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Green Chemistry an Overview and Its Use for Chemical Synthesis

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Abstract – Green chemistry literature has undergone a dramatic rise in the new millennium. In addition, papers of this kind are published in general, organic, and catalytic chemistry journals in adhoc journals. In this region, the high proportion of communications suggests this is a hot topic. These studies are mostly for more environmentally friendly chemical processes considered on enhanced catalytic structures, less toxic solvents & rarely, physical "alternative" techniques. Although compliance with the postulates of green chemistry (GC) is recognizable in this direction. The number of preparatory papers proposing an environmental assessment, for example is rapidly increasing.

Keywords – Green Chemistry; Green Synthesis, Development of Green Chemistry, Principles of Green Chemistry, Application of Green Chemistry.

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I. INTRODUCTION

Anastas (1998) coined term GC in 1991. Anastas and Warner created Green Chemistry Anastas ' twelve principles (1999) which serve as guidelines to prevent chemists from developing and evaluating how green synthesis, compound, process technology is. Such principles tackle some basic aspects such as the use of different solvents, the amount of waste generated, the use of catalysts and reagents, energy efficiency, nuclear economy, and the utilization of safer chemicals & conditions for reaction.

The approach to green chemistry is comprehensive in nature and includes almost all branches of chemical sciences such as synthesis, catalysis, bio-inorganic, nano-chemistry, material science, drug discovery, pharmaceuticals, etc. The Green Chemistry Revolution presents an immense no. of opportunity to develop and apply new synthetic solutions using renewable feedstock; environmentally friendly reaction conditions, reducing fuel, and developing chemicals that are less toxic and intrinsically safe. The source and foundation of GC is inherent in a green world to achieve environmental and economic sustainability. One important element of sustainable chemistry is commonly defined as chemical research aimed at optimizing chemical processes and products with regard to consumption of energy and materials, inherent health, toxicity, environmental degradability, etc. Although progress has been made in organic chemistry, green chemistry, and chemical material environmental assessment, the social dimension of sustainable chemistry continues to be fully understood in all branches of chemical science.

The inclusion of sustainable chemistry in chemical education from the very beginning is a prerequisite for this. GC is use of set of principles that diminish or eradicate use of hazardous substances in chemical product design, manufacture and application. For reality, Green Chemistry is used to address a much broader range of issues than covered by the concept. Green Chemistry also includes eliminating other related environmental impacts as well as using and producing better chemicals with less waste, including reducing the amount of energy used in chemical processes. GC is no unlike from traditional chemistry it promotes similar creativity & innovation that traditional chemistry is central. There is a distinction, however, not seen in their goals to rate the world very high. But with growing environmental awareness around the world, chemists are faced with the challenge of developing new goods, processes, and services that meet the necessary social, economic, and environmental goals. Since the types of chemicals and the types of transformations are very different, so are the solutions proposed for Green Chemistry. [1]

II. HISTORY

Green chemistry is based on developments in pre-field areas and disciplines, including catalysis, atom-economic. Before green chemistry was established in early 1990s, processes, emissions, & industrial chemicals in people's daily lives caused widespread concern about possible adverse impacts on human health & surroundings. "Instead of continuing to refer litigants, lawmakers and regulators to address these critical issues in a reactive manner, members of the chemical community are united around a common goal: to design chemical products & processes that decrease or eradicate them.

1. The 1990s was also the decade when the area of sustainability was developed and the 1990 Pollution Prevention Act was passed, signaling a regulatory policy change from pollution control to pollution prevention as most effective strategy to tackle many environmental issues. The United States in 1995. President Bill Clinton assisted Environmental Protection Agency (EPA) in setting up an annual awards program recognizing scientific advances in academia and industry that promoted green chemistry.

2. It produced the annual Green Chemistry Challenge Awards, a significant forum for green chemistry awareness.

3. In 1997, 1st GC Ph.D. program was developed by University of Massachusetts in Boston.

4. In collaboration with EPA, Dr. Joe Breen, a 20-year-old retired EPA staff member and chemist Dennis Hjeresen co-founded the Green Chemistry Institute (GCI) as an independent non-profit organization with a workforce dedicated exclusively to promoting green chemistry. [2]

III. THE DEVELOPMENT OF GREEN CHEMISTRY

Sustainable chemistry in its mature form, as mentioned above, can be considered a discipline established for about 10 years. Thus, when entering the second decade of 21st century, it might be worth analyzing its development and understanding in which direction(s) it moves. It has become difficult to update the state of the art of green chemistry, as this subject is too comprehensive. What is attempted below is to offer a review of which topics in the field of green chemistry can be classified and correspond to the key concepts of this discipline. On the one hand, the summary compares what is expected from green chemistry and how chemists react to this expectation in other one.

