ChemE Chronicles

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FROM HOD'S DESK

PROF. ADITYA KUMAR

Dear friends and well-wishers,

It gives me immense pleasure to present the latest issue of *ChemE Chronicles*, our humble initiative to connect with students, alumni, and well-wishers of the Department of Chemical Engineering at IIT (ISM) Dhanbad. Each edition continues to grow richer with contributions and enthusiasm from every member of our department — and I extend my sincere gratitude to all who have made this possible.

The past few months have witnessed remarkable academic and research activities in the department. Our faculty members have been active in national and international collaborations, while our students have brought laurels through academic accolades and placements. The department continues to see high-quality publications in reputed journals, reflecting the strong research culture and teamwork among our faculty, research scholars, and students.

This issue highlights **academic visits and notable accolades** on various occasions. It is truly amazing to witness the enthusiasm and commitment that drive our departmental community forward.

As in every issue, our recurring sections — **"ChemE Trivia," "Feature Article," "Chemical Engineering News," and "Alumni ChEnect"** — continue to bring knowledge, perspective, and inspiration. In this edition, the **ChemE Trivia** section explores the fascinating world of **bioreactors** — the living heart of biochemical and bioprocess industries. From early fermenters to advanced perfusion and single-use systems, the article delves into how chemical engineers continue to optimize life-based processes for pharmaceuticals, biofuels, and sustainable materials.

The *Feature Article* of this issue, titled **"Hydrogen: Fuel of the Future,"** focuses on one of the most promising frontiers in sustainable energy. As the world transitions toward decarbonization and green energy, hydrogen-based technologies, electrolyzers, and fuel cells will play a defining role — an area where chemical engineers will continue to lead innovation. We also continue to highlight research contributions that have emerged as peer-reviewed articles.

I encourage our readers to stay connected, contribute ideas, and share achievements that make our department stronger. Let us continue this collaborative journey — celebrating learning, research, and innovation together.

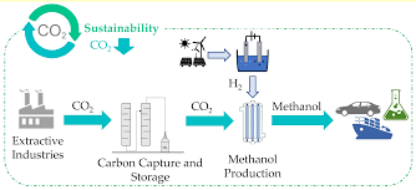
*Please send your suggestions to: che@iitism.ac.in

What's Inside

Chemical Engineering News

Foundation stone of CO_2 to Methanol Pilot Plant for advancement of CCU technology unveiled

The foundation stone for India's first of its kind CO2-to-Methanol pilot plant with an overall capacity of 1.4 Tons Per Day (TPD) was unveiled at Thermax Limited premises in Pune, Maharashtra. This pioneering project, supported by DST, Ministry of Science and Technology, Government of India is to be implemented in collaboration with the Indian Institute of Technology (IIT) Delhi and Thermax Limited, Pune, under Public-Private Partnership (PPP) mode, with an overall cost of approx. Rs. 31 crore. Read More



CHEMCON 2025

The 78th annual session of the Indian Institute of Chemical Engineers (IIChE) — CHEMCON 2025 — will be held from **27–30 December 2025** at Annamalai University, Annamalainagar, Tamil Nadu. The theme, *"AI-Driven Chemical Engineering Processes – Transformation and Sustainability"*, emphasises the role of artificial intelligence in future chemical-process industries through smart modelling, optimisation, and sustainable practices. The congress will feature memorial and plenary lectures, seminars, exhibitions and panel discussions bridging academia, industry and research Read More

Alumni ChEnect

PROF. GAURAV CHAUHAN

BTECH [2011-2015]

Q. Welcome to the "Alumni ChEnect" interview series! Please tell us in detail about your current job.

I currently work as an Assistant Professor in the Department of Chemical Engineering at IIT Indore. My job responsibilities include teaching, research and administrative duties. I largely spend my days interacting with students, doing research and teaching.

Q. Please tell us about your academic journey, starting from school days.

I started my academic journey at a small school in Haridwar, Uttarakhand where I studied until 10th standard. Afterwards, I switched to a relatively bigger school in Haridwar as well for my 11th and 12th standard. Thereafter, I got into IIT(ISM) and joined the department of Chemical Engineering there. During my UG days, I got immensely inspired by a TED talk on Youtube about a Chemical Engineering professor working on breast cancer therapeutics. I also became keenly interested in research during my final year in college and decided to pursue PhD in the department of Chemical and Biomolecular Engineering at the University of Tennessee Knoxville, USA. I have been using interdisciplinary skills and concepts to solve problems in biology. Thereafter, I worked as a postdoctoral researcher at the Department of Biomedical Engineering at the Washington University in St. Louis, USA.

