International Journal in Management and Social Science
Volume 09 Issue 11, November 2021 ISSN: 2321-1784 Impact Factor: 7.088
Journal Homepage: http://ijmr.net.in, Email: irjmss@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal

SYNTHESIZED CATALYST BY ITS UTILIZATION IN SOME IMPORTANT ORGANIC TRANSFORMATIONS

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ABSTRACT

Catalytic processes are indeed greener modification as they complete in much shorter time with minimizing the need of external energy source with atom economy and high selectivity. In this article we presented a short review on utilization of different catalysts such as ionic liquids, transition metal ions, nano particles, surfactants, amino acids etc. for C-C coupling reactions to oxidation reactions. Stereoselective and regioselective transformations are also carried out using catalyst in organic synthesis. Use of catalyst in rate enhancement of oxidation reaction is of immense interest and a surplus rate increment is obtained by use of promoters.

Keywords: Catalyst, promoters, organic transformations, transition metal catalyst

INTRODUCTION

Catalysis is one of the fundamental pillars of green chemistry, the development of chemical products and methods that minimises or reject the use and generation of hazardous substances. The design and use of new catalysts benefit and catalytic systems are simultaneously achieving the dual goals of environmental protection and economic benefit. Use of Catalysis in organic reactions provides new reaction route, it can increase the stability of a transition state, reactivity of a nucleophiles, susceptibility of an electrophile to nucleophilic attack, leaving ability of a group by converting it into a weaker base.

Catalysis is a phenomenon by which even a tiny concentration of foreign substance enhances the reaction rate by lowering the activation energy Catalysis is one of the key principles of green chemistry that can significantly minimize the production or use of hazardous chemicals, simultaneously achieving both environmental as well as economic objectives. Catalysis can primarily be categorized into two types; homogeneous catalysis and heterogeneous catalysis, distinguished by their phase difference from reactants. Homogeneous catalysts are usually in the same phase as the reactants, i.e., liquid or gaseous phase, due to which they have considerably high activity and selectivity. Homogeneous catalysts have a major downside as their recovery from the reaction mixture is extremely cumbersome and generates a large number of spent materials, which can be considered an additional expense. Heterogeneous catalysts are in a different phase than reactants, i.e., solid-state; hence the recovery of heterogeneous catalysts can be accomplished by the simplest possible way, such as filtration/centrifugation/decantation, and recycled with or without activation. However, most heterogeneous catalysts are less active than their homogeneous analogues, as the phase difference hinders the interaction between substrate and catalytic site.

CATALYST IN ORGANIC TRANSFORMATIONS

Most of the organic transformation highly solvent dependent and catalyst are also used in different volatile organic media. Efforts have been made to replace such solvent by universal one. Water as a solvent has many advantages over conventional organic solvents a sit is most abundant, cost-effective, environmentally compatible, nontoxic, and non-inflammable solvent. To overcome solubility effect, use of surfactants under micellar conditions in water as an alternative green solvent in place of several hazardous organic solvents is much effective with additional catalytic effect. Some other alternative solvents such as ionic liquids, fluorinated solvents or supercritical CO2 show promising role in the related field.

Table 1: Catalysts and solvents in organic reaction

Catalysts	Solvents
Ionic Liquids	$CHCl_3$
Organometallic compounds	DCM
Enzyme	Acetonitrile
Nano-particles	Toluene
Solid metal oxide	DMSO
Lewis acid	Pyridine
Surfactant-micelle	Water surfactant

TRANSITION METAL CATALYSTS

Metal complexes of Ag(III), Cu(II), Ni(IV) and Ce(IV) ions are good oxidising agent in acid or alkaline media under proper reaction condition. Metal ions are known to play important role in many catalytic biological and nonbiological reactions.

- Transition metals are d block elements present in the middle section of the periodic table.
- They behave as catalysts, either in metallic state or in compound.

- Catalysts are recovered at the end of reaction and not used up during the reaction.
- They undergo temporary change during the course of reaction, but turned back into the original chemical state.
- Cerium (IV) oxidation reactions are catalysed by Cr(III), Cu(II), Ag(I), Ir(III), Pd(II), Ru(III), Os(VIII), Hg(II), Mn(II) for different types of substrates.
- Cr(VI) oxidation reactions are also catalysed by different metal ions.
- Role of osmium (VIII) and ruthenium (III) as catalyst in redox reaction is also investigated.

NANOPARTICLES AS CATALYST

Nanoparticles are efficiently used as catalyst in different organic transformation successfully. Pt nanoparticles over Pt/CeO_2 catalysts are utilised for catalytic oxidation of toluene. Hydrogen generation from methanolysis of ammonia borane using rhodium (0) nanoparticles was reported. Nanoceria supported palladium (0) nanoparticles are found to be effective catalyst for dehydrogenation of formic acid at room temperature. Cu-based nanoparticles have been known for varied applications such asazide-alkyne cycloaddition, reduction reactions, oxidation reactions, C-C coupling reactions. Heterogeneous Pd(0) nanoparticles are also found practical application in C-C cross coupling reactions. An environment friendly reduction of nitrobenzene to aniline in aqueous medium was performed by tri-block copolymer polyoxyethylenepolyoxypropylene–polyoxyethylene (P123) stabilized Pd nanoparticles. Micelles nanocelluloses as supports for metal nanoparticles are highly productive in carrying out organic transformations.

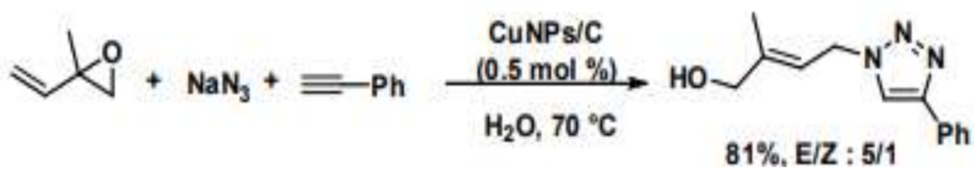

Figure 1: Azide-alkyne cycloaddition reaction by Cu NPS/C in water.

CONCLUSION

Catalytic process completes in much shorter time with minimizing the need of external energy source with atom economy and high selectivity, hence these processes are indeed greener modification to the existing process of chemical transformations. Several examples are presented here, from C-C coupling reactions to oxidation, attest the applicability and potential of catalyst in synthetic organic chemistry. Icing to the cake is done by promoter catalyst combination. Studies showed that such combinations complete a slow chemical process almost instantly.

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