As for the first issue, Anastas and Warner's concepts, which were rephrased differently, articulate the main challenge in sustainable chemistry (and chemical engineering). Which allow chemists to use alternative feedstocks, avoid dangerous reagents or materials, and reduce waste. Green chemistry is an interdisciplinary endeavor, led by the" benign by nature" concept. It involves incorporating the desirable features as early as possible when designing a system and contemplating the product's entire lifecycle, preferably.

It is no longer acceptable for" a new molecule to be developed or a new process to be discovered" and then for the synthesis and implementation to be optimized in separate steps. Alternatively, the chemical and engineering aspects have to be fused from the start and the environmental aspects have to be quantitatively assessed at an early stage, giving priority to new processes that combine productivity and environmental protection. The goals are those suggested by the 12 principles listed above or in similar statements such as those due to Clark and Sheldon. They include an increased integration of the reagent atoms in the material, the use of catalytic rather than stoichiometric reagents, as well as the development of new synthetic pathways, new methods of purification, and the implementation of intensive less harmful processes. In fact, the system must be economically sound, otherwise it is futile to be environmentally friendly. Indeed, industry has resisted or resisted the introduction of this approach in many cases, fearing an increase in costs. However, awareness is growing that due to the social pressure and regulation introduced, there is no alternative choice. However, some cases show that the implementation of the" clean" method makes economically satisfactory solutions.

It's less easy to judge what's yellow, or how green is a proposed new technique. The" revolutionary" concept is to concentrate research and development not simply on a higher yield, but on a lower and better sustainability. It is obviously a demanding task to arrive at solutions that are acceptable in all respects, which is not always achieved in a single paper or in a patent pretending to contribute to green chemistry. In addition, the statement is based on a single aspect in many cases. A new catalyst is sometimes claimed to increase a process's yield under mild conditions, but no attention is paid to testing whether such catalyst is hazardous to man or climate, too costly, labile or difficult to obtain. Moreover, maintaining mild conditions of costly reagents and solvents (economically or environmentally) or a significant amount of energy, so that industrial implementation is not feasible. Nevertheless, the full meaning of the word" green chemistry" applies only to a fraction of the published literature checked under this heading, since the total consideration of the process is missing. Nonetheless, examining the papers published with this keyword may be worthwhile, since they conform to what chemists think is green chemistry. This can be compared to the standards from this type of work. After all, the role that chemistry will play in the future and the horizon that will be opened depend on what kind of work chemists it will do, which remains driven in part by curiosity. [3]

IV. PRINCIPLES OF GREEN CHEMISTRY

GC is an extremely compelling way to compact with aversion to contamination as it apply creative logical responses to natural circumstances that are certifiable.

Waste Control

It is ideal to avoid squandering than after it has been made to take care of waste.

Atom effectiveness

Engineered planning must be designed to improve all the supplies used in the product as part of the procedure.

Application of non- destructive of reagents

It involves the use of reagents and engineered techniques that decrease the risk and produce eco-friendly products that have no adverse effect on humans and environment.

Safer Chemicals Scheming

Chemicals and reagents, while limiting their harmfulness, must achieve their coveted capacity.

Safer Solvents and Auxiliaries

Latal and toxic alcohol, benzene (known cancer), CCl_4, $CHCl_3$, perchloroethylene, CH_2Cl_2 are commonly used in unions. More stable green solvents have now supplanted these.

Design for Energy Efficiency

Despite their ecological and monetary consequences, the vitality requirements of synthetic procedures must be interpreted and restricted.

Use of Renewable Feed stocks

It is planned to use sustainable, but still monetarily practical, raw materials and feedstock. Referring to the case of sustainable feedstock which integrates agricultural products and exhaust feedstock which incorporates fuel supplies from non-renewable energy sources (oil, gas or coal).

Shorter combinations

If appropriate, superfluous derivatization should be restricted or a strategic space should be handled and such measures require additional reagents and may result in squandering.

