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Green Chemistry Alternatives for Sustainable Development in Organic Synthesis

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Abstract: This paper includes green efforts towards awareness of green chemistry as an alternative for organic synthesis on existing methods and provides new tools, knowledge and design of organic synthesis in a way which will contribute to the societal economy to protect environment and health. To avoid the environmental hazards generated from organic synthesis green chemistry alternatives plays a key role in sustaining the planet from gray effect of various chemical and solvents in synthesis.

Keywords: Green Chemistry**,** sustainable development, green alternatives, organic synthesis.

I. INTRODUCTION

Green chemistry is a new approach for organic synthesis that is growing rapidly at both national and international repute. Green synthesis has been introduced as method for environmental and economic progress. The main idea of green chemistry is to enhance production efficiency, minimize waste generated during the production. Green synthesis must follow few of the green strategies, such as avoid waste, be atom economic, avoid auxiliary substances, use catalytic amount of catalyst and recycled, reduce energy requirements and be energy efficient, use renewable materials and bio-degradable materials.

Green and sustainable chemistry simply stated as "The design, synthesis and applications of chemical techniques and methodologies used for to minimize and reduced generation of feedstock, by-products, solvents, reagents that are harmful to human beings and environment". To save our environment form the disadvantages of gray chemistry, green chemistry is the best alternative for green era of synthesis.

Dr. Paul Anastas and Dr John Warner outlined Twelve Principles of Green Chemistry which are as follows:

1. To maximize atom economy: - To take care that all atoms in reactants are actually present in the product than so many by-products. For example, Use of solvent-less sample preparation techniques.
2. To design less hazardous chemical synthesis: - To find the safer paths for chemical synthesis which are not harmful to environment and human beings. For example, Adipic acid synthesis by oxidation of cyclohexene using hydrogen peroxide.
3. To prevent waste: - To apply only those chemical reactions which can't make by products that need to thrown away. For example, new, less hazardous pesticides (e.g. Spinosad).
4. To use renewable feedstock:- To utilize starting material which are renewable in nature such as plants rather than non-renewable as fossil fuels etc. For example, Hydrogenation of carboxylic acid to aldehydes using solid catalysis.
5. To use catalyst in catalytic amount: - Use very little amount of catalyst in chemical transformation than putting lot of different chemicals together. For example, Supercritical fluid extraction, synthesis in ionic liquids.
6. To increase energy efficiency: **-** Avoid waste of energy for synthesis try to do reactions at low or room temperature. For example, Polyolefin's- polymer alternative to PWC (polymerization may be carried with lower energy consumption)

7. To do real time analysis for pollution prevention:- Monitor the chemical reactions and control in such a way that they do not pollute the environment. For example, production of surfactants.
8. To use safer solvents and reaction conditions: - Always take non-hazardous solvents and other materials for any chemical reactions means simply find safer solvents. For example, on fiber derivatization vs. derivatization in solution in sample preparation.
9. To avoid chemical derivatization :- Do not try to make derivatives of harmful compounds in order to carry a transformation, this change requires more chemicals convert to desired substance. For example, Efficient Au (III) catalyzed synthesis of □-enaminones from 1,3-dicarbonyl compounds and amines.
10. To minimize potential for accidents: - Avoid the use of chemicals which catch fire easily or explode or lead to harmful emission. For example, Synthesis of biodegradable polymers.
11. To make biodegradable substances: - Design and synthesize chemicals and products which can be degrade easily after use.

12. To design safer chemicals and auxiliary products:- Prefer to make chemicals or products which are not poisonous or harmful to the environment. For example, Di-Me carbonate (DMC) is an environmentally friendly substitute for di-Me sulfate and Me-halides in methylation reactions.

Green techniques can be largely reviewed by the first two of the above principles, with the following ten being separate areas of organic synthesis. Generally speaking-designing efficient, effective, and environmentally benign chemicals and organic processes largely captures the concept of green and sustainable chemistry.

In this way green chemistry principles should be applied for all aspects of life cycle including human beings. By implementing these ideal principles in chemical synthesis one can save nature and can remain safe from different threats of chemicals.

II. CLASSICAL CHEMISTRY IN ORGANIC SYNTHESIS

For the development of science the synthesis of molecules is an important parameter. Organic chemistry is the only area where we find classical routes for the synthesis of molecules. Synthesis of smaller, easily and commercially available, building up complex molecular structure is art in organic synthesis. Therefore, the efforts of synthetic chemist are focused on target oriented synthesis as well as method oriented synthesis. In target oriented synthesis the goal of synthesis is to obtainment of a more or less complex organic molecule. The method oriented synthesis is concerned with the development of new reagents, new catalyst, new reaction and work procedure.

By the turn of 20th century millions of organic compounds has been discovered and synthesized using classical organic synthetic methods. The various methods implemented for synthesis of organic compounds includes use of organic solvents, use of toxic reagents and catalysts, use of harsh reaction conditions, tedious work up process, long reactions times, which prompted us to further development of new greener alternatives to organic synthesis.

These methods used in classical chemistry for organic synthesis have hazardous impacts on human beings and environment. Some inherent features of most of the organic solvent are high flammability, volatility, their danger and toxicity. Every year waste solvents form the industries are released into the atmosphere causes air pollution and water pollution. Continuous inhalation and high concentration exposures can causes severe diseases. In classical organic synthesis catalysts are used are substances or reagents to enhance or accelerate the rate of reactions. But there are certain drawbacks and limitations for use of catalysts in classical organic synthesis such as, insolubility of catalyst, higher activation energy of catalysts, use of stoichiometric amount, toxic in nature, costly and expensive, limited selectivity.

