MESSAGE FROM THE ASSOCIATE DEAN

Dear students,

It gives me immense pleasure to launch the second edition of “Chemunique”, Issue 1. The Chemical Engineering department of SASTRA University had its humble beginnings nearly 20 years back. It has ever since made great strides in various fields and has become a niche course in SASTRA University. The department boasts of well-equipped laboratories and investments to the tune of 24 lakh rupees have been made to purchase equipment such as fluidized bed dryers, rotary dryer, packed adsorption column, various heat exchangers and industrial models of distribution column and software of the like of ASPEN Plus to name a few. It has an excellent library stacked with contemporary books and a massive collection of ebooks which have benefited the students immensely.

We have always laid emphasis on knowledge acquisition and a constant learning process. This approach is manifest in our students who are actively involved in industrial projects in companies like CPCL (Chennai Petroleum Corporation Limited), BHEL (Bharat Heavy Electricals Limited) and get to study abroad under the Semester Abroad Programme (SAP) in prestigious varsities like Harvard and MIT. The growing number of students who have become successful entrepreneurs is also an encouraging sign. Naturally, this magazine is an extension of our commitment to knowledge and excellence. The innovative articles and puzzles speak volumes of your creativity and technical capability.

My advice to you would be to make the best possible use of the facilities provided here, acquire maximum practical knowledge thereby having a sound, comprehensive learning and more importantly to update yourself and stay ahead of the game.

Wishing you luck and success,

Dr.R.Kumaresan,

Associate Dean,

Department of Chemical Engineering,

School of Chemical and Biotechnology
“Chemunique” was visualized as a par to inform and intrigue students as well as indoctrinating a sense of responsibility and commitment to the society that comes with being an engineer. The entire process of the magazine from conception to actualisation has given us immense pleasure and satisfaction. We would like to thank the Associate Dean, members of Indian Institute of Chemical Engineers (IIChE) Student Chapter, alumni and professors for their constant support and endurance. Before you start to flip through the pages, we would like to remind you of Che Gueverra’s words:

Revolution is not an apple that falls when it is ripe; we have to make it fall.

Enjoy the read!!
Women in Engineering

Srinidy Ravichandran, II Year Chemical Engineering

Women are universally underrepresented in science and technology. India, viewed as a potential powerhouse of innovations, is no exception. True, the subcontinent’s institutes of scientific learning are open to all its citizens, but potential female engineers still hesitate at the thresholds of laboratories. Is this because they have seen few role models of their gender in such establishments? Or is it because they lack the motivation from the society? A recent study conducted by government of USA with various class of working/graduating women engineers in industrial, chemical engineering shows that, Women comprise more than 20% of engineering school graduates yet only 11% practise engineering, a statistic that has not changed for nearly 20 years. despite decades of academic, federal, and employer interventions to address this gender gap In fact, the proportion of women engineers has declined slightly in the past decade, suggesting that while the pool of qualified women engineering graduates has increased, they are not staying in the field of engineering. Clearly, while our educational system is having some success at attracting and graduating women from engineering programs, women who earn engineering degrees are disproportionately choosing not to persist in engineering careers, and research has not systematically investigated what factors may contribute to their decisions.

The stereotype thinking of common man and not giving enough freedom since birth has hampered many budding women engineers, especially when it comes to chemical engineering, one common thing every girl has to surpass before entering what she really wishes to do, “being a girl you have so much of responsibility, taking core jobs would be difficult to manage both personal and professional life, chose some easy majors where you can balance both lives”, to those out there who think the same, women do have major amount of desk work as design and procurement engineers and can balance their lives. It’s all about passion and dedication to work and nothing to do with gender.

To the women engineers reading this, think why you chose this, never give up on your passion for anything and feel privileged to utilise the opportunity given to you while many still aspire for it.

And to those employers who think twice before giving an opportunity to a woman, do think twice because probably that woman is twice as capable as you are just that she lacks the right path and opportunity.
Dr. R. Kumaresan, Associate Dean, Department of Chemical Engineering

Did you join chemical engineering by choice or by chance?
It is by choice. In 1972 I got into Alagappa College of Technology, Karaikudi in Mechanical Engineering branch. I studied there for 30 days. Simultaneously I had also applied in Madras University for chemical engineering and I instigated my voyage as a chemical engineer in the latter one. I was very much fascinated towards chemical engineering so I joined and studied which was a five year course.