Use of Catalytic instead of Stoichiometric reagents

Impetuses are used as part of small quantities and can typically be used as a preferred solitary solution over stoichiometric reagents used as part of overabundance and work. This will improve selectivity, lower a switch's temperature, minimize reagent-made waste and possibly keep away from unnecessary side reactions encouraging spotless creativity.

Design for dreadful conditions

Compound objects should be prepared so that they divide into harmless bribery items and do not hang on in nature towards the end of their power.

Techniques to control pollution

Different techniques include the production of hazardous substances in the form of actual, in-process monitoring and control.

Use of Safer Chemicals and Process

To mitigate the risk for chemical incidents, including spills, explosions, and fires, materials and the type of a material used in a chemical process should be selected. [4]

V. GREEN CHEMISTRY IN THE INDUSTRY

As for the industry's market, there are several accounts available, some highlighting utilization of a green feedstock, others manufacturing technology. A noteworthy contribution is a survey conducted in 2004 among industrial experts. Several experts are consulted on what could be achieved in Europe to boost the competitiveness of the chemical industry. To the question of which method they will support, they identified first of all Computer Aided Molecular Design and then the Integrated Material and Process Design, Process Synthesis, Industrial Symbiosis and Ecology, Lifetime System Optimization, Process Integration, and others. The logic was straight forward, the best item to make was to be selected first. Then the integration between the various aspects of the design of the product and the process leading to it should be ensured instead of focusing on a single aspect (i.e. a holistic approach had to be used).

The next question was the best technology to use. The responses are distributed more uniformly here, with 10 things receiving support between 65 and 90%. These suggestions can some broad categories (see Figure 1). These were: a highly selective catalyzed synthesis (see category ' ' green synthesis " in Figure 1, mean 90% support); the use of green energy sources (80% mean support); the engineering aspects (both process intensification and small-scale economic processes, mean support of 75%); the use of green feedstock (see category ' ' renewable " in Figure 1, mean support of 75%); (See class " products" in Figure 1, meaning support 70 percent); and finally, medium selection and purification technique (mean support 70 percent). As for the reaction groups that need the most urgent attention, a Round Table consisting of pharmaceutical industry experts put forward five general processes that would have benefited greatly from accomplishment of green methods. They've been:

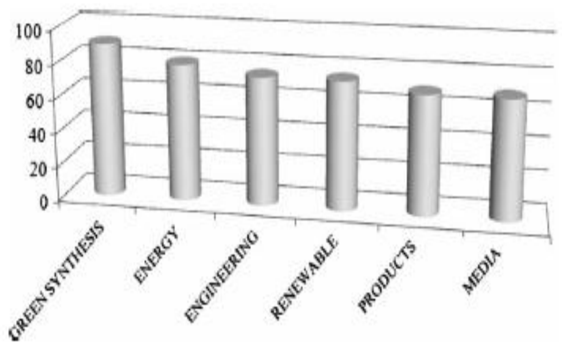

Figure 1. Classification of the issues considered by a panel of industry experts to be important for green development. Prepared in (33) from data. [5]

VI. LITERATURE SURVEY

Rummi Devi Saini et.al. [2018] Green chemistry is one of these days ' most studied subjects. Major work on GC is aimed at reducing or eradicating hazardous bi-product production and eco-friendly optimizing the desired product. The three major growth in GC utilize of super-critical carbon dioxide, water as a green solvent and asymmetric synthesis use of hydrogen. The traditional heating methods were gradually replaced by microwave heating to reduce carbon footprint. These days, only foods with low carbon emissions are highly encouraged. This paper primarily emphasizes the use of green chemicals. [6]

Sangeeta Verma et.al.[2018] Issues of the past decade include various methodologies that protect human health & environment in green chemistry that is economically beneficial. The starting of GC is often seen as a reaction to the need for man-made products and the techniques used to manufacture them to minimize the damage to the environment. The present study concludes the application of the concepts of GC in industry, laboratory and education. There is also a short introduction to green chemistry and prospects for the future. Green Chemistry is a new approach to the production, storage & application of chemical substances, thereby increasing the threats to human health and contamination of the atmosphere. Anastas suggested twelve green chemistry principles that are more important, helping to prevent and eco-friendly environmental pollution. During laboratory work, certain precautions should be known as near fume hoods when not necessary, micro-scale experiments to reduce waste, etc. Green chemistry is also a precious device for everyday life via utilizing green dry cleaning of clothes (use of perchloroethylene as a replacement for liquid CO2), make turbid water clearings, biodiesel processing, etc. Many important methods used in drug and chemicals synthesis that are known to be eco-friendly as microwave-assisted synthesis, dry media organic synthesis reaction, computer-assisted drug design, green solvent use, green catalyst use, etc. [7]