Q.Why did you choose chemical engineering? Was it out of passion, or driven by circumstances? Please walk us through your thoughts as a Class 12 pass-out. .

I largely chose chemical engineering by virtue of my JEE rank and aptitude. I had rank-ordered my choices based on what I thought were good choices. Largely, employability after B. Tech. featured in those choices. In hindsight, they were largely uninformed and influenced by previous year rankings. I had great introspection during my UG days to understand what would be a good career for me, and in the end it worked out well.

Q. How has IIT (ISM) Dhanbad helped you in this journey? How did the BTech/MTech/PhD programme here help shape your career path? How did the academic environment and campus life contribute to your personal growth?

IIT (ISM) helped me immensely with providing a solid peer group to explore my potential and learn important life skills. I, especially, remember the founding head of the Department Prof. V. K. Saxena and his infectious positivity and attitude. I credit him immensely for my career along with the whole department. I practiced squash everyday during college and that discipline is helping me to this day.

Q. What is your typical work-day like?

On a given day, I split my time between mentoring my PhD and UG students for their research projects, teaching and administrative work . On the day when I have class, I spend my mornings preparing for my lecture. Thereafter, I interact with my PhD student to go over their research. I usually reserve afternoon for administrative work and meetings. Any other spare time in between is usually filled with research work.

Q. What are the pros and cons of the profession in your honest opinion?

The biggest pro of my profession is that I work on cutting edge problems that very few people in the world do. Other pros include interaction with young, bright minds as well as world-class researchers. The cons of my profession are that progress can be very slow and that there are a lot more failures (by design) than successes. However, the joy of discovery is beautiful although rare.

Q. How has your career evolved since you graduated, and what advice would you give to current chemical engineering students aspiring to follow a similar path?

My career has evolved quite a lot since I graduated. I never expected to work as a biophysical researcher, but every step of the way, I made a few choices which ultimately lead me to my current profession and career stage. I would advise our students to also follow their heart when it comes to choosing a profession. I would advise them to explore a lot of choices and choose a path which gives them joy. In my opinion, one should work on problems that interest them and then the rest will fall in place from there.

ChemE Trivia

- A bioreactor is any vessel or device that supports a biologically active environment — where living cells or enzymes catalyze chemical transformations. Its design follows the same principles as a chemical reactor: mass transfer, energy balance, and reaction kinetics.
- Bioreactors exemplify how chemical engineering principles extend beyond petroleum and polymers — uniting life sciences with process systems engineering to improve global health and sustainability.
- From insulin and enzymes to mRNA vaccines, biodegradable plastics, and biofuels — bioreactors lie at the heart of the bioeconomy.
- The first industrial bioreactor was the *acetone–butanol–ethanol (ABE) fermenter* operated by Chaim Weizmann during World War I, producing solvents for explosives. Later, during World War II, large stirred-tank fermenters were developed for penicillin production, marking the beginning of modern biochemical engineering.
- Key design parameters for a bioreactor design are agitation rate, gas–liquid mass transfer coefficient, shear stress, temperature, pH, and substrate concentration. Maintaining homogeneous mixing and sterile conditions is crucial for productivity.
- Unlike chemical reactors, biological systems are shear-sensitive and non-linear, making it difficult to scale laboratory data to production scale. Engineers often use *dimensionless numbers* (Re, We, Fr, and Power number) to ensure similarity.
- Bioreactors are key to **bio-plastic** production — *Polyhydroxybutyrate (PHB)* and *Polylactic acid (PLA)* are both microbially synthesized.
- Bioreactors produce over 60 % of all modern pharmaceuticals, including *insulin*, *monoclonal antibodies*, and *vaccines*.
- During the COVID-19 pandemic, single-use bioreactors enabled rapid vaccine scale-up in record time (< 6 months).

Feature Article

Hydrogen: The fuel of the future

- Among all sustainable energy carriers, hydrogen stands apart for its versatility, energy density, and zero-carbon footprint at the point of use. When produced from renewable sources, it forms the cornerstone of the "Hydrogen Economy" — an energy landscape where hydrogen enables clean power generation, mobility, and industrial decarbonisation.
- Although hydrogen is the most abundant element in the universe, it rarely exists in pure molecular form on Earth. Conventional hydrogen production through *steam methane reforming* accounts for nearly 95 % of global supply but emits large volumes of CO_2. A sustainable route, water electrolysis, splits water into hydrogen and oxygen using electricity from renewable sources.
- Under the National Green Hydrogen Mission (2023), India targets 5 million tonnes of green H_2 per year by 2030, potentially cutting 50 million tonnes of CO_2 annually. Realising this vision demands indigenous catalyst development, efficient water electrolysis systems, safe hydrogen storage and transport solutions, and widespread deployment of fuel-cell-based power systems.
- Chemical engineers are uniquely positioned to drive these transformations — uniting electrochemistry, materials science, thermodynamics, and process design.