Could you share your experiences as a chemical engineering student?
During my days, the student-professor relationship was very congenial. The Professors were very proficient. My professors Mr. Chennakesavan, Mr. Jagannadhaswamy, Mr. Mohan and Mr. Subramaniam were all robust in their subjects and morale. All of them were very dedicated towards students, particularly Mr. Manikavasagam Pillai. I am very proud to say that I am a student of him. He has also written many books in Mathematics. All of them were very strict in the class at the same time they make teaching very interesting.

Which is your favourite area in chemical engineering?
I like almost all subjects in Chemical Engineering but my favourites are heat transfer, mass transfer, transport phenomena, fluid mechanics and process control. I submitted my post graduate project on heat and mass transfer in helical coil through a steam generator. These are helpful for the liquid metal fast breeder reactor in the current nuclear reactors. During my postgraduation days I was interested in heat transfer and later during my working years, I developed interest towards Energy Engineering. This induced interest in energy saving in distillation, crystallisation and boilers. Through all these experiences I learnt a lot about unit operations and also developed interest towards mass transfer.

How difficult was getting a core job during your graduating years?
During 1979, students who graduate as Chemical Engineers were limited. Hardly 300 to 400 Chemical Engineers used to graduate in a year. Also there were many process industries like petrochemicals, pharmaceuticals, petroleum industries, inorganic chemical industries and glass industries. So getting a job was not very difficult. If we would approach the people they would definitely place us. Then you need to undergo a training period of about six months before starting your job. I also went through a similar process in Neyveli Lignite Corporation Limited (NLC) before getting placed. Later I was employed directly as an Assistant Project Engineer in Southern Petrochemical Industries Corporation Ltd. (SPIC).

Can you take us through your industrial experience?
I worked in industries for a span of 20 years. I started working as a researcher at Central Electro
Chemical Research Institute (CECRI), Karaikudi. There I did a pilot plant study of extracting Gallium from bauxite ore. Currently Madras Aluminium Company Ltd (MALCO) is doing research regarding this. While setting up this pilot plant I was called by NLC. My salary during those days was Rs.900. I worked at NLC for three years. I developed interest to work in the field of plant erection and commissioning. Meanwhile SPIC was coming up with their plant at Tuticorin. I applied there for the post of Assistant Project Engineer. There I was placed in the department of erection of boilers, water treatment plants and cooling towers. Then I was placed in the main plant for erection of ammonia reactor, ammonium chloride crystalliser and many other erection and commissioning operations. During this period which spanned for about 11 years, I used to work in shifts for production of urea, diammonium phosphate, ammonium chloride and soda ash. Then I was elevated to the position of chief manager of Technical Services of alkali division where I did all technical calculations. During this period I went through all the chemical engineering books again as I had to do all the technical calculations on my own.

It’s a common argument that to work in industries is different from what we learn in colleges. What is your opinion about this?
I do not agree to this. I believe college is a place to learn the theory and industry is a place to apply this. As student you may not know completely about the chemical industry but here you learn the basics of chemical engineering. You have to keep whatever you learn here in your mind and apply it in the industry. No building can be built without a strong foundation and this is the place where you get this foundation. Once you have finished your learning in colleges you have to dedicate yourself towards chemical engineering. Nowadays due to various reasons many students are preferring software companies as it is the need of the hour. Our country needs young people in the field of software. There will come a time when this sector is saturated with jobs and people will start preferring to work in their core companies. Quality engineers are needed in the production side and to produce such quality engineers, the number of engineering seats must be reduced and proper screening must be done before enrolling a candidate into an engineering college.

What do you think are the qualities that we must develop in order to be successful in an industry?
First and foremost the student must be technically sound and must have exhaustive wisdom in all the subjects. Students must have a daring mind to face any problem and they must be ready to work towards solving the problem. Work in any industry is time bound so the students must be punctual in their work.

Why did you take up teaching even after having so much industrial experiences? And what made you join you SASTRA?
My experience in the field of technical services motivated me to take up teaching. Since I read all the chemical engineering books again during my time at technical services, it was easy for me to take up teaching. I started teaching during February, 2000 at Mohamed Sathak Engineering College, Kilakarai. My director appointed me as a professor and the head of chemical engineering department. Students in that college were poor in English and one could not teach them in English. I first experienced this when I took a class of fluid mechanics on
Hagenpoiseuille’s equation and the students happened to look at me in a very strange manner. They did not understand my teaching and I had to get down to their level and speak in a mix of Tamil and English. When I taught them I used to remember my professors and I tried to emulate their teaching. I used to remember my professor Mr. Vedayan, who used to draw very accurately on the board. All these thoughts motivated me to be a good teacher.

