Green Chemistry for Chemical Synthesis

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Abstract: *Green chemistry has been a major part of sustainable development and also had an important trend in recent years. In order to extrapolate the state of the work in this field, a systematic laboratory work has been performed, also it's is used to identify possible developments for future research. Now specially, the main aim of this research is to investigate how Green Chemistry, Sustainability and Circular Economy concepts are related to each other and how researchers are addressing and analyzing this relation. Since the main purpose of this chemistry is to produce intermediate substances that are generally used by other industries, this focus is mainly placed on industrial sector. Or we can say, chemistry involves most of production systems. Green chemistry for chemical synthesis define our future challenges and scopes in working with chemical procedures and products by inventing new reactions that can give maximum desired products and less or no by-products, designing new synthetic procedures and apparatus that can simplify operating in chemical productions, and to seek greener solvents that are environmentally and ecologically benign. Following basic principles of green chemistry should be followed:*
1) Prevention of waste or by-products.
2) Maximum incorporation of reactants in final products.
3) Minimization of hazardous products
4) To design safer chemical
5) To select most appropriate solvents
6) Use of catalyst should prefer.
7) Biodegradable products.
8) Such manufacturing plants should be designed to eliminate the possibility of accidents.

Keywords: Green Chemistry, Green Synthesis, Development of Green Chemistry, Principles of Green Chemistry, Application of Green Chemistry.

I. Introduction

Over the past two centuries, fundamental theories and reactivities in chemistry have been productively established. Such theories and reactivities have been providing the one of the main foundations for the chemicals that generates critical basic living needs such as food for the world's population, it achieves various medical areas that save n number of lives and improve people's health, and produces such materials which are helpful to the present and future needs of human.

Less than two centuries ago, organic compounds were believed to be only approachable through biological processes under "vital forces". Today, many complex molecules of great complexity can be synthesized.

The total syntheses of natural products with mostly high complexity such as vitamin B12 and palytoxin in the laboratory are references of achievements as compare to the construction of the great achievements at the molecular scale. The capacity or ability to generate selective molecules for medicines, pharmaceuticals, petro-chemicals and materials much of science and the research themes within the chemistry laboratories.

II. Methodology

Some consideration was given to the use of different reagents in acquired quantities, which were not involved into the target molecule and would result in significant by-products. But, in a balanced chemical reaction, a simple addition or cyclo addition incorporates all atoms of the starting materials into the final product. Some of these methods belong to less-common techniques, as, for example, magnetic field-assisted synthesis etc.

Microwave irradiation: So what is microwave irradiation? This is a green source of heating both in organic and inorganic synthesis, and it is based on the conduction and dipolar polarization type. A number of organic molecules have been reported as because of this economic, efficient, fast and clean way, now recognized as a conventional synthetic chemistry tool, which has made a great contribution to organic synthesis. The electromagnetic energy, is being transformed into heat and other kind of energy, due to this is able to drives interactions between compounds. Microwave irradiation and the components are in a direct interaction with each other, due to that a minimum of energy is needed for its heating, and also without expanding the process to the furnace material in that.

The Microwave heating is almost rapid, very fast, due to the fast transfer 'Microwave energy—heat', and can be stopped immediately by a simple turning-off of the Microwave equipment.

Hydro(solvo)thermal synthesis: A solution reaction-based approach is applied to synthesize compounds, crystallize and grow single crystals and poly-crystals at high pressures (normally up to 10 bar) and elevated temperatures (generally up to 300°C) in water or organic solvent media.

The main advantage of the this method is the possibility of the formation of the crystalline components, which are unstable at the melting point of the desired compound; the main disadvantage is the necessity to have expensive equipment. Morphological control and crystallinity for the formed compounds can be made available by changing pressure and temperature, solvent and reaction time or precursors' method's ratio. Hydrothermal reactions in the water are normally considered as more stable and suitable for green chemistry purposes, because it's being environmental friendly, and are widely used and applied to textile a variety of materials. This method required as minimum loss of reactants and mainly higher yields of products, are especially useful to obtain classic and unique nano-structures with desired shape and size control: these are in the form of powders, or films and especially these are from one- to three-dimensional nano-crystals.

Solvents and catalysis in green processes: For the organic synthesis, where hazardous solvents are mostly used, the 12 rules of green chemistry can be successfully applied maximal atom economy (avoiding formed by-products and the wastes, in particular using solventless techniques, i.e. dry media), safe and non-hazardous chemical routes without harmful chemicals, use of renewable precursors (i.e. plants are used instead of fossil fuels), catalysts in small amounts (These are non-harmful and preferably solids catalyst are used in order to be renewable), safer chemicals and solvents, biodegradable substances, as well as prefer to avoid energy waste, to prevent pollution and To minimize possibility of hazardous accidents. Solvents represent a major source (80–90%) of pollution in organic (and not only) chemical processes. Conventionally organic solvents, which are derived from oil, are , hazardous and possess bad health, on environment and safety impacts. So, the are to be used as green medium for Organic synthesis need processing biodegradability, low toxicity, boiling should be high, it should be easily recyclable and immiscible with water. Due to this, non-toxic and biodegradable glycerol, which is the main side product in the formation of biodiesel, is mainly suitable for green synthetic organic synthesis and also called 'organic water'. It has various advantages which are as great availability, can be biodegrade, not so expensive, vapour pressure is low, high boiling point; also, glycerol is immiscible that is it can be mixed with aliphatic hydrocarbons, because of high polarity it is capable to form hydrogen bonds and solubilizes both inorganic and organic compounds.

