IPS Academy

Institute of Engineering & Science

Department of Chemical Engineering

Annual Magazine 2022-23

B'Reactive

Dear Readers

In continuation of our endeavors to inform, educate as well as provide an opportunity to deserving people.

This edition of Magazine '**B Reactive'** embodies myriad of articles from IPS Academy, Institute of Engineering & Science, Department of Chemical Engineering. Newsletter through this edition attempts to diversify by dealing with various questions relating to chemical engineering, in the form of surveys which point to the general perception of people regarding these matters. Besides that it doesn't forget its primary objective that is to promote chemical engineering from its grass root levels.

We hope that this edition would be enjoyable as well as informative.

Editors...

Words from the desk of Head

This decade is a time of unparalleled growth and change for India, with the opening up of the frontiers of the world through globalization, there is a need for efficient competence in the global scenario. This need for competence is what that drives our Department to strive for the pinnacle of success. Since its inception in the year 2004, the Department has always strived to create a cadre of professionals who are technically and professionally proficient.

The Department prides itself on preparing the students for creative careers in industries, academia and Government agencies. 400 numbers of students have successfully graduated and are catering to the needs of society.Our accomplished courses and adept faculties not only endeavor to cover the complete syllabus but to motivate students to learn beyond the syllabus which definitely develops complete knowledge of the subject (practical and theoretical) and develop skill sets of students to become promising engineers in future.

As per the need of current growing trend, the department have initiated post graduation course from 2010 in Chemical Engineering with specialization “Computer Aided Chemical Process Plant Design”. The Department has been successfully carrying out testing & IEDC projects over two years.

Prof. Rajesh Kaushal
Head
IPS Academy
Institute of Engineering & Science
Chemical Engineering Department

Message from the Principal

Technical Education is the most potential instrument for socio-economic change. Presently, the engineer is seen as a high-tech player in the global market. Distinct separation is visible in our education between concepts and applications. Most areas of technology now change so rapidly that there is a need for professional institutes to update the knowledge and competence.

Institute of Engineering and Science, IPS Academy is a leading, premium institution devoted to imparting quality engineering education since 1999. The sustained growth with constant academic brilliance achieved by IES is due to a greater commitment from management, dynamic leadership of the president, academically distinctive and experienced faculty, disciplined students and service oriented supporting staff.

The Institute is playing a key role in creating and ambiance for the creation of novel ideas, knowledge, and graduates who will be the leaders of tomorrow. The Institute is convinced that in order to achieve this objective, we will need to pursue a strategy that fosters creativity, supports interdisciplinary research and education. This will also provide the students with an understanding and appreciation not only of the process of knowledge creation, but also of the process by which technology and knowledge may be used to create wealth as well as achieve social economic goals.

I am delighted to note that the engineering graduates of this institute have been able to demonstrate their capable identities in different spheres of life and occupied prestigious position within the country and abroad. The excellence of any institute is a measure of achievements made by the students and faculty.

Dr. Archana Keerti Chowdhary
Principal
IPS Academy
Institute of Engineering & Science

IPS Academy Indore
Institute of Engineering & Science
(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)
DEPARTMENT OF CHEMICAL ENGINEERING

IIChE STUDENTS' CHAPTER

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Content

Uses of Ammonium Nitrate in Industries

Simran Baweja 4th Yr
Ankash Gupta- 4 th Yr

India is indeed an agriculture-based country, with a large population engaged in activities. The use of fertilizers, including ammonium nitrate, is critical for improving soil fertility and crop yields. Ammonium nitrate is particularly useful for crops that require high levels of nitrogen, such as wheat, maize, and other cereal crops. Ammonium nitrate provides a readily available source of nitrogen that plants can easily absorb and use for their growth and development. It also helps to improve soil structure and fertility, which is important for maintaining healthy crops. Ammonium Nitrate a chemical compound. NH4N03 that exists as colorless, crystals at room temperature but changes to monoclinic crystals when heated above32 ^{0}C. It is extremely soluble in water and soluble in alcohol and liquid ammonia. It is predominantly used in agriculture as a high-nitrogen fertilizer and is also used as a component of explosive mixtures in mining, quarrying, and civil construction. Ammonium nitrate is commercially available both as a colorless crystalline solid and processed into prills for specific applications. Does not readily