PROF. KHANTESH AGRAWAL

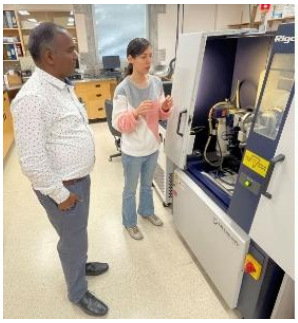
Academic visits

Prof. Suresh Kumar Yatirajula, Assistant Professor in the Department of Chemical Engineering attended the Canadian Society for Chemical Engineering (CSChE) 2025 Conference, held in Montreal, Canada, from October 5–8, 2025, and presented his research paper.

A General Body Meeting of the IIChE Dhanbad Regional Centre (DRC) was held on 2nd November, 11 AM at the conference room of the Department of Chemical Engineering, IIT (ISM) Dhanbad. Dr Mithilesh Kumar Jha, Professor (HAG), Department of Chemical Engineering and Joint Faculty, Centre for Energy and Environment, Dr B. R. Ambedkar National Institute of Technology, Jalandhar, and currently Principal, Muzaffarpur Institute of Technology, Muzaffarpur interacted with the faculty members of the Chemical Engineering Department to discuss upcoming activities of the Dhanbad Regional Centre and the Student Chapter.

Accolades

Prof. Arun Samanta participated in the "Hackathon on Carbon Capture Technology - 2025" organized by CMPDI Ranchi, a subsidiary of Coal India Limited under the Ministry of Coal, Govt. of India, from 23.06.2025 to 25.06.2025. His research proposal was selected as one of the winners (2nd Runner-Up) in this Hackathon under the "Problem Statement-1: Direct Air Capture (DAC) of GHGs" category. Subsequently, the felicitation program for the Hackathon winners was held on 04th September 2025 in Mumbai.



Prof. Suresh Kumar Yatirajula, Assistant Professor in the Department of Chemical Engineering was invited to deliver a talk and explore future research collaborations at the Department of Chemical and Biological Engineering, College of Engineering, University of Saskatchewan, Saskatoon, Canada, from October 8 to 10, 2025.

Publications

1. Yasmin, S., & Chandra, B. (2025). Laminar-turbulent transition for the flow of dilute polyacrylamide solutions through rectangular microchannel. *Physics of Fluids*, *37*(7).
2. Pisuwala, M., Maurya, A., & Chandra, B. (2025). Onset of purely elastic instability and elastic turbulence in the torsional flow of polymer solutions: Influence of gap thickness. *Physics of Fluids*, *37*(4).
3. Dwitish Manikanta, V. V., Kamaliny, S., Pratap Singh, P., & Sengupta, S. (2025). Mechanistic insights into CO_2 methanation: comparative study of Ni and Ni–Fe/Al_2O_3 catalysts via TPSR and in situ DRIFTS. *Research on Chemical Intermediates*, 1-16.
4. Shastri, A. K., & Yatirajula, S. K. (2025). Evaluating Indian high-ash coals for coal-water slurry applications: A focus on rheology and characterization. *Chemical Engineering Research and Design*.
5. Shastri, A. K., & Yatirajula, S. K. (2025). Characterization and rheological studies of Indian high ash coal water slurries: effect of particle size distribution with artificial neural network (ANN) analysis. *International Journal of Coal Preparation and Utilization*, 1-25.
6. Shankar, S., & Bhaumik, S. K. (2025). Waste LD-Slag-Derived Sorbents for Calcium Looping-based Carbon Capture Technologies in Steel Industries. *Journal of Environmental Chemical Engineering*, 117205.
7. Pandit, S. K., Yadav, K., Chauhan, P., & Kumar, A. (2025). Accessing the corrosion resistance for metallic surfaces using long-chain fatty acids. *RSC Applied Interfaces*.
8. Chauhan, P., & Kumar, A. (2025). Development of superhydrophobic jute for food grain storage applications. *Food Chemistry*, 145017.
9. Singh, S., Sahu, M., Prajapati, S., Mitra, M. D., Kumar, A., Singh, A. K., ... & Verma, D. K. (2025). ZnSnO3 quantum dots-reinforced boron carbon nitride nanosheets for enhanced tribological performance. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, *718*, 136857.
10. Pathak, A., & Nandanwar, M. N. (2025). Integrating Physics-Informed Neural Network Model for State-of-Charge and Internal States Estimation in the Lead-Acid Batteries. *Journal of The Electrochemical Society*, *172*(11), 110502.