II. Literature Review

According to the main systematic literature review methodology, different types of questions were formulated, in order so that it can be schematic and to get a broad view about the evolution of green chemistry research.

The selected articles were analyzed through different criteria, including the Triple Bottom Line (TBL) framework, and were divided into different clusters, according to purposes, impacts and scope of each research.

The analysis of papers shows that chemical industry is able to contribute to a fair transition towards a greater economic, environmental and social sustainability. Even if the main focus of GC is the environment, GC is getting closer to TBL pillars, representing the main tool for chemical industry to implement Sustainable Chemistry (SC) system and to realize the transition towards sustainability and CE. Finally, main results were summarized in a framework that shows the connections among systems and tools, highlighting main synergies.

The processes and syntheses that have as main focus the green chemistry that have been found in the literature has great advantages over traditional methods, among which are the reduction of toxic emissions to the environment, reactions that do not generate by-products and processes more optimal, which in turn reduce production costs, such as costs derived from the treatment or storage of waste and the adverse health effects on personnel working in the process.

III. Result and Discussion

- Cleaner air: Less release of hazardous chemicals to air leading to less damage to lungs
- Cleaner water: less release of hazardous chemical wastes to water leading to cleaner drinking and recreational water
- Increased safety for workers in the chemical industry; less use of toxic materials; less personal protective equipment required; less potential for accidents (e.g., fires or explosions)
- Less exposure to such toxic chemicals as endocrine disruptors
- Many chemicals end up in the environment by intentional release during use (e.g., pesticides), by unintended releases (including emissions during manufacturing), or by disposal. Green chemicals either degrade to innocuous products or are recovered for further use
- Plants and animals suffer less harm from toxic chemicals in the environment
- Lower potential for global warming, ozone depletion, and smog formation
- Less chemical disruption of ecosystem
- Higher yields for chemical reactions, consuming smaller amounts of feedstock to obtain the same amount of product
- Fewer synthetic steps, often allowing faster manufacturing of products, increasing plant capacity, and saving energy and water
- Reduced waste, eliminating costly remediation, hazardous waste disposal, and end-of-the-pipe treatments
- Allow replacement of a purchased feedstock by a waste product
- Better performance so that less product is needed to achieve the same function
- Reduced use of petroleum products, slowing their depletion and avoiding their hazards and price fluctuations
- Reduced manufacturing plant size or footprint through increased throughput
- Less use of landfills, especially hazardous waste landfills

IV. Conclusion

Green chemistry is a considerable contribution to this field. The 12 key principles of green chemistry, on whose basis the present review has been written, mean, in particular, the use of alternative raw materials (such as plants, agricultural wastes), renewable sources and effective catalysts, non-hazardous manufacture when possible without the use of toxic chemicals and ideal case when CO2 and water as by-products, prevention of unnecessary wastes, lower-hazard chemical reactions, minimization of energy consume, leading to degradable reaction products, non-persisting in the environment. Energy-efficient processes such as biotransformations, photochemistry, ultrasound or microwaves and use of bioactive molecules in chemical processes yielding high-value molecules—all these are green processes.

The green chemistry methods include several non-contaminating physical methods as microwave heating, ultrasound-assisted and hydrothermal processes or ball milling, frequently in combination with the use of natural precursors, which are of major importance in the greener synthesis, as well as solvent-less and biosynthesis techniques. Biological methods (the use of bacteria, viruses, yeasts, plant extracts, fungi and algae) perfectly fit to the green chemistry, in particular to nanochemistry, resulting in biologically produced nanoparticles, which are non-toxic, stable, environmentally friendly and cost effective. Plant extracts contain polyphenols, terpenoids, proteins, enzymes, peptides, sugars, phenolic acids and bioactive alkaloids as a driving force for nanoparticle formation.

It is important to highlight that green chemistry and the awareness that this has given to the scientists has allowed us to make exhaustive revisions of the traditional methods to optimize them and to implement them based on the standards of the present time and, in some cases, the traditional methods have been substituted, bringing as a consequence more optimized processes both at the laboratory level and at the industrial level, as it has been seen in the reports mentioned in this review.

Acknowledgement

I would like to thank I/C principal Dr. Sajid Shaikh, and all my seniors in chemistry department Mr. Shoaib Khan, and Mr. Nitin Pawar sir for their advice and kind suggestions.

Next I would like to thank this institution A-I-J Degree college of Science, Murud Janjira because of which I got chance to writes this research paper. Which have provided opportunity by organizing International E-Conference on recent trends in chemical science, physical science, life science and computer technology. I would also like to express my very great appreciation to all the staff of the A-I-J Degree college of Science Murud Janjira.

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