I have been called in many countries like Malaysia for jobs but I joined SASTRA as it is very close to my native place, Pattukotai. When I finished my master of engineering at IISc, I got job offers in many industries across India. I asked my professor Mr. Venugopal for his advice on where to join, he told me that “East or west home is the best”. If one could find a place to work near his home then he would be very comfortable. Moreover students at SASTRA are much more intelligent than the students in my previous college. The communication capabilities of sastrites are also very good. I believe this is because students are selected on the basis of Merit at SASTRA. I can boldly say that SASTRA is thriving not only because of its excellent management but also because of its students.

Any future plans for the department and any message for the students?

I am very much thankful to the management for providing a bounty of Rs.1500000 for the establishment of new heat and mass transfer laboratories. I am planning to introduce a distributed control process laboratory exclusively for Chemical Engineering students. Distributed control systems are widely used in industries today. Students must develop the attitude of working hard and must orient themselves towards working in Core Company and most importantly they must be very strong in their fundamentals.

Did you know??

Swetha N., III year Chemical Engineering

- The word engineer comes from a Latin word meaning 'cleverness'
- World’s first chemical engineer - George E. Davis
- Chemistry traces its roots back to the ancient study of alchemy
- Golf balls have dimples because they help reduce drag; this allows the ball to fly further than a smooth ball would
- An acre of hemp produces more paper than an acre of trees
- Peanuts are one of the ingredients in dynamite
How Plant pulls H₂O??

Anusha Seethepalli, III year Chemical Engineering

Water, being the most limiting factor for plant growth and productivity, is the principle determinant of vegetation distributions worldwide. Since antiquity, humans have recognized plants' thirst for water as evidenced by the existence of irrigation systems at the beginning of recorded history. Despite this dependence, plants retain less than 5% of the water absorbed by roots for cell expansion and plant growth. The remainder passes through plants directly into the atmosphere, a process referred to as transpiration. The amount of water lost via transpiration can be incredibly high. Several processes work together to transport water from its roots upward through the rest of its body. To understand how these processes work, we first need to know one key feature of water: Water molecules tend to stick together, literally.

Water molecules are attracted to one another and to surfaces by weak electrical attractions. Water is so important to plant growth and survival, then why would plants waste so much of it? The answer to this question lies in another process vital to plants — photosynthesis. To make sugars, plants must absorb carbon dioxide from the atmosphere through small pores in their leaves called stomata. However, when stomata open, water is lost to the atmosphere at a prolific rate relative to the small amount of CO₂ absorbed. The balance between transpiration and photosynthesis forms an essential compromise in the existence of plants; stomata must remain open to build sugars but risk dehydration in the process.

Water flows more efficiently through some parts of the plant than others. The relative ease with which water moves through a part of the plant is expressed quantitatively using the following equation:

Flow = Δψ / R, which is analogous to electron flow in an electrical circuit described by Ohm's law equation: i = V / R, where R is the resistance, i is the current or flow of electrons, V is the voltage.

In the plant system, V is equivalent to the water potential difference driving flow (Δψ) and i is equivalent to the flow of water through/ across a plant segment. Using these plant equivalents, the Ohm's law analogy can be used to quantify the hydraulic conductance of individual segments or the whole plant.

Unlike animals, plants lack a metabolically active pump like the heart to move fluid in their vascular system. Instead, water movement is passively driven by pressure and chemical potential gradients. The bulk of water absorbed and transported through plants is moved by negative pressure generated by transpiration. This process is commonly referred to as the CohesionTension (C-T) mechanism. This system is able to function because water is "cohesive", hydrogen bonds allow water columns in the plant to sustain substantial tension. This is how water is transported to tree canopies 100 m above the soil surface.
Revisiting SASTRA

Emil Mathew, VA-Tech WABAG

Why Chemical Engineering? When you address yourself as a Chemical Engineer,

What’s your level of excitement?

Honestly chemical engineering was more of a chance more than a choice. However, given the versatility it equips you with, I am proud to be one and would recommend it to anyone who asks me for career advice.

