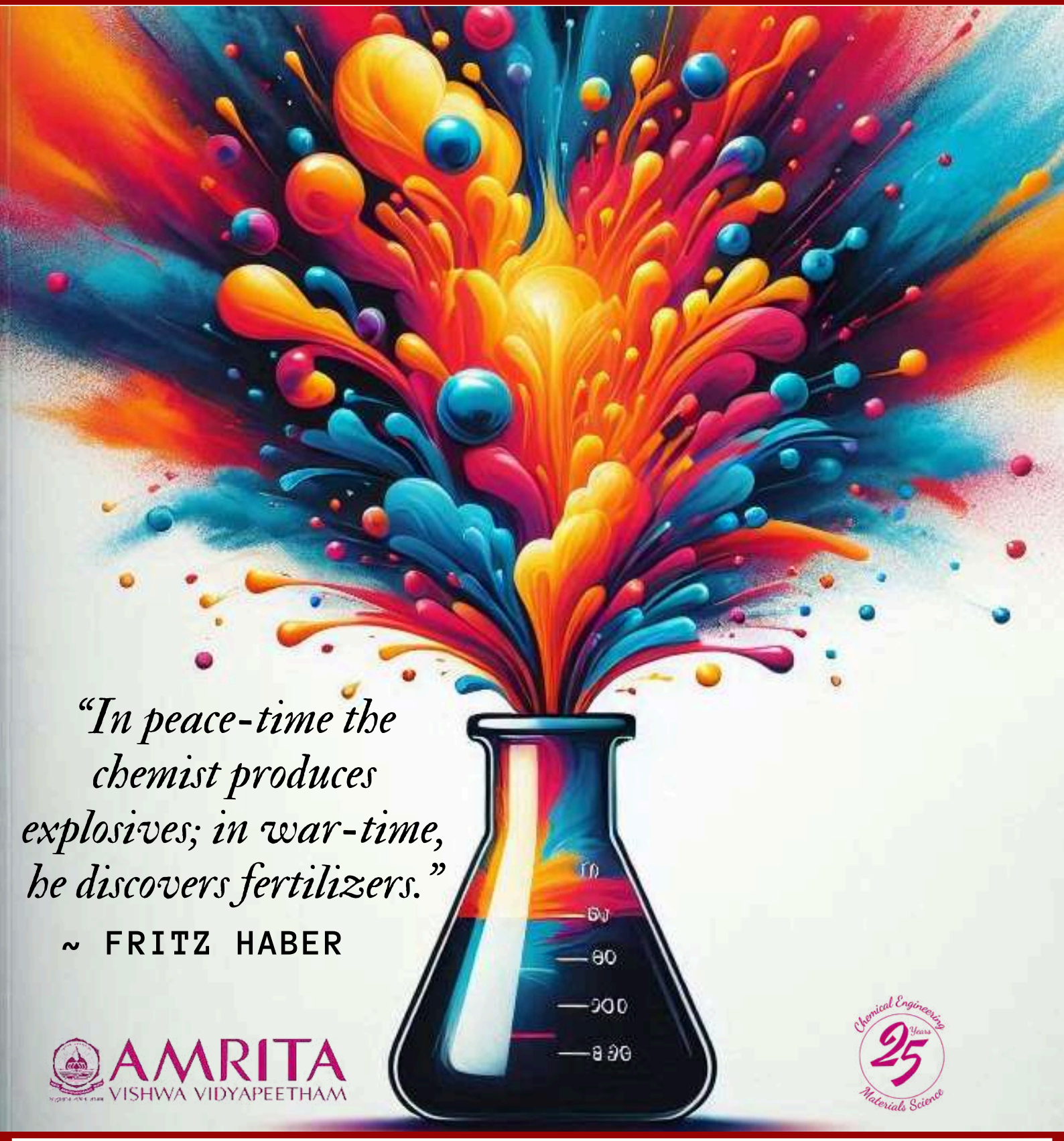
DEPARTMENT OF CHEMICAL ENGINEERING AND MATERIALS SCIENCE

THE REACTION TIMES

STORIES BEYOND THE BEAKER



NEWSLETTER ISSUE 1: DECEMBER 2024 - APRIL 2025

TABLE OF CONTENTS

TABLE OF CONTENTS

INTRODUCTION:

Welcome to The Reaction Times, the student-run newsletter of the Chemical Engineering & Materials Science Department! Think of it as your ultimate guide to everything thrilling, thought-provoking, and downright cool in the world of chemical engineering. Whether it's deep dives into groundbreaking research or bite-sized industry insights, we've got you covered. But we're not just about technical brilliance—we're stirring in a dash of creativity and a whole lot of student-driven passion. So whether you're a chemical engineering geek, a sustainability enthusiast, or just here for the fun, this is your space to learn, contribute, and get inspired!

But wait—there's more! The Reaction Times isn't just a collection of research papers and academic jargon. The Reaction Times features a Creative Corner, where poetry, drawings, and essays come alive, while our research highlights and student contributions showcase the department's brightest minds. So, whether you want to stay ahead of industry trends, share your work, or just enjoy some chemical musings, you're in the right place.

MISSION:

Welcome to The Reaction Times, where chemical engineering meets curiosity, creativity, and a little bit of chaos! We're here to prove that this field isn't just about heat exchangers and reaction kinetics (though we love those too). Our mission? To spark conversations, break down complex concepts, and make you fall in love with the magic of chemical engineering. Through student-written articles, research highlights, and a creative corner, we're turning learning into an experience, not just a requirement. So buckle up, future engineers—because here, we don't just study reactions; we start them!

Our Mentor

Mr. Amal G S
Assistant Professor

The Reaction Times wouldn't exist without the support of Amal G S. From the very inception of this newsletter, he has been a driving force, offering insightful ideas, constructive feedback, and the motivation to think beyond the ordinary. His mentorship encourages us to explore, innovate, and push the boundaries of our knowledge, ensuring that this platform not only informs but also inspires. Whether it's refining our content, sparking thought-provoking discussions with remarkable patience, his dedication has been instrumental in bringing this vision into a reality. He's the reason our ideas go from "let's revolutionize chemical engineering" to "let's actually finish this on time."

Chairpersons Message

Dr. Nikhil K. Kothurkar

Dear Students, Faculty, and Readers,

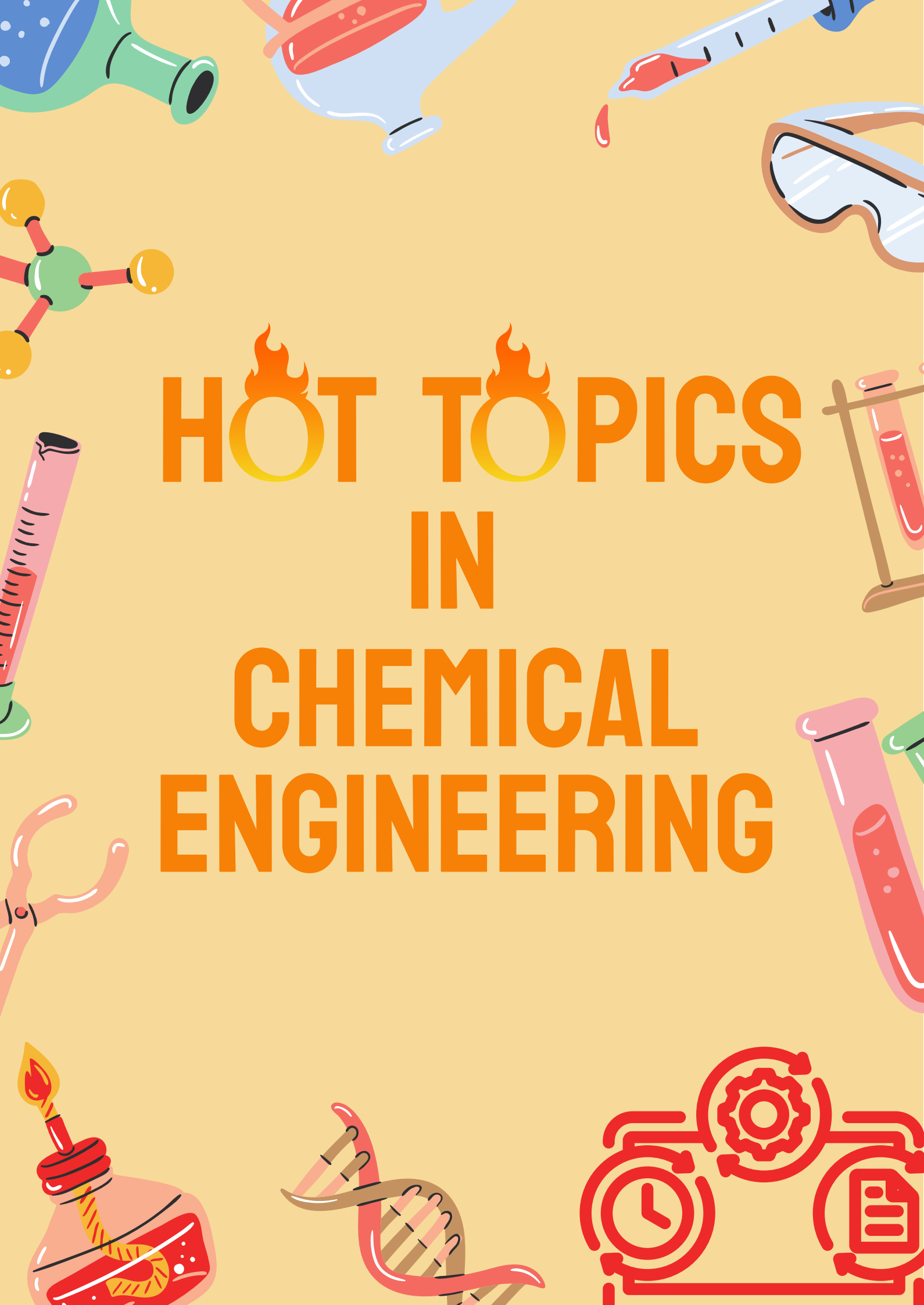
I am delighted to introduce this edition of our department newsletter, a wonderful initiative spearheaded by our talented students. This newsletter serves as an excellent platform for students to showcase their diverse talents and achievements.

