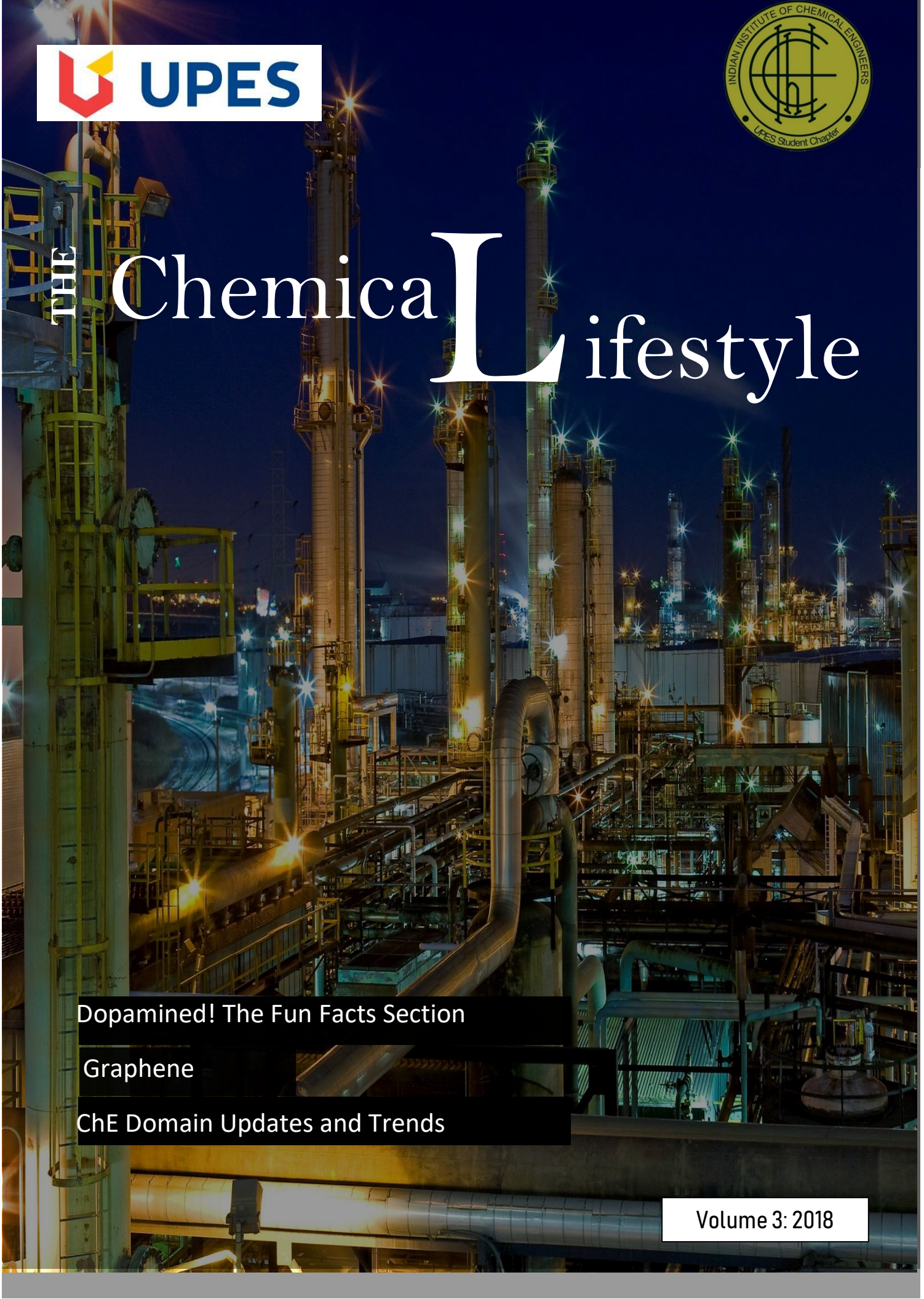

THE Chemical Lifestyle

Dopamined! The Fun Facts Section

Graphene

ChE Domain Updates and Trends

Volume 3: 2018

ABOUT IIChE

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

Over the years the Institute has developed a distinct profile of its own. Even as the IIChE is always moulding itself and playing a proactive role to keep up with the ever-changing needs of the society and the economy, the basic objectives remain largely unchanged since its inception.

~

ABOUT IIChE UPES SC

IIChE UPES Student Chapter was established in 2012 with an aim of bridging the unsaid between the academicians and industry professionals. The chapter has continued to achieve a lot throughout its journeys since inception and has gained a remarkable reputation and respect through its exemplary actions.

The IIChE UPES Student Chapter is a student run body, advised by Dr. Adarsh Kumar Arya and Mr. Amit Kumar Thakur. The IIChE UPES Student Chapter is a student run body, headed by Dr. Adarsh Arya and Mr. Amit Kr. Thakur, the Faculty Advisors who work to ensure that all the hopefuls of the Chemical Engineering domain stay well acquainted with the ever changing dynamics of the Chemical Engineering world and to give them an added advantage in the professional sphere, after they finish their education in the University.

Dear Readers,

Welcome to yet another edition of The Chemical Lifestyle. We are starting afresh this year galvanized with your constant support and encouragement. The Chemical Lifestyle is all set to take a leap with better than ever advanced technologies flourishing in. There has been a paradigm shift in the academic guild, with focus shifting to newer subjects like catalysis, reaction engineering, transport process, nano-technology etc. You will find numerous such worldly affairs that took place in ChE domain in the news segment.

IIChE's role has been pivotal in providing the Chemical Engineering fraternity with a platform for critical interaction and networking. The Student Chapter of IIChE at UPES has done tremendous job over the years in shouldering this responsibility. Through this magazine, we want to do our bit in restructuring the conventional roles as a camaraderie and venturing into newfangled horizon. We have always strived to open up a portal to a world of opportunities and ideas for our young readers.

We hope that The Chemical Lifestyle follows up to your expectations once again, and shall be a resourceful companion in your quest of knowledge.

Signing off with some food for the thought for budding Chemical Engineers" Keep dreaming and be persistent".