What has SASTRA taught you?

Between all the orthodoxy and conventionalism, what I learnt the most was to be street smart and unconventional. Apart from the classroom teaching, the exposure it gave me expanded the dynamics of my thinking and molded me into a better person.

The One Word that strikes your mind when you hear ‘SASTRA’:

Friends. Nostalgic memories of all the crazy things I did with friends creep in.

An Experience/Moment at SASTRA you cherish forever:

There are just too many. All the birthday celebrations, cricket leagues, never ending chit-chats, events we participated (won few, lost many), getting caught for proxy attendance, KS pro-night dance with friends etc.

The Inspirational people you met in SASTRA and your Area of interest:

A lot of people impressed me in many ways and of the few who had a lasting impression on me are friends like Ms.Mowshimkka Renganathan, who followed her passion and started an NGO called Bhojan Atews. Any work/field that doesn’t get monotonous and is exciting, interests me. Your favourite hangout at SASTRA? What made you bunk classes (if any)?

Krishna Canteen and the adjoining staircase near its entrance! Classes were bunked mostly because I overslept after a long night of movie/serial/games/playing cricket inside the hostel.
Why WABAG? How did it happen?

Being a person with concern over environmental issues, WABAG was a justifying career choice. With both demand and scarcity of water equally increasing, the scope for WABAG as a company is very bright. How I joined WABAG was more of serendipity. With a stiff competition from my studious friends, I was more surprised than anyone else as I cleared each round. In a retrospect, I should say I just got lucky that day.

How far could you apply the theoretical knowledge in practice?

Every work is based on theoretical knowledge and the practicality in applying them is what you gain with experience. A cushion for deviations from ideality is what we call as “standard engineering practice”. Both theoretical and practical knowledge should complement each other.

Can you describe your duties at WABAG?

I work as a design engineer in our desalination division. When a client comes up with a tender, we design a desalination plant by choosing appropriate treatment steps, developing process flow diagram, P&IDs, mass balance, sizing equipment, estimating chemical and power consumption, cost estimation, sourcing suppliers and negotiating with vendors. Objective is to come up with the most optimized design at the cheapest cost so that our company gets the project as we bid to win the tender.

What major problems did you face as a fresher?

Apart from the college to corporate transition which includes being more diplomatic, formal dressing, understanding hierarchy, no more bunking etc. which everyone faces, the one I faced was different. With a happy college boy look, it was difficult to get your vendors/suppliers to take you seriously especially when it came to vendor negotiations in meetings. I always used to pull a senior along with me just to avoid this awkwardness.

If you have to recruit a technologist for WABAG, what do you expect from the Candidate?

An open mind and willingness to learn. Academically, strong fundamentals in fluid mechanics would help.

Tell us about your future career plans:

Having worked in an operational plant and now as a design engineer, I am looking to expand my knowledge in business development by moving into sales and marketing.

Your Success Mantra: Take the road less travelled.
Nanotechnology and Chemical Engineering - Challenges Ahead

Dr. Gautham B. Jegadeesan, Senior Assistant Professor, Department of Chemical Engineering

Nanotechnology is any technology dealing with phenomena or structures that can occur at the nanometer scale. Nanometer is one-billionth of a meter ($10^{-9}$ meter), approximately 100,000 times smaller than the diameter of human hair, or about half the size of a DNA molecule. The United States Environmental Protection Agency's (US EPA) 2007 White Paper on Nanotechnology\(^1\) states "Nanotechnology is the manipulation of matter for use in particular applications through certain chemical and/or physical processes to create materials with specific properties". It goes on to define nanotechnology as "the understanding and control of matter at dimensions of roughly 1 to 100 nanometers". Nanotechnology has pushed the frontiers of human capacity for scientific research, created new technological innovations, and laid a pathway which has great promise for improving our standard of living.