burn but will do so if contaminated with combustible material. Accelerates the burning of combustible material. Produces toxic oxides of nitrogen during combustion. Used to make fertilizers and explosives, and as a nutrient in producing antibiotics and yeast. Ammonium nitrate is the ammonium salt of nitric acid. It has a role as a fertilizer, an explosive and an oxidizing agent. It is an inorganic molecular

entity, an ammonium salt and an inorganic nitrate salt. This project file aims to provide an overview of the manufacturing process of ammonium nitrate by prilling process. The prilling process is a widely used method for producing ammonium nitrate, Which involves the formation of small spherical pellets or prills of ammonium nitrate. The prilling process is preferred due to its low energy consumption, high production rate, and ease of operation.

Modeling and Simulationon of Oxidation of $S0_2$ through Contact Process.


Gargi Soni 4th Yr **Rahul S. 4th Yr**

Modelling and simulation of oxidation of $S0_2$ through the contact process is an important topic in chemical engineering. The contact process is a commonly used method for the industrial production of sulfuric acid, which is a highly important chemical used in various industries. The process involves the oxidation of sulphur dioxide ($S0_2$) to sulphur trioxide ($S0_3$) which is then used to produce sulfuric acid. In this article, we will explore the modelling and simulation of the oxidation of $S0_2$ through the contact process. The Contact Process: The contact process is a method used for the industrial production of sulfuric acid. It involves the oxidation of sulphur dioxide to sulphur trioxide using a catalyst. The reaction is exothermic, and it is carried out in several stages. The first stage involves the conversion of sulphur to sulphur dioxide. This is typically done by burning sulphur in the presence of air. The sulphur dioxide produced in this stage is then oxidized to sulphur trioxide using a catalyst, typically vanadium pentoxide. The sulphur trioxide is then dissolved in sulphuric acid to produce oleum, which is then diluted to produce commercial-grade sulphuric acid. Themodeling and simulation of the oxidation of S02 through the contact process involves the use of mathematical models to describe the behaviour of the system. The models used in this process typically involve a set of differential equations that describe the reaction kinetics, mass transfer, and heat transfer within the system, The models are used to predict the behaviour of the system under different conditions, such as changes in the operating parameters or catalyst properties. The models used in the simulation of the contact .Process typically involve the following variables: •Temperature: The temperature of the system plays a crucial role in determining the reaction kinetics and heat transfer within the system. Catalyst Properties: The properties of the catalyst, such as its surface area and porosity, are also important variables that affect the reaction kinetics. The simulation of the contact process involves the use of computational methods to solve the set of differential equations that describe the behaviour of the system. The simulation results can be used to predict the performance of the system under different conditions and to optimize the operating parameters of the system. Modelling and simulation of the oxidation of S02 through the contact process is an important area of research in chemical engineering. The contact process is a widely used method for the industrial production of sulphuric acid. Modelling and simulation of this process can help to optimize the performance of the system and improve the efficiency of the process. The models used in this process typically involve a set of differential equations that describe the reaction kinetics, mass transfer, and heat transfer within the system. The simulation of the contact process involves the use of computational methods.