Prateek Srivastava

Head-Editorial Committee (2017-2018)

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Maverick Pixels- For the Independence Day IIChE UPES SC organised an event: "Maverick Pixels". It was a non-technical fun event conducted online between 6th August and 14th August. For the event, participants have to send images depicting their perception of independence with a suitable caption of not more than 50 words. The event was a massive success as huge number of participants turned up to the IIChE page for submission of their photos.

Intern Talk - To give an insight into the real case scenarios and to expose the budding professionals to the way this world works, IIChE UPES Student Chapter organized 'Intern-Talk' on 13th September 2017. Intern-Talk was one of the remarkable interactive session of IIChE UPES Student Chapter that is conducted every year to enlighten the minds and to tune themselves to face the battle out there. This year, too, Intern Talk was conducted with some of the distinguished personalities of our university. The speakers were Aditya Raj, Deepak Gocher, Kartikey Sharma and Siddharth Kwatra. They gave an insight into both technical as well as academic internships. Their valuable advice was highly valued and as always, it came out with a much-expected success.

Chemostrophe: (15th Nov.- 17th Nov. 2017)- This had three events under its banner which are as follows: -

Element-O-Chem- In round one, the participants had to fill the missing elements in

the periodic table. Whereas in round two, people had to find the elements on the basis of the hints given. It was an intriguing contest as the students whacked their brains to hunt the elements.

Periodic Wars- Starting from an individual participation, the event went on for a single round. The participants had to pick an element from the four blocks and debate over it. The element was supposed to be pre-booked. The participants had to have a thorough knowledge of the chemical and physical properties of elements and deliver at least 8-10 points in support of their element within 3 minutes.

Donation Drive (23rd- 25th November) - Keeping the idea of goodwill in mind, IIChE UPES Student Chapter made an effort to make a difference in the lives of the needy! A donation drive was organised from 22nd to 24th November. There were many people who contributed to this noble cause and a lot of different items ranging from shoes to clothes were collected. The items collected were distributed in the slums of Nanda-ki-Chowki. Truly, the smiles on the faces of the children and people were worth every effort.

M.E.L.A. (22 January – 29 January) – This had four events under its banner and they were conducted covering the different genres like Music, Entertainment, Literature and Art, justifying the fest's name. They are:

Murder Mystery: Murder Mystery, first event conducted under the banner of M. E. L. A 2018, saw a massive number of participations in the Old Amphitheatre. The participants were extremely thrilled by the captivating plot of the mystery given to them to solve.

Placement Talk: Keeping the placement fever in mind, IIChE UPES Student Chapter organised "Placement Talk". It was an interactive session with the already placed seniors where students put up all their queries regarding placements and

further learn from the examples of their seniors.

Music Maestro: "Music Maestro" by IIChE UPES student chapter was organized under the umbrella of MELA on 24th of January '18 at Vivekananda auditorium. The event proved to be a grand success involving huge enthusiasm from the participants. In the three-round event including the rapid-fire round. The participants held their breath prior to the final judgment as the event ended up with a tiebreaker.

Tellyfiesta: Telly Fiesta won the hearts of all who were there in the Vivekananda Auditorium! The excited faces of the participants said everything! From guessing the voice of Heisenberg of Breaking Bad to recognising Harvey's talk with Steven Huntley, we witnessed it all!

Tattoo Bash: Tattoo bash proved to be a big hit! The event affirmed that of all the qualities an engineer possesses there is an artist inside each of them. Some used a sheet while some exhibited thoughts on their hand and the black and white procreations sang beautifully in synchronisation with their imaginations.

Instorica: To publicise the initiation of IIChE's Instagram page, we organised Instorica. The participant had to use any of the three different Instagram features like Boomerang, Superzoom and Rewind to make the most creative clip along with the most creative caption.

Edupedia: Edupedia was based on the "Board Examination" theme, following the "Traditions" of school examination. It was a single round event in which a short test of 30 minutes (and reading time of 10 minutes was provided) was conducted on board exam pattern covering general knowledge, vocabulary and aptitude.

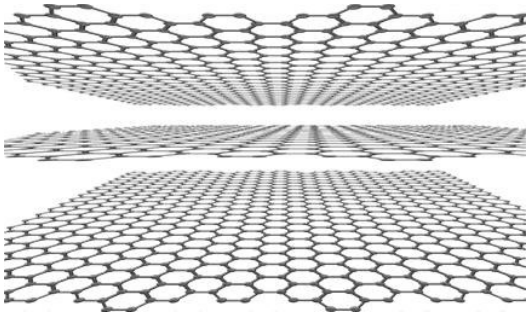
Graphene

Carbon has only three naturally occurring crystalline structure; Graphite, Diamond and Fullerene. A single layer of graphite is called as graphene. Graphene consists of a single layer of carbon atoms arranged in a hexagonal lattice in which each carbon atom is bonded to only three other atoms with a hybridization of sp2. The length of carbon-carbon bond is about 0.142nm. The carbon atoms each have one unpaired electron which will move if we apply an electric current, enabling graphene to readily conduct electricity. Graphene was isolated and characterized in 2004 by Andre Geim and Konstantin Novoselov of University of Manchester for which they were awarded the Nobel Prize in physics in 2010.

It is the first 2-D crystal and the thinnest compound known to man (with only one atom thin), strongest compound ever (100-300 times stronger than steel) and is still lightweight. It is the best conductor of heat and electricity, is bendable and can take any form you want. It can self-repair gaps in its sheets, when exposed to molecules containing carbon, such as hydrocarbons. Bombarded with pure carbon atoms, the atoms perfectly align into hexagons, completely filling the holes. Graphene, when one atom thick is hundred times more chemically reactive than thicker sheets. Graphene is chemically the most reactive form of carbon. It is the only form of carbon in which every atom is available for chemical reaction from two sides.

Graphene finds its use in a lot of fields like energy, membranes, electronics, sensors, etc. It is used to purify water by utilizing a graphene-based membrane. It can also be used in semi-transparent mobile phones. It is a transparent and flexible conductor that holds promise for various material/device applications, including solar cells, light-emitting diodes (LED), touch panels and smart windows or phones.

