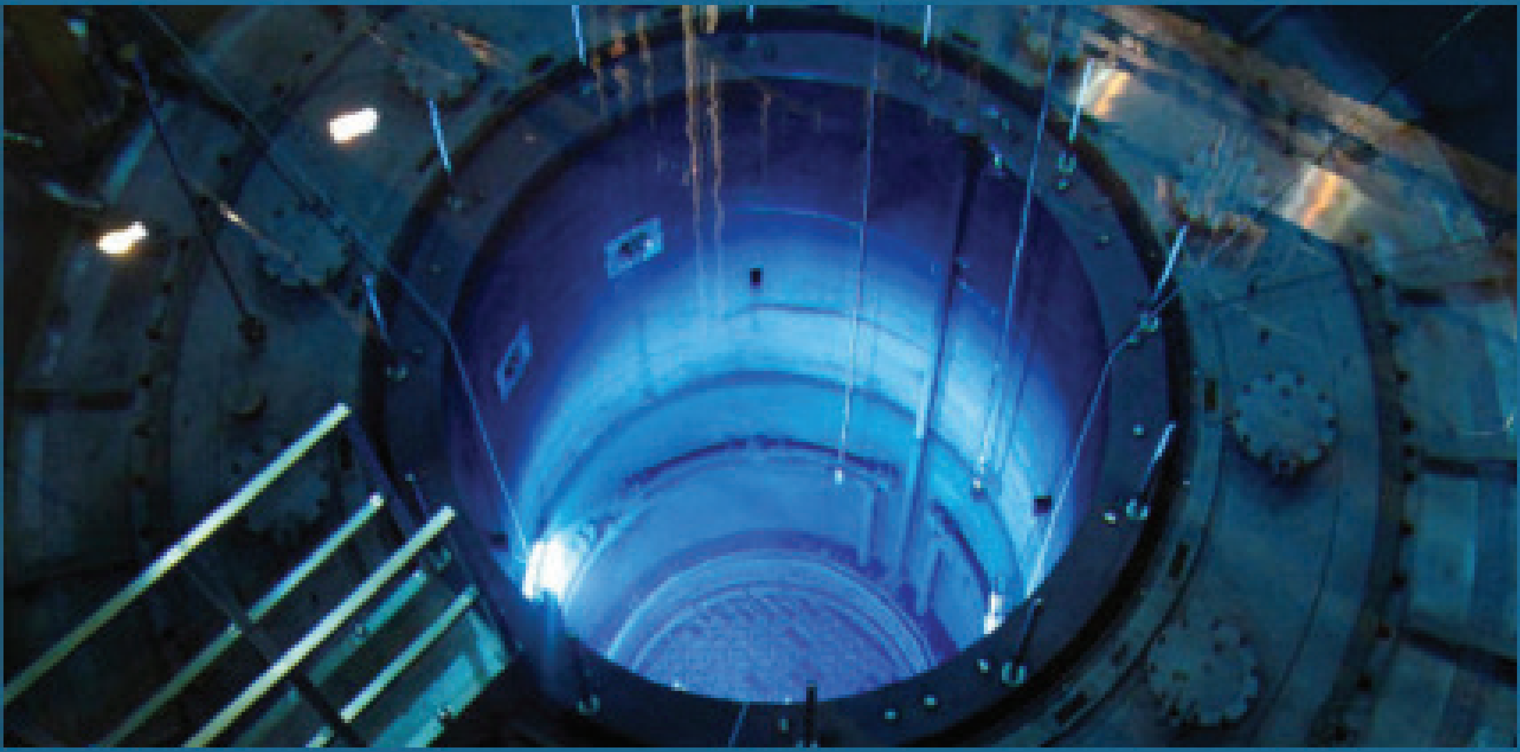
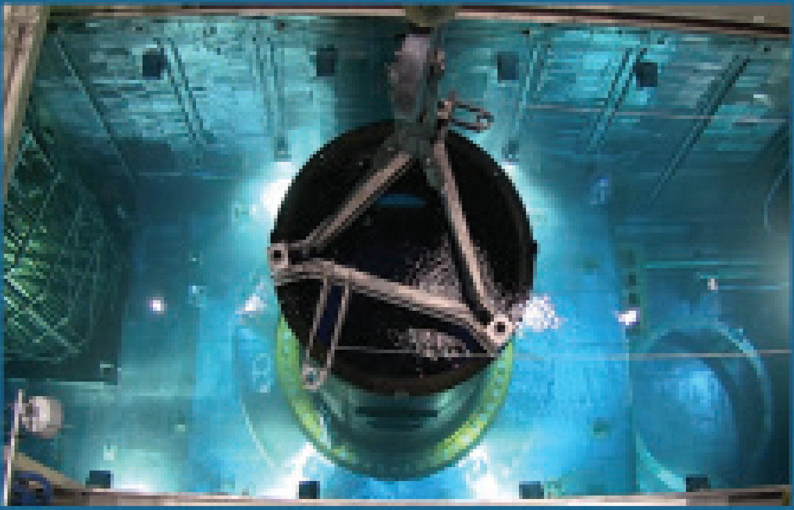
NEWSLETTER