Use of software in chemical Engineering

Vishal Patel 4th Yr Manish Bondre 4th Yr

Software plays a crucial role in modern chemical engineering, efficiency, accuracy, and safety in various tasks. Here are some common uses of software in chemical engineering: Process simulation: Software like Aspen Plus, HYSYS, and CHEMCAD are used for process simulation, allowing chemical engineers to model and optimize chemical processes. This helps in predicting process behaviour, analysing process conditions, and optimizing process parameters to improve efficiency and productivity. Process control: Software such as Distributed Control Systems (DCS) and Supervisory Control and Data Acquisition (SCADA) systems are used for process control in chemical plants. These software systems monitor and control process variables in real-time, ensuring safe and optimal operation of chemical processes. Computational fluid dynamics (CFD): CFI) software like ANSYS Fluent, COMSOL Multiphysics, and OpenFOAM are used for simulating and analysing fluid flow, heat transfer, and mass transfer in chemical processes. This helps in optimizing equipment design, evaluating safety measures, and understanding the behavior of complex fluid systems. Data analysis and statistical modeling: Software like MATLAB, R, and Python are used for data analysis and statistical modeling in chemical engineering, These tools help in processing and analysing experimental data, optimizing processes using statistical methods, and developing predictive models for process behaviour. Process safety and risk assessment: Software like PHAWorks, DNV GL Phast are used for process safety and risk assessment in chemical industries. These software systems help in identifying and evaluating potential hazards, analysing risks, and implementing safety measures to prevent accidents and protect personnel and the environment. Chemical property prediction: Software like ACD/Labs, ChemDraw, and SciFinder are used for predicting chemical properties, such as thermodynamic properties, chemical reactions, and molecular properties. These tools assist in designing new chemicals, optimizing chemical processes, and predicting the behaviour of chemical compounds in various conditions. Process economics and optimization: Software like Aspen Economic Evaluation, SuperPro Designer, and ProMax are used for process economics and optimization in chemical engineering. These tools help in estimating costs, evaluating economic viability, and optimizing process parameters to improve profitability. These are just some of the many ways software is used in chemical engineering to enhance efficiency, accuracy, and safety in various tasks. Software continues to play a critical role in advancing the field of chemical engineering and driving innovation in process. .

Manufacturing process of Sulphuric Acid

Sulfuric acid is the largest-volume industrial chemical produced in the world (200 million tons per year). Concentrated sulfuric acid (93-98 %) is used in the manufacture of fertilizers, explosives, dyes, and petroleum products.1 mole of sulphur trioxide reacts with 1 mole of water to produce one mole of sulphuric acid.

This is the Contact process, which is a commercial method. In this reaction, vanadium oxide is used as a catalyst. The starting material for sulfuric acid manufacture is clean, dry sulfur dioxide ($S0_2$) gas. This can be obtained by burning molten sulphur from metallurgical off-gases or by decomposing spent sulphuric acid. Over the last decades the contact process has been used to produce sulfuric acid, replacing the traditional «Lead Chamber» process dating back to the 18th Century. In the contact process $S0_2$ is oxidized to sulphur trioxide ($S0_3$) at high temperature (about 450 ^{0}C) in the presence of a vanadium catalyst. S03 then is dissolved in concentrated sulfuric acid forming fuming sulfuric acid (oleum).

Simran Samadhiya 3rd Yr

This can then be reached safely with water resulting acid strength can be adjusted by controlling the flow rates of sulphur trioxide and water. The resulting acid strength can be varied from 91 to 100% sulphuric acid. It is used in the manufacturing of metals such as copper, zinc etc and used as a catalyst in the manufacturing process of nylon .and in the manheim process for the manufacturing of HCI. It is also used in petroleum refining.

Process intensification for enhanced efficiency in chemical processes.

Anshul Pandey 3rd Yr

Process intensification in chemical engineering involves various technical concepts and approaches. Here are some key technical terms associated with process intensification:

Microreactors: These are small-scale reactors designed to carry out chemical reactions with high efficiency and control, often on a microscale.

Continuous-flow Processes: Involves the continuous passage of reactants through a reactor, allowing for efficient reactions, reduced residence times, and improved control.

Multiphase Systems: Refers to systems involving more than one phase, such as gas-liquid, liquid-liquid, or solid-liquid, and optimization of mass transfer between them.

Heat Integration: The use of heat exchangers and other techniques to recover and reuse heat within a process reducing energy consumption.

Membrane Separation: The use of semipermeable membranes to separate components in a mixture, often used for separation and purification.

Catalysis: The use of catalysts to accelerate chemical reactions, often enabling milder reaction conditions and higher selectivity.

