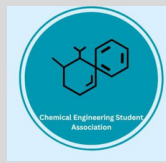


ALKEMY

(A Hall of Fame)



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Nano-Catalysts Improve Reaction Efficiency

★ Introduction

- Catalysts are substances that speed up chemical reactions without being consumed. In modern industries, catalysts are essential for producing fuels, fertilizers, plastics, medicines, and many other products.
- When catalysts are engineered at the nanoscale (1–100 nanometers), they are called nano-catalysts. Due to their extremely small size and high surface area, nano-catalysts significantly improve reaction efficiency, reduce energy consumption, and support environmentally friendly processes.

👉 Why Size Matters in Catalysis

At the nanoscale, materials behave differently compared to their bulk form.

Key Advantages of Nano-Catalysts:

- ◆ Very high surface-to-volume ratio
- ◆ More active sites for reaction
- ◆ Faster reaction rates
- ◆ Lower activation energy
- ◆ Better selectivity toward desired products

Because chemical reactions occur on the surface of catalysts, increasing surface area directly improves efficiency.

🏭 Industrial Applications

Nano-catalysts are widely used across various industries:

Petroleum Refining

- Used in cracking processes to convert heavy crude oil into valuable fuels like petrol and diesel.
- Ammonia Production
- Iron-based nano-catalysts are used in the Haber process for fertilizer manufacturing.

⚡ Case Study: Automotive Catalytic Converters

Modern vehicles use nano-sized platinum-group metals to convert toxic exhaust gases into less harmful substances:

- Carbon monoxide → Carbon dioxide
- Nitrogen oxides → Nitrogen
- Unburnt hydrocarbons → Water and CO₂

Without nano-catalysts, controlling vehicle emissions would be far more difficult.

🚀 Future Scope

Research is focused on:

- Designing highly selective catalysts
- Developing low-cost alternatives to precious metals
- Creating reusable and recyclable nano-catalysts
- Applying nanotechnology in renewable energy systems

Nano-catalysis is expected to play a major role in hydrogen economy and sustainable fuel production.

👉 Career Opportunities

Students interested in nano-catalysis can pursue careers in:

- Petrochemical industries
- Renewable energy companies
- Pharmaceutical manufacturing
- Research and development laboratories
- Advanced materials industries

Nanotechnology skills are highly valued in modern chemical engineering.

★ Conclusion

- Nano-catalysts represent a major breakthrough in chemical engineering. By manipulating materials at the atomic scale, engineers can design reactions that are faster, cleaner, and more efficient.
- In the world of chemical engineering, small particles are creating big industrial transformations.

