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GREEN CHEMISTRY: A NEW APPROACH IN INDUSTRIES AND LIFE

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ABSTRACT

Green chemistry has been emerging as an advanced branch of science which includes synthesis and processing which reduce negative impacts on environment and human health. It is the use of chemistry in the production of non toxic chemical substances which minimize the harmful effects of the nature. It also plays an important role in the production of novel methods to make solar cells, fuel cells and batteries for energy storage. Green chemistry is a tool not only for reducing the pollution while it has wide applications. It applies to industrial prospect, organic chemistry, inorganic chemistry, biochemistry, analytical chemistry and physical chemistry. The aim of this paper is to discuss the principles of green chemistry, new innovative techniques implemented in industries and its role in everyday life.

Keywords: Biochemistry, Industries, Innovative techniques, Principles.

I. INTRODUCTION

The term green chemistry was first coined by P .T. Anastas in 1991 Known as the father of green chemistry. According to Environmental Protection Agency ,"The design of chemical products that eliminate the use of hazardous substances". Green chemistry reduces pollution by keeping the hazardous material away from the environment. It applies across the life cycle of a chemical product, including its design, manufacture and ultimate disposal. Green chemistry is a traditional concept in process of chemistry which is used to distinguish methods and processes that can ensure the long term productivity in the environment so that coming generations can survive on the earth without any risk of health. Green chemistry offers enhanced chemical process economics associated with a reduced environmental burden. This can be applied to design environmentally benign synthetic protocol, to produce life-saving medicine, environmentally friendly agrochemical, new enzymes for bio catalytic chemical processes, renewable energy sources, energy efficiency in chemical reactions and innovative materials while reducing environmental effects.

Green chemistry is the method of chemistry devoted to the principles of securing eco-friendly, green alternative chemical fabrication. Paul Anastas and Warner formulated rules for how sustainability can be achieved in the production of chemicals [1].

II. BASICS OF GREEN CHEMISTRY

1. Anticipation of waste

It helps to remove/clean up waste produced in the various chemical reaction.

Organic fertilizers, green manure, biogas and vermi-compositing etc. are the examples that generated from the waste [2].

2. Less hazardous chemical synthesis

Non toxic products should generated by different synthetic products. Solvent free reaction and microwave organic synthesis and adipic acid synthesis by oxidation of cyclohexene using hydrogen peroxide are the following process which are eco-friendly in nature [3].

3. Atom Economy

This describes the conversion efficiency of chemical process in terms of all atoms involved in the reaction.

Examples- Rearrangement reaction, Diel's Alder reaction and Hydrogenation of carboxylic acid to aldehydes using solid catalysts.

4. Designing safer chemicals

Chemical products should be prepared in such a way that they generate non toxic substances and it is safe for using in various chemical methods as well as for environment.

Example- polyphenylsulfone is used in interior panels of aircraft and underground train [4].

5. Safer solvents and auxiliary

The use of auxiliary substances should be made unnecessary. Liquid carbon dioxide is used as a solvent in the extraction of caffeine from coffee beans [5].

6. Design for energy efficiency

Energy requirements should be used in control condition or at low temperature and pressure. To develop the alternatives for energy generation like photovoltaic cell, bio-based fuel and solar water heater [6].

7. Use of renewable foodstocks

Foodstock should be used again and again instead of depleting. Production of surfactants is an example of renewable food stocks [7].

8. Reduce Derivatives

Blocking groups, protection, deprotection, temporary modification of chemical/physical process is the part of the reaction which requires additional reagents [8].

9. Catalysis

Selective catalysts should be used in the chemical reaction like efficient Au(III) catalysed synthesis of b-enaminones from 1,3-dicarbonyl compounds and zeolite is also used as a shape selective catalyst [9].

10. Design for Degradation

Synthesis of substances should be in that manner it would be easily degradable at the completion of the reaction viz. Synthesis of biodegradable polymers [10].

11. Real time analysis to control the pollution

Use of in-line analyzers for waste water monitoring and various analytical methods should be developed so that it helps to prevent pollution problem.

12. Inherently safer chemistry for accident prevention

During chemical process the material should be selected in better way that minimize accident like explosions and fires and is healthy for environment as well as humans.

Example- methyl halides in methylation reaction [11].

III. APPLICATIONS IN INDUSTRIES

Safe raw materials can be used for the production of reagents used in the some industrial chemical processes.

3.1 Green synthesis of adipic acid from glucose:

As glucose is illimitable, it can be converted into adipic acid in the presence of enzyme from genetically modified bacteria. This production of acid guards the workers and environment from threats of hazardous chemical compounds and then this adipic acid can be used in the production of nylon, lubricants and plasticizers etc. instead of its production from benzene which has many carcinogenic properties.