Materials in nanoscale (nanoparticles, nanostructures materials, and engineered atoms) show intermediate behavior between a macroscopic solid and an atomic (or molecular) system. In addition to their smaller particle size, nanomaterials possess unique characteristics such as large surface to volume ratio, higher chemical reactivity, better optical, magnetic properties and biocompatible surface properties, compared to their bulk-sized counterparts. Because of such unique size-dependent properties, nanomaterials have been found useful in a wide range of applications. Nanotechnology, itself an interdisciplinary field, with roots in chemistry and material sciences, has found applications in other disciplines including physics, mechanical engineering, bioengineering, chemical engineering, medicine, and environmental engineering. For example, their enhanced optical and magnetic properties make them attractive for various biological and medical applications such as cell labeling, drug delivery, DNA structure probing, bio-molecular detection and analysis, and magnetic resonance imaging. In recent years, Nanobiotechnology and Medical Nanotechnology has made giant strides in the field of tissue engineering (e.g., skin grafts for wound healing etc.), low cost smart drug delivery systems\(^2\). Nanowires and quantum dots for semiconductor applications, carbon nanotubes and fullerenes in electronics and drug delivery applications, and nano fluids in fuel cells, heat transfer and pharmaceutical processes are some of the other applications of nanomaterials. In recent years, engineered nanomaterials such as zerovalent iron, TiO\(_2\) among others, are utilized in the field of environmental remediation of air, soil and water. Nanomaterials are also used in our everyday products such as sunscreens (contains TiO\(_2\) or ZnO nanoparticles), and washing machines (nano Ag as anti-microbial agent).

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\(^2\) Cutting-edge research in the field of medicinal nanotechnology is being done here at our University, at the Center of Nanotechnology and Advanced Biomaterials.
Nanotechnology Market Growth

Over two decades of research activities on nanomaterials has resulted in giant scientific advances in their applications, and introduction of a number of nanotechnology-based products into the marketplace. The Woodrow Wilson Center reports that approximately 1.600 products containing nanomaterials are currently available commercially. According to Aitken et al's.³ Review on nanomaterial manufacturing trends, US and the UK account for 79% of the global manufacturing market, with Asia contributing 21% of the global demand. A 2007 study by the Freedonia Group⁴ estimated, albeit conservatively, that demand for nanomaterials globally will increase almost 20 % each year, and by 2025, will approximately be $ 34 billion, with the fastest gains in India and China. Other studies estimate that, nanotechnology enabled product sales will reach anywhere between $ 30 billion to $3.1 trillion by 2020. Given such high demands and production of nanomaterials, the Assocham TechSci Research group⁴ estimates that from 2015 onwards, the global nanotechnology would require about 2 million professionals, with almost 25% of the work force coming from India. Considering that the birth and commercialization of modern engineered nanomaterials was largely due to the efforts of a small group of enthusiastic academic researchers and scientists, and a few venture capitalists, the astronomical growth in the nanotechnology market is phenomenal, and is not expected to subside, as several global industries, both old and new are entering the nanomaterials market.

Challenges Ahead

Despite such encouraging signs, several challenges to the development of nanotechnology lie ahead, particularly in the areas of (1) environmental risk assessment and; (2) bulk manufacturing. This has resulted in a rather slow translation of nanotechnology from the laboratory to the commercial marketplace.

Uncertainties in health and environmental effects associated with exposure to engineered nanomaterials raise questions about potential risks from such exposures. Assessing the risks of nanomaterials requires better understanding and insight of their mobility, bioavailability, and toxicity beyond their physicochemical properties. Many recent research studies have shown that nanomaterials can readily penetrate various types of cells and thus their presence in the cells affects the human metabolic systems. But, sometimes the particles alone might not cause the trouble. Their toxicity might be synergistic when they carry harmful metals or other toxic chemicals. Numerous studies have shown that biological interactions between nanomaterials and cellular targets depend on the size, surface area, and surface chemistry and reactivity of nanomaterials. For example, difference in the extent of pulmonary inflammation and cytotoxicity among nanoparticles are associated with their surface free radical activity. Several toxicological studies have gleaned useful information on the specific disease mechanisms, doseresponse, and particle characteristics that influence toxicity, including size, shape, surface area, chemistry, reactivity, and solubility. For example, insoluble nanomaterials like TiO₂ stuck in the lungs can cause oxidative stress from surface free radicals as well as trigger too many defensive cells into the lungs, leading to

⁴ Source: www.assocham.org/prels/shownews.php?id=4538
inflammation and fibrosis. However, it should be noted that critical effects to human health or ecosystems are dependent on the concentration and amount of the nanomaterials used.

Currently, nanomaterial exposure and health effects do not present any substantial risks to human health or ecosystems, given their limited use in commercial products and their exposure pathways. However, with increasing demand for nanomaterials, there is a greater potential for release from point and non-point sources and thereby, a greater potential for exposure. Despite several advances in nanomaterial risk sciences, regulatory guidelines on production and use is still in its infancy and needs to be developed before the full potential of nanomaterial capabilities is unleashed in the marketplace.