Through the informative articles and updates, readers will gain a deeper understanding of the fascinating field of chemical engineering and materials science. It is heartening to see the enthusiasm and dedication of our students in bringing this newsletter to life.

I look forward to many more editions that continue to highlight the innovative and inspiring work being done within our department.

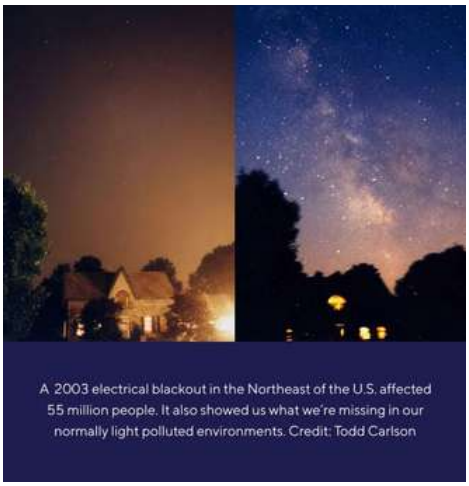
Warm regards,

Dr. Nikhil K. Kothurkar


HOT TOPICS
IN
CHEMICAL
ENGINEERING

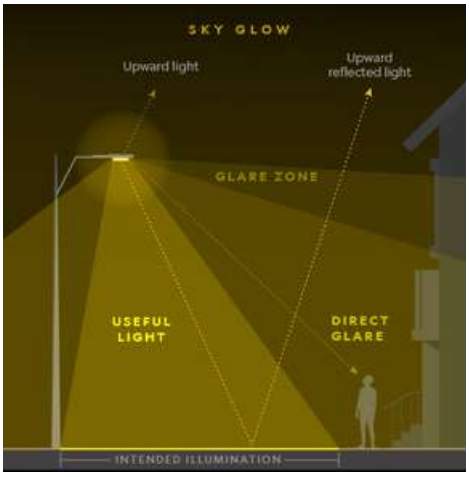
Light Pollution: An Essay

If you had looked into my eyes that night, you would not have seen black. Or brown. Or blue or green, for that matter. Instead, what you would have seen was light—light shining so bright and glorious, it renders you speechless.



A 2003 electrical blackout in the Northeast of the U.S. affected 55 million people. It also showed us what we're missing in our normally light polluted environments. Credit: Todd Carlson

You would have beheld streaks of brilliant purple and stars by the pocketful, sprayed across the beautiful tapestry of the cosmos, reflected against inky dark space. The marvelous elegance of the entire universe spread above stays forever etched in my mind. So much so that all I must do is close my eyes, and I can recall the moment captured in time instantly.



Sometimes, however, I feel as though it was all just a sham, something my wild, childish imagination fabricated. This doubt in me had crept up because when I look up at the night sky now, all I see is the solitary moon as he mourns the loss of his companions, who have been buried among the glaring, blinding lights of the city. So, I decided to Google it and prove to myself that it was not just a figment of my imagination. To my utter delight, the bewitching night sky filled with stars and dark blue and purple hues did exist—it was all real. No mortal can conjure an image so alluring; only the universe can.

> The universe has a way of making one feel small, yet connected.

The universe has a way of making one feel small, yet connected. It has been said that we are all made of stardust. The iron in our blood, the calcium in our bones, carbon- the very essence of life; they have all been forged in the blazing, fiery cores of colossal stars. These remnants of bygone times weave the fabric of existence. In the vastness of the night, beneath the fading stars, there is an uncanny sense of unity- ominous in its reminder of our lost connection with the infinite; of the unseen, fragile thread binding us all together.

It is heart-wrenching to think some people have never experienced stargazing. The night sky is disappearing, and we only blame ourselves for it. We are cruel and have not given the current generation the ability to witness the grandeur of the cosmos. The lights we have created have outshone the stars themselves, tainting the sky an incriminating red.

Light pollution occurs when there is excessive artificial light, which obscures the stars and planets and is a problem that has been plaguing our country and the world for decades, but it is something that takes a backseat and is usually overlooked when the topic of the environment comes up.

The problem of excessive light was first noticed by astronomers at the Mount Wilson observatory in California noticed a hindrance to their stargazing due to the increasing ‘skyglow’ from the nearby metropolitan city of Los Angeles, which prevented them from observing fainter celestial objects. The issue then gained more recognition in the 1930s as more and more reports began flooding in from astronomical observatories all over the world that had been negatively affected by the ‘skyglow’ from neighbouring cities that had been rapidly expanding due to urbanisation.

By the 1970s, the negative effects of excessive light had become a pressing concern for many observatories and was widely discussed in astronomical communities. A key paper titled "Light Pollution: Outdoor lighting is a growing threat to astronomy" by KW Rigel (1973) published in the journal Science marked a significant moment in its recognition as an environmental issue. The current statistics are frightening: around 83% of the United States population lives under light-polluted skies, and 99% of the population of the USA and Europe live in areas affected by skyglow. Moreover, light pollution is a problem that is worsening—so much so that from 1992 to 2017, the amount of light pollution has increased by 49%.

What is more concerning is that light pollution does not only affect the aesthetics of the sky; it is detrimental to the ecosystem and has an adverse effect on human health. It has been shown that in temperate countries, excessive light disrupts the seasonal cycle of trees. All one must do is go outside and observe trees in fall, and one would notice that all the leaves have turned a brilliant orange except for those directly under the streetlights.

A more pressing concern of the overly bright, artificially lit skies is that millions of migratory birds die every year. Birds that navigate by moonlight and starlight wander off course as they get falsely lured by excessively illuminated buildings, promptly colliding to their deaths. Even though light pollution is worsening at a staggering rate of 9.6% per year, which is nearly five times that of greenhouse gas emissions, it is easier to curb the former than the latter. According to the International Dark-Sky Association (IDSA), individuals can play a pivotal role in bringing the stars back to our skies.

Simple steps such as using LED lights instead of blue lights, avoiding the use of excessive decorative lighting, and using bulbs that have covers and face downwards can massively reduce light pollution. Light trespassing, which occurs when lights from one house are deliberately shone into their neighbour's house, should be penalized as it is very uncomfortable for others and can cause sleep disorders such as insomnia.

However, no matter how small, governments and authorities are waking up to the reality of light pollution, and measures are being taken to control it. Still, much must be done if we want future generations to experience the night sky as their ancestors have. We should not let the night sky slip away from us. Even now, there are a few places left on Earth where the might of the cosmos can be felt, but the privilege of experiencing it should extend to every human, no matter where they live. Mankind has always had a burning longing to reach for the skies, and we should not extinguish that desire by blanketing the heavens.

> **And so, I close my eyes once more, yearning for a night when the stars reclaim their rightful place in the cosmos, whispering tales of distant realms.**

Process Analytical Technology : A Cornerstone for Modern Biopharmaceutical Manufacturing

The biopharmaceutical industry, characterized by its reliance on complex biological systems and stringent quality requirements, faces the dual challenge of enhancing efficiency and maintaining consistency in production. Process Analytical Technology (PAT) emerges as a pivotal framework, offering tools and strategies to integrate quality into the manufacturing process. As mandated by the U.S. Food and Drug Administration (FDA), PAT aligns with the Quality by Design (QbD) paradigm, emphasizing process understanding, control, and adaptability.

The Foundations of PAT

PAT involves the systematic use of advanced tools and techniques to monitor and control manufacturing processes in real time. Its key objectives include identifying critical quality attributes (CQAs) of products, linking them to critical process parameters (CPPs), and establishing a control strategy to ensure consistent outcomes:

1. Critical Quality Attributes (CQAs):
These are measurable physical, chemical, or biological properties that influence product performance and safety, such as protein folding, glycosylation profiles, and impurity levels.

2. Critical Process Parameters (CPPs):
Factors like pH, temperature, and dissolved oxygen are directly linked to CQAs and are tightly monitored to maintain product quality.

3. Multivariate Data Analysis (MVDA):
Biopharmaceutical processes generate vast, complex datasets. MVDA enables the extraction of meaningful insights, detecting subtle correlations and predicting outcomes based on multiple interrelated variables.

> Process Analytical Technology (PAT) lord of manufacturing process.

Innovative Tools and Techniques

The implementation of PAT relies on cutting-edge analytical technologies and models, each playing a unique role in process monitoring and optimization:

1. Spectroscopic Techniques:
Near-infrared (NIR) and Raman spectroscopy provide non-invasive methods to analyze chemical compositions and monitor CPPs in real time.

2. Chromatography and Electrophoresis:
These tools ensure the separation and quantification of product components, including impurities and active pharmaceutical ingredients.

3. Mechanistic Modeling:
Mechanistic models describe process behaviors using mathematical equations. They simulate scenarios to predict outcomes under varying conditions, assisting in process optimization and risk mitigation.

4.'Omics' Integration:
Systems biology approaches, incorporating genomics, proteomics, and metabolomics, enable a deeper understanding of cellular mechanisms. This knowledge supports the identification of new CQAs and the design of robust control strategies

Applications of PAT in Biopharmaceuticals

1. Upstream Processing
PAT is instrumental in optimizing cell culture conditions, such as monitoring nutrient consumption, metabolite production, and biomass accumulation. Advanced techniques, like dielectric spectroscopy, measure biomass capacitance, offering insights into cell health and viability.

2. Downstream Purification
In purification stages, PAT tools like UV spectroscopy monitor impurity profiles and aggregation states. For example, UV absorbance at 280 nm detects protein concentrations, while at 410 nm, it can identify host cell proteins breaking through filtration processes.

3. Virus Filtration and Product Safety
Real-time monitoring during virus filtration ensures the removal of viral particles, addressing a critical safety concern in biopharmaceutical production. PAT-driven adjustments maintain filter integrity and operational efficiency.

Economic and Regulatory Impact:

1. Cost Efficiency

Implementing PAT reduces material wastage, optimizes resource use, and minimizes batch failures, leading to significant cost savings. By enabling real-time adjustments, PAT decreases the need for extensive post-production testing

2. Regulatory Alignment

PAT supports compliance with FDA and ICH guidelines by embedding quality assurance throughout the manufacturing process. It simplifies regulatory submissions and facilitates faster product approvals.

Challenges and Solutions in PAT Implementation:

1. High Implementation Costs:

The upfront investment in PAT tools and infrastructure can be significant. However, the long-term operational savings and enhanced process reliability justify the expenditure.

