TFC membrane, the water permeability increases due to increased diffusion through the nanopores.
- Enhanced electrical conductivity of IEMs. A novel CEM for electrodialysis was incorporated with graphite nanoparticles, which displayed uniform distribution of graphite nanoparticles and provided conducting areas for membrane, easy flow channels for counter ion transportation, and led to a decline in membrane electrical resistance. The combined effect may strengthen the electric field around the CEM and lead to a possible decrease in concentration polarization. IEMs for ED applications must possess especially high ionic conductivity and high permselectivity for counter ions. However, nanosized defects in 2D graphene layer can lead to mutual selectivity between co-ions or permselectivity between counter ions in graphene-based membranes. To alleviate this issue, a heterogenous, 3D, macroporous network of Laser Induced Graphene (LIG) was embedded in the CEMs.

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The introduction of LIG increased the conductivity of the membrane and effective capacitance in the membrane-electrolyte interface. Compared to purely organic polymeric membranes, composite IEMs have superior properties. Moreover, using conducting polymers in the modification of nanomaterials combines the electrochemical properties of the polymer with the properties of the nanomaterials.

3. **Carbon Nanofibers:** Carbon Nanofibers (CNFs) are 1D nanomaterials having unique properties. They are considered great candidates for inorganic fillers for fabrication of mixed matrix membranes, due to their high aspect ratios and high specific surface area. Moreover, CNFs have a highly interconnected fiber structure, with a tunable fiber diameter, and a partial negative charge which helps enhance selectivity and ion flux. The high electrical conductivities of CNF also help reduce concentration polarization by enhancing the electrochemical properties of the membrane and the electrical field strength around the membrane. CNF embedded membranes are commonly prepared by mixing CNF into the casting solution. CNFs were incorporated in mixed matrix electro dialysis membranes to improve membrane properties. The study found that increasing CNF concentration up to 0.5 wt% decreased the surface roughness, which reduced the boundary layer at the membrane solution interface, and increased surface hydrophilicity. The addition of CNFs also improved membrane potential, transport number, and permselectivity, as well as the mono ionic permeability and flux.

4. **Activated carbon nanoparticles (ACNPs):** ACNPs have distinct physical and chemical properties, surface morphology, uniform particle size, biocompatibility, and large surface area. In a DCMD system, a hydrophobic active layer was prepared by electrospinning ACNPs along with PVDF co-hexafluoropropylene and cast on a thick hydrophilic support layer. When 1.5% by weight of ACNPs were used, a 10% increase in flux over the benchmark PTFE membrane was observed. Membranes with high conductivity (ACNPs) were incorporated in CEMs. The produced membranes had improved ion exchange capacity, membrane potential, fixed ionic concentration and selectivity. Application of these membranes in ED showed high dialytic rate of unwanted ions. Similarly, an AC-co-Chitosan composite nanoparticle embedded IEM was developed to surface area and high adsorptive property of activated carbon with the hydrophilicity and functionality of chitosan. The developed membranes demonstrated improved properties such as increased IEC, ionic flux, and permeability, owing to the exceptional adsorption capacity of the composite nanoparticles. The study also found that incorporating the AC-co-Chitosan composite nanoparticles also increased the dialytic rate for copper ion removal.

Proud of you!

Congratulations Prof. G.D. Yadav !



Bestowed SASTRA CNR Rao Award for Excellence in Chemistry and Material Science on 28th February 2024 at Thanjavur. Prof CNR Rao himself chooses the Awardee.

Congratulations Shri RG Rajan !



Shri R. G. Rajan, an Independent Director on multiple boards and a recognized expert in the fertilizer industry, has been honored with the prestigious "U.S. Awasthi IFFCO Award for Lifetime Achievement in the field of Development of the Fertilizer Industry" for 2023. This award was presented by the Fertilizer Association of India, the apex body representing all fertilizer companies. Shri Rajan's illustrious career includes his tenure as the Chairman and Managing Director of Rashtriya Chemicals and Fertilizers. Additionally, he has served as the Chairman of both the Fertilizer Association of India (FAI) and the Standing Conference of Public Sector Enterprises (SCOPE).

Beyond his leadership roles, Shri Rajan is an accomplished author, having written the highly acclaimed book "Life Lessons For Managers." He also contributes regularly to various national magazines and newspapers. His extensive experience and contributions to the fertilizer industry and management literature have made him a respected figure in both fields.

