

9. Catalyst for Sustainability

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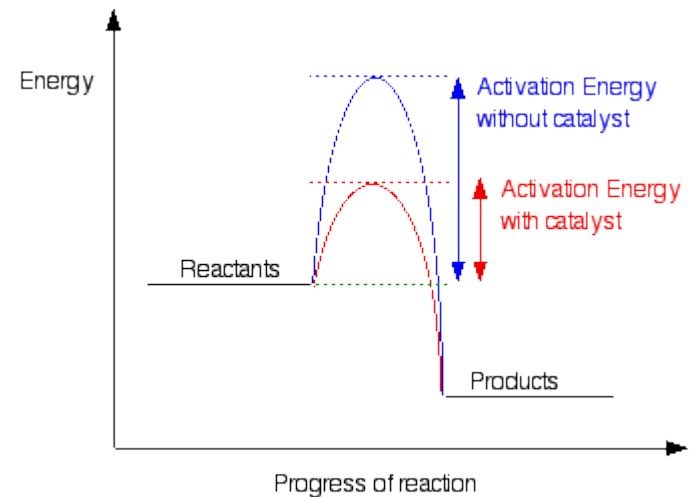
Catalyst for Sustainability

- A catalyst is a substance that increase the rate of chemical reaction

In catalyzed reactions,

- The reaction requires less activation energy for synthesis of chemicals
- Higher efficiency was found in the generation of fewer undesired compounds such as co-products, and other waste substances.

- It is not consumed in chemical reactions
- It is being used in very small quantity
- In 2020, global catalyst demand was US\$ 35.5 billion

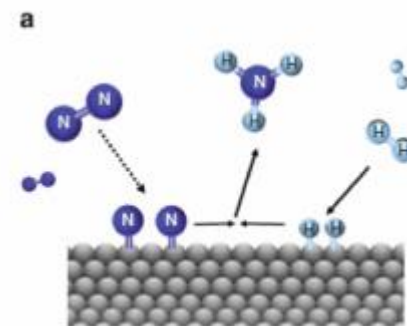


Types of Catalysts

- Catalysis is broadly divided into;

- a) Heterogeneous catalysis

- b) Homogeneous catalysis



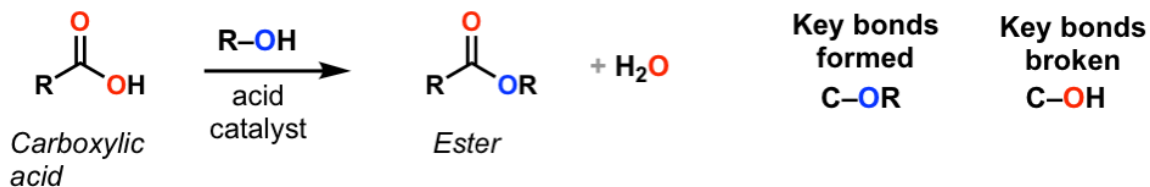
- Heterogeneous catalysis: Reactants and catalyst exist in different phases

- In Haber process H_2 and N_2 mix in the presence of Iron catalyst to form NH_3

- Homogeneous catalysis: Both reactants and catalyst exist in same phase

- Esterification of carboxylic acid is an example

Reaction of carboxylic acid with alcohol to make an ester (Fischer esterification)



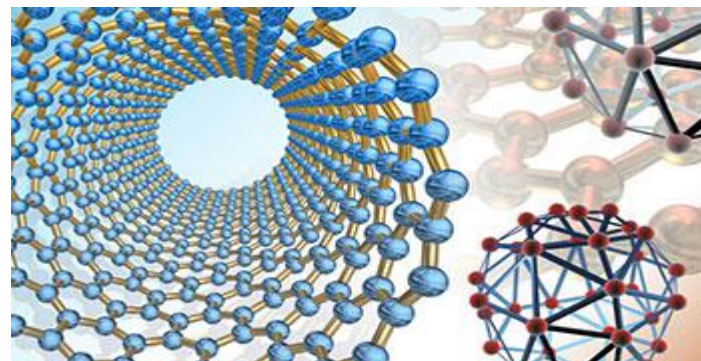
Types of Catalysts

- Enzyme catalysis (biocatalysis), photo catalysis, organocatalysis, electrocatalysis, are few other examples of catalysis
- The advantages of Heterogeneous catalysis over homogeneous was that catalyst can be easily recovered, recycled and reused
- Zeolites (hydrated aluminosilicates of the alkaline and alkaline-earth metals) are currently used catalysis either as support material or catalyst itself
- They provide high surface area and leads to increase in rate of reaction



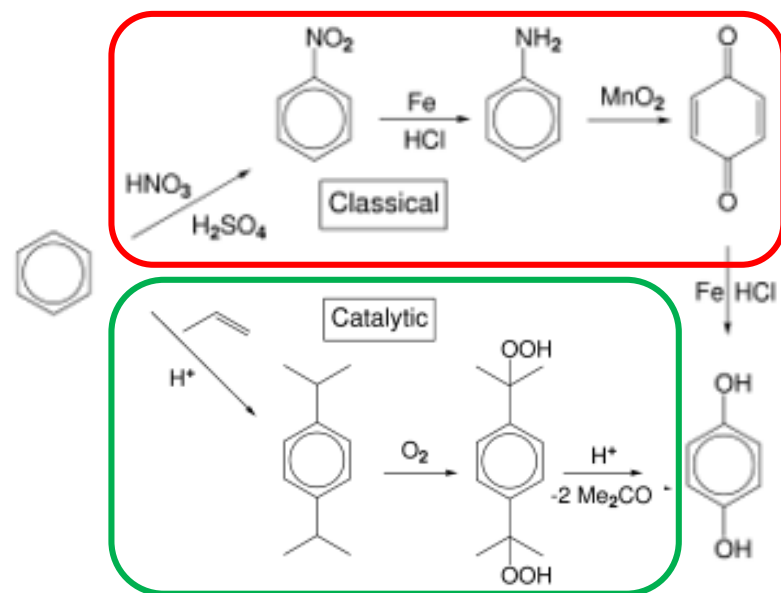
Nano Catalysts

- Nano-catalysts have combined advantages of both the homogeneous and heterogeneous catalytic systems.
- Nano catalytic system allows the rapid, selective chemical transformations with excellent product yield coupled with the ease of catalyst separation and recovery.
- As a particle decreases in size, a greater proportion of atoms are found at the surface compared to those inside. For example, a particle of
 - Size-30 nm --> 5% of its atoms on its surface
 - Size-10 nm -->20% of its atoms on its surface
 - Size-3 nm --> 50% of its atoms on its surface



Advantages of Catalysts

- The technologies used for the production of many substituted aromatic compounds have not changed in more than a century
- The time has come to replace with catalytic chemistry
- Traditionally hydroquinone was made from aniline by using stoichiometric amount of MnO_2
- Recent techniques involve auto oxidation followed by acid catalyzed re-arrangement
- For 1 kg of hydroquinone, classical method produce > 10 kg of inorganic salts whereas, catalytic method generates < 1 kg of inorganic salt as waste/byproducts



Green Catalysts

- Many heterogeneous catalysts are toxic. Therefore, green catalyst need to be developed having less toxicity without compromising in efficacy
- The term “green catalyst ” has no single definition. Currently, it is most commonly associated with catalysts that are less toxic, recoverable and/ or prepared from readily available starting materials.

THANK YOU

Any Queries ??...

THANK YOU