2. Complex Data Management:

The large datasets generated require robust computational infrastructure and skilled personnel to analyze and interpret.

3. Integration with Legacy Systems:

Adapting PAT into existing facilities may pose technical challenges. This necessitates phased implementation and targeted upgrades.

Conclusion:

Process Analytical Technology is a cornerstone for modern biopharmaceutical manufacturing, transforming traditional practices into dynamic, adaptive systems. By ensuring consistent quality, enhancing efficiency, and aligning with regulatory frameworks, PAT meets the growing global demand for safe and effective biopharmaceuticals. As the industry embraces technological advancements, PAT will remain at the forefront of innovation, driving progress in drug development and production.

The Magic of Chemical Engineering that Changed our World

Chemical Engineering: A blend of science and innovations that integrates maths, physics, chemistry, and biology in everyday life. For decades, it has been a core engineering domain that has solved real-world problems. Chemical engineering holds transformation at its hub where raw materials are transformed into products keeping efficiency and sustainability in mind. Certain examples of transformations include- crude oil into fuels, air into fertilizers, sand into silicon chips, etc.

The Industrial Revolution, which took place between the eighteenth and nineteenth centuries, reformed manufacturing processes and transformed the modern world by molding agriculture and transportation systems. One of its prominent results was the growth and rapid development of chemical processes that played a relatively important part in many branches of industry and greatly affected economic and social evolution. The Industrial Revolution brought game-changing innovations in chemical engineering such as the Haber-Bosch process, petrochemical advancements, the development of polymers, etc.

> **The Industrial Revolution brought game-changing innovations in chemical engineering**

Chemical engineering as a course was first established in the United Kingdom where it was taught at the University of Manchester in the year 1887.

The Haber-Bosch process brought about a significant change in the field of chemical engineering. It was developed by an industrial chemist Fritz Haber and brought up to large scale process by chemical engineer Carl Bosch. The Haber-Bosch process takes atmospheric nitrogen and converts it to ammonia.

The nitrogen from atmosphere at high temperature and pressure reacts with hydrogen in the presence of a metal catalyst to produce ammonia. During the industrial age, it helped feed the world's population by producing sufficient food and also produce synthetic fertilizers.

This process showed the connection between science and engineering where a scientific discovery is taken upon and applied in a large scale industrial process which is the overview of chemical engineering . The Haber-Bosch process is currently not sustainable but efforts are being made by chemical engineers for new methods of nitrogen fixation under ambient conditions to produce ammonia sustainably.

Chemical engineering profoundly impacts modern society with its influence in diverse fields such as healthcare, energy, food production, and environmental sustainability. It permits the rapid design and manufacture of key products on a large scale such as pharmaceuticals, fuels, and consumer goods. Developments in chemical engineering have extended opportunities for cleaner energy generation through biofuels and hydrogen production, improvements to waste handling, and control of environmental degradation.

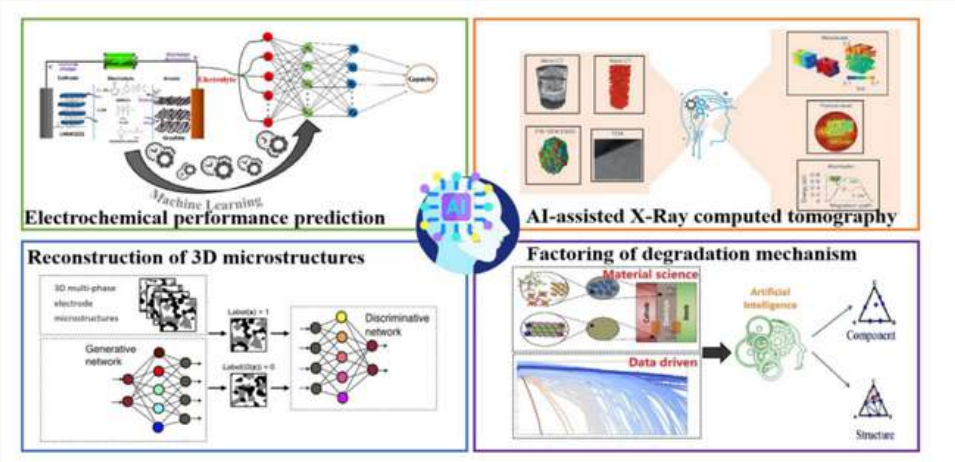
Chemical engineers must address several challenges due to the demands of chemical engineering in the face of a rapidly growing world. The major issues of welfare are the development of processes that are sustainable to minimize environmental impact, reduce carbon emissions, and effectively manage finite resources. Further complications arise while designing scalable systems for renewable energy, water purification, and waste reduction. However, the integration of cutting-edge technologies such as artificial intelligence, biotechnology, and nanotechnology shows a lot of promise for the future

> Proceeding with the creation of the next generation of innovative materials, optimizing energy storage, and implementing green chemistry practices leads to sustainability and resiliency in the field of chemical engineering.

Newest Innovations in Chemical Engineering

AI for science in electrochemical energy storage: A multiscale systems perspective on transportation electrification:

The electric vehicle (EV) industry, crucial for low-emission transportation, is undergoing a significant transformation driven by advancements in battery and electrochemical energy storage technology. Artificial intelligence (AI) has the potential to revolutionize these technologies by enhancing efficiency and performance while accelerating development cycles. This systematically reviews the current state-of-the-art and future perspectives of AI in battery research and applications for EVs. Various AI methodologies, including unsupervised learning, supervised learning, reinforcement learning, and generative AI, are explored to improve battery performance, longevity, and safety.

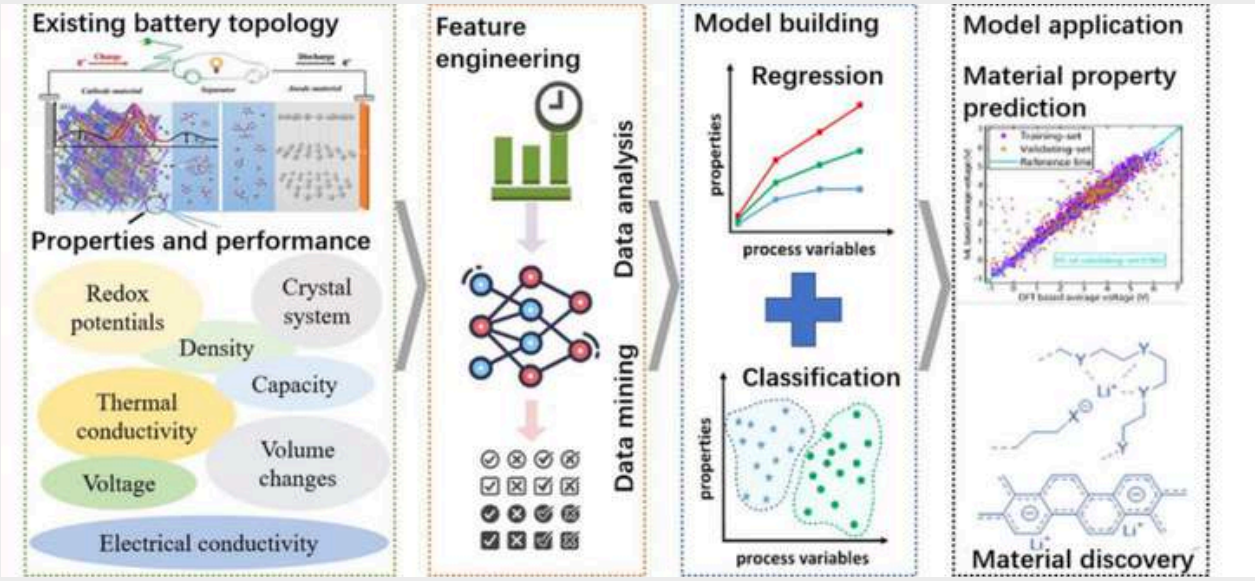


The review identifies key challenges in advancing AI for electrochemical energy storage: data shortages, cyberinfrastructure limitations, data privacy issues, intellectual property obstacles, and ethical complexities. Groundbreaking opportunities presented by AI applications, such as large language models, foundation models, multimodal learning, and few-shot learning, are also highlighted. AI-based technologies offer promising pathways for rapid material discovery, predictive maintenance, and the development of efficient, scalable, and reliable battery systems.

Strategic directions for future research are proposed, emphasizing the need for comprehensive data and cyber infrastructures, enhanced interpretability, ethical AI use, and interdisciplinary collaboration. Ultimately, this identifies key challenges and opportunities for AI-driven innovations in battery technology, contributing to the advancement of low-emission transportation through electrification.

Artificial intelligence in battery science: from 3D microstructure reconstruction to electrochemical performance and degradation prediction;

AI for battery material and electrochemical structure discovery:
The integration of AI into battery material science and electrochemistry marks a transformative advancement in battery research. The synergy of AI with materials science is a catalyst that accelerates the discovery and optimization of battery materials and structures. This section explores various areas of this synergy, highlighting the significant advancement made in battery material prediction, structural analysis, and performance enhancement through AI-driven approaches.

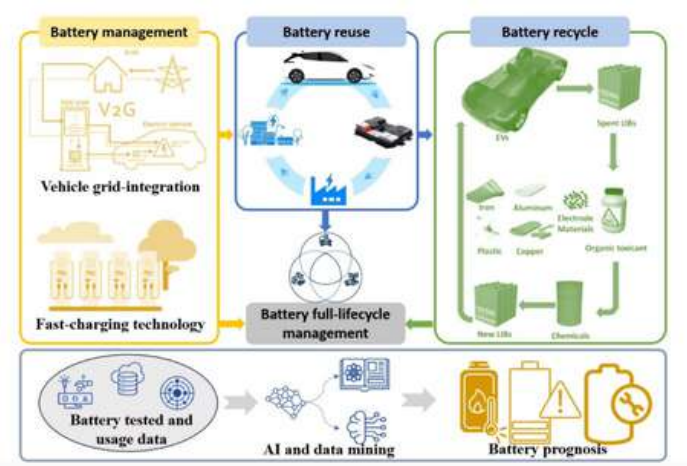


Artificial intelligence in battery material discovery: bridging properties, performance and machine learning for enhanced predictive modeling. Integrating AI in battery health assessment: leveraging voltage relaxation, impedance spectroscopy, and charging curve analysis for accurate remaining useful life prediction (upper left) AI for predicting battery life based on this field.