Hybrid Processes: Combining multiple unit operations or processes into a single integrated system to improve efficiency and reduce intermediate storage.

Green Chemistry: A focus on designing chemical processes that are more environmentally friendly by reducing waste, using safer reagents, and optimizing resource use.

Process Integration: The holistic approach of optimizing an entire process by considering interactions between unit operations and minimizing waste.

Intensified Separation: Techniques for more efficient separation of components in mixtures such as distillation, adsorption and extraction.

Reaction Engineering: The study and optimization of chemical reactions, including kinetics, mass and heat transfer and reactor design.

Modular Design: Building processes using modular units that can be easily scaled up or down, enhancing flexibility and reducing capital costs.

Process Analytical Technology (PAT): The use of advanced analytical tools for real-time monitoring and control of chemical processes.

Energy Efficiency in Manufacturing in industries.

Exploring energy efficiency in manufacturing within the field of chemical engineering is essential for sustainability and cost-effectiveness. Here are some topics to consider:

Energy Audit and Analysis: Discuss the process of conducting energy audits to identify areas for improvement in energy consumption within chemical manufacturing facilities.

Process Integration: Explain how process integration techniques, such as pinch analysis and heat exchanger networks, can be used to optimize energy usage in chemical processes.

Heat Recovery Systems: Highlight the importance of heat recovery systems, including the design and implementation of heat exchangers to capture and reuse waste heat.

Combined Heat and Power (CHP) Systems: Explore the benefits of CHP systems in chemical manufacturing, which simultaneously generate electricity and thermal energy, leading to increased energy efficiency.

Cogeneration: Discuss the concept of cogeneration, where excess heat from chemical processes is used to generate electricity, reducing overall energy consumption.

Renewable Energy Integration: Examine how chemical manufacturing facilities can incorporate renewable energy sources like solar and wind power to reduce their reliance on conventional energy sources.

Energy-Efficient Equipment and Technologies: Highlight the use of energy-efficient machinery, sensors, and automation systems in chemical manufacturing to optimize energy consumption.

Energy Management Systems (EMS): Explain how EMS can help monitor and control energy usage in real-time, providing insights for energy efficiency improvements.

Lean and Green Manufacturing: Discuss the principles of lean manufacturing and how they align with green and energy-efficient practices in chemical engineering.

Energy-Efficient Reactor Design: Explore innovative reactor designs that maximize energy efficiency while maintaining product quality and yield.

Waste Heat Utilization: Showcase successful applications of waste heat utilization in chemical manufacturing, including examples from different industries.

Energy-Efficient Materials: Discuss the development and use of materials that have properties contributing to energy efficiency, such as insulation and catalysts.

Regulatory Compliance and Incentives: Address government regulations and incentives related to energy efficiency in the chemical manufacturing sector.

Sustainability Reporting: Explain the importance of sustainability reporting and how it can drive energy efficiency improvements while meeting environmental and corporate social responsibility goals.

Success Stories and Case Studies: Present case studies of chemical companies that have successfully implemented energy-efficient practices, detailing the challenges they faced and the results achieved.

Supply Chain Optimization in chemical industry

Optimizing the supply chain in the chemical industry is crucial for efficiency and cost savings. Here are some key aspects to explore in a magazine focused on supply chain optimization in the chemical industry:

Raw Material Sourcing: Discuss strategies for sourcing raw materials efficiently, including global procurement, vendor selection, and risk management.

Inventory Management: Address best practices in managing chemical inventories, including safety stock levels, just-in-time inventory, and demand forecasting.

Transportation and Logistics: Explore the logistics of chemical transportation, including modes of transport, safety regulations, and cost-effective distribution.

Warehouse Management: Cover topics related to warehouse design, layout, and automation in the chemical industry, with a focus on improving storage and retrieval processes.

Regulatory Compliance: Discuss the unique regulatory challenges in the chemical industry, including safety regulations, labeling, and hazardous materials handling.

Supply Chain Visibility: Highlight the importance of real-time visibility into the supply chain and the use of technology such as IoT and blockchain to enhance transparency.

