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Sustainable Green Chemistry in Green Technology Environment

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***Abstract*: Green Technology is the development and application of concepts of green chemistry through different technological processes. This "Green" approach involves use of renewable raw material, create economic efficiency, identify, and use alternative chemical reactions and use of non-conventional solvents to achieve economic and environmental benefits. To be green substitute for hazardous organic solvent, the alternative green chemistry solvent should be non-volatile, non-flammable, stable, non-toxic, biodegradable and made with environment friendly processes. Such solvents can be used in big manufacturing industries for various purposes and bring down the pollution effect on environment through sustainability and re-use, recycle aspects. "Ecotoxicology" is the method to determine the toxic impact of newly synthesized chemicals by monitoring the greenness of the processes.**

***Keywords*: Green technology, green solvents, eutectic solvents.**

1. Introduction

In the year 1991 by Paul Anastas and John Warner introduced the concept of green technology. In their book "Green Chemistry: Theory and Practice". They defined green chemistry as "The way of creation and application of chemical products and processes that reduce or eliminate the use or production of substances hazardous to human health and the environment.", Similarly in 2012, as per US CPA's definitions, green chemistry is "Design of chemical products and processes that reduce or completely remove the application and creation of harmful and dangerous substances."

Even if the definition of green chemistry is simple, its concept is complex and summarized in 12 principles of green chemistry. Green technology concept can be implemented by following those principles and satisfying these criteria in the technological processes. When it comes to green manufacturing, many solvents are needed in the processes and after first use or mostly second time use, industry treated those coolants or solvents as waste and this process will harm the environment badly, so for efficiency and sustainability, which plays an important role in industries, resulting lower the pollution effect [1].

In a survey, it is observed that industries not bothering about usage of non-renewable resources and use them freely, which will not bring cost effectiveness thus, compromising quality to increase quantity and using it to produce a product over and over will not bring efficiency, which impacting business too [2].

Energy is the most essential thing to ensure sustainable development and the forward ongoing approach of human civilization. For over the last three decades, the consumption of energy has doubled the rate it was back in the last century [3]. For sustainable development, green design along with green manufacturing processes comes together, we can consider sustainable product development through design and manufacturing processes for example here, even with Carbon Fiber Re-enforced Composites (CFRC). As they possess advantages like high weigh-to-strength ratio, easy molding feature, higher tensile property which gives material a long life and of course, turned into the sustainable product [4].

At present, automobiles or even machining systems which uses traditional solvents and coolants, have sensor technologies, which gives health of coolants and solvents for when to replace or top up at least. So, easy to use and green manufactured sensors, called Micro-Electro Mechanical Systems (MEMS) sensors, being used widely. MEMS are sensors are designed, developed and mass produced for more efficiency at first place, when comes to sustainability [5].

Because, of the miniature sizing, these sensors are widely used for effective costing and quality input [6], [7]. Hence, these solvents will a much bigger role in automotive companies, as automobiles have lots of parts which are in metal kinds and need heavy machining with the coolants passed on it to cool it down to retain the chemical and physical properties of those parts.

We can use these solvents/coolants at many industries like dye, manufacturing of heavy-duty machines, automobile. Coolants can be used in automotive radiators and for engine cooling. As traditional engines already causing harmful gases because of petrol and diesel usage. Sometime, due to overheating of an engine causes pre burn or unburn fuel scenario comes in picture. So, why these engines overheat, because, many times, radiator won't work properly or coolant level is down, or improper and ineffective coolants gets used because of high coolant prices.

So, these bio-degradable coolants are helpful in this case, to keep the engine cool and let complete fuel burn with full energy transfer efficiency. As Petrol, Diesel became so restricted to be available, biodiesel took place over them, which can burn almost completely and emits 85% less cancer-causing agents through the exhaust of any automobile using bio-diesel engine,

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this is an outline or approach of green development which requires green, sustainable design, along with manufacturing processes sustainability [8]. The main purpose green solvents, chemical or coolants is to remove hazardous chemicals from it to reduce, adverse effects on environment through pollution.

2. Pillars of Green Chemistry for Sustainable Technology

A. Prevention

At first place prevent the waste instead creating it and then clearing.

B. Safe Chemical Design and Development

Design and develop chemical to their specific function with less toxicity.

C. Atomic Level Research

Synthesize the chemical with such materials which will not react with the end product.

D. Chemical Synthesis

Practically, create the methods and processes, substances in the chemical (for ex. Coolants and solvents) so that it possesses less toxicity and impact on surrounding nature and society.

E. Auxiliaries

Separation agents should avoid and if needed develop the process to create them biodegradable.