3.2 Production of biodiesel oil:

The fats lodged in the plant oils e.g. from soya beans can be used for the synthesis of biodiesel oil by removing glycerine molecule by trans-esterification process which can be further used in the production of soap.

3.3 Use of CO_2 as supercritical fluids(SCFs)for dry cleaning of clothes:

As CO_2 is cheap , easily available and inflammable ,it has been tremendously used in many textiles and metal industries and for dry cleaning of clothes. Supercritical fluids(SCFs) includes the liquids and gases at temperature and pressures higher than critical temperatures and pressures supercritical fluids can dissolve many compounds with different polarity and molecular masses due to its high compressibility near critical point that makes it easy to adjust density and solution ability by a small change of temperature and pressure. This can be used for dry cleaning of clothes instead of perchloroethylene (PERC) which pollutes water resource and are cancer causing agents.

3.4 Use in Greener Pharmaceuticals:

Pharmaceuticals companies are selecting less hazardous reagents reducing reaction steps and developing better catalysts. Chemotherapy drug paclitaxel (Taxol), was originally made by extracting chemicals from yew bark tree, a process that used a lot of solvent in addition to killing the tree. The drug is now made by growing tree cells in a fragmentation vat.

3.5 Synthesis of compounds without the use of solvent:

It is fast and eco friendly method because it eliminates the use of solvent which are not safe for human health. The preparation of benzilic from benzyl by conventional method.It involves the reaction of benzyl with potassium hydroxide solution in the presence of ethanol.

3.6 Microwave induced organic synthesis:

Organic synthesis and functional group transformations can be carried out more efficiently by the use of eco friendly solvent free microwave approach. They help in preventing pollution by reducing the use of solvents in organic synthesis. For the reduction of waste and minimization of energy use microwave assisted solvent free reactions has been considered as appropriate methodology. Microwave assisted condensation reactions have been accompanied using benign reagents such as ammonium acetate .Microwave expedited dehydration reactions using montmorillonite K10 clay [12] or envirocat reagent [13] have been accomplished in the synthesis of imines and enamines via reactions of primary and secondary amines with aldehydes and ketone respectively. The traditional conversion of thiocarbonyls to carbonyls involve the use of stoichiometric amounts of oxidants that are either inherently toxic or involve the use of tedious process. The solvent free dithiocarbonylation process can be used to overcome these difficulties. It involves the use of clayfen [Iron(II)nitrate on clay] or clayan [Ammonium nitrate on clay] ,that is accelerated by microwave irradiation.

3.7 Use in agrochemicals:

The use of biofeedstocks and biocatalysts provide a direct link to agriculture. Traditional farming practices leave unwanted chemicals in the environment, in the soil, water and air. The green chemistry involve the manufacturing of active ingredients of bio pesticides. For instance , the extraction of d-limonene is regulated as conventional insecticide due to its toxic mode of action. In contrast, the oil from which d-limonene may be derived when used as a pesticide, normally have a non toxic mode of action and are regulated as bio pesticides.

3.8 In paper and pulp industry:

Green chemistry practices in paper and pulp industry improved the pulp and paper properties with reduction in use of conventionl bleaching chemicals and generation of pollutants during bleaching of pulp. The most significant environmental impacts of the pulp and paper manufacture resulting from pulping and bleaching processes. The disposal of waste water contains various chemicals, bleaching and whitening agents which are

the major environmental concern. The use of Green bleaching chemicals prior to conventional bleaching series reduced the biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), color and adsorbable organic halogens (AOX) in the bleaching filtrate compared to the use of conventional bleaching chemicals. Use of xylanase enzyme prior to bleaching reduced the TDS, color and AOX in the bleaching filtrate. The use of green chemistry procedures help to reduced the pollution emerging from paper and pulp industry.

3.9 Green Chemistry for organic solar cells:

The energy production methods are associated with some degree of environmental degradation. The organic solar cells are manufactured using π- conjugated (semiconducting) polymers which involves low energy intensity and minimum production of toxic waste even at low cost. The principles of green chemistry, applied to the synthesis of conjugated polymers, are identified as important guidelines for the multi-tonne manufacturing of these materials. A general theme in both green chemistry and process research is that low cost can be correlated to environmental benignity when the costs of disposing wastes are high. This Perspective then highlights five synthetic strategies that satisfy several of the criteria of green chemistry: (1) polymerization using metal-mediated cross-coupling reactions that reduce or eliminate stoichiometric organotin waste; (2) the use of heterogeneously catalyzed polymerizations; (3) polymerization involving activation of C–H bonds; (4) use of biofeedstock-derived starting materials; and (5) polycondensation reactions that evolve water as a byproduct.