2020-2021





COVER STORY

Combating corrosion in world's aging nuclear reactors

CHEMICAL ENGINEERING ASSOCIATION
NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

CONTENTS

THEME OF THIS EDITION:
CATALYSIS

TEAM

Dr.K.M. Meera Sheriffa Begum
HOD
Chemical Engineering
NITT

Dr.J.Sarat Chandra Babu
Faculty Advisor, CheA

Surya
Chairperson
ChEA 2020-2021

Kande Ashish
Overall Coordinator
ChEA 2020-2021

Mayank
Treasurer
ChEA 2020-2021

CONTENT
Saatvi S
Mithran Jeyashankar
Viswa Subramanian

DESIGN
Rasika N
Naveen Kumar

EDITORIAL

Dr.J.Sarat Chandra Babu
Faculty Advisor, CheA

Catalysis has been an integral part of process engineering for centuries. Since the times, the process engineering laid out on well-structured principles of science for the last 150 years, extensive contributions have been made by scientific community to understand the role of catalyst at molecular level in enabling both selectivity and high yield otherwise could be realized only at harsh, in engineering terms, process conditions. After Second World War, as things started to settle down, the process engineering leaped into a diversified life source for economy and technological development of the society in terms of energy, food and materials.The underlying key for the success, obviously, is advances in catalysis. During the last few decades, as you all are aware that nanotechnology brought the paradigm shift in life style of numerous options with functional materials. It has shown a revolutionary developments in handling the challenges of health-care, food and energy.

The first generation is all about material science with enhancement of properties that are achieved by the incorporating "passive nanostructures". This can be in the form of coatings and/or the use of carbon nanotubes to strengthen plastics. The second generation makes use of active nanostructures, for example, by being bioactive to provide a drug at a specific target cell or organ. This could be done by coating the nanoparticle with specific proteins. The complexity advances further in the third and fourth generations. Starting with an advance nanosystem for e.g. nanorobotics and moving on to a molecular nanosystem to control growth of artificial organs in the fourth generation of nanomaterials.

The synthesis methods have evolved from an art to a scientific feat. Introduction of artificial intelligence (AI) and machine learning (ML) into the vast data on the materials is resulting in identifying exotic structures with precise functionalities and designing materials for target applications using data-driven methods. MRC at IISc, Bangalore has initiated “aNANt” database, probably, one of the largest,hostingover 23,000 materials data. The applications of nano-catalysis have now gone well beyond the scope of science fiction stories. Thus process engineering is maturing itself to a “Lab-to-Business” concept in the realm of nano-catalysis.

The students have taken up the right theme and wish them a successful career as process engineers of next generation.

EDITORIAL

Dr.K.M. Meera Sheriffa Begum
HOD

Dear Students,
I would like to convey our Budding Engineers that failure is the seed of success. Attempt with confidence and Win. Believe that strategy and vision are more important to energize and inspire the organization. The future belongs to those who create it. Let us work towards to be a Global leader in Chemical Engineering !!!