The rolled over sheet of graphene is carbon nano tube. Carbon nanotubes find extensive applications in a lot of areas like nanotechnology, electronics, optics, material science, etc. These nanotubes work around the primary limiting factor in microchip processing speed by taking chip architecture into the third dimension. Graphene, carbon nanotubes can effectively stack transistors on top of one another on microchips, allowing for exponentially more transistors on a chip without increasing the size. More transistors mean more operations per second, which means more processing power and quicker processing speeds.



In 2013, a three-dimensional honeycomb structure of graphene was termed as 3D graphene. Graphene supercapacitors serve as energy storage alternative to traditional electrolytic batteries. Amongst its advantages are fast charging, long life span and environmentally friendly production.

Graphene film is a strong candidate for the replacement of indium tin oxide, which is a commercial product used as a transparent conductor. It is used in touch screens and as an electrode in solar cells.

SUBMITTED BY
Harshit Yadav

Dopamined! – Fun Facts to keep your senses triggered!

1. Every 500m you drive will melt 15kg of glacier ice over the next century, a new study reveals.

Curious to jump in the car and drive around the corner to buy some milk? You've just caused 1kg of glacier ice to melt. That's the disturbing finding of a new climate study. IT'S too late. That's the finding of a new study into the rate of glacier ice loss. The iconic Himalayas and the Rockies are going to be devastated. Nothing can be done to stop glaciers from melting over the next 100 years.

Source: Infogiltz.com

2. Your car's airbags are packed with salt sodium azide, which is very toxic.

Sodium azide (NaN3) is a highly volatile and highly poisonous compound which is used to inflate airbags when a collision causes the sodium azide to violently explode and inflate the airbags. However, even in minute amounts, it can kill everything from bacteria and fungi to animals and humans. The presence of the deadly compound represents a serious threat to vehicle occupants, rescuers and others who might come into contact with it as well as an increasing threat to the environment.

Source: Naturalnews.com

3. 'Infinitely' recyclable polymer shows practical properties of plastics

Colorado State University researchers have developed a plastic-like polymer, which can be "chemically recycled and reused, in principle, infinitely." The polymer can be recycled back to its original monomer units at high temperatures or via a catalyst at low temperatures. Currently developed on a lab scale, researchers are working on its large-scale development to replace plastic materials.

Source: Inshorts.com

4. What led to the world's worst nuclear disaster?

On April 26, 1986, one of the four reactors at Ukraine's Chernobyl nuclear power plant exploded causing the world's worst nuclear accident. While experimenting to run the reactor at low power, engineers disconnected its emergency systems, which made the reaction unstable. The reactor's control rods were withdrawn to power it again but later reinserted, which triggered an explosive chain reaction. Thirty-two people died and dozens more suffered radiation burns in the opening days of the crisis, but only after Swedish authorities reported the fallout did Soviet authorities reluctantly admit that an accident had occurred. The Chernobyl station was situated at the settlement of Pripyat, about 65 miles north of Kiev in Ukraine. Built in the late 1970s on the banks of the Pripyat River, Chernobyl had four reactors, each capable of producing 1,000 megawatts of electric power.

Source: History.com

5. Japanese island in the Pacific Ocean has 16,000 million kg rare-earth elements.

Japanese researchers scoured the deep-sea mud of the western Pacific Ocean, and found minerals worth feeding the global demand for tech on a "semi-infinite basis". The deposits were found within Japan's exclusive economic waters, and contained more than 16,000 million kg of the rare-earth elements needed to build hi-tech products from smartphones and radar devices to missile systems and electric vehicles, said the study. Yttrium was one of the metals included in the recent discovery, and the metal can be used to make camera lenses, superconductors, and mobile phone screens. The research team comprised of several universities, businesses and government institutions including the University of Tokyo and the Japan Agency for Marine Science and Technology. The team surveyed the western Pacific Ocean near Minami-Torishima Island, Japan.

Source: Indiatoday.in

6. Facts about Thorium, the nuclear fuel.

In its liquid state, thorium has a greater temperature range than any other element, with nearly 5,500 degrees Fahrenheit (3,000 degrees Celsius) between melting and boiling points. Thorium dioxide has the highest melting point of all known oxides. Thorium is about as abundant as lead and at least three times as abundant as uranium. The abundance of thorium in Earth's crust is 6 parts per million by weight, according to Chemicool. According to Periodic Table, thorium is the 41st most abundant element in Earth's crust. Thorium is mainly mined in Australia, Canada, the United States, Russia and, India, according to Minerals Education Coalition. The most stable

isotope of thorium, Th-232, has a half-life of 14 billion years, according to the EPA. According to Los Alamos, thorium is created in the cores of supernovae and then scattered across the galaxy during the explosions.

Source: Livescience.com

7. Lightning strikes produce Ozone, hence the characteristic smell after lightning storms.

Ozone, the triple oxygen molecule that acts like a protective stratospheric blanket against ultraviolet rays, is created in nature by lightning. When it strikes, the lightning cracks oxygen molecules in the atmosphere into radicals which reform into ozone. The smell of ozone is very sharp, often described as similar to that of chlorine. This is why you get that “clean” smell sensation after a thunderstorm.

Source: ZMEscience.com

8. Meet the Rarest Natural Element on Earth, Astatine.

It's so rare, there's just 30 grams total in Earth's crust. Named after the Greek word for unstable (astatos), Astatine is a naturally occurring semi-metal that results from the decay of uranium and thorium. In its most stable form - astatine-210 - it's got a half-life of just 8.1 hours, which means even if you did happen to stumble on some of it, half of it would be gone by the end of a workday. Depending on how it decays, it'll either turn into the isotope of bismuth-206 or polonium-210.

Chemical Engineering Trends and Updates

News – 1:

Ultrafine Fibbers Have Exceptional Strength

Researchers at MIT have developed a process that can produce ultrafine fibres — whose diameter is measured in nanometres, or billionths of a meter — that are exceptionally strong and tough. These fibres, which should be inexpensive and easy to produce, could be choice materials for many applications, such as protective armour and nanocomposites.

The new process, called gel electrospinning, is described in a paper by MIT professor of chemical engineering Gregory Rutledge and postdoc Jay Park. The paper appears online and will be published in the February edition of the Journal of Materials Science.