The other key issue with the development of nanomaterials is its scalability from a laboratory scale to commercial manufacture. Generally, nanomaterials are prepared in the laboratory using wet chemistry (sol-gel synthesis), self-assembly, chemical vapor deposition or molecular condensation (a bottom-up approach), while nanomaterials are prepared in the industry via mechanical milling, precision engineering or lithography (top-down approach). Often, during the industrial manufacture of nanomaterials, functional properties of the nanomaterials, often observed in the laboratory, are lost. In addition, bulk production of nanomaterials can also result in agglomeration of the nanomaterial, thereby their size-dependent properties are reduced. A long term challenge for manufacturing nanomaterials is to create flexible, bottom-up or topdown continuous assembly units that can be used for the true industrial scale production of such materials, while maintaining their functionality, size and also reducing costs and energy use.

How Chemical Engineering helps in Nanotechnology Development

Chemical engineering, often referred as process engineering, is that branch of engineering that applies physical, chemical and life science, mathematics and economics for the production of chemical, materials and energy. Chemical engineering emerged from applied chemistry, and by applying principles of heat, mass, momentum transfer, chemical reactions and separation processes, developed an organized approach to the design of a chemical process systems (unit operations) for manufacturing chemical products. At its root, chemical engineering translates innovations from the research laboratory to the industrial manufacturing plant.

The same principles guiding the manufacture of phenol or cumene can also help developing process systems for the manufacture of nanomaterials. For example, knowledge of transport phenomena assists in the development of nanomaterial drug delivery systems, or determine transport of nanomaterials in the environment. Chemical kinetics and thermodynamics can be used to develop complex functional nanomaterials. Separation process can be used effectively to reduce nanomaterial exposure pathways, and thereby reduce risks to human health and ecosystems. The key to designing complex, yet cost-effective processes for the true industrial manufacture of nanomaterials is: (1) to better understand changes in chemical properties (e.g., fluid flow, reactivity) of these small-sized particles; (2) knowledge of molecular engineering and molecular dynamic simulations; and (3) a better understanding of chemical unit operations and process control. Therefore, it is incumbent upon chemical engineers to develop and harness their knowledge in the field, and synthesize/manufacture nanomaterials of scientific and practical interest, using energy-efficient, cost-effective and environmentally-benign processes.
Chapter 1: DANCING CAT FEVER

Mr. Howard travels to a rural village called Minamata in Japan where he encounters a group of infected local populace. Their vision is partially impaired and some are even paralyzed. Mr. Howard discovers that the cause of the disease was due to consumption of contaminated fish. Join Mr. Howard to save Minamata by searching across and down in 'Board I'.
1. Isolate all the toxic compounds
2. Identify suitable antidotes
3. Refrain from certain things to give pure drinking water to victims
4. Manufacture a useful chemical warfare agent to do the same
5. Prepare health foods for everyone
6. Construct homes for everyone

Chapter 2: FALL OF CHISSO CORPORATION

This story is a sequel of Dancing Cat Fever. Mr. Howard saves the infected people. Later a lawsuit was filed against Chisso Corporation. The court orders them to make a huge compensation for each surviving patient. However the Chisso's corporate men have planned to take revenge against Mr. Howard. Help Mr. Howard to escape from all death traps.
7. Purchase blankets and warm clothes
8. Design ammunition
9. Strong tools may come in handy
10. Sometimes bleeding has to be stopped artificially
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(Answers at last)
India’s energy crisis threatens its economic growth. With India consuming high levels of energy, serious measures should be taken to avoid severe energy supply crunch. The energy crisis, global warming and a need for renewable energy sources have given rise to a massive interest in the research community. Alternate source for the non-renewable energy is becoming the basic need. The world’s energy crisis is going to hit us hard. It’s time we act.

In India, the energy generated from the waste is very less when compared to energy from wind, solar and hydro. The Municipal solid waste generated per year is almost 55 million tonnes. Now, we are living in a world of plastics and polymers, from the dress we wear to the mobile phones we use. They find wide range of applications in almost every field. We consume around 6.2 million tonnes of polymers per year, and there are tremendous wastes generated too. Recycling and biodegradation of plastics have always been a part of research community. Due to economic problems, it is a small scale process in India.