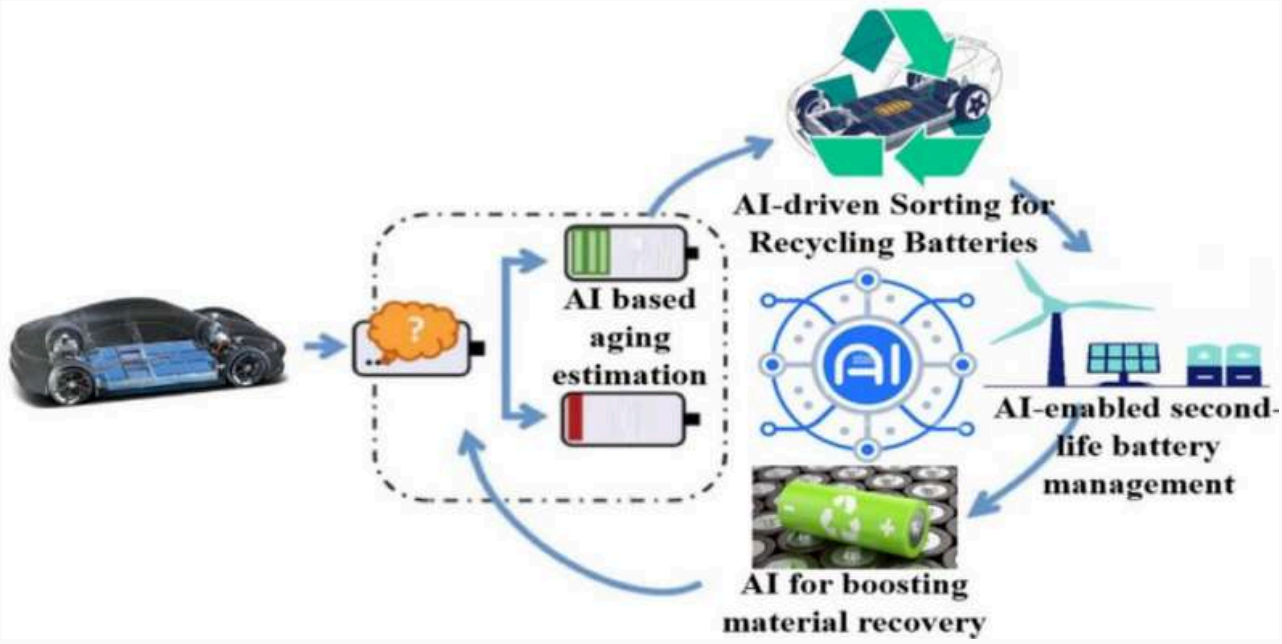
Sustainable life-cycle management of EV batteries: AI-enhanced approaches from grid integration to recycling.

AI for battery life-cycle management optimization:

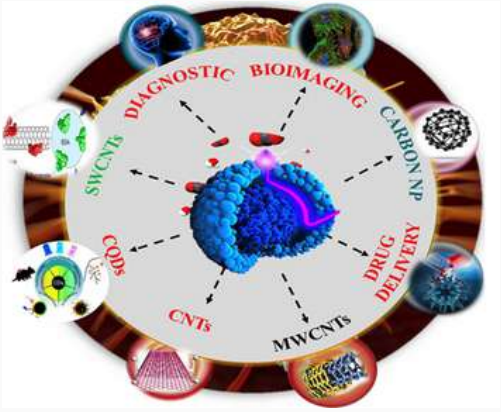
In transportation electrification sectors, optimizing battery life-cycle management is essential for enhancing performance, extending longevity, and ensuring sustainability. AI plays a key role across various stages of the battery life cycle, from fast charging to end-of-life recycling and safety management. This shows the sustainable life-cycle management of EV batteries, highlighting the role of AI in optimizing each phase, from grid integration and fast-charging to battery reuse and recycling strategies.



AI-driven end-of-life management for EV batteries: enhancing sustainability through second-life applications and recycling. Advancing electrochemical energy storage with AI: a synthesis of large language models, foundation models, multimodal machine learning, and few-shot learning techniques.



Revolutionizing Cancer Care with Carbon-Based Nanomaterials



Cancer remains a leading cause of death globally, with millions of lives claimed annually. Traditional cancer treatments often struggle with challenges like drug resistance, non-specific targeting, and limited imaging accuracy. However, the emergence of carbon-based nanomaterials has brought innovative solutions to cancer diagnosis and therapy. These advanced materials hold immense potential to improve outcomes by enhancing precision and minimizing side effects.

Nanoparticles have transformed cancer detection and diagnostics by significantly enhancing imaging technologies. Magnetic, polymeric, metallic, and graphene-based nanoparticles are capable of traversing biological barriers and binding to cancer-specific markers, enabling better tumor detection. Techniques such as MRI, Optical Coherence Tomography (OCT), and PET scans benefit greatly from the superior contrast and sensitivity provided by nanoparticles. For instance, iron oxide nanoparticles enhance MRI imaging of liver cancers, while gold nanoparticles improve the visualization of brain tumors. These developments allow for more accurate and real-time cancer detection, paving the way for personalized therapies.

CNTs have also shown promise in treating breast, pancreatic, and prostate cancers. Functionalized CNTs can be tailored to target specific proteins and biomarkers, such as folate receptors and glucose transporters, improving drug delivery precision. In breast cancer, CNTs coated with folic acid and drug-conjugated copolymers have enhanced treatment efficacy. In prostate cancer, CNTs combined with paclitaxel and PSMA antibodies have shown significant effectiveness in targeting cancer cells. These targeted approaches reduce the impact on healthy cells and improve therapeutic outcomes.

The integration of carbon-based nanomaterials in cancer care marks a paradigm shift in oncology. By offering enhanced imaging capabilities and targeted therapies, they address longstanding challenges in cancer treatment. As research continues, carbon nanotubes and nanoparticles are poised to play a central role in advancing cancer diagnostics and therapy.

CNT's ability to deliver drugs directly to tumors with reduced side effects holds great promise for more effective and less invasive treatments. These groundbreaking technologies could redefine the future of cancer care, offering hope to millions of patients worldwide.

Carbon Nanotubes (CNTs) for Brain Cancer Detection and Therapy

The blood-brain barrier (BBB) poses a significant challenge in delivering medicines to the brain, particularly for treating diseases like brain cancer. Nanotechnology has emerged as a promising solution to overcome this hurdle. Carbon nanotubes (CNTs), cylindrical structures made of carbon atoms, have shown remarkable potential in brain tumor treatment by serving as carriers for anticancer drugs. By attaching specific molecules (ligands) to CNTs, researchers can efficiently transport these drugs into brain cells, bypassing the BBB.

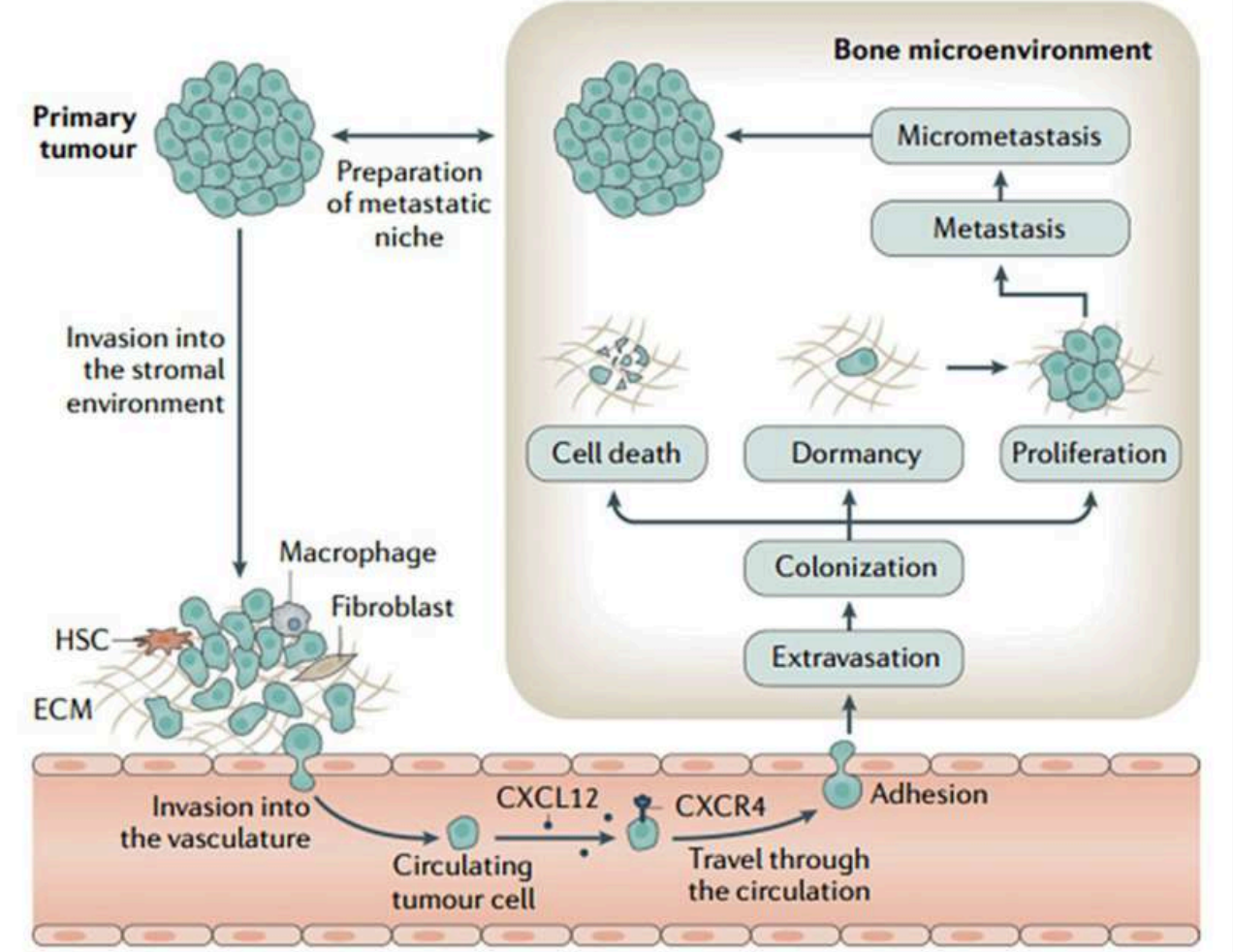
A notable study demonstrated the use of PEGylated CNTs (CNTs coated with polyethylene glycol, or PEG) to deliver Mangiferin (MF), a natural anticancer agent, to glioblastoma and astrocytoma cells. PEGylation enhanced the drug's compatibility with red blood cells, improving its safety profile. Additionally, the CNT-PEG-MF combination increased the drug's bioavailability by four times compared to its pure form. This advancement prolonged the drug's action within the body, reduced the need for frequent dosages, and significantly improved treatment efficiency. These findings highlight CNTs' transformative role in creating safer and more effective therapies for brain cancer.