Swraj Singh Tomar 3rd Yr

Demand Planning and Forecasting: Examine the role of accurate demand forecasting and how it impacts inventory, production, and overall supply chain optimization.

Chemical Packaging and Labeling: Discuss innovations and best practices in chemical packaging and labeling to ensure compliance and safety.

Quality Control and Assurance: Address the importance of quality control in the supply chain, including testing, inspection, and certifications.

Environmental and Sustainability Initiatives: Explore how supply chain optimization can contribute to sustainability goals, including reducing carbon emissions and minimizing waste.

Collaborative Supply Chain Partnerships: Highlight successful collaborations and partnerships in the chemical industry supply chain, including supplier-customer relationships and alliances for mutual benefit.

Digital Transformation: Cover the adoption of digital technologies and Industry 4.0 principles to optimize the chemical supply chain, including data analytics, AI, and automation.

Risk Management: Discuss strategies for mitigating supply chain risks, including geopolitical, environmental, and economic factors that can impact the chemical industry.

Cost Reduction Strategies: Provide insights into cost reduction methods and techniques specific to the chemical supply chain, such as bulk purchasing and negotiation strategies.

Case Studies: Showcase real-world examples of chemical companies that have successfully optimized their supply chains, detailing the challenges they faced and the results achieved.

Hydrogen as a Fuel: Powering the Future

Jay Choudhary 2nd Yr

Hydrogen, the most abundant element in the universe, is emerging as a promising contender in the quest for sustainable energy sources. Its potential as a clean fuel is gaining momentum due to its minimal environmental impact and versatility. This article explores the basics of hydrogen as a fuel, its current uses, and the exciting future prospects.

Hydrogen is an odourless, colourless gas that can be produced through various methods, including electrolysis, steam methane reforming, and biomass gasification. It is a versatile energy carrier because it can be used in multiple forms - gaseous or liquid - and can be stored efficiently. Hydrogen's combustion emits only water vapor, making it a clean alternative to fossil fuels.

Transportation: Hydrogen fuel cells power electric vehicles, offering a longer driving range and shorter refuelling times compared to battery-electric vehicles. Leading automakers are investing in fuel cell technology. Industrial Processes: Industries use hydrogen for various applications, including refining oil, producing ammonia, and upgrading heavy crude oil.

Future Outlook:

Economic Viability: As technology advances and economies of scale are realized, the cost of producing hydrogen is expected to decrease, making it a competitive option compared to fossil fuels.

Effect of Micro Plastic on Marine Life

Prem Prakash Singh, 1st year

Plastics are widely used around the world due to ease of manufacturing, low cost, stable chemical properties, and good water resistance, the production has been steadily increasing year by year. The commonly used plastics include polystyrene, nylon, polyurethane, polypropylene, etc. These plastics are gradually decompose by the physical, chemical and biological effects in the environment, plastics are easily fragmented under the effect of environmental forces, however, it takes about a long time for these plastics to be completely decomposed. Most plastics will form plastic debris with a small particle size, plastics debris whose diameter is less than 5 mm is called microplastics. The microplastics pollution has caused many hazards to marine life. Plastics are chemically stable and can exist in the environment for hundreds of years or longer. Due to the cheapness and wide applicability of plastics, the global plastics industry has developed rapidly since the 1950s, the production of global plastics growing by 4% every year. About 10% of the waste plastics finally discharge into the ocean through various channels, which account for about 60% to 80% of marine waste, and they are even as high as 90% to 95% in some areas. Marine micro plastics will affect many aspects of the marine fish and marine food chain. Microplastics can harm the reproductive health of marine life. Under the influence of polystyrene microplastics, the number of egg cells ovulated by the Crassostrea gigas is significantly reduced, and the sperm motility level was reduced .The microplastics can have a toxic effect on fish and other aquatic life, including reducing food intake, delaying growth, causing oxidative damage and abnormal behaviour. At present, the pollution of marine microplastics has become more and more serious and has become a global pollution incident, but there is a lack of effective treatment methods.