Commodity plastics are the plastics that are used in high volume and wide range of applications. These are three main commodity polymers- polyethylene, polypropylene, and polyvinyl chloride. Even though plastics have broad range of applications in our day to day life, they are always being looked upon for causing pollution. As a coin has two sides the usage of any scientific invention has its duality.

According to me, the waste from plastics can be used in energy generation, which only can’t bring about the change in India’s renewable sources. Polymers can offer new opportunities for the generation, storage and saving of energy. They are the promising materials for these applications due to their intrinsic advantages i.e. cost effective production, good qualities, easy processing, light weight, a wide range of properties can be varied by compounding them. Now-adays technologies use waste polymers to produce viable fuels at low cost by incineration and chemical degradation. We can bring about a change in the generation of power from polymers.

Chemical engineers being very well versed in chemistry, physics, mathematics, and engineering, they are suited to meet the challenges of all types of energy production and have contributed long to the discovery and commercial-scale exploitation of traditional sources of energy. The vast scientific and technical knowledge required in Chemical Engineering is greater than any other branch. A chemical engineer needs to have good hold of not only his own subjects but others too.

This is what makes a chemical engineer a "Universal Engineer".
SAFETY AS A CAREER

Akash L., III year Chemical Engineering

Every time summer vacation would be the most exciting vacation for all of us but this time it was a bit serious for me because I had got an internship at DNVGL (Det Norske Veritas Germanischer Llyod). It is a safety and risk management company and it provides assurance, inspection consulting, project management and execution. It focuses on technical services and solutions along the entire life cycle of oil and gas (upstream, midstream, downstream) and energy installations onshore and offshore. The scope of technical services includes safety, integrity, reliability and performance management.

It was a quite different environment for me where people used to work for real projects and that was totally of corporate environment, where everything was formal and professional. My purpose there was to learn a safety study (Hazard Operability), which is essential to conduct on every chemical plant. A safety engineer should know each and every detail of the chemical plant. The primary goal of a safety engineer is to identify the possible hazards, analyse them for their cause, consequence of the hazard, estimate the risk due to that hazard and reduce the risk to the acceptable level. Risk is the combination of probability of failure event and severity resulting from the failure. Mostly the failure case of the assumed scenario will reveal all possible hazards. A safety engineer reduces the likelihood, frequency and severities of a possible hazard or risk, which eventually reduces the risk to an acceptable level and look for the asset integrity of the company which is doing the projects. Therefore the work of a safety engineer starts from early design of the system.

We had to look for all possible hazards in a running plant but actually the feed of this safety inputs are incorporated for the primary design of the projects and it is designed, constructed and commissioned as per the safety norms. This type of detailed engineering will be done by the HSE team of that particular company; they will get the inputs from the third party consultant and will be directing the plant accordingly. The scope of chemical engineers is not restricted to process engineering and its operations. We can even choose our career into safety and risk management.

Interesting Facts

Madhu Preetha M., III year Chemical Engineering

- Crystals that light up when you crush them!!-There is a chemical called europium tetrakis, demonstrating the effect of triboluminescence
- There are more atoms in a single glass of water than water in the oceans of Earth
- A rubber tyre is actually one single giant molecule.
- Oxygen was the atomic weight standard for the other elements until 1961 when it was replaced by carbon 12
NANOTECHNOLOGY- An Emerging Future Trend in Water Management

Raghavi Krishnan, II year Chemical Engineering

According to the WHO, there are about one billion people in the world who have no access to potable water, majorly in the developing countries, and a further of 2.6 billion people lacking access to proper sanitation. The world is facing formidable challenges in meeting the rising demands of potable water as the available supplies of freshwater are decreasing due to extended droughts, overpopulation, more stringent health based regulations and so on. Moreover increasing pollution of groundwater and surface water from a wide variety of industrial, municipal and agricultural sources has seriously reduced the water quality levels in these sources, effectively reducing the supply of freshwater for human use.

Given the importance of potable water to people in both developed and developing countries, and taking into account concerns regarding the viability of current practices of meeting the increasing demand of all water users, there is a clear need for the development of innovative technologies and materials whereby challenges associated with the provision of safe potable water can be addressed. Research in wastewater treatment by adsorption has resulted in the development of different materials like Activated Carbon, Zeolites and Aluminosilicates that can effectively remove metals from solution. But, Carbon Nanotubes (CNT) and Carbon Nanofibres can be effectively used in place of these. CNTs work better because of their high aspect ratio and larger surface area.