IChE forthcoming events

Indian Chemical Engineering Congress CHEMCON 2024

Role of Chemical Engineering towards Sustainable
Development and Atmanirbhar bharat

77th ANNUAL SESSION

December 27-30, 2024

Organized by

Indian Institute of Chemical Engineers
Doaba Regional Centre



at

FIST Sponsored
Department of Chemical Engineering
Dr. B. R. Ambedkar NIT Jalandhar
G. T. Road, Bypass, Jalandhar-144008, Punjab, India
Website: www.chemcon2024.com

IChE forthcoming events

Second Announcement
20th Annual Session of
Students' Chemical Engineering Congress



SCHEMCON 2024

on

New Paradigms of Chemical Engineering

(20th – 21st September 2024)

Organized by

IChE-RGIPT Student Chapter

**Department of Chemical and Biochemical Engineering
Rajiv Gandhi Institute of Petroleum Technology**

in association with

**Indian Institute of Chemical Engineers
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Indian Institute of Chemical Engineers (IICChE)

IICChE began its journey on 18th May 1947 with burning nationalistic fervor as India was on the cusp of gaining its independence in August 1947. Ever since its inception, the mission of IICChE was to contribute to the nation-building through dissemination of knowledge and enhancement of skill in Chemical Engineering and its allied fields. While the path has not been easy, IICChE has been steadfast in its role.

Today it has emerged as a premier body of Chemical Engineering education and profession in India, having several thousands members across the country. The Platinum Jubilee of IICChE is a means to salute its 75-year long journey through many successes and a few setbacks. As a matter of fact, IICChE is always molding itself and playing a proactive role to keep up with the dynamic needs of the economy and the society. The administration of the Institute is governed by an all-India Council. The activities of the Institute are spread across the country through its 46 Regional Centers and more than 181 Student Chapters. The Regional Centers promote and complement the activities and objectives of the Institute.



IICChE Mumbai Regional Center (MRC)

IICChE-MRC is also confluence of streams of professionals from academia, research institute and industry. It provides them the appropriate forum for joint endeavors, hand-in-hand, to work for human being through application of chemical engineering and allied sciences. If you are interested about, attached to or involved in chemical engineering related activities - whether as a student as a seasoned professional - you shall find the programme of IICChE immensely beneficial, opening up doors of new possibilities and existing possibilities

IICChE-MRC is one of the regional centers of the Indian Institute of Chemical Engineers (IICChE), the apex professional society of Chemical Engineers in India. The Mumbai Regional Centre (MRC) is the biggest of them with respect to the all-India membership. Many members of the Institute serve on various technical committees of the Government of India and of chemical and allied industries.

Address: IICChE Mumbai Regional Centre B-18, Vardhman Complex, Gr Floor, Opp Home Town & 247 Park, LBS Marg, Vikhroli (West), Mumbai - 400 083. Phone: 022 4558 5485. Email: info@iicchemrc.org

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IChE-MRC Best Undergraduate Design Project Award

Genesis : There are around 10-15 undergraduate Chemical Engineering Departments affiliated to IChE MRC. Every college has an undergraduate project as a part of its curriculum. More than 1000 students compulsorily do project as the requirement of their UG program. It is a team activity and considerable weightage is given for the efforts that students put into the project. It also has a strong presence in their CV and job interviews. It is proposed to introduce a popular prize to further motivate students and make them put in serious effort in this activity. Every year the best project will be selected for prize by following a very systematic and rigorous protocol.

Process: All the affiliated colleges will be invited to send their entries. Criteria for selection will be communicated every year in each participating college. Only one nomination per college, sent by the head of the department, will be entertained. An expert committee panel approved by EC-MRC will be formed. The panel members will go through the reports, and do a critical assessment to select the best project.

The award will be announced and given away in an event attended by sponsors, selected students and college teachers. Panel members would comment on the overall quality of the projects and give inputs. The winning team(s) will respond. The winners would receive awards worth more than or equal to 30k (first prize) and 20k (second prize). The names of the winners and the project abstract will be displayed on the IChE web page. A small article in chemical magazines will be published to popularize the achievement.

Prize Sponsors: The prize will be named after the sponsor organization: XYZ-IChE MRC Best Undergraduate Project Award. A prior publicity would be given to all the colleges among 1000 students in and around Mumbai, every year. The award will be given in the hands of the company nominated person in every annual event of IChE MRC. Post publicity of the event will be done on IChE website; LinkedIn, Facebook of MRC and also on various social media platforms and in Chemical magazines.

