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Nanotechnology in Chemical Industry

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ABSTRACT: *Nanotechnology involves the manipulation of matter at the atomic and molecular scale. Integrating chemistry and materials science, Nanotechnology is emerging as a primary driver of technology, delivering significant impacts in many areas of society. Nanotechnology is now used in chemistry, physics, biology, and engineering. This paper provides a brief introduction to the use of nanotechnology in the chemicals industry.*

KEY WORDS: *nanotechnology in chemical industry, nanomaterials, nanoscience*

1. INTRODUCTION

It is known in the chemical industry that the microstructure of a material is key to determining its properties. Controlling structures at the micro- and nano-levels is crucial to new discoveries. Nanotechnology is defined as the controlled manipulation of nanomaterials with at least one dimension less than 100nm [1]. Nanotechnology is the understanding of matter at dimensions of roughly 1-100 nanometer. It involves the creation and application of materials and devices at the level of molecules and atoms. It offers the chemical industry at least six opportunities [2]: (1) Tools for research, (2) New materials, (3) New processes for fabrication, (4) Nanoelectronics, (5) Nanoparticle technology, and (6) the revolutionary unknown such as nano-CDs and quantum computers.

WHAT IS NANOTECHNOLOGY?: Techniques are now available which make it possible to manipulate materials on the atomic or molecular scale to produce objects which are no more than a few nanometers in diameter. The processes used to make and manipulate such materials are known as nanotechnology, the materials or objects themselves are called nanomaterials, and the study and discovery of these materials is known as nanoscience. Richard Feymann, the Nobel Prize-winning physicist, introduced the world to nanotechnology in 1959. Nanotechnology involves the manipulation of atoms and molecules at the nanoscale so that materials have new unique properties. Nanotechnology is a multi-disciplinary field that includes biology, chemistry, physics, materials science, and engineering. It is the science of small things—at the atomic level or nanoscale level [3].

II. APPLICATIONS

Nanotechnology is being applied in different industries covering medicine, electronics, biomedical, performance materials, consumer products, and manufacturing. Some of these are currently in production, while others are in an advanced state of development.

- **Nanocatalysis:** This is a rapidly growing area which involves the use of nanomaterials as catalysts for a variety of catalysis applications. Due to their complex chemical properties at the nanometer scale, even characterization of the various active sites of most commercial catalysts proves to be elusive. Replacement of metal catalysts by catalysts tailored at the nanoscale improves chemical reactivity and reduce costs [4].

- **Chemical sensors:** Nanotechnology can help sensors detect very small amounts of chemical vapors. Because of the small size of nanoparticles, a few gas molecules are sufficient to change the electrical properties of the sensing elements.

- **Pharmaceuticals:** Nanotechnology is being applied to the pharmaceutical fields. The reason is to improve drug solubility. It is also being employed to develop new therapeutic devices. The use of various pharmaceutical nanocarriers has become an important area in nanomedicine. Nanotechnology promises precisely targeted drug delivery of therapeutic molecules to the diseased areas of the body [5].

- **Advanced materials:** Nanotechnology can be used to produce smart materials with applications in chemical industry, medical and domestic markets, and manufacturing sectors.

- **Food:** Nanotechnology is already impacting several aspects of food science, from how food is grown to how it is packaged. Nanotechnology can be applied in the agricultural production, food processing, safety, food packaging and preservation, bacteria identification, food quality monitoring, and pathogen detection [6].

- **Oil & gas:** Nanotechnologies have the potential to introduce revolutionary changes of materials used in oil and gas industries. Application of nanomaterials, such as solid composites and functional nanoparticle-fluid, has brought major technological advances in the oil and gas. Nanomaterials are also used for heavy oil recovery, fracturing fluids, hydraulic fracturing fluids, oil well cementing, flow assurance, and drilling [7]. There are great possibilities in nanotechnology research to revolutionize the petroleum industry.

Industry leaders are actively involved in nanomaterials research. The chemical industry can reap huge benefits from nanotechnology in the future if new nanomaterials are developed. The potential for nanotechnology knows no bounds.

III. ISSUES AND CHALLENGES

The public is wary of the potential of nanotechnology for harm as well as excited by its potential for good. There is legitimate concern that nanomaterials may carry unknown environmental, health and safety risks [8]. The related issue of who should make decisions about the pursuit of particular nanotechnology research programs, and how they should do so, becomes important. Synthesis of nanomaterials such as quantum dots is difficult and expensive to reproduce. Nanomaterials are currently expensive for many practical applications due to high cost and low production volumes. Manufacturing challenges include operations ranging from particle formation, coating, dispersion, to characterization, and modeling.

IV. CONCLUSION

Nanotechnology is built upon the concept that the technology of the future will be built on atoms. It has impact on every area of science and technology, providing industrially relevant enabling technology that will generate significant new product and market opportunities. Nanotechnology is already having an impact in many areas of chemical industry and its impact on our lives will grow at an exponential rate.

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