Nanofiltration (NF) is a rapidly advancing membrane separation technique due its unique charge-based repulsion property and high rate of permeation. Due to the lower operating pressure and higher flow rates, NF is inexpensive when compared to reverse osmosis. Nanocatalysts have the advantage of high specific surface areas and low mass transfer restrictions. These give a chance to reuse the catalysts several times in the water purifiers. The exceptional properties of Nanofibres are large specific surface, high porosity and small pore size. These are then used as Nanofilter. Biofouling of membranes caused by bacterial load in water reduces the quality of drinking water. Nanobiocides are such metal nanoparticles and engineered nanomaterials that can be incorporated into the nanofibres and can show high antimicrobial activity and stability in water. Contaminants could be easily removed at low concentrations due to the increased specificity of nanotechnology and the development of ’smart filters’ tailored for specific uses. Nanomaterials will become essential components of industrial and public waste water treatment systems as more progress is made in nanotechnology in terms of economically efficient and eco-friendly technology development.
“So, I will learn my oxides, methane, hydrocarbons, too. Then maybe I can help the earth—it’s really overdue!” said Ann Hart, President of Temple University, Philadelphia. It was known to be in 1745 that the “rock oil” extraction and refining was initiated under the vision of Empress Elisabeth of Russia. Henceforth, petroleum has been and continues to be our main source of energy and also parents numerous highly useful compounds derived from it.

“There’s no bigger torrent than man’s greed” said Gautama Buddha. With the ever-increasing population on the Earth and the necessity of meeting the demand for basic supplies has eventually tweaked the availability of oil reserves. This would soon lead to the complete exhaustion of the fuel, if continued, which indeed poses a challenge to mankind and the need of the hour is to immediately find its substitute which is more reliable and unpolluting.

Being the country with a bubbling population of 1.2 billion, the mounting energy aspiration of India is quite high to its energy production rate. All the stakeholders in India’s energy industry, few of them global, are striving to ensure energy availability to all, at an affordable price, within the framework of mutually inclusive growth. The dynamics and complexity of Indian economic policies have made sure that this challenge is not easily met. By 2030, the total energy requirement for the country would increase to 400,000 million watts which perhaps could be realised by exploiting renewable energy sources.

India being a tropical country, solar power is considered the best suited renewable energy source for the country. The abundance of sunlight proves it fit to be seemingly effortless to convert it into power through photovoltaic cells and solar thermal cells. The government of India projects a massive expansion in installed solar capacity, and aims to reduce the price of electricity generated from solar energy, to match that from fossil fuels like coal and diesel by 2030. Gujarat state has already set up solar panels to generate nearly 690 MW of electricity and the power is being fed to the electric grid.

If more and more solar power grids are established and the subsidies promised in the economic policies to solar energy utilization are duly rendered, then the nation could at last hope for a renewable, economical, clean, efficient and self-sustaining fuel to meet the growing crisis. A nation that cannot control its energy crisis cannot sustain an independent future. So, can India do it? Yes. It can.
ANSWERS:

1. **DDT, METHYL MERCURY, LEAD**
   
   *Because DDT being an agricultural insecticide, Hg(II) salts being greatly soluble in water and paints containing lead oxide.*

2. **EDTA**
   
   *Because EDTA being a chelating agent can bind with heavy metals. Later they can be removed from body.*

3. **CALCIUM, MAGNESIUM, CARBONATE, BICARBONATE, CHLORIDE, SULPHATE**
   
   *Because to soften the hard water.*

4. **CHLORINE**
   
   *Because chlorine is used as common disinfectant.*

5. **GLUCOSE, PROTEINS**
   
   *Because glucose is an energy source and proteins are polymers of amino acids.*

6. **CALCIUM OXIDE, SILICA, ALUMINA, HAEMATITE, WATER**
   
   *Because they are major components of cement.*

7. **PROTEINS**
   
   *Because silk is a keratin.*

8. **SULFUR, CARBON, KNO3**
   
   *Because they are found in gun powder.*

9. **IRON, CARBON**
   
   *Because steel is an alloy of iron and carbon.*

10. **POTASH ALUM**
    
    *Because potash alum is a blood coagulant.*
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