A. P. Katariya et.al. [2017] Unlimited use of chemical and chemical waste disposal leads to pollution of the environment. To prevent or mitigate environmental damage; in various organic syntheses, green techniques are used. Green methods have important environmental and economic benefits over conventional processes of synthesis. Several green techniques are discussed here, like reactions and ultra-sonic reactions. [8]

Devhade JB et.al. [2014] The role of chemistry and chemist in the environment-conscious era is to establish processes and design products that can either eliminate or mitigate toxic by-products and other pollutants generation. Any new combination of the chemical method and an aspect of environmental awareness must be taken into consideration. As it says, "preventing pollution and reducing the production of waste would slowly purify our past sins." A new kind of chemical revolution has arisen after nearly one and a half centuries, i.e. "Green Chemistry." Green chemistry is also referred to by development chemistry, green chemistry, environmentally friendly chemistry and environmentally friendly chemistry as clean chemistry positive. [9]

Paulo M Donate [2014] This study explains how to apply the principles of GC to turn biomass into multiple types of molecules. This involves the key reactions used to transform renewable feed stocks into chemical products that are potentially applicable as raw materials or synthetic intermediates in fine chemical industries, with focus on preparative organic synthesis, based on selected papers published over the past three to four years. [10]

J. A. Linthorst [2010] This article gives an overview of the roots and development of green chemistry. To add to the understanding of green chemistry, this analysis suggests that contextual influences and the word's user-friendliness are drivers of explosive growth in green chemistry, primarily from a historical point of view. It is noted that there was significant political support for its development, in which the Pollution Prevention Act of 1990 was a formal political point of departure, but the origins of green chemistry go back to informally before 1990. The U.S. in all this. EPA had an important role to play, but not only contributed to the development of green chemistry. [11]

VII. APPLICATIONS OF GREEN CHEMISTRY IN DAILY LIFE

A. Green Dry Cleaning of Clothes

Percholoroethylene (perc) is the solvent most widely used in dry cleaning clothing. Perc ($Cl_2C= CCl_2$) is considered to be carcinogenic and contaminates the groundwater at its disposal. Joseph De Simons, Timothy Remark and James Mc clain are developing a new technology known as micell engineering where liquid carbon dioxide and dry clean clothing surfactant can be used as a cleaner solvent. Many dry cleaners now commercially use this process. Dry cleaning systems have been upgraded with green solvent based replacement carcinogenic PERC to use this technology.

B. Green Bleaching Agents

When producing good quality white paper, wood lignin used for it is conventionally extracted by putting small pieces of wood in a sodium hydroxide and sodium sulphide bath followed by its chlorine reaction. Chlorine also reacts with aromatic lignin rings during the cycle to the formation of chlorinated dioxins and chlorinated furans. These are carcinogenic compounds that cause problems with nutrition. Cambegie mellon university Terrence Collins developed a green bleaching agent which involves the use of H_2O_2 as a bleaching agent in the presence of certain activators such as TAML which catalyzes the rapid transformation of H_2O_2into bleaching hydroxyl radicals. In a shorter time and at much lower temperature, this bleaching agent breaks down lignin. It can be used in washing, resulting in less water use.

C. Eco Friendly Paint

Oil-based' alkyd ' paints release large amounts of volatile organic compounds (VOCs) as they dry and heal. Such VOCs have a lot of environmental consequences. Procter & Gamble and Cork composites & polymers produced a mixture of soy oil and sugar to use paint resins and solvents extracted from petroleum petrochemicals that reduced dangerous volatiles by 50%. Chermpol MPS, paint formulation, use these bio-based oils to substitute solvents based on petroleum and create more user-friendly paint. Sherwin William created water-based alkyd acrylic paints from recycled soda bottle (PET), acrylic and soya bean oil. Such paints provide performance benefits and low performance.

D. Putting Out Fires the Green Way

The conventionally used synthetic firefighting foams have been used worldwide to release toxic substances into the air polluting atmosphere and to destroy the ozone layer. New foam called pyro cool has now been developed to extinguish fires efficiently without creating toxic substances such as in other firefighting products.