An update: A distinguished expert committee has been established to evaluate the submitted projects. Chaired by Professor R. K. Malik, a former faculty member of IIT Bombay, the committee comprises Professor Anand Patwardhan from ICT and Mr. Sanjay Balgaonkar, AVP at Ion Chemicals. The committee will conduct a two-phase evaluation process. In the initial phase, nominees will receive comprehensive feedback on their project proposals, highlighting areas for enhancement and improvement. Following the submission of revised projects, the committee will undertake a thorough assessment to determine the final award recipients.

IICHE-MRC Best Undergraduate Design Project Award

Projects are expected to contain ...

Executive Summary: concise overview of the project goals, methodology, and key findings.

Chemical Focus: In-depth description of the chosen chemical, including its history, properties, applications, market specifications, global and Indian market size, import/export data.

Production Considerations: Detailed analysis of production routes, process selection rationale, and a clear description of the chosen production process.

Process Schematics: Inclusion of block diagrams, process flow diagrams, and piping and instrumentation diagrams along with descriptions of the equipment involved.

Material and Energy Balances: Presentation of mass and energy balances for the chosen process. Integration of a flow sheet generated using a specific software package (mentioning the chosen software and its property package).

Thermodynamic and Kinetic Analysis: Application of thermodynamic and kinetic principles to the chosen process.

Sensitivity Analysis: Exploration of how critical operating parameters affect the process performance.

Design Aspects: Detailed sections on process design, equipment design (including material selection for construction - MOC), mechanical design, and overall plant layout.

Reactor Design: Specific and detailed design considerations for the process reactor.

Site Selection: Justification for the chosen site based on factors like resource availability, production capacity, and profitability.

Process Control and Instrumentation: Selection and description of appropriate instrumentation and control systems for the process.

Safety and Environmental Considerations: Comprehensive assessment of Health, Safety, and Environment (HSE) aspects, including discussions on effluent treatment plant (ETP) considerations and a sample Hazard and Operability (HAZOP) study.

Cost Analysis: Detailed breakdown of equipment costs and overall production costs.

Economic Evaluation: Complete economic analysis of the plant, encompassing capital cost, revenue projections, break-even point, return on investment (ROI), cash flow analysis, and relevant financial ratio analysis.

Feasibility Assessment: Conclusion regarding the technical, economic, and ecological feasibility of the designed process.

Annexes:

List of Tables, List of Figures, List of Abbreviations, List of References, Sample Equipment Specification Sheet, Material Safety Data Sheet (MSDS) for both hazardous raw materials and the final product. This standardized format ensures a comprehensive and comparable evaluation of design projects from various engineering colleges during competitions.

Become IChE Member

The Indian Institute of Chemical Engineers (IChE) is the apex professional body of chemical engineers in India. It has a membership of about fifteen thousand including Corporate Members and Student Members. There are forty-one Regional Centers and forty-seven Student Chapters of the Institute in different parts of India. The Institute represents the chemical engineering profession in India. Many members of the Institute serve on various technical committees of the Government of India and of chemical and allied industries. Here are some of the benefits that a member of the Institute enjoys.

- Since IChE is the recognized forum, membership of the Institute itself is considered as a professional accomplishment of a person.
- Member can join numerous seminars, symposia, workshops, training programme, special lectures, industry visits and other professional activities. Participation in such programme is either free or may involve a subsidized fee.
- Corporate member is eligible to contest in the annual election to the 25-member Council, which is the highest policy-making body of the Institute.
- IChE has an active consultancy programme. An interested member may seek and get help from the Institute in his endeavor to offer consultancy services to potential industrial customers.
- Member can join the four-day Annual Professional Meet called CHEMCON at a subsidized fee. Various professional meets organized by IChE acts as a forum for interaction and networking of the professionals
- The student members may join as member of seminars specifically meant for them and can participate in a number of competitions. One of such popular seminar is SCHEMCON which is organized by one of the IChE Student Chapters.
- Corporate member may be nominated to various government and non-government bodies in different areas, if found suitable.

Details about types of membership, membership fees & subscriptions, membership card etc. are available on IChE website.

<https://www.iiche.org.in/joiniiche.php>

Online Application forms for Life Fellowship, Life Membership, Life Associate Membership, Student Membership, Organisational Membership are also available on IChE website.



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