CNTs for Bone Marrow Cancer Detection and Therapy

Bone marrow, a frequent site for cancer metastasis, presents unique challenges due to its poor blood circulation and adhesion receptors that facilitate cancer cell growth. CNTs have demonstrated great potential in addressing these issues by enabling targeted drug delivery. For instance, researchers functionalized CNTs with aptamers to deliver daunorubicin, a potent anticancer drug, to acute lymphoblastic leukemia cells. This method resulted in a significant increase in cancer cell destruction, showcasing the efficacy of CNT-assisted treatments in bone marrow cancers.

Another breakthrough involved CNTs coated with antibodies to target prostate cancer cells specifically. In this study, CNTs were functionalized with prostate-specific membrane antigen (PSMA) antibodies to deliver paclitaxel, a commonly used prostate cancer drug. This targeted approach ensured precise delivery of the drug to cancerous areas, significantly enhancing its therapeutic efficacy.

Moreover, the CNT-based delivery system proved more effective than conventional methods, providing a promising avenue for treating prostate and colorectal cancers. These advancements underline the critical role of CNTs in developing precise, efficient, and impactful therapies for bone marrow-related cancers.



Carbon nanotubes are proving to be valuable tools in cancer therapy. Their ability to deliver drugs efficiently and target specific cancer cells has opened new possibilities for treatment. CNTs are being studied in various forms, such as multi-walled (MWCNTs) or single-walled (SWCNTs), and have been shown to carry a range of anticancer drugs, including paclitaxel, gemcitabine, and doxorubicin. The drugs can be delivered to different cancer types like colorectal, breast, liver, lung, and pancreatic cancer, often improving treatment effectiveness and reducing side effects. Additionally, CNTs can be combined with other agents or functionalized with specific molecules to improve their targeting ability and enhance the treatment of metastatic cancers.


RESEARCH
TRIUMPHS

RESEARCH TRIUMPHS

1) High-performance thermoplastic polyaryletherketone/carbon fiber composites: Comparison of plasma, carbon nanotubes/graphene nano-anchoring, surface oxidation techniques for enhanced interface adhesion and properties

Dr. Meera Balachandran
Journal: Composites Part B: Engineering
Quartile: Q1
Impact Factor: 13.1
Scopus Percentile: 99%
Co-Authors: Kumar P S., Jayanarayanan K.

2) Biomass derived nitrogen-doped activated carbon and novel biocompatible gel electrolytes for solid-state supercapacitor applications

Dr. Thirugnasambandam G M
Journal: Journal of Energy Storage
Quartile: Q1
Impact Factor: 9.4
Scopus Percentile: 90%
Co-Authors: Selvaraj M., Balamoorthy E.

3) Co Mo (1-x)S_2 intermixed reduced graphene oxide as efficient counter electrode materials for high-performance dye-sensitized solar cells.

Dr. Nikhil Kishore Kothurkar
Journal: International Journal of Hydrogen Energy
Quartile: Q1
Impact Factor: 7.2
Scopus Percentile: 95%
Co-Authors: Senthilkumar R., Ramakrishnan S., Balu M., Batabyal S.K., Yoo D.J., Kumaresan D.

4) Design and tuning of monodisperse microporous ternary hydrogels of GO-$MgFe_2O$-Gelatin for removing divalent metal ions: Doping optimization and insights into adsorption mechanism

Dr. Nithya K
Journal: Applied Surface Science
Quartile: Q1
Impact Factor: 6.7
Scopus Percentile: 95%
Co-Authors: Gopika G., Sathish A.

5) Fabrication of Barium Titanate Nanowires-GNP Composite Bilayer Photoanodes for the High- Performance Dye-Sensitized Solar Cells

Dr. Duraisamy Kumaresan
Journal : Applied Surface Science
Quartile: Q1
Impact Factor: 6.7
Scopus Percentile: 95%
Co-Authors: Murali B., Gireesh Baiju K., Krishna Prasad R.

6) Non-isothermal crystallization kinetics of halloysite nanotube/short glass fibre-reinforced polypropylene composites

Dr. Rasana N
Journal: Journal of Thermal Analysis and Calorimetry
Quartile: Q1
Impact Factor: 4.4
Scopus Percentile: 95%
Co-Authors: Kalathil M.R., Santoshi R.B., Jayanarayanan K

7) Nano filler incorporated epoxy based natural hybrid fiber confinement of concrete systems: Effect of fiber layers and nano filler addition

Dr. Jayanarayanan K
Journal: Structures
Quartile: Q1
Impact Factor: 4.1
Scopus Percentile: 90%
Co-Authors: Joseph L., Kalyana Chakravarthi E., P S.K., Mini K.M.

Faculty Spotlight: Dr. Murali Rangarajan
A Visionary in Advanced Materials and Green Technologies

Dr. Murali Rangarajan
Chairperson of CoE-AMGT
Professor, Department of Chemical Engineering and Materials Science

The Department of Chemical Engineering is proud to feature an inspiring conversation with Dr. Murali Rangarajan, an esteemed faculty member whose journey at Amrita Vishwa Vidyapeetham, Coimbatore, spans an impressive 17 years. From his early days as an Assistant Professor to his current role as the Chairperson of the Center of Excellence in Advanced Materials and Green Technologies, Dr. Rangarajan has been a driving force in research and innovation. His passion for sustainable solutions and cutting-edge materials has not only shaped academic discourse but also inspired countless students and researchers. In this exclusive interview, he shares his experiences, insights, and vision for the future of chemical engineering.

1) What made you so passionate about Electrochemistry, your one of the research interest?

Definitely I did not choose to get into electrochemistry. I got into Central Electrochemical Research Institute for my B.Tech in chemical and electrochemical engineering. It was the most competitive entrance exam that I wrote, the most challenging of the lot which I got into.It happened to be offered by a research center, I always had an interest in pursuing research. So I decided I will take that up and see how it goes. And the Best part of it is we had the scientists from CSIR, Sikri. The scientists themselves taught us. We did not have a separate faculty for our courses at all, including courses such as the mathematics and physics and chemistry. Everything was taught. economics, process economics which we have, everything was taught by scientists. And we did not have separate B.Tech labs. We did all our experiments in the same labs where the scientists worked. So in the first four years of my B.Tech which is the undergraduate studies for four years of my studies, I got exposed to all kinds of research facilities right from the get go. which is not very common in undergraduate institutions. And it's no surprise that one of the things that I've tried to promote in this department, and this department has been very, very welcoming of new ideas, new things to explore, is to provide research exposure to undergraduate students.

Subjects like computer science, students of CS could apply their knowledge right after their initial semesters and they can begin projects, but subjects like chemical engineering might not allow such a freedom. So Sir, Do you think Chemical engineering is kind of an old traditional subject?

Far from it. I will give you my perspective of what chemical engineering has been, Now more than ever chemical engineers stand to contribute even more in terms of innovation and development compared to all other domains. Chemical engineers are by nature process engineers.

What we do is you want a product to be produced, you have some raw materials. we developed the industrial scale processes. So, the key word here is scale. How do you achieve scale of production and efficiency of production and economy of production all three, scale efficiency and economy and how do you design a process for it, this is what we do. So, many of what we learn in terms of design are so general that we can go and apply this anywhere pretty much and that has historically been the case. f you look at how many departments have evolved out of chemical engineering, entire material science engineering evolved out of chemical engineering, entire biomedical engineering has evolved out of chemical engineering. Chemical engineers have traditionally been the most diverse group of engineers in terms of going out of chemical engineering domain and succeeding most. People have done all kinds of things and have been successful because we are... taught to look at a big picture, a process is a big picture at the end of the day!
So, I believe that chemical engineers are uniquely positioned to leverage our ability to engineer processes. All we need is a certain switch in our mindset.
We are not just the back end, we are the heart and the soul of all of this. Don't think of it as front, back, think of it as a circle, we are at the center of it.

2) As the head of a COE-AGMT, there would be immense pressure. What was the biggest challenge you had until now?

I am a process engineer, right? So, I love streamlining processes. So, in some sense I feel from 2007 December 27th when I joined Amrita, that's at some level that's what I have been doing particularly with respect to administrative responsibilities that have been given to me. Taking over as chairperson of that centre is one another way to streamline the various processes. AMGT is not just a center for advanced research, We have our areas of strength which we keep projecting by four major verticals: one is clean energy one is sustainable resource management which basically includes water, soil and air. And the third is polymer composites, which I like to call materials for strategic applications because primarily that vertical has been focusing on materials for aerospace, defence, nuclear applications and we have a very long and fantastic history in that domain. Fourth one vertical of course, is process intensification which is basically a lot of new next generation I.e thermal management reactor and for multiple applications. But we also serve as the major analytical instrumentation facility for the entire campus. Which includes master students, for the PhD students, for the post-docs, we serve many educational institutions across a 500 kilometer radius. Streamlining all of these processes so that this process becomes efficient. The results which are provided, the quality of the results that we give everything, improving all of that is something that I have worked on. And then using the revenue to procure more equipment, expand the center itself in terms of the facilities so that we are able to do more studies.
Setting up the center along with my colleagues as a team we went and we presented we defended this. We went as a team got one of the first grants called FIST grant (facility for infrastructure in science and technology) after hours of hard work this is how we got our ACM standing like a microscope. Many departments have gotten it although we are the first to get it. The centre was set up through funding from Ministry of Education, which used to be called Ministry of Human Resource Development. To this day, this is the only centre in the entire Amrita that was funded by the government. Materials research is equipment intensive, expensive, time-consuming process. There is no shortcut in this. You can't just sit with a laptop and get things done. Hence, we needed these facilities to spearhead a lot of the research when we came in none of this was there right.