In materials science, Rutledge explains, "there are a lot of trade-offs." Typically, researchers can enhance one characteristic of a material but will see a decline in a different characteristic. "Strength and toughness are a pair like that: Usually when you get high strength, you lose something in the toughness," he says. "The material becomes more brittle and therefore doesn't have the mechanism for absorbing energy, and it tends to break." But in the fibres made by the new process, many of those trade-offs are eliminated.

"It's a big deal when you get a material that has very high strength and high toughness," Rutledge says. That's the case with this process, which uses a variation of a traditional method called gel spinning but adds electrical forces. The results are ultrafine fibres of polyethylene that match or exceed the properties of some of the strongest fibre materials, such as Kevlar and Dyneema, which are used for applications including bullet-stopping body armour.

News – 2:

Newly Isolated Nutmeg Compound Out-Cools Menthol

Rinsing with menthol-flavoured mouthwash causes a tingly, cooling sensation because the compound triggers a cold-sensitive ion channel in sensory neurons. Now scientists have found a compound that is even more chilling. Isolated from nutmeg, the chemical is the most potent activator of the cooling channel yet found in nature.

l-Menthol, which comes from mint, is the king of naturally derived cooling compounds and is added to products such as cough drops and cosmetics. But menthol

has some shortcomings: At low concentrations, its effect can be weak and short-lived, and bumping up its concentrations too high can cause irritation.

To find other cooling agents from natural sources, Tomohiro Shirai and colleagues at Kao Corp. screened extracts of various botanicals and spices for the ability to activate the cold-sensitive ion channel, called transient receptor potential melastatin 8 (TRPM8). After many years of searching, the researchers eventually isolated a compound in nutmeg that binds to and activates TRPM8.

The compound—part of a class of plant molecules known as neolignans—is about 30 times as potent as l-menthol and almost as potent as icilin, a synthetic cooling agent. The nutmeg compound binds TRPM8 at a different site than menthol does, meaning it could complement menthol's effects if the two were combined in a product.

News – 3:

Silkworms Spin Super-Silk after Eating Carbon Nanotubes and Graphene

Silk—the stuff of lustrous, glamorous clothing—is very strong. Researchers now report a clever way to make the gossamer threads even stronger and tougher: by feeding silkworms graphene or single-walled carbon nanotubes (Nano Lett. 2016, DOI: 10.1021/acs.nanolett.6b03597). The reinforced silk produced by the silkworms could be used in applications such as durable protective fabrics, biodegradable medical implants, and eco-friendly wearable electronics, they say.

Researchers have previously added dyes, antimicrobial agents, conductive polymers, and nanoparticles to silk—either by treating spun silk with the additives or, in some cases, by directly feeding the additives to silkworms. Silkworms, the larvae of mulberry-eating silk moths, spin their threads from a solution of silk protein produced in their salivary glands.

To make carbon-reinforced silk, Yingying Zhang and her colleagues at Tsinghua University fed the worms mulberry leaves sprayed with aqueous solutions containing 0.2% by weight of either carbon nanotubes or graphene and then collected the silk after the worms spun their cocoons, as is done in standard silk production. Treating already spun silk would require dissolving the nanomaterials in toxic chemical solvents and applying those to the silk, so the feeding method is simpler and more environmentally friendly.

In contrast to regular silk, the carbon-enhanced silks are twice as tough and can withstand at least 50% higher stress before breaking. The team heated the silk fibres at 1,050 °C to carbonize the silk protein and then studied their conductivity and structure. The modified silks conduct electricity, unlike regular silk. Raman spectroscopy and electron microscopy imaging showed that the carbon-enhanced silk fibres had a more ordered crystal structure due to the incorporated nanomaterials.

News – 4:

New Lithium Ion Battery Will Not Burst into Flames

When coated onto a lithium-ion battery electrode, a new composite material protects the battery from bursting into flames if it is overcharged or develops an electrical short. The material, which may lead to safer designs of Li-ion and other types of batteries, was reported by Stanford University researchers in the inaugural issue of Nature Energy.

Li-ion batteries, which power devices including smartphones, electric cars, and hoverboards, rarely catch fire. Industry experts put the figure at less than 1 fire per 10 million battery cells, not counting battery abuse tests. Yet the batteries are used so widely and pack so much energy that researchers still strive to prevent these unlikely failures by coming up with ever more reliable safety features.

Some of the features in use or under development are based on thin films of protective materials within the battery that undergo changes in response to rising temperatures. The changes in the material's structure or other properties block the flow of current, thereby allowing the battery to cool safely. Others strategies call for modifying electrolyte solutions inside the battery with chemical additives that inhibit combustion reactions.

But these films and additives tend to cause irreversible changes—once they've been activated, the battery cannot be reused. Or the materials aren't effective enough because they respond too slowly to temperature variations or work only in a narrow voltage range.

News – 5:

Plastic Contaminates Table Salt in China

Diners in China who season their meals with sea salt may be unwittingly consuming microscopic pieces of plastic pollution.

When researchers analysed fifteen brands of common table salt bought at supermarkets across China, they found among the grains of seasoning micro-sized particles of the common water bottle plastic polyethylene terephthalate, as well as polyethylene, cellophane, and a wide variety of other plastics.

The highest level of plastic contamination was found in salt sourced from the ocean: The researchers measured more than 250 particles of plastic per lb of sea salt. The team, led by Huahong Shi of East China Normal University also found tiny particles of plastic in salt sourced from briny lakes, briny wells, and salt mines, although at lower levels—between 3 and 165 particles/ lb.

Shi and colleagues argue that plastic contamination originates from the vast amount

of plastic pollution floating around marine environments where sea salt is sourced. For instance, bits of plastics might abrade from larger objects, such as water bottles, dumped in the water or they might come from cosmetic products, such as face washes, that use plastic microbeads as exfoliants. The researchers add that other points of entry for plastic contamination are also possible, including during salt processing, drying, and packaging.

