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APPLICATIONS OF CHEMISTRY IN INDUSTRY WITH TECHNOLOGY

K.ANANYA[1], P.H.CROWN[2], G.ABBULU[3]

1. UG 2ND YEAR STUDENT , FORENSIC DEPARTMENT , GIET DEGREE COLLEGE , AP
2. UG 2ND YEAR STUDENT , FORENSIC DEPARTMENT , GIET DEGREE COLLEGE , AP
3. UG 2ND YEAR STUDENT , FORENSIC DEPARTMENT , GIET DEGREE COLLEGE , AP

ABSTRACT

This volume, "Chemical Technology and Informatics in Chemistry with Applications," showcases the extensive scope of research and applications in industrial and engineering chemistry, as well as cheminformatics. Highlighting cutting-edge developments, the book underscores the dynamic nature of these fields today. Various chapters explore industrial processes for emerging materials, assessing practical applications across diverse conditions, thereby contributing to the development of a new generation of materials. Additionally, the informatics approach to chemical science is addressed in several chapters. The book is divided into two sections: the first delves into new insights in engineering chemistry, while the second, focusing on chemical informatics, explores promising future prospects and novel approaches. This emerging field holds significant implications for industrial and pharmaceutical applications .

KEYWORDS

INTRODUCTION:-

Chemistry plays a vital role in various industries, contributing to advancements through technological integration. The process of the scientific study of the various properties and actions of matter is generally known as chemistry .chemistry requires various laboratory tests using numerous techniques related to chemistry. Chemistry nowadays is much more needed in our day to day lifestyle. It plays a very important key role in our daily things like food, shelter, health, water etc. Another significant advancement is the development of new materials and products through technology driven research and development. This has led to the creation of innovative materials such as lightweight alloys , super conductors,and advanced polymers , which have wide ranging uses in industries like Aerospace, Electronics, and Automotives.

Moreover,technology has facilitated the implementation of sustainable practices in chemical industries. Through the process optimisation and development of ecological friendly alternatives , industry can reduce the waste , energy consumption , and environmental impacts . These are some of the basic examples where chemistry is widely used: Silicon, Petroleum, Paper, Leather. This includes the use of renewable energy sources, and the development of greener chemical reactions

Finally, the introduction of technology and the application of chemistry in industry as opened up new possibilities ,improved efficiency, and driven innovation.

HISTORY :

Throughout the history , the integration of chemistry and technology in industry has been a game changer. The industrial revolution, which took place in the 19th and 20th century. With the advent of steam engines and the utilization of electricity, various industries have been experienced and unprecedented growth and transformation.

As technology continued to grow day by day the application of chemistry in industry became even more intricate the 20th century witnessed another significant milestone with the rise of computer technology. In the present day ,technology remains an essential component in the application of industrial chemistry

CHAPTER 1:

PETROLEUM

Drilling mud is a complex system essential for petroleum prospecting, composed of water for heat dissipation, oil for lubrication, clay for rheology, and heavy metal salts for density. The formulation varies by region due to geological and physicochemical differences. Enhanced oil recovery (EOR) targets remaining oil in depleted wells and involves complex processes like surfactant-polymer flooding. Despite challenges in reservoir complexity and cost, EOR is attractive, as approximately 65% of the original oil remains in depleted wells. Surfactant-polymer flooding aims to mobilize residual oil by injecting surface-active agents into the reservoir, creating an oil bank for efficient mobilization. The process involves preflooding to condition the reservoir, surfactant injection to reduce interfacial tension, and polymer injection to drive the surfactant slug, preventing water fingers from penetrating the oil bank. Optimization requires careful control of interfacial tension, avoidance of undesired surfactant aggregate structures, and consideration of surfactant-polymer compatibility to ensure process efficiency. These technologies present both scientific and technological challenges but offer significant potential for recovering valuable oil resources.

Acid fracturing is a crucial oil well stimulation technique involving the injection of acid (HCl or HF) at high pressure to fracture porous media or widen existing fractures in the rock structure. Surface chemistry principles are employed to control fluid loss and decrease the rate of acid spent during this process.

To mitigate fluid loss, surfactants are utilized as thickeners, forming micelles that gel the acid. These gelled acids remain shear-stable, allowing for quick reforming of micellar chains after shearing. Surfactants offer advantages as thickeners by providing high viscosity to active acid solutions while ensuring low viscosity to spent acid, aiding in the recovery of treating fluids.