3) Sir, having had the privilege of being both a student and a professor at a foreign university, and now teaching in India, you bring a unique perspective. From your experience, what is the one significant difference you observe between Indian students or the education system here and the learning methods abroad?

The so called thing which is there in all our education is the focus on the facts of "science and technology" than theirs, they are taught to make an argument a logical case; for example, we can state facts there is a big difference. So, somewhere what we need is to balance the two. And the balance I think will come from our class, our strength in mathematics, Our average is way better than their average in terms of the math skill, coding skills and all of that for that matter. So another thing is we have been trained generation-ally to do grunt work without having a problem these kind of works whether it is coding or whether it is crunching numbers or whatever they tend to get bored. I would refer you to, I don't know if you all ever watch this series called "Yes Minister", It's an old, old series. It's British sitcom, which is a satire on how government works. So in that one of the episodes, the minister complains about how education is so useless. Nobody's learning anything useful. It's just a rote stuff. It's so boring for the students. And you know, what is the use of doing this? They just sit in a class from morning till evening. And then the The Civil Servant just goes, "I thought that is excellent preparation for what they are going to see!" (XD). The key area where I think the students must focus in striking a balance, if that that happens our education system would stand out.

4) What was the most challenging decision you had to make in your research or career?

So, in terms of my career in a big picture sense joining Amrita meaning returning back to India in some sense was the biggest challenge that I had to. I had to face because I did have options in the US. I came back because of family circumstances. I came back and the choice of being in academia was an easy choice because that I always wanted to be from almost from my childhood I wanted to be a professor. So, it was a no-brainer and Amrita was again a no-brainer particularly because of my personal connection with Amma. This move back to India was a challenging decision to take because I had to give up what was pretty much what I thought was going to be the way of my life. But if you look at it from the perspective of career, to answer your question,the real answer would be I had to change completely my area of research once I came into Amrita. I had to completely restart, reorient myself towards research. And I am very fortunate that I did this at Amrita because Amrita gave me that kind of space to do it. Amrita's biggest plus point is that there is this immense focus on community, on people, alright. Living Labs is a very clear-cut example of it. So, how do I align my research, thought process to this commitment? that was a very meaningful challenge for me. I understood that the university has a vision, where we have to find our place. That was a very satisfying challenge in some sense. So really two challenges. One challenge is to completely revamp my research priorities because I had to start moving into experiments from what I was primarily a theoretical and simulation person. Second is to set up this research infrastructure.
So it is immensely satisfying to work here ..I mean it's hard, it's frustrating but it is also immensely satisfying

5) Do you have a favorite movie or show that you would love to recommend students to watch?

“Yes Minister.”I believe especially now more than ever people should have more awareness about how society functions. What is the role of a community? What is the role of you know how a community develops and what is the structure that is provided by the government?
I am sorry to say this, our teaching of civics is pathetic and most of us do not have any sort of attachment or bonding to our home place. It's very sad if you look at it. We have no second thought about moving out of our place and getting out wherever. It's a good thing in some sense, but it doesn't mean we should forget about where we come from, whatever roots are. And this rootlessness has really what our country is paying a price for it. So I believe, it's a really funny satire if you like that kind of stuff. There was a time when I had my serious doubts with as to whether I would be a good chemical engineer or a good researcher, whether this academics is my cup of tea or not and so I ended up exploring so many things like everybody does. I ended up trying to make movies. So, I ended up in my very first movie that I worked on. It was an independent production. I was the first assistant director as well as the production manager for that movie. It was a feature length film. It was in the US. I cannot watch a movie like everybody else watches anymore but if you give me a genre, I'll give you what my favorites are;
Comedy: Doctor Strange Love. It's an old, old comedy. Doctor Strange Love is one of my most favorite comedies. And then there is also the other extreme, it's like total slapstick. I love, love, love Charlie Chaplin. I love the Tamil attempts at all of this, like Michael Madana Kamarajan and all of these. Drama: At your age, when I was in college something that deeply deeply moved me was Schindler's List, another movie that got screened when I was at IIT Kanpur, was Saving Private Ryan. That moved me very deeply. Shawshank Redemption, Fantastic movie.

7) Sir, Any advice that you would like to give to the students pursuing engineering ?

Become an Engineer! There is huge difference between a user and an engineer, everything that is around you... try to see how value addition happen, it’s a way of life, it’s a thought process that every student must imbibe. A lot of processes that were developed by our ancestors were unsustainable , its our responsibility to make sustainable be it air, water, soil anything and everything. Don’t become a product of the system, who just knows whats this and whats that rather go a step further, understand & apply, that will make you an engineer.

8) If you could sum up chemical engineering in one word, what would it be?

Two words: Universal Engineers!
Remember: We are not just the back end, we are the heart and the soul of all of this. Don't think of it as front, back, think of it as a circle, we are at the center of it.

TRENDS IN CHEMICAL INDUSTRY

1) Recent Trends in Chemical Engineering in India and Worldwide

The chemical engineering landscape is undergoing a transformative shift, both in India and globally. A significant trend is the integration of artificial intelligence (AI) into process engineering. For instance, the Mid-Michigan Section of the American Institute of Chemical Engineers recently hosted a seminar on "Generative Artificial Intelligence for Process Engineering," highlighting AI's growing role in optimizing chemical processes. Additionally, there's a strong push towards sustainable practices, with innovations like liquid metals being explored to replace energy-intensive processes, potentially reducing the industry's carbon footprint. In India, companies are increasingly focusing on green chemistry and sustainable manufacturing, aligning with global efforts to make the chemical industry more eco-friendly.

2) Companies Showing Recent Growth and Emerging Companies in the Chemical Engineering Field in India and Globally

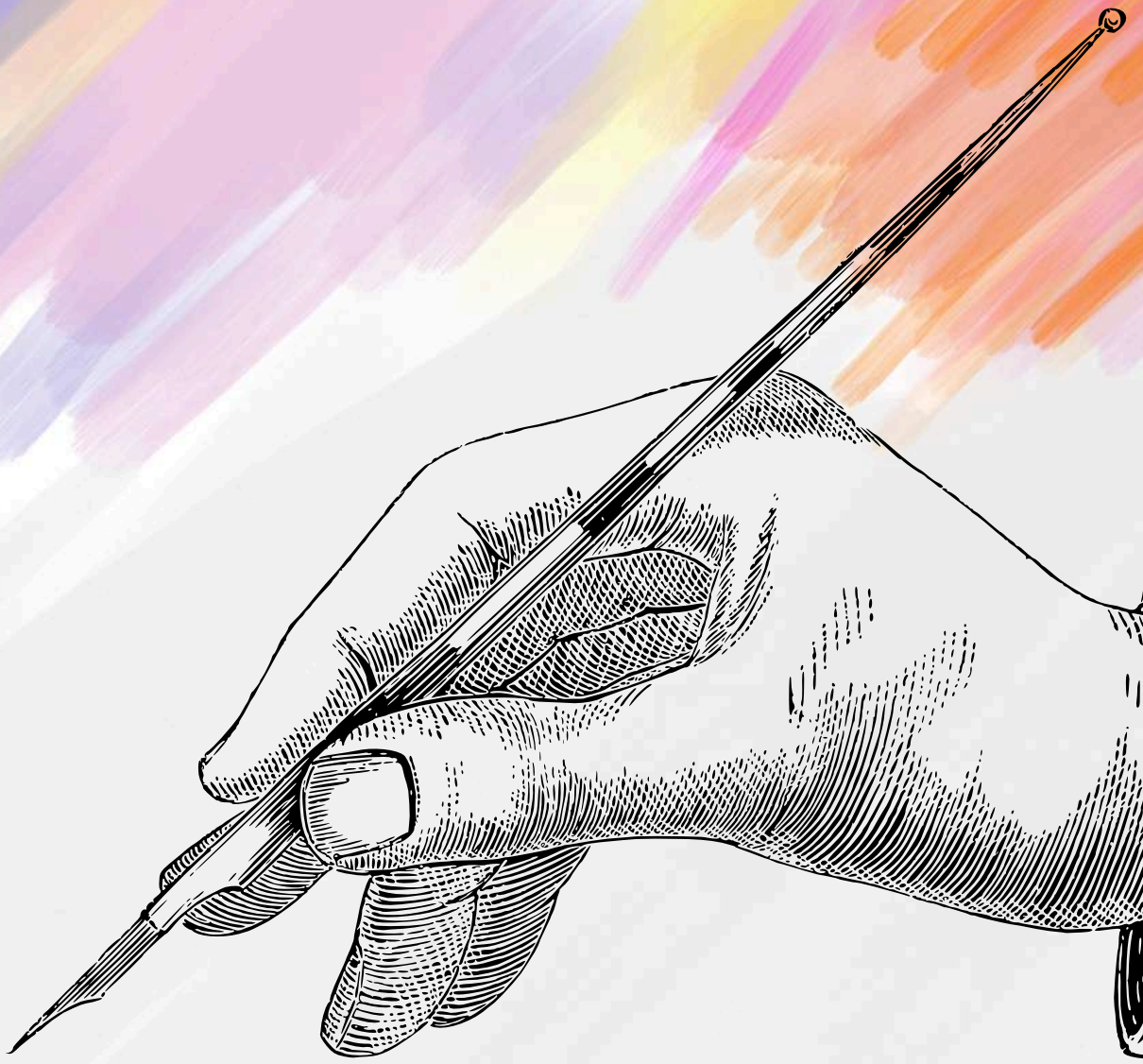
Several companies are making notable strides in the chemical engineering sector. Globally, Johnson Matthey is at the forefront of the hydrogen revolution, leveraging its expertise in catalytics to drive clean energy solutions. In India, Mstack Chemicals has secured $40 million in a Series A funding round, aiming to expand its global operations and enhance research and development efforts. Additionally, Log9 Materials, an Indian nanotechnology company, is pioneering in areas like sustainable energy and filtration, with innovations such as aluminum–air batteries and aluminum fuel cells.These developments underscore the dynamic growth and innovation within the chemical engineering industry.