News – 6:

New Safe Homes for Old Unwanted Chemicals

If you have a stomach ache, you can take magnesium oxide to feel better. But if you have a headache because your barge full of MgO got wet at a terminal in Arkansas, better to call Damon Carson, owner of Repurposed Materials, and see if he'll take it off your hands. Carson collects bulk materials that are obsolete, off-spec, out of date, surplus, or once-used. He also collects information about how those products can be used in a different industry.

Each potential purchase puts in motion a bit of detective work. For example, Repurposed Materials recently bought 60 giant sacks of a polymer absorbent that someone abandoned at a freight terminal. Carson resold it to a man who works in hockey facilities. The customer reported that he used the polymer to make a slush that seals the ice surface to the rink's sideboards.

Carson's business experience began with regular trash; years ago, he and a partner started a company to haul garbage from Colorado ski resorts. They sold the firm to Waste Management. This time, he says, his business aims to keep stuff out of the landfill.

"My very first project was reusing old advertising billboards," Carson explains. "They have print and designs on one side, but are made of high-quality, waterproof vinyl. When the ad campaign is over, the vinyl can be used as tarps for hay bales." Now five years old, Repurposed Materials has 12 employees and storage locations in Denver, Atlanta, Dallas, and Chicago.

News – 7:

Caffeine used as a catalyst to make gels for drug delivery

Researchers looking for a safe catalyst to use when creating gels for drug delivery have found that caffeine, when combined with citric acid, can be used to make biocompatible gels. Polymer gels have a wide range of applications from medicinal uses to food science, but up until now it has been difficult to synthesise them without using toxic catalysts that require significant post-processing to make the gels safe for human use. Now, a team at MIT and Brigham and Women's Hospital in Boston has

developed a method to make a gel without using harmful substances – using caffeine and citric acid instead.

"Polyesters allow for the intentional design of ingestible materials made from bioderived resources," said Angela DiCiccio, lead author of the paper. Catalysts previously used in polyester synthesis weren't mild enough to enchain molecules without causing unwanted reactions or requiring high heat. "Our new platform provides an elegant solution to this problem using inexpensive materials and broadly accessible chemistries," said DiCiccio.

Caffeine can act as a mild base which gives it the ability to draw protons from other molecules. When it deprotonates citric acid, the result is a carboxylate that can open up the rings in epoxides. This allows ester bonds to form and creates a biocompatible polyester.

News – 8:

World's largest oxygen production plant inaugurated at Sasol Secunda

Environmental Affairs Minister Edna Molewa on Monday inaugurated French gas company Air Liquide's €200-million air separation unit (ASU) at chemicals and energy group Sasol's Secunda plant, in Mpumalanga. The ASU is the biggest oxygen production unit in the world, with a capacity of 5 000 t/d and brings the total number of ASUs in Sasol's fleet to 17, said joint Sasol CEO Bongani Nqwababa.

The 16 ASUs that Air Liquide built for Sasol prior to the new plant had a capacity of 40 000 t/d of oxygen. The new plant will further increase oxygen for Sasol's fuels and chemicals production processes. The ASU also produces gases such as xenon and krypton, which are used in medical scanners and high-speed photography equipment. Unlike the other ASUs which are operated in-house, Air Liquide will own and operate the new plant, which is considered the most energy-efficient oxygen train on Sasol's site. Air Liquide CEO Benoît Potier said at the launch event, which Engineering News Online attended, that the ASU would provide the French company with a new source of liquid gases to supply the growing industrial gas market in South Africa.

"Our commitment is not only to Sasol, but also the South Africa economy and society. Our first Air Liquide branch was inaugurated in South Africa more than 60 years ago and we have since demonstrated commitment in developing industrial infrastructures," said Potier, adding that Air Liquide employed 800 people in South Africa in the industrial and health sectors.

News – 9:

New, Extremely Valuable Helium Deposit Discovered in Africa

Using a new technique, scientists have discovered reserves of helium in Tanzania said to be equivalent to seven times the amount of the noble gas consumed worldwide each year. The new source could alleviate recurrent shortages of helium that have plagued users of scientific instruments and medical imaging equipment. Working with the start-up firm Helium One, scientists at Oxford and Durham universities uncovered the reserves in Tanzania's East African Rift Valley. The researchers theorize that intense heat from volcanic activity in the Rift Valley releases helium in ancient crustal rock. The gas then accumulated in underground reservoirs. The scientist say they have combined methods used in oil exploration with seismic images of gas-trapping structures and calculations from independent experts to estimate helium reserves of 1.5 billion m3 in just one part of the Rift Valley.

The scientists presented the findings on June 28 at the Goldschmidt Conference, a gathering of geochemistry experts in Yokohama, Japan. Today, helium is recovered as a by-product of natural gas extraction. But with prices of helium now about four times higher than they were a decade ago, prospectors are looking for new sources. The Tanzania helium reserve would be the first to be discovered and developed intentionally.

Solubility Enhancement of Drugs using Recrystallization by Liquid Antisolvent

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Abstract

Albendazole was being chosen as the drug for the experimentation of the concept of antisolvent crystallization. Albendazole was first dissolved with organic solvents in order to prepare a saturated solution, this saturated solution was then mixed with water which was chosen as an antisolvent leading to particle precipitation. Process variables such as temperature, concentration of solution and solution injection rate were manipulated in order to find the property changes which occur on the precipitate particles. The precipitated crystals were mainly subjected in an ultrasonicator in order to find the effects of ultrasonic waves acting on the particles. The intensity of the ultrasonic waves, the sonication time and the moment when the ultrasonic waves were applied were all regulated during the antisolvent crystallization experiment. The different property changes including variation of size due to factors like solution injection rate, ultrasonication etc. were recorded in order to find the efficiency and applicability of this technique in industrial, pharmaceutical areas.

Introduction

The precipitation technique like the antisolvent crystallization has emerged to be a reliable material induced crystallization technique which exploits the use of antisolvents for the process of precipitation. Antisolvent crystallization has been an important alternative due to the fact that it does not fall into the category of energy induced precipitation techniques which have been conventionally adopted. When termed energy induced, we refer to evaporation crystallization as an energy induced technique due to the fact that it employs heat energy for the precipitation process to occur. Talking about antisolvents, no external heat sources have been adopted for running this process. Due to the absence of heat for the precipitation action, we can employ this technique in areas where fear of thermal degradation of heat sensitive particles prevail. These industries mainly include the pharmaceuticals and food industries. Keeping these ascendancies in mind we can use this technique for biological particle experimentation which include recrystallization followed by particle size reduction processes which are generally the case involved with the drug industry.