F. Energy Efficient Processes

Wherever the synthetic method is used, try to develop it to sustain in room temperature and not in the temperature-controlled environment.

G. Use of Renewable Energy

For technicality and economic processes, use the renewable sources, instead of depleting ones.

H. Minimization in Biproducts

To achieve biproducts, organizations use additional reagents which are usually harmful when go through reaction processes, avoid it by using renewable raw material.

I. Catalytic Convertors

These are better because of stoichiometric reagents.

J. Degradable Aspect

Chemical substances should be created as degradable in an environment as a priority and must be breakdown into degradable atomization for safer environment.

K. Analytical Approach

Analyze the quantitative and qualitative hazardous substance impact on pollution in real time, to control the processes and modifications wherever necessary.

L. Safer Chemistry in between Environment and End User

Explosiveness, Fire prone and releasing fumes should be consider while development and approach the safety everywhere on the first place.

The goal of green chemistry i.e., obtaining the environmental and economic benefits, can be achieve through directions such as use of renewable raw material, use of alternative reaction condition like ultrasound-microwave assistant processes, and also by use of non-conventional solvents as substitute for hazardous solvents. These solvents should be non-volatile, in order to reduce air pollution; non-flammable, for process safety; stabile, for recycling and reusing. Potentially Synthesized by an environmentally friendly synthetic procedure, nontoxic and biodegradable, for environmental impact. These vast requirements can be partially matched by ionic liquids (IL) and few by deep eutectic solvents (DESs) [9]-[13]

The development of ILs started a few decades ago and they were considered as a promising alternative to traditional organic solvents, from both the environmental and technological perspectives. But in the recent years, the perception of their “greenness” was partially changed, as the scientific community intensively assessed the risk of their application based on the entire lifecycle, including preparation methods, methods of their degradation after use and their impacts on the ecosystem [14]. Also, the cost of these solvent is 5 to 20 times higher than regular solvents which make them economically non-viable. Due to the above-mentioned drawbacks, scientific research went further on with the investigation of alternative solvents and the 4th generation of ILs entered the stage [15]-[20].

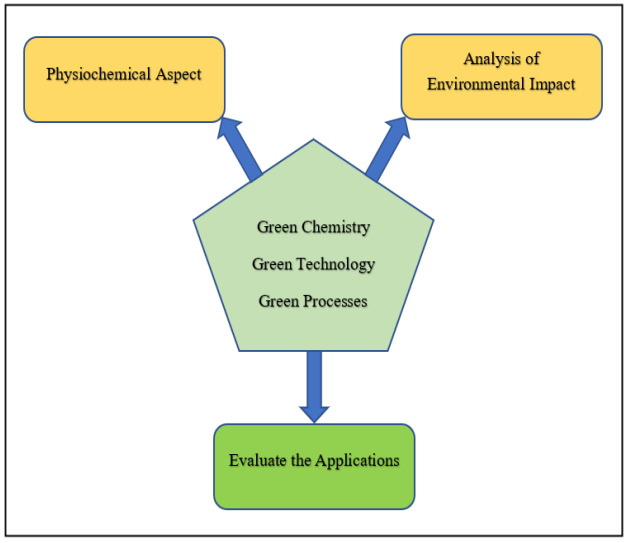

Fig. 1. Proposed directions of green solvents development

The 4th generation is, namely, natural ILs and deep eutectic solvents, which have in common that they can be synthesized from natural or renewable compounds; but actually, DESs are not the 4th generation as they are not composed of ions [21].

DESs are prepared by mixing few low-cost components (e.g., quaternary ammonium salts, amides, organic acids, polyalcohol) to form a eutectic mixture based on hydrogen bonding interactions.

DESs have similar physical properties and phase behavior to ILs and retain most of their excellent technological properties, but at the same time being low-cost alternative with the

presumed better environmental profile [22].

Overall, investigations on alternative solvents are directed towards three major domains:

1. Synthesis and physicochemical characterization
2. Evaluation of environmental impact
3. Possible applications in green processes and technologies

Ecotoxicology, an interdisciplinary scientific field based on the combined knowledge of ecology and toxicology, can serve as a way of monitoring the greenness of the process. By applying methods and techniques of ecotoxicology we can check the twelve principles of green chemistry in order to elucidate if the obtained process and/or technology satisfies most of those criteria and whether it is or it is not in agreement with the concept of green chemistry.

3. Conclusion

In order to develop new solvents, coolants, or any chemical along with less or zero impact on environment in the matter of pollution, green approach is must. Because of many manufacturing industries usage of chemical and their improper treatment causes hazardous outputs adversely impacting human health has to be stopped and bio-degradable chemical need to be developed.

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