E. Turning Turbid Water Clear In Green Way

The use of aluminum in residential and industrial wastewater is traditionally made explicit. Alum is found to increase toxic ions that cause Alzheimer's disease in treated water. The tamarind seed kernel powder was found to be an effective and economical agent for clearing municipal and industrial waste water as with alum. Tamarind kernel dust is also non-poisonous, biodegradable, and economical. The tamarind seed kernel dirt, powder and starch mixture, starch and alum in a sample are taken from four flocculants. Flocculants with slurries are obtained by combining the measured amount of clay and steam. The deposition of dust and suspended particles were found to be quite porous, allowing the water to flow through it. It also became lighter, making exposure to a larger volume of clear water simpler. Starch flocks are light weight and less stable, and it was not easy for water to move through. The study found that the powder has potential as a cost-effective flocculent with performance, like more advanced flocculants like potash alum.

F. Computer Chips

Computer chip manufacturing requires a lot of chemicals, huge amounts of water and electricity. Scientists at Los Alamos National Laboratory have developed a method for using supercritical carbon dioxide in one of the chip preparation phases, which significantly reduces the amounts of chemicals, energy and water required for chip development. Richard Wool, University of Delaware's former director of Affordable Composites from Renewable Sources (ACRES), developed a method for using chicken feathers to generate computer chips. The fabric was worn to render a fiber light but solid enough to withstand mechanical and thermal conditions.

G. Medicine

The pharmaceutical industry works to develop medicines with less harmful side effects through methods that produce less deadly waste. Merck and Codexis developed a second-generation green synthesis of sitagliptin, an active ingredient, in Januvia, a drug used for type 2 diabetes. This resulted in an enzymatic process that removed the need for a metal catalyst, reduced waste, increased yield, and increased protection. The drug, Simvastatin, which is sold under the brand name Zocor, is used on a large scale to treat high cholesterol. The traditional method of making this drug used a large number of steps, used large quantities of harmful reagents, and during the process produced a significant amount of toxic waste. Professor Yi Tang, University of California, used an engineered enzyme and low-cost feedstock to synthesize it. Codexis, a biocatalysis company, has mastered both the enzyme and the chemical process, which greatly reduces risk and waste, is competitive and meets the requirements of customers.

H. Solar Cell

Solar cell is the most important example of green technology. This converts the light energy through the photovoltaic cycle directly into electrical energy. Solar photovoltaic technology has been found to be one of the few low-carbon renewable producers with both scalability and technological development balancing ever-increasing global electricity demand. The use of solar photovoltaics has risen by 43 percent per year on average since 2000. The generation of solar power results in lower consumption of fossil fuel, decreased pollution and greenhouse gas emissions.

I. Building with Green Technology

For through their environmental impact, green buildings use a range of environmentally friendly techniques. The use of domesticated materials, reflexive solar design, natural ventilation, and green roofing engineering will allow builders to build a building with a much lower carbon footprint than average. Both techniques are beneficial to the environment as well as constructing cost-effective buildings that are safer for the inhabitants. Green ventilation strategies minimize the need for traditional air conditioning by allowing natural airflow. [12]

CONCLUSION

Green Chemistry is a multi-faceted discipline developed as a contribution of chemistry to sustainable development, preventing environmental damage. Clearly, the problem in the industry is growing, because public alarm and regulatory restriction in this case have a more direct impact. The guidelines to be followed have been clearly outlined by various industry committees. Essential topics are therefore not limited to the different aspects of synthesis and purification, but require a more comprehensive survey. The ultimate goal is to launch a new product only after the (environmentally) correct decision has been confirmed. The use of green resources and energy needs to progress at the same time in order to open up new perspectives. Synthesis tends to be the most important theme for the academic community, more instance than the synthesized material's environmental actions. Reports of" new"' synthesis are by far the literature's main component known as green chemistry. Nonetheless, there are only partial findings in many of the articles considered. Those usually lack the early consideration of all the related environmental aspects that should be unique to this discipline, as well as any sensitivity to the scaling-up engineering perspective. Given this, a pattern imparted by the success of green chemistry postulates may definitely be recognized. As a result, chemists pay more attention to optimizing catalysis, removing toxic reagents, and reducing or eliminating solvents (far less to using actual "alternative"' methods). However, most preparatory papers include an environmental assessment of the systems under consideration. If not immediately, this research would certainly contribute to industrial development in the long range as well.

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