3) Recent Groundbreaking Discovery in the Field of Chemical Engineering

A recent groundbreaking discovery involves the use of liquid metals to revolutionize traditional chemical engineering processes. Researchers have found that liquid metals can serve as catalysts, potentially replacing energy-intensive methods that have been in use since the early 20th century. This innovation could lead to more sustainable and efficient chemical production, significantly reducing greenhouse gas emissions and energy consumption in the industry.

4) Companies in India Which Hire Chemical Engineering Graduates

India's robust chemical industry offers numerous opportunities for chemical engineering graduates. Leading companies such as Aether Industries, specializing in advanced intermediates and specialty chemicals, and Rossari Biotech, focusing on specialty enzymes and chemicals, are known to recruit chemical engineers. Additionally, emerging firms like Log9 Materials and Mstack Chemicals are expanding their teams to support innovative projects in nanotechnology and sustainable solutions. Companies such as : Reliance Industries Limited, Tata Chemicals, Aditya Birla Group, SRF Limited, Pidilite Industries, Deepak Nitrite, Aarti Industries, UPL Limited, Atul Ltd, Honeywell, VA Tech Wagbag, Saint Gobain, Godrej Chemicals, BASF and Kalyani Group are known for recruiting chemical engineers to drive innovation and maintain their competitive edge



THE CREATIVITY CATALYST

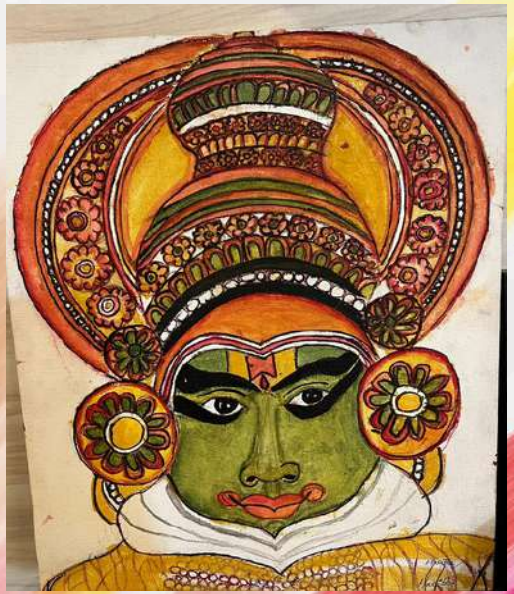
-STUDENTS CORNER

Palette & Particles

ABHINAYA CHE22008

ANANYASAI CHE22033

SHIVANEE CHE24047

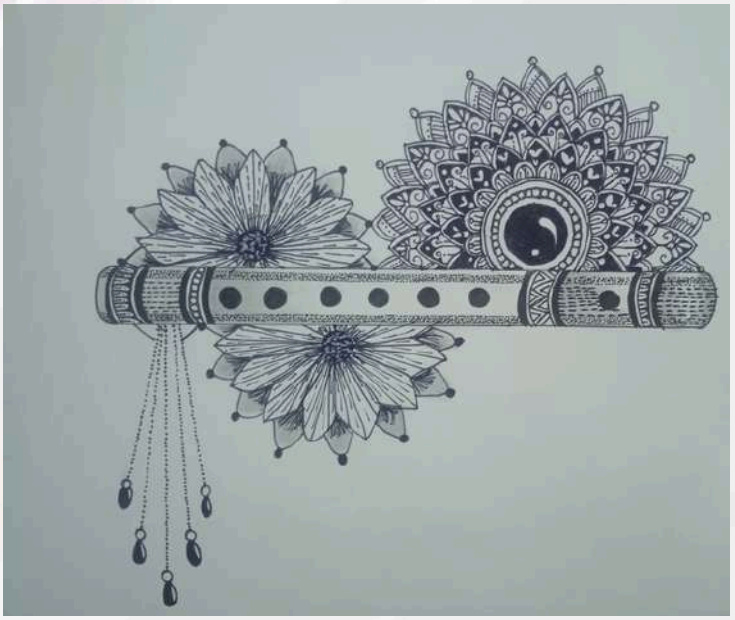


HARITHA S CHE22048

MAHIMA BOTHRA CHE22025

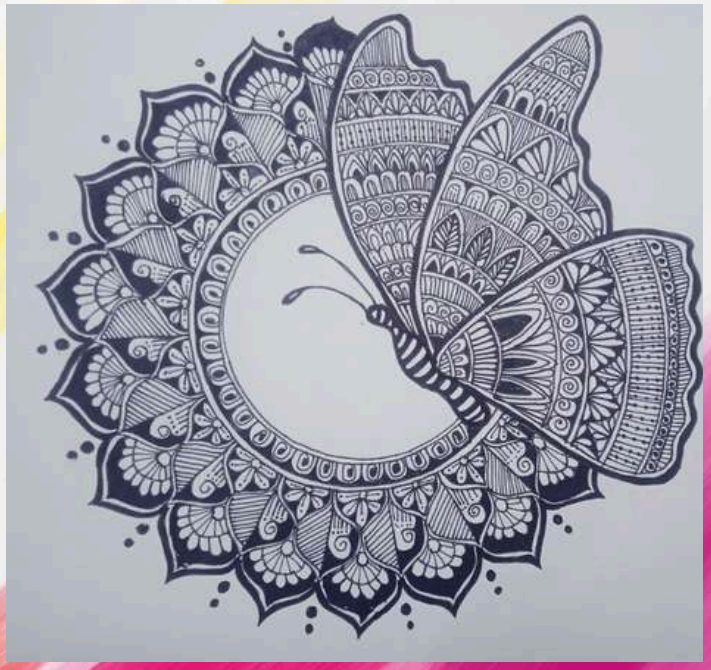
Palette & Particles

ANURSRI CHE24007



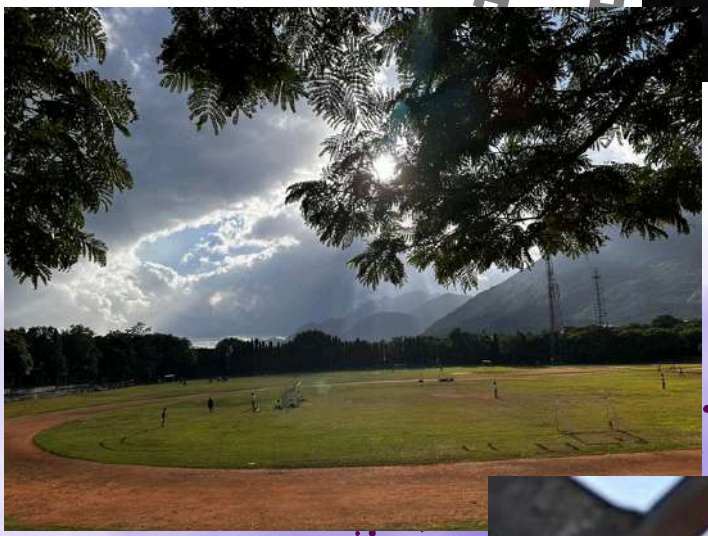
PUNNYA CHE22035

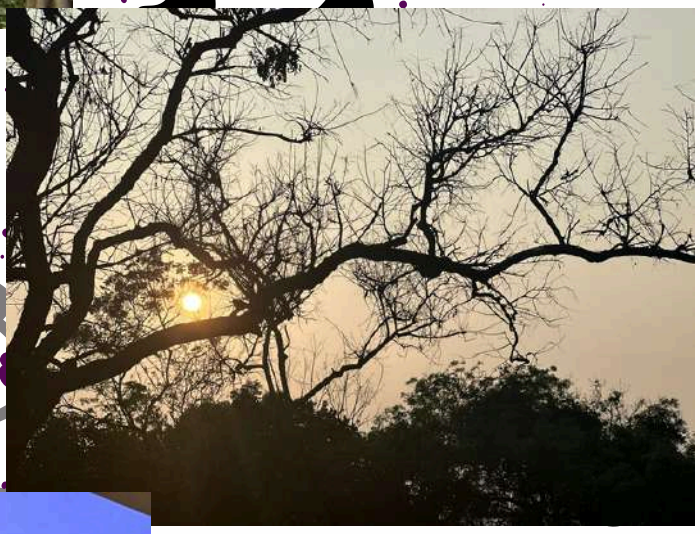
PUNNYA CHE22035

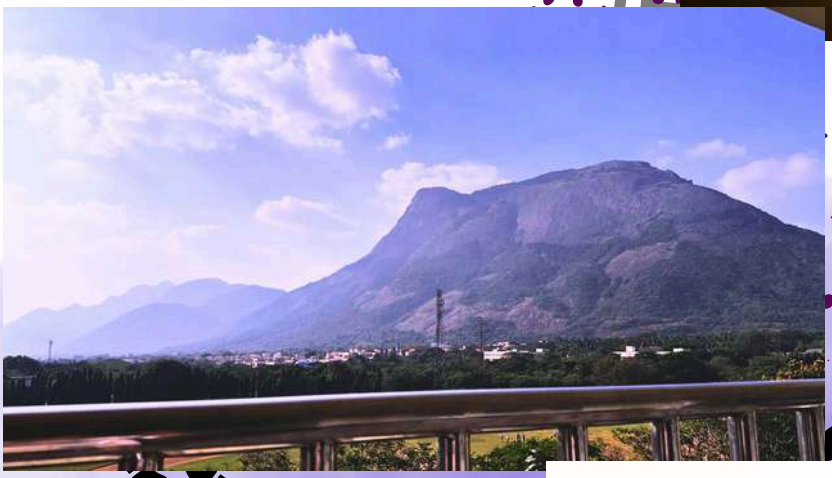


ANURSRI CHE24007

CAMPUS BEAUTY!







~Abhiram CHE24059

Hang In There!

What do we think of the word "hanging"? "Dying"? Do people hang themselves only to kill themselves? or do they say "die" to "end their life"? How often have we seen people hanging for life? Here's an image—a photograph—that shows how people hang themselves to survive. This picture was taken on July 27, 2024, somewhere in Amrita, where we can see a man hanging from a rope to paint the walls of Amrita and bring some colors not only to Amrita but also to his life. The struggles a man or a woman goes through to survive have no limits. No matter if it is a 10-to-4 job in an air-conditioned room, burning yourself in 50-degree sunlight in the scorching heat of Dubai, or carrying weights on your back heavier than yourself. Ultimately, people find different ways to survive and earn a livelihood—to bring smiles to the faces of their families, to buy them good clothes, to earn enough for two meals a day, and to live this beautiful life.

