ICH 502: INDUSTRIAL CATALYSIS AND GREEN CHEMISTRY

Course objective:

- To study in detail about the types and applications of catalysts
- Understanding the role of organometallic compounds as catalysts
- To learn about nanocatalysts and their applications
- To understand green chemistry techniques.

UNIT I: **14 hr**

Preparation of catalyst and their behaviour, Selection, preparation and evaluation of catalysts-test reaction, promoters, carriers and stabilisers, Role of supports, preparation & structure of supports, silica, alumina, silica-alumina, zeolites, carbon catalyst manufacture, catalyst size and shape, pre-treatments, deactivation process, sintering, poisoning and catalyst fouling.

Definition of performance criteria of catalysts: Activity, selectivity, temperature response, catalyst life. Surface active agents, classification of surface active agents, micellisation, hydrophobic interactions, critical micellar concentration (CMC), factors affecting the CMC of surfactants.

UNIT II: **14 hr**

Catalysis by Organometallic Compounds:

Transition metal hydrides: Synthetic routes, structure and reactivity, synthetic applications. (Pd, Ni, Fe, Co, Ti complex); Coordinative unsaturation, oxidative addition and reductive elimination and insertion reactions, olefin hydrogenation, Wilkinson's Catalyst, Wacker process, Zeigler-Natta process, olefin metathesis, Monsanto process for the synthesis of acetic acid, heterogenization of homogeneous catalysts using polymer supports.

UNIT III: **14 hr**

Catalysis by Nanocatalysts

Synthesis of Nanoporous Catalysts Microporous materials: Zeolites- Zeotypes – Overall steps in zeolite crystallization- Zeolite synthesis via.- dry gel route- Zeolite Y- determination of surface acidity- shape-selectivity; Mesoporous aluminosilicates: Synthesis of Mesoporous Silica- MCM-41-SBA-15; Aluminophosphates; Mesoporous Carbon- Sulfated Zirconia- Ag/SiO_2 composite nanocatalysts. Nanophotocatalysis and Catalysis of Gold nanocrystals Introduction to photocatalysis: Principle- Band energy engineering- Degradation of dye, Hydrogen generation-Organic synthesis.

UNIT III: **14 hr**

Green Chemistry

Definition and principles, planning a green synthesis in a chemical laboratory, Green preparation-Aqueous phase reactions, solid state (solventless) reactions, photochemical reactions, Phase transfer catalyst catalysed reactions, enzymatic transformations & reactions in ionic liquids. Synthesis using scavenger resins, catalysis and biocatalysis.

Sonochemistry: Introduction, instrumentation, the phenomenon of cavitation, types of sonochemical reaction, Sonochemical esterification, substitution, addition, oxidation, reduction and coupling reactions. Microwave induced organic synthesis: Introduction, reaction vessel and reaction medium, concept, specific effect, atom efficiency, % atom utilisation, advantages and limitations, alkylation of active methylene compounds, N-alkylation, condensation of active methylene compounds with aldehydes, Diels-Alder reaction, Leuckardt reductive amination of ketones, ortho ester Claisen rearrangement and synthesis of enaminoketones.

Course Outcome

The students will learn the following

- Preparation of catalyst and their applications in industry.
- Utility of organometallic compounds in catalysis.
- Synthesis and application nanocatalysts

References

1. Heterogeneous Catalysis, D.K. Chakrabarty and B. Viswanathan, New Age International (P) Limited, 2008
2. Nanoporous Materials: Synthesis and Applications, Edited by Qiang Xu, CRC Press, 2013
3. Catalysis: Principles and Applications, Edited by B. Viswanathan, S. Sivasanker, A.V. Ramaswamy, Narosa Publishing House, 2011
4. Photocatalysis, Edited by Masao Kaneko, Ichiro Okura, Springer, 2003.
5. New and Future Developments in Catalysis, Edited by Steven L. Suib, Elsevier, 2013.
6. Catalysis by Gold, Geoffrey C. Bond, Catherine Louis, David T. Thompson, Imperial College Press, 2006.
7. Green Chemistry edited by Bela Torok Timothy Dransfield , Elsevieer,2017.
8. New Trends in Green Chemistry, V.K.Ahluvalia ,1st ed, Springer Nature, 2019.
9. Green Chemistry, Theory and Practice, Paul T. Anastas and John C. Warner, Oxford University Press, 1998, New York, USA.
10. Real-World Cases in Green Chemistry, Michael C. Cann, Mare E. Connelly, American Chemical Society, 2000.
11. Green Chemical Synthesis and Processes, Paul T. Anastas, Luren G. Heine and Tracy C. Williamson (Editors), ACS Publication 2000.
12. Green Chemistry in India, M. Kidwai, Pure and Applied Chmistry, Vol. 73, No.8, 1261-1263,2001.
13. Pure and Applied Chemistry, Special Topic Issued on Green Chemistry, IUPAC, Vol. 72, No.7, July 2000.
14. Organic Synthesis: Speical Techniques, V. K. Ahluwalia and Renu Aggarwal, Narosa Publishing House, 2001, New Delhi.
15. Green Chemistry: An Introductory Text, Mike Lancaster, Green Chemistry Network, University of York, RSC, 2002.
16. Green Chemistry in Indian Context: Challenges Mandates and Chances of Success, Upasana Bora, Mihir K. Chaudhri and Sanjay K. Dehury, Current Science, Vol. 82,1427,2002.
17. Organic Synthesis in Water, Paul A. Grieco (Editor), Blackie Academic and Professional, London, UK.
18. Organic Reactions in Aqueous Media, CHAU-JUN Li and TAK-Hang Chan, John Wiley & Sons Inc., New York.