Precipitation of a solute is accomplished in antisolvent crystallization through an expansion in the molar volume of arrangement that instigates a reduction in the dis-solvable power toward the solute by expansion of an antisolvent. Indeed, the job of the antisolvent is to lessen the solubility of a solute in the arrangement and to start precipitate development. The significant driving force which instigates the formation of precipitate is due to the emergence of a supersaturated solution when the solution comes in contact with an antisolvent. In this way, the antisolvent must demonstrate a high miscibility with the arrangement and furthermore should display about zero solubility toward the solute.

The antisolvent technique has been employed in many areas to alter the solid solute properties when it witnesses an antisolvent. Like mentioned above the main fundamental principle behind this technique is that the antisolvents employed must show zero solubility towards the solute and should express high

miscibility towards the solvent adopted, Due to this the selection of antisolvents to meet the requirements of the process is very important.

In the following experiment performed, water has been chosen as the appropriate antisolvent due to the fact that it shows negligible solubility towards many drugs and has high miscibility with polar solvents like alcohols.

Due to the adoption of water as a significant antisolvent, major embrace of experimental equipment drops drastically which allows to observe and monitor various other process variables like ultrasonic waves when applied to the recrystallization process. Crystallization process which is carried out under the grace of ultrasonic waves are termed as sonocrystallization and this technique is primarily adopted in order to reduce particle size. Many other factors can be monitored which include the rate of nucleation, crystal growth and its sizes etc.

Giving an overview about the drug which has been chosen to study the concept of antisolvent crystallization albendazole, Albendazole is an anthelmintic (an-thel-MIN-tik) or anti- worm medication. It prevents newly hatched insect larvae (worms) from growing or multiplying in your body. Albendazole is used to treat certain infections caused by worms such as pork tapeworm and dog tapeworm. Few reasons to choose this drug as the preferred solute is because it shows very low solubility in water and shows significantly high solubility in polar solvents.

Result and Discussion

Methodology

As per the selection of albendazole as solute, ethanol as the solvent and water as the antisolvent, a saturated solution of albendazole in ethanol was first prepared. A small quantity by weight of albendazole was measured and mixed in 200ml of ethanol (99.5%). A saturated solution from this stage is prepared by thoroughly mixing the 2 phases and filtering out the excess of the solute.

An equal amount of distilled water is also taken in order to check the hydrophobic nature of albendazole. Now, we have our saturated albendazole solution with ethanol and distilled water. We slowly start adding the water which acts as the antisolvent into the saturated solution of albendazole in ethanol. On adding so we notice precipitate formation due to the formation of a supersaturated solution and due to an expansion in the molar volume of arrangement that instigates a reduction in the dis-solvable power toward the solute by expansion of an antisolvent.

We let the mixture of the saturated solution and the antisolvent to rest until all the precipitate formed has settled. This is the main concept behind the antisolvent crystallization technique. The first analysis which is to be done is the measurement of size of the precipitated crystals. This can be done by subjecting the solution containing the precipitated crystals through an ultrasonicator and running the ultrasonicated sample in a particle size analyser. The main motive behind using the ultrasonicator is to provide agitation to the precipitate crystals in the solution in order to form a homogeneous mixture as well as break any coagulations formed by the precipitated drug by using sound energy above 20,000 Hz.

On running the agitated sample into a particle size analyser, it can give you the size of the crystals which have been precipitated due to the antisolvents and the particle size distribution chart of the drug precipitate. We do the size analysis before and after the experimentation in order to find the size reduction of the drug crystals.

Study of Solvent Effect

We have experimented this technique by using various solvents for the drug albendazole and fulfenamic

acid. We have used ethanol, acetone, and DMSO keeping water as the antisolvent in each case. The particle size analysis for the drug using each of the above solvents are given below. The below given data on the particle size of the drug before and after the recrystallization process using different solvents would also give us a brief understanding on the solvent effect on the drug and would give an inference on which solvent would best be applicable for a selected drug.