Imagine there is nothing to do, and you are just sitting on your sofa, watching something on Netflix, and eating everything in a confined, four-walled room. I just want you to think—is that life worth living? These struggles are what make life worth living and beautiful too.

An Ode to Chemical Engineering

In a lab full of flasks, an imagination takes flight,
A sprint of warmth, and the destiny ignites.
From the tiny bubbles in a boiling beaker,
To the towering columns of a chemical seeker.

We dance with molecules, coax them to react,
We design the future, that's a chemical truth!
From polymers stretching in silken threads,
To purifying water in which existence quietly treads.

We harness the winds, the earth, and the sun,
To craft a world where development is spun.
Catalysts hum in a silent embrace,
Producing new marvels, with elegance and grace.

With power efficient, and waste became to gold,
Sustainability shines, as our story unfolds.
It's not simply reactors, or pipelines that glide,
It's the heartbeat of development, wherever we go.

Here's to the mixers, the towers, the gears,
To the distillers of wish, the engineers!
Where equations meet goals, and atoms align,
In the alchemy of lifestyles, our work is divine.

A Sonnet of Amrita's Charm

Beneath the Western Ghats, where mountains rise,
Amidst the whispering winds, our day takes flight,
Through leafy paths at morning's gentle guise,
We walk to Block Two, guided by golden light.

The clouds descend to grace the mountain's crest,
A painter's dream, our corridor's fine view;
In break-time's pause, these scenes bring tranquil rest,
A fleeting calm the weary minds renew.

The sunset speaks, in hues that swiftly fade,
Of transient woes, of fleeting pain and strife;
In ground's benches, we watch day's bright cascade,
And grasp the truth: all fades, restoring life.

Come Gokulashtami, all our energies entwine,
In dance, in craft, in skits of the divine.

Anokha calls with boundless skills to hone,
A feast of learning, joy, and bonds well sown;
Professors guide, our dreams begin to bloom,
With peers we share both laughter and the gloom.

In Amrita's arms, where skies and minds are free,
We find the roots of growth and destiny.

A Dance of Shadows and Light

Life, a canvas of shifting hues,
Painted with reds, and grays, and blues.
A symphony sung in a fractured key,
Where joy and sorrow wrestle to be free.

The sun may rise, a golden crown,
Yet storms will gather to strike it down.
Each step we take, both fierce and frail,
A journey balanced on a trembling scale.

In the quiet heart of a bitter fight,
A seed of wisdom ignites its light.
Through battles waged in the soul's darkest nights,
We find the strength to claim newest heights.

Dreams may shatter, hopes may fade,
But scars are maps of choices made.
And though we stumble, though we fall,
The will to rise outshines it all.

For conflict carves, with a steady hand,
The shape of who we are, unplanned.
In the clash of shadow and light we find,
The masterpiece of the human mind.

The Road Ahead

The path behind, a tale once told,
Of battles fought, of dreams grown cold.
Yet in the whispers of the past,
The seeds of strength are sown to last.

The road ahead is rough, unpaved,
A canvas blank, yet to be braved.
With every step, new skies unfold,
A tapestry of hopes retold.

Let go the weight of yesterday,
It dissolves in morning's ray.
The heart, though scarred, beats strong and true,
Each beat a rhythm to start anew.

Through valleys deep and mountains steep,
Through restless nights and shortened sleep,
The spirit stirs, it knows the way—
The dawn awaits at break of day.

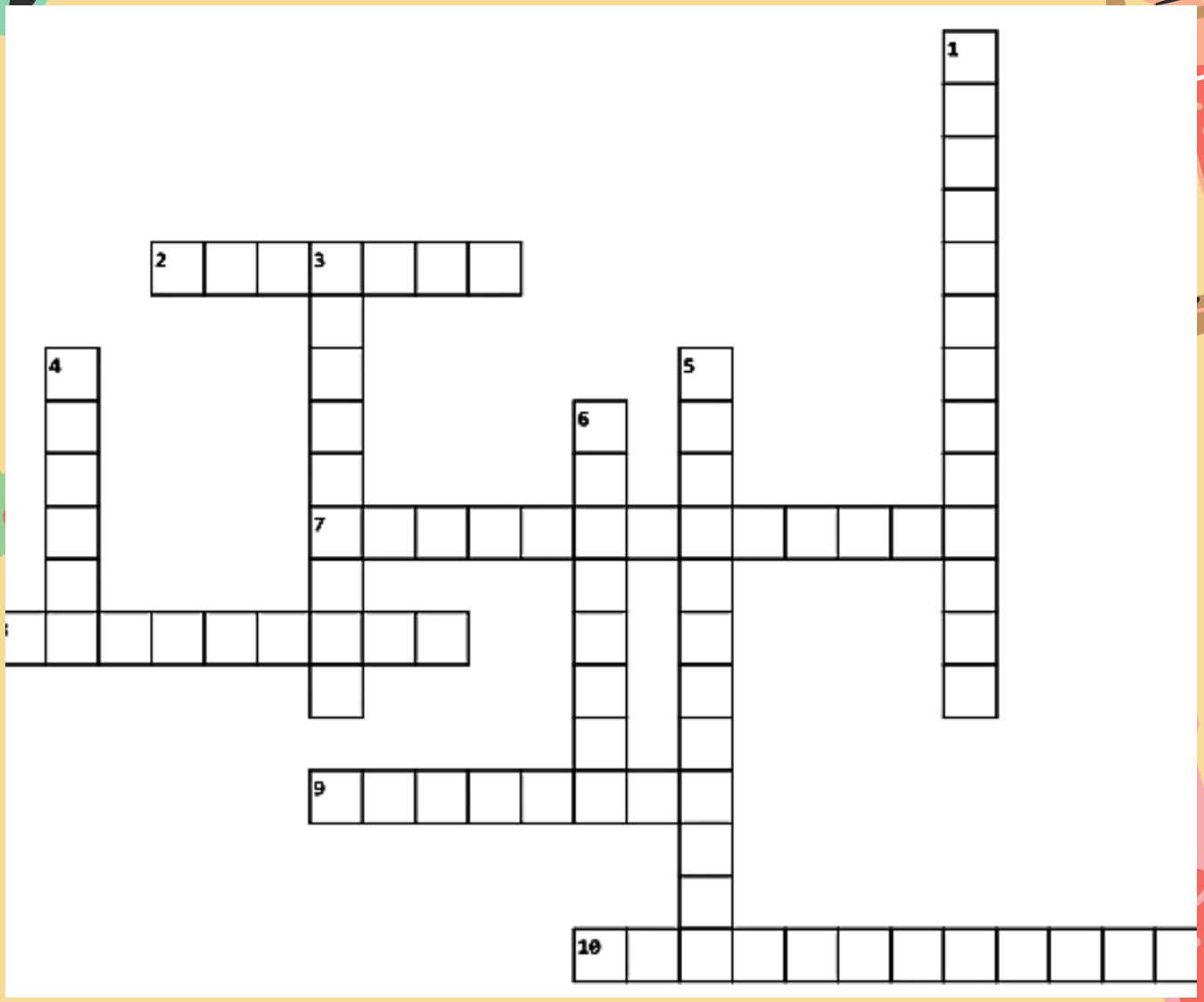
The winds may howl, the skies may weep,
Yet courage wakes from where it sleeps.
For moving forward is life's decree,
To chase the horizon, to dare, to be.

So, lift your gaze, embrace the fight,
The road ahead is yours by right.
With every step, your soul will find—
The strength to leave the past behind.

Blooming Breeze

The truth arises, unshaken it stands-Falsities fade, their grip disbands!
"Look ahead!" the universe says, To the horizon where your destiny sways.
Do not halt-march ahead!
Let not despair weigh your tread.
Why do you ponder the hurdles past?
The dawn awaits-your light will last.
Stay strong, my friend, with steady resolve,
Life's mysteries we shall dissolve.
"You have the strength," the whispers declare,
In your heart lies courage rare.
Keep the faith, endure with pride-
Victory, my friend, will be your guide!
Let the darkness break into rays-
The sun will shine, and love will blaze

Chemical Engineering Crossword



Across

2. A substance that dissolves another substance to form a solution

7. The process where solid particles settle out of a liquid

8. A device used to measure fluid flow rate

9. Material that speeds up a chemical reaction without being consumed

10. Law stating that the total energy in a system remains constant

Down

1. Device used to transfer heat between two fluids

3. A property of fluids that resists motion

4. Unit used to measure pressure in a system

5. Separating a mixture based on boiling points

6. The study of flow and deformation of matter

GATE QUESTIONS

1) For a pure substance undergoing a phase change at constant pressure and temperature, which of the following statements is true?
(A) Enthalpy remains constant.
(B) Entropy remains constant.
(C) Gibbs free energy remains constant.
(D) Internal energy remains constant

2) In laminar flow through a circular pipe, the velocity profile is:
(A) Parabolic
(B) Linear
(C) Uniform
(D) Hyperbolic

3) The Nusselt number is a dimensionless number that represents the ratio of:
(A) Convective to conductive heat transfer
(B) Radiative to convective heat transfer
(C) Conductive to radiative heat transfer
(D) Convective to radiative heat transfer

4) In a counter-current gas absorption column, increasing the liquid flow rate while keeping the gas flow rate constant will:
(A) Decrease the absorption efficiency
(B) Increase the absorption efficiency
(C) Have no effect on absorption efficiency
(D) Decrease the mass transfer coefficient

5) A proportional-integral-derivative (PID) controller is used to:
(A) Eliminate steady-state error and improve transient response
(B) Only eliminate steady-state error
(C) Only improve transient response
(D) None of the above

Credits

Editor : Pillai Ambika Shrikumar
CB.EN.U4CHE22032

Graphic Designer: Mahima Bothra
CB.EN.U4CHE22025

Graphic Designer: Abhijith Babu
CB.EN.U4CHE22003

Title Credit: NAGA SREE VARANASI
[CB.EN.U4CHE24072]

Any suggestions?
Feel free to write us through the QR code here!