Rooba Karthick
Overall Co-ordinator
ChEA 2019-2020

Alchemy-the word itself is sure to bring a smile for everyone in our dept.Such a close to the heart fest with so many brainstorming sessions to decide the workshops,events, co-ordinating for publicity, setting quiz questions, the fun sessions with seniors etcetc.We are in an unprecedented time and this requires lot of efforts which I am sure the team lead by Surya, Ashish, Mayank will take care of and make this edition an unforgettable one.

Dola Pavan Kalyan
Vice chairman
ChEA 2019-2020

CheA, an eternal festival of knowledge and joy which always thrives on encouraging the passionate chemical engineers. Year upon year, it is becoming a basic necessity of improving oneself and no wonder why with year-long activities like intern-talks, webinars, seminars and ALCHEMY. Especially, alchemy which breaks all the barriers in raising everyone for their best and beyond. I wish a grand success to you all for the academic year 2020-2021. Thank you.

Surya
Chairperson
ChEA 2020-2021

Chemical Engineering Association always believed in spreading knowledge, it was a wonderful journey from being a team member to leading the association as a chairperson. This year we hope to implement the vision of our department in all our undertakings. We strive to be a team that is motivated and coordinated. I hope we as a team will pull this association and alchemy to greater heights and certainly, we will make beautiful memories which we can cherish for a lifetime.

Kande Ashish
Overall Coordinator
ChEA 2020-2021

Being an Overall Coordinator, my job is to take part in all activities regarding ChEA and coordinating different teams to make sure everything goes well. It has been a sheer pleasure to be a part of team that never limited themselves to their own responsibilities. I would like to take this opportunity to convey a message to juniors, in the final year dedicate yourself completely to your department which will create a strong bonding with each and every one in your department, especially with people whom you missed in the first three years of college including faculties, juniors and non-teaching staff. Department sentiments is a much needed thing to cherish about.

Mayank
Treasurer
ChEA 2020-2021

Being the Treasurer, my job is to take care of all the monetary works related to Chea activities. Money is very crucial for every fest and therefore has to be handled with utmost care and honesty. Being a Treasurer, it is very important to have a good bonding with each team and it also helps in understanding their respective work. I would like to convey that being a part of CHEA gives one a hands on experience on handling events and how to work in a team. It is very important that everyone volunteer for their department so that it achieves recognition and success and therefore I would invite all the juniors to come up and take this responsibility and make this year's CHEA a grand success.

Mithran
Content Head
2020-2021

Alchemy was always instrumental in shaping budding chemical engineers for a brighter tomorrow. The events, workshops and guest lectures conducted enhances and enriches engineers and students alike so they could serve the society better. The stage is finally ready for Alchemy ‘21 to set new standards, surpass expectations and catalyse the future everyone hopes for.

Hariekumar
Publicity Head
2020-2021

Publicity team had always been the face of Alchemy with respect to other college students. This year we hope to implement the vision of our department in all our undertakings. We, as a team will strive to be efficient and take alchemy to reach heights.

EX-COM

SURYA B J

CHAIRMAN

ATTI SRINIVAS (PHD)

VICE CHAIRMAN

KANDE

OVERALL COORDINATOR

MAYANK

TREASURER

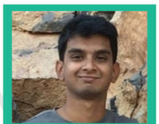
CORE

VISWA

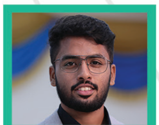
SAATVI

MITHRAN

CONTENT



ANSINATH



HARIE

MONEESH

PUBLICITY

NIMRISHA

ARINDAM

MARKETING

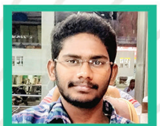
HARSHIT

GOVIND

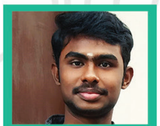
ANUJ

DHARSHINI

EVENTS



SHASHANK



DINAKAR

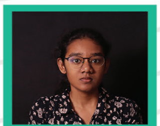
ORGANISING COMITTEE

MADHU

SHAMBU

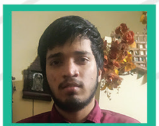
WEB-OPS

NAVEEN



RASIKA

DESIGN



MANOHAR

PR & HOSPITALITY

NILA

NISHANTH

GUEST LECTURES

DEVENDER

SRIRAM

AFNAS (PG)