PARTICLE SIZE ANALYSIS OF ALBENDAZOLE SAMPLE

Raw sample particle size (average diameter): 2253nm

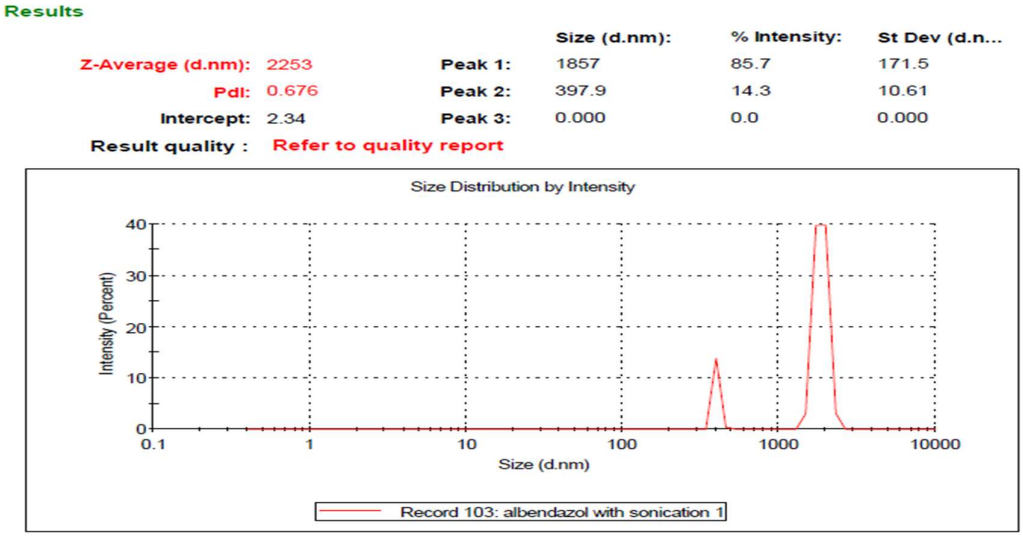

Fig.1 particle size and distribution chart of raw albendazole

Particle size of albendazole using ethanol as solvent: 604.8nm

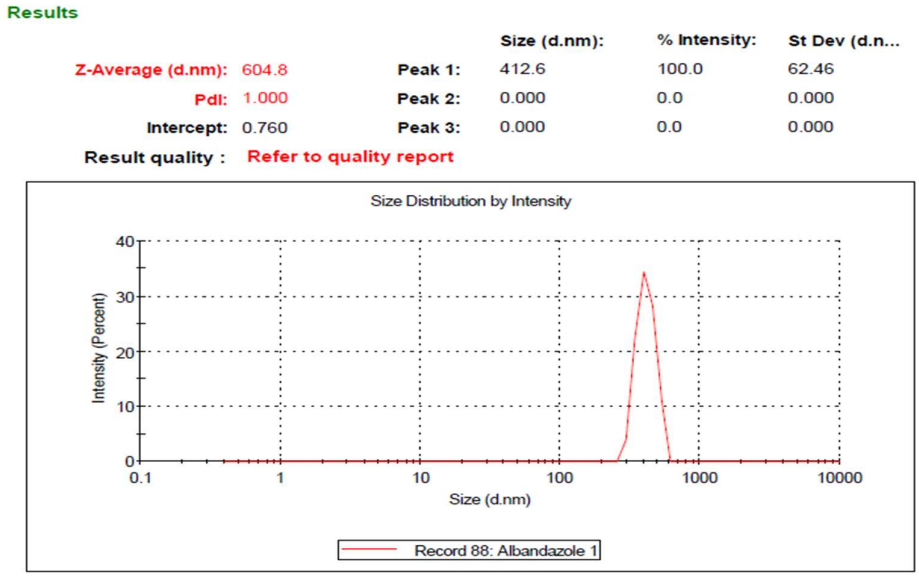

Fig 2. Processed sample size and distribution using ethanol

Particle size of albendazole using acetone as solvent: 1328nm

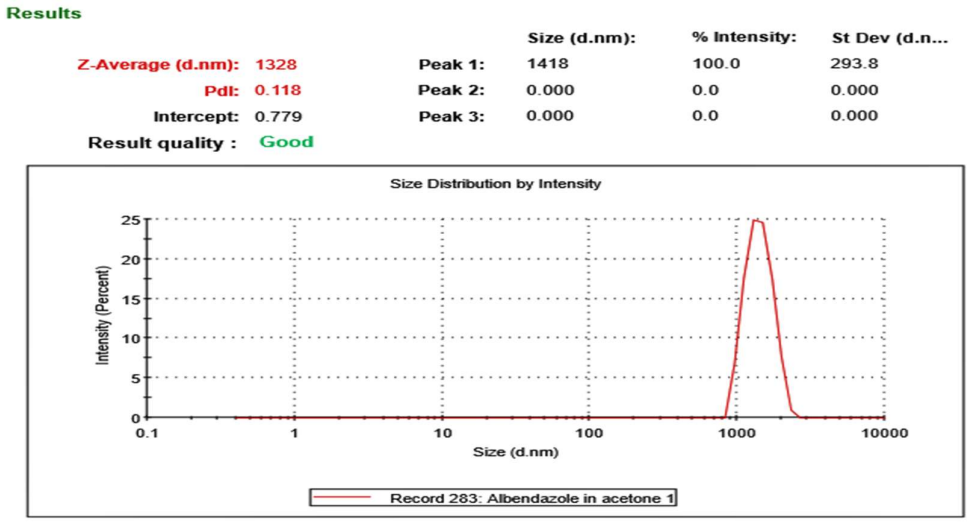

Fig 3. Processed sample size and distribution using acetone

Particle size of albendazole using DMSO as solvent: 103.6nm

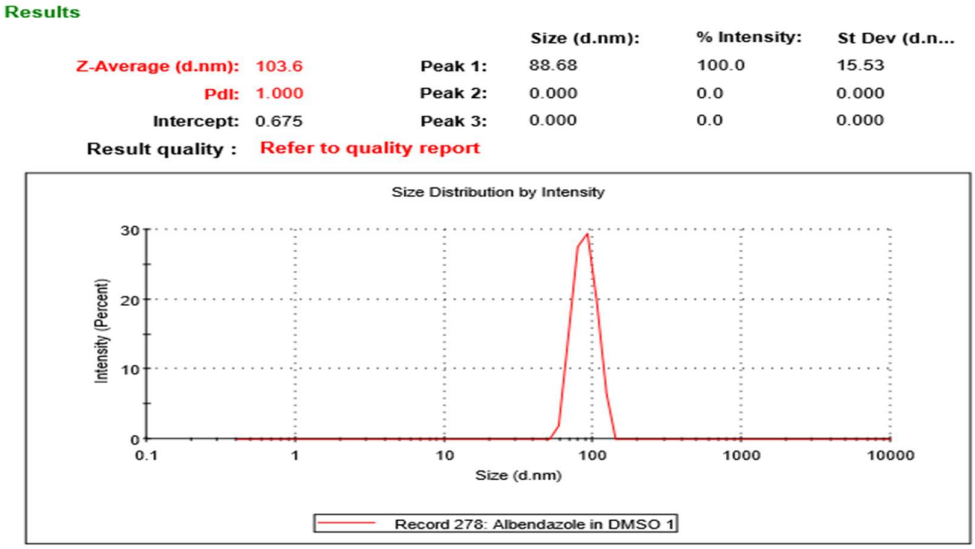

Fig 4. Processed sample size and distribution using DMSO

The results incurred from the above charts indicate DMSO as the most suitable solvent for the drug albendazole in aiding particle size reduction through antisolvent recrystallization technique.