IV. ENACTMENT OF GREEN CHEMISTRY IN EVERYDAY LIFE

4.1. Green dry cleaning of cloths:

Per-chloroethene is mainly used as a dry cleaner but it has carcinogenic nature Joseph De Simons developed a new technology known as Micell technology. In this liquid CO_2 can be used as a dry cleaning agent proposed by Timothy Remark and James Mc Clain [14].

4.2. Green Bleaching agents:

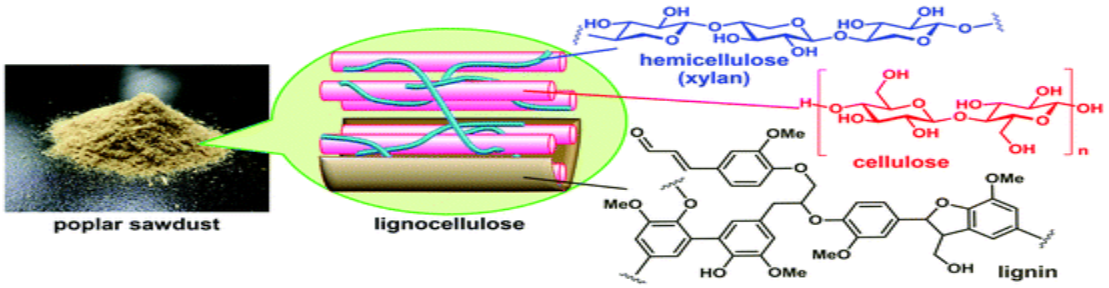
Terry Collins is the professor of chemistry at Carnegie Mellon University has been engaged in green oxidation technologies by producing non toxic catalysts for activating natural oxidants like hydrogen peroxide which is used as a bleaching agent in the presence of activators (Tetra-amido macro cyclic ligand).During reaction it produces hydroxyl radicals that causes bleaching. This bleaching agent breaks down lignin [15].

4.3. Bio-degradable plastic:

Eco flux compostable polyester film developed by Badan Aniline and Soda Factory by Friedrich Engelhorn, is the largest chemical company in the world. Ecoflux is used for manufacturing biodegradable bags with cassava starch and calcium carbonate. Plastics products can now be prepared from plant sugars from renewable crops like corn, potatoes and sugar beets [16].

4.4. Lignocellulosic biomass used as a Biofuel

Cellulosic ethanol technology is one of the most commonly used technologies for production of biofuel. They are derived from the cellulose in plants. Now a days, cleanliness and pollution free environment is the major issue. For solving these problems solid waste management is the fundamental need to maintain the cleanliness of the environment. Keeping this view in mind, in current scenario lignocellulosic biomass has of great concern to generate biofuel. Lignocellulosic biomass means plant dry matter which contains polysaccharides cellulose, hemicellulose and lignin. It has two fragments-carbohydrate polymer (cellulose/hemicellulose) and aromatic polymer (lignin). There is presence of cross linkage of ester and ether in between these two fragments.



Carbohydrate polymer is used to convert into ethanol and remaining fraction containing lignin can be burned as boiler fuel to enhance the conversion process and produce extra electricity. Lignocellulosic biomass is divided into three classes. (i) virgin biomass includes all naturally occurring terrestrial plants. (ii)Waste biomass includes agricultural and forest waste. (iii) Energy crops – They are crops with high yield of lignocellulosic biomass. It include switch grass and elephant grass. The use of lignocellulosic biomass is very difficult because pentose sugar is not readily fermentable. Firstly, conversion of pentose sugar into simple sugar takes place with the help of enzymes and acids and secondly fermentation of simple sugar occurs by microorganisms. Lignocellulosic biomass has various advantages. It improve energy security, decrease urban air pollution and reduce accumulation of carbon dioxide in atmosphere [17].

4.4 Ecofriendly paint:

Procter and Gamble developed a mixture of soya oil and sugar which reduced the hazardous volatiles by 50 percent. Water based acrylic alkyd paints from recycled soda bottle plastic acrylic and soya bean oil has developed by Sherwin Willliam [18-19].

4.5 Nano petroleum fuels:

Benzol: During coal carbonization benzol is obtained as by-product. It is the mixture of aromatic hydrocarbons benzol has a high anti knocking value so it can be used as motor fuel and hence, it reduces the fuel consumption as well as generation of toxic pollutants.

Power alcohol: It is basically ethyl alcohol which has been used internal combustion engines. It is mixed with gasoline in the ratio of 4:1 to increase its octane number [20].

4.6 Extinguish fire via green approach:

Various chemical is used to put out the fire producing toxic material. To eliminate the hazardous one a new foam called Pyro-cool is used to extinguishing fire without creating any toxic material [21].

4.7 Green and clear water:

Alum is used to purify water but it produces toxic ions which causes