III. EMERGING GREEN CHEMISTRY TOOLS IN ORGANIC SYNTHESIS

The difficult task for chemists and others is to create new products, processes and services that achieve the societal, cheap and environmental boons that are now required in organic synthesis. This requires a new approach which sets out to minimize the materials and energy requirement of chemical processes and products, minimize or eliminate the dispersion of hazardous chemicals in the environment, to make as large as possible the use of renewable resources and extend the durability and recyclability of products. For organic synthesis the challenges for chemists include the discovery and development of new synthetic pathways using green chemistry tools such as,

- Green solvents
- Green catalysis in organic synthesis
- Dry media synthesis
- Catalyst free reactions in organic synthesis
- Energy efficient synthesis

1. USE OF GREEN SOLVENTS:
Green solvents have been distinguished for their low toxicity, low miscibility in water, easily biodegradable under environmental conditions, large boiling point (not easy evaporating, low offensive smell, health problems to workers) and easy to recycle after use. Recently, green solvents used by the chemist are Water, Ionic Liquids, Supercritical fluids and Polyethylene glycols. By using these green solvents under the concepts of green chemistry, has achieved outstanding progresses towards the development of green reaction processes in organic synthesis.

2. GREEN CATALYSIS IN ORGANIC SYNTHESIS:
Catalysis is one of the key part of Green Chemistry, the design and use of new catalysts and catalytic systems are simultaneously obtaining the dual objectives of environmental protection and economic benefit. Catalysis offers numerous Green Chemistry advantages including lower energy necessities, catalytic against stoichiometric quantity of materials, enhanced selectivity, and decreased use of processing and separation agents, and permit for the use of less hazardous materials. Catalysis is principally divided in two branches: homogenous catalysis, when the catalyst is in the same phase as the reaction mixture (typically in liquid phase), and heterogeneous catalysis, when the catalyst is in a different phase (typically solid/liquid, solid /gas/liquid/gas). One of the main advantages of homogenous molecular catalysts, when they work under ideal conditions, is that their active sites are spatially well separated from one another, just like as they are in enzymes catalysis. Heterogeneous catalysis, in particular, addresses the goals of Green Chemistry is to providing the ease of phase separation of product and catalyst, bifunctional phenomena involving reactant activation over between support and active phases, thereby eliminating the need for separation through distillation or extraction. In addition, environmentally useful catalysts

such as clays and zeolites, may replace more hazardous catalysts currently in use. The choice of the catalyst is of prime importance in these environmentally conscious days. Green Chemistry requires the replacement of highly corrosive, toxic and polluting acid catalysts with eco-friendly and renewable catalysts like ionic liquids.

3. DRY MEDIA SYNTHESIS IN ORGANIC SYNTHESIS:

A dry media reaction or solid-state reaction or solvent less reaction is a chemical reaction system in the absence of a solvent. A solvent-free or solid state reaction may be carried out using the reactants alone or incorporating them in clays, zeolites, silica, alumina or other catalytic substances. Thermal process or irradiation with UV, microwave or ultrasound can be used to bring about the reaction. Solvent-free reactions obviously reduce pollution and economic due to simplification of experimental procedure, work up skill and saving in time. These would be especially significant in industrial production. Often, the products of solid state reactions turn out to be different from those incurred in solution phase reactions. This is due to specific spatial orientation or packing of the reacting molecules in the crystalline phase. This is true not only of the crystals of single compounds, but also of co-crystallized solids of two or even more reactant molecules.

4. CATALYST FREE REACTIONS IN ORGANIC SYNTHESIS:

In organic synthesis the term catalyst is used to a substance or reagent which enhance or accelerates the rate of reaction. The process in which catalyst is used is called catalysis. A catalyst may participate in multiple chemical transformations. The impact of a catalyst may vary due to the presence of other substances which reduce the catalytic activity or which enhance the activity. Unlike other reagents in the chemical reaction, a catalyst is not consumed.

The catalyst may alters reaction rate or selectivity, or enable the reaction at lower temperatures. The catalyst lead to the making of several bonds in one sequence without changing the reaction conditions, isolating the intermediate and reagents, thus allowing a decrease of waste, cost and labour. Thus investigations have highlighted certain limitations and drawbacks of the aforementioned protocols, such as insolubility of catalysts, longer reaction times due to higher activation energy of catalyst, use of stoichiometric amount, toxic in nature, costly and expensive, limited selectivity, etc.

Conventionally, catalysts (homogeneous and/or heterogeneous) or reagents along with organic solvents (lethal, poisonous, or environmental benign solvents) are usually applied in classic organic reactions to achieve targeted products. Avoiding the use of catalyst and dangerous solvents in organic reactions is a highly challenging task. So, catalyst free synthesis of various organic compounds makes a best greener alternative for chemist in organic synthesis.

IV. CONCLUSION

The effect of globalization and technology can be minimize by using new alternatives for the greener methods in organic synthesis using green chemistry principles like solvent-free organic reactions, catalyst- free organic reactions, use of water and ionic liquids as a green solvents in organic synthesis. The literature survey describes a growing demand of synthetic methodologies for the welfare of society and human health. These perspectives of green chemistry prompt us to develop greener alternatives to organic synthesis.

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