Conclusion

Albendazole was crystallized from organic solutions of ethanol using water as an antisolvent. The effect of the process parameters, such as the concentrations of the drug solution, crystallization temperatures, mixing rates of the drug solution and antisolvent, and the presence of ultrasound were investigated. The average particle size of the crystals decreased when the concentration of the drug solution increased. It was found that the particle size definitely reduced when the solution was sonicated during the crystallization process. Solvent effect was studied on albendazole

sample to determine the size variation on utilizing different solvents. From the acquired results, DMSO is the most suitable solvent in the case of albendazole. Acetone, DMSO can be used as a suitable solvent for fulfenamic acid in order to get maximum size reduction. This was also conducted for other drugs where water can be potentially used as an antisolvent.
Characterization of the experimented drugs were performed to find out the change in physical and chemical properties. The antisolvent crystallization for the above chosen drugs were successful.

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Interview with Mr. Abhinav

ABHINAV AGARWAL
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Placed at TechnipFMC plc

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TechnipFMC plc is a UK based oil and gas EPCM Company which provides complete project life cycle services from Concept till Commissioning. It looks after projects for upstream, downstream, fertilizers, chemicals, pharmaceuticals, LNG and metal industries offering initial conceptual design, detailed engineering design, procurement, commissioning, maintenance, management and decommissioning. With the vision of enhancing the performance of world's energy industry, it works to bring together the scope, know-how and determination to transform its client's project economics. It was formed by the merger of US based FMC technologies and France based Technip. It is a global leader in oil and gas technologies which operates in various segments namely subsea, offshore onshore and surface technologies. It owns and operates a fleet of several heavy vessels used for installation of subsea oil extraction systems on the seabed. It also designs and manufactures umbilical cable and flexible pipes. It is listed on NYSE and Paris Stock Exchange. It has presence in 48 countries worldwide with more than 37,000 employees from 128 nationalities. It has 3 headquarters in Houston, Paris and London. In India its operating offices are located at Chennai, Noida, Mumbai and Hyderabad. It has also started a modular manufacturing yard at Dahej, Gujarat. In India, it has extended its services to clients such as ONGC, BPCL, RIL, NFL, IOCL, L&T, GAIL, Cairn Energy etc.

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1.) Placed in TechnipFMC! What's the feeling like?
The feeling is great and fully satisfactory. It makes me feel that yes, the benefits of these 4years of hard work has finally reaped. There were several ups and downs, but now it seems everything that has happened in these 4 years was worth it and totally necessary. Of course, there is a long way to go but for the time being I feel contented.

2.) What is your message to the juniors, regarding Chemical Engineering domain?
Congratulations if you've taken up ChemE knowingly or unknowingly. Slowly and

gradually you would understand that it is not at all a piece of cake to be a Chemical Engineer, it takes efforts and determination. But you will also know that it is a fortune that you've entered into a domain which has such wide scope and utilization in almost every other field. Chemical Engineers are often called universal engineers because of the associated versatility. Chemical Engineering is among the top paying domains worldwide. It is one of the most sought-after domains in R&D. Every other process industry whether manufacturing or design preferably employs chemical engineers. Oil & gas, pharmaceuticals, fertilizes, metals, textiles, FMCG, paper, plastics, rubber, paints, cement are only a few. So, buckle up and be ready to dive into one of the most exciting domains.

3.) Life at UPES.

Enrolling for my undergraduate studies at UPES has been one of the very wise decision of my growing years. Life at UPES has been one hell of a roller coaster ride. You deal with plethora of opportunities and people from all walks of life, from even the remotest corners of the nation even internationally. You begin with personality enhancement classes which makes you super familiar with the college and your class. You discover new dance moves at your fresher's party. There are annual blood donation camps, marathons, sports tournaments, cultural & technical fests, industrial seminars, workshops and whatnot! And it is supplemented by the beautiful campus situated at a picturesque location.

4.) What are the standard things one should keep in mind before entering the industrial world?

Things would not go in the industrial world as it is in your learning phase. You would have to make compromises; you would have to learn to adapt with changes and that too frequent. You would perhaps find that the work you do and the books you studied are not in line and proper coherence. It will be difficult to make a work-life balance. But in the end, it is all about what you feel to do right which will eventually lead you forward.

5.) Important things to learn before sitting for placements.

Be well versed with all the aptitude sections namely quantitative, logical and verbal before the onset of placement session. Be a master and make a stronghold of at least 3 technical subjects which can be titled as your area of expertise. At the same time, it is essential to have fundamentals of all the core chemical engineering courses crisp and clear. You can practice them at the same time while you are at your internship. Placements are about both preparation and presentation. While preparing it is

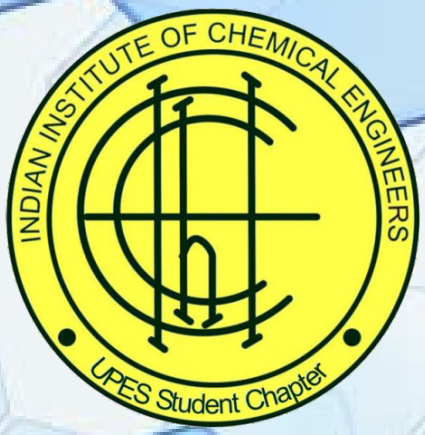
necessary to work on non-verbal communication. Do not forget to wear your smile while entering the interview room. Lastly, there might be several rejections, waiting period, stress interviews but do not lose your calm and have a firm belief that you will succeed and will come up with flying colours.

6.) Message to the Freshers.

These 4 years are going to be the most rewarding and ravishing learning experience of your lifetime. Utilize it to your best, be voracious in anything and everything that you put your hands and feet into. It is really important to focus on your technical part because that is what ultimately will fetch you a placement. But do not limit yourself to your curriculum only but explore yourself and the possibilities of evolving into a best version of you. Take part in college events, Uurja, Ignite, take positions of responsibilities, involve into some community work, travel to unexplored destinations, make great friendship with classmates, juniors or seniors, in fact, do whatever you feel would add to your persona and build your experience.

7.) Views on academic internship and industrial internship.

Academic internships are particularly more preferable for higher studies. You will get a taste of research methodology and will get to use some of the very sophisticated state-of-the-art techniques and instruments. In contrast, industrial internships are must if you are interested to work in corporates and industries. You will understand the dynamics of an industry and how people in a team work together to achieve a common purpose. If unsure of the future course ask your faculties, they are the ones with the rock-solid experience and had been through all this.



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