Foamed acid and acid-external emulsions are additional methods employed to control acid solution loss. However, the use of oils in emulsions requires a large oil concentration, reducing the available acid for fracture etching. Retarders, such as alkyl sulfonates and alkyl phosphonates, are used to control the acid reaction rate by forming hydrophobic films on carbonate surfaces.

Antifoaming and defoaming agents play a crucial role in downstream processing of recovered crude oil. These agents, including hydrophobic silicas, silicone oils, glycol-based polymers, amides, mineral oils, and fatty acids, prevent or eliminate foam formation caused by impurities and corrosion products in process streams.

Corrosion inhibition is vital in the petroleum industry, where metallic parts are susceptible to corrosion, impacting oil wells, refineries, and petrochemical plants. Approximately $300 billion in revenue losses in the USA alone in 1999 were attributed to corrosion, with significant savings possible through effective corrosion control methods.

CHAPTER-2

SILICON

Over the past decade, one-dimensional nanostructures, including wires, rods, and tubes, have garnered significant attention due to their unique properties compared to bulk materials. These structures offer a valuable platform for exploring the impact of dimensionality and size reduction on electrical, thermal, and mechanical properties, with potential applications in electronics, optoelectronics, and various nanoscale devices. Particularly, one-dimensional silicon carbide (1D SiC) nanostructures, such as nanowires (SiCNWs), have emerged as noteworthy entities with exceptional characteristics like high breakdown field strength, thermal conductivity, and saturation drift velocity.

Various synthesis methods have been developed to address historical challenges in fabricating 1D SiC nanostructures. Chemical synthesis routes have gained prominence for their diversity and cost-effectiveness compared to advanced techniques like nanolithography. The discovery of SiC nanorods, initially prompted by carbon nanotubes, has spurred innovations in chemical vapor deposition methods and catalytic approaches involving different catalysts.

Due to their distinctive properties, including high thermal stability, strength, thermal conductivity, and a large band gap , 1D SiCNWs (Silicon Carbide Nanowires) have found extensive applications. SiC nanorods with thicknesses in the range of several tens of nanometers exhibit impressive elastic modulus and ultimate bending strengths, measuring at 610–660 GPa and 53.4 GPa, respectively. These values are two or more times higher than previous observations for SiC whiskers with micrometer diameters [47]. As a result of their enhanced mechanical characteristics, SiCNWs are well-suited for applications in nanoelectronics and field.plasticity and strength, make them suitable for applications in composites for advanced technological uses. The review emphasizes the diverse applications of 1D SiC nanostructures, including sensors, hydrogen storage, energy applications, and biomedical uses. Additionally, it discusses toxicity concerns associated with these nanostructures. The article concludes by outlining future directions and opportunities in the field of 1D SiC nanostructures, providing a comprehensive and up-to-date perspective on their synthesis, applications, and potential challenges.

Carbon nanotubes, 1D silicon nanomaterials and 1D silicon carbide nanomaterials:

Due to their distinct characteristics, carbon nanotubes (CNTs) and silicon nanowires (SiNWs) stand out as two crucial classes of one-dimensional nanomaterials, attracting extensive research attention . The remarkable properties exhibited by these nanomaterials, including small diameter, high aspect ratio, exceptional mechanical strength, robust thermal and chemical stabilities, excellent heat conduction, and intriguing electrical and electronic properties, contribute to their status as highly promising candidates for a diverse array of applications. The unique attributes of CNTs and silicon-based nanomaterials make them subjects of extensive study, opening up avenues for a wide range of transformative possibilities.

Processing of 1D SiC nanomaterials for different applications

Due to their distinctive properties, including high thermal stability, strength, thermal conductivity, and a large band gap 1D SiCNWs (Silicon Carbide Nanowires) have found extensive applications. SiC nanorods with thicknesses in the range of several tens of nanometers exhibit impressive elastic modulus and ultimate bending strengths, measuring at 610–660 GPa and 53.4 GPa, respectively. These values are two or more times higher than previous observations for SiC whiskers with micrometer diameters . As a result of their enhanced mechanical characteristics, SiCNWs are well-suited for applications in nanoelectronics and field.