FRANKLIN (PG)

WORKSHOPS

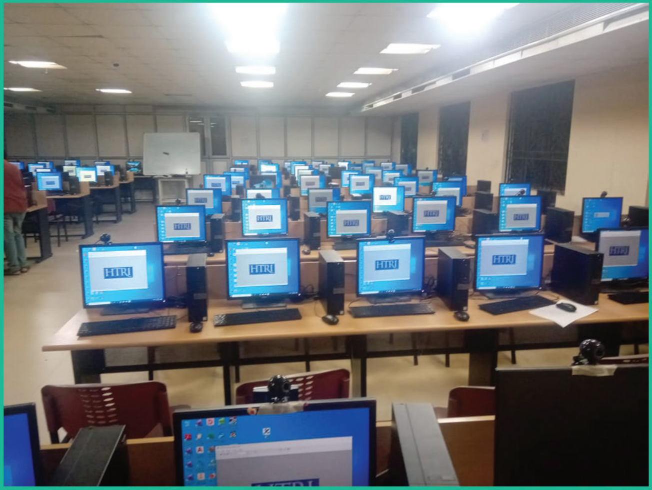
HISTORY OF DEPARTMENT

The history of chemical engineering at NIT is inextricably bound with the history of the discipline itself. Established in 1967, the Department of Chemical Engineering, NIT Tiruchirappalli, is regarded as one of the premier centres for Chemical Engineering in India by industries and academia. It also distinguishes being ranked as one of India's top seven Chemical Engineering divisions with a group of well-qualified faculty, staff, and motivated students. The Department's vision is to be a global centre of academic and research excellence to serve society. It's the first HOD Ibrahim.

This course was designed to meet the needs of students who desire a general training in mechanical engineering and a portion of their time to study of applications of chemistry to the arts, especially to those engineering problems that relate to the use and manufacture of chemical products.

In 1968, the Department of Chemistry granted Bachelor's degrees for Chemical Engineering, the first of their kind to be bestowed anywhere. After Dr. Ibrahim's death, esteemed Professors led the program through a continued rise in popularity. It began a new era and the beginning of the Ph.D. in 1973 and the first Mtech in 1975. In 1974, NIT became one of Ia new era and the beginning of the Ph.D. in 1973 and the first Mtech in 1975. In 1974, NIT became one of India's first schools to award Ph.D. degrees in chemical engineering. Since that time, the Department of Chemical Engineering has led the nation in awarding graduate degrees. With over 6,000 living alumni, the Department's remarkable history is alive and continuing to make an impact in research labs, corporate R&D facilities, and universities around the world.

OVERVIEW OF ALCHEMY '19



OVERVIEW OF ALCHEMY '19

The Chemical Engineering Association was set up under the Department of Chemical Engineering at the National Institute of Technology, Tiruchirappalli with the aim of enhancing and enriching the knowledge in chemical engineering. It provides a platform for people from different academic institutions to share their ideas, knowledge and technical expertise with chemical engineering students and graduates, to keep up with the latest developments.

Alchemy – The technical Symposium organized by the institute is one of the best Chemical Engineering symposiums in India. This symposium includes various events, offers workshops on leading technologies and provides the platform for budding engineers to showcase their potential and talents.

Alchemy '19 was held at the National Institution of Technology, Tiruchirappalli, from the 18th to the 21st of October, 2019. Around 200 people from different colleges around the country attended.

Over three days, eight events and four workshops were conducted. The events hosted included a paper presentation and a quiz. The workshops covered a wide range of software from OpenFoam to HTRI.

Prominent guest-lecturers like Mr. Raghavan Desikamani and Mr. KS Kasi Viswanathan arrived to inspire and educate the Chemical Engineering community at Alchemy '19.

The last edition's sponsors were Unibic biscuits, The Souled Store, Livpet, Black Thunder, College Fever, Know a Fest, Suryan FM 93.5, and Ethil Restaurant Pt. Ltd.

Cash prizes worth ₹40,000 were awarded to winners in various events. To summarise, the last edition of Alchemy proved to be a great success.

COMBATING CORROSION IN WORLD'S AGING NUCLEAR REACTORS

MOTIVATION

Forty years of hard labour in punishing conditions sounds like an interminable sentence. Imagine the sentence extended over and again! That is the plight of nuclear reactors. These giant metal contraptions were typically designed to generate electricity for about 40 years, day after day resisting damage from a corrosive, watery world of extreme temperatures, pressures, and ionizing radiation. Now many are being asked to soldier on for at least another 20 years.

To extend reactors' lifetimes, scientists and engineers are continually improving methods for monitoring and predicting the integrity and strength of these multibillion-dollar metal structures. Moreover, they are developing corrosion-resistant replacement materials to keep nuclear reactors operating safely and reliably for 60 years or longer.

According to the US Energy Information Administration (EIA), 96 reactors operate in 29 US states. The 440 or so reactors located throughout the world are 30 years old, on average, and getting older. Although some of them are scheduled to be shut down and decommissioned, many are being upgraded with new parts to extend their years of operation significantly. Moreover, more nuclear facilities are on the horizon. Another 50 nuclear reactors are being constructed in 15 countries, mainly China, India, Russia, and the United Arab Emirates. Furthermore, to help keep pace with a projected 28% increase in world energy use by 2040, another 100 reactors with anticipated service lives spanning many decades are on order or planned.

INTRODUCTION - A LOOK INSIDE REACTORS

Nuclear power systems harness the intense heat released in nuclear reactions and use it indirectly to generate electricity. The principle of operation is much the same as that in power plants that burn coal, natural gas, and other fossil fuels, which together accounted for roughly 63% of electricity production in India in 2019. Unlike power plants that generate heat by burning fossil fuels,

commercial nuclear reactors typically use pellets of uranium dioxide with diameters and lengths on the order of 10 mm. Fuel manufacturers load these bean-sized pellets into 4.5 m long slender metal tubes made of a neutron-permeable zirconium cladding material. Then they bundle the tubes together, forming assemblies of roughly 200 or more fuel rods, depending on the design and size of the reactor. Hundreds of these assemblies containing millions of pallets weighing a total of roughly 100 metric tons are submerged in a giant vessel filled with a heat-carrying medium, or coolant. In the great majority of commercial reactors, the coolant is water. The heat that drives the reactor comes from 235U nuclei in the fuel pellets. As these nuclei undergo spontaneous fission, they split into two smaller nuclei and liberate heat and neutrons. The neutrons can collide with other 235U nuclei in the pellets and cause them to fission, liberating more heat and additional neutrons. Those neutrons can strike other nuclei, thereby setting off a chain reaction that heats the fuel-rod assemblies and in turn heats the water. Plant operators regulate the chain reaction and reactor temperature by inserting neutron-absorbing control rods into the core and withdrawing them.

The most common type of nuclear power reactor is a pressurized water reactor. These reactors keep the water under high pressures—greater than 15 MPa (150 atm)—so that it remains a hot liquid as it flows over the fuel rods. The water can reach temperatures of about 320 °C. To prevent the spread of radioactive material, water in this section circulates through a closed cycle: a system of pipes known as the primary loop, making no direct contact with the outside world. This circulation of superhot, pressurized water transfers heat to a secondary loop, causing another, nonradioactive collection of water to boil, turn to steam, and drive the turbine.

THE PROBLEM

Constant contact with high-temperature, high-pressure water can take a toll on metal no matter how tough it is. Furthermore, because of the intensity of the heat, pressure, and radiation in the reactor environment, a small defect can quickly grow into a large one. For that reason, inspectors regularly use high resolution ultrasound, electromagnetic imaging, and other methods to search for tiny flaws, cracks, and signs of fatigue in 25 cm thick reactor walls, safety systems, and other reactor components. Although the stainless steels and nickel-based alloys from which many reactor components are made have largely resisted damage and corrosion, some have not done as well as others.

A CLOSE CALL

In a couple of well-known cases, a type of chemically induced damage known as stress corrosion cracking (SCC) majorly weakened vital parts. CC had caused tiny cracks to form in a part of the control-rod mechanism where welding joined various alloys, including a nickel-chromium-iron material known as alloy 600. The cracks allowed hot borated water to slowly escape from the interior of the reactor through that site. As the leaked water pooled and evaporated, the concentration of boric acid increased, gradually forming a corrosive solution that ate through much of the thickness of the reactor head, which was not made of alloy 600. The progressing corrosion did not penetrate a lower layer, made of yet another alloy, which held the pressurized coolant in check, averting possible disaster.

THE SOLUTION-ACCIDENT TOLERANT FUELS

Replacement materials may also be in the offing for fuel-rod cladding—the zirconium alloy from which the hollow fuel rods are made. The cladding needs to be permeable to neutrons so they can diffuse through the fuel assemblies, causing fission and sustaining the nuclear chain reaction, but robust enough to survive in a reactor.

Researchers have been driven to make rapid progress in that area since 2011 when an earthquake-triggered tsunami caused an electrical blackout at the Fukushima Daiichi power station in Japan. v

Several approaches to making such accident-tolerant fuels (ATFs) are now in various stages of development. The ongoing test of the new materials follows a smaller one that began in late 2019 in a reactor at Southern Nuclear's Edwin I. Hatch Nuclear Plant in Georgia.

MOLTEN SALT REACTORS - THE FUTURE?

Corrosion resistance is key to the success of today's nuclear reactors. Nevertheless, it may play an even more significant role in future types of reactor design to be more thermodynamically efficient, more economical, and safer. One example, which is still under development, is the molten salt reactor (MSR), a type of reactor in which the nuclear fuel is contained in a molten salt—a high-temperature liquid that also serves as the coolant. The concept has been studied on and off since the 1960s.

Compared with today's high-pressure water reactors, which run at about 320 °C, MSRs run at higher temperatures, such as 750 °C or higher. This higher temperature is central to boosting thermodynamic efficiency. Furthermore, they operate at atmospheric pressure, which bypasses the need for solid materials and expensive safety systems. However, the molten salt can be highly corrosive to reactor materials. Molten salts are hygroscopic: they tend to attract oxygen, water, sulfur, metal halides, and other impurities that can corrode materials.

CONCLUSION

While the timeline for MSRs' reaching operation is relatively long, anticorrosion work in conventional reactors has moved relatively rapidly toward implementation. That is unusual for the field. In under a decade, research programs were developed and funded, best candidates for ATFs have been identified and tested, and industry got on board, ramping up production of the new materials to conduct large-scale tests. With safety regulators' ongoing input, fuel-rod assemblies made from new materials are now sitting in commercial reactors, generating electricity and providing real-world experience.

RECENT RESEARCH ACHIEVEMENTS

Faculty: 20 including visiting faculty

Publications: 60 + publications and two patents in last year
Current strength of Research Scholars: 20

Project students: 04

Project collaborations: DRDO, ISRO, BHEL, BARC, CSIR, DST, Royal Academy of Engineering London, UK, The Royal society UK, and so on...

Part-time scholars: around 10

Awards and Achievements:

Our department has contributed in preparation of In-house hand sanitizer with support of our staff members, Mr.N.Kannan, Mr. Robinson and Medical Team

A pilot plant Gas-Solid System in a Downer Reactor has successfully installed at NIT-Trichy by Prof. SARAT CHANDRA BABU J and his team.

Mr. Tamilnadu J (402116001) has received THE BUDDING RESEARCHER AWARD on the Teacher's Day celebration 2020 along with 13 other department research scholars.

Mr.Manish Kumar has received the Best Oral Presentation in Technical Session at international conference on ENERGY AND ENVIRONMENTAL TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT held at NIT-Allahabad.

MrUllas Krishnan has received appreciation from institute director for his outstanding performance during 2018-19 as PhD/MS Secretary at institute level.

OUR POWER COMES FROM THE PERCEPTION OF OUR POWER

ALCHEMY

alchemy.nitt.edu