Issues related to one dimensional SiC nanomaterials

Engineered nanomaterials (NMs) derive their unique physicochemical properties from various factors, including their small size, chemical composition, surface structure, solubility, shape, and aggregation. The appeal of these nanomaterials lies in their distinct characteristics at the nanoscale, influencing their behavior and interactions with surrounding environments. Their small size grants them novel properties, while chemical composition and surface structure dictate reactivity and functionality. Solubility impacts dispersibility and bioavailability, shaping their biological and environmental impact. Furthermore, the specific shape of nanomaterials plays a crucial role in governing their properties and applications. Additionally, the tendency to aggregate can influence stability and performance. The comprehensive understanding of these attributes is vital for harnessing the potential of engineered nanomaterials across various fields, from medicine to electronics, ensuring their safe and effective utilization.

CHAPTER-3

PAPER

There is a great deal of variation in the pulp and paper sector in terms of end applications, distribution routes, raw materials, products, and quality levels. According to RISI (2014), the output of paper and board increased globally by 0.8% in 2013 to a record 403 million tons, despite continuous reductions in North America and Europe. By 2020, production in the pulp, paper, and publishing industries is expected to reach 500 million tons. The increase in tissue and packaging grades has offset the decrease in the production of graphic paper worldwide. China continues to lead the globe in both production and demand; in 2013, it accounted for 26% of worldwide production and 25% of world consumption, with the US coming in second. In terms of pulp production, the United States is also in the lead with 49.4 million tons in 2013.

Despite the advancements in digital technology, paper consumption is on the rise, fueled by increasing demand in Asia and emerging nations. While new technology has led to a decline in newsprint consumption in the United States and Western Europe, less than half of the wood pulp produced in 2013 was used for printing, writing, and newsprint paper. The remaining pulp was utilized for various products such as cardboard packaging, toilet tissue, and paper towels, with demand continuously growing in emerging markets, particularly led by China.

China has become the world's largest consumer of paper, accounting for 25% of global demand in 2013, surpassing the United States and Western Europe. Despite this, China's paper use per person remains a third of that in the United States. Global paper consumption has grown at an average rate of 1.7% annually over the past decade, and it is expected to increase further as urbanization in Asia and emerging markets continues.

The pulp and paper industry has significant environmental and social impacts, being a major producer of pollutants, waste products, and gases contributing to climate change. The industry is also a large consumer of raw materials, including fresh water, energy, and forest fibers. Deforestation for fiber and the negative effects on local communities are among the industry's challenges.

Pulp and paper production is a major contributor to environmental problems, such as energy consumption, deforestation, effluent discharge, and air and water pollution. The industry has undergone changes in environmental performance, and there is a growing need for more sustainable practices. Sustainability, defined as the ability to maintain valued qualities in the physical environment, is crucial, and various definitions exist in academic literature.

Sustainable manufacturing is seen as the creation of products with processes minimizing negative environmental impacts, conserving energy and natural resources, ensuring safety for employees and communities, and being economically sound. Pulp and paper companies face sustainability issues due to the resource-intensive nature of their industry. Governments worldwide have strengthened environmental regulations, shaping the industry and prompting innovations, such as the use of recycled fiber.

Addressing environmental challenges and embedding sustainability into every management decision is crucial for the pulp and paper industry, considering the impact on resources, energy costs, and talent shortages. Adopting sustainable practices can create significant value and avoid unnecessary costs. Table 1.1 outlines goals for achieving an environmentally and socially sustainable paper production and consumption system.

CONCLUSION

AOPs, or advanced oxidation processes, are a useful treatment for wastewater tainted with dangerous organic pollutants. Because of their strong oxidation ability, hydroxyl radicals efficiently decompose a wide range of organic molecules, turning them into totally mineralized or biodegradable products. Research has shown that AOPs significantly reduce organic pollution in the petrochemical industry, to the point where wastewater is almost nonexistent. AOPs significantly reduce toxicity even when they are not completely broken down, making biological treatment easier. This feature is essential to the oil business since it allows water to be reused for things like irrigation, which lowers production costs and the environmental impact. Cost efficiency is increased by using solar-driven processes and optimizing reagent concentrations.

Fenton's reagent shows promise as a way to lessen organic pollution in soils contaminated by oil. This substitute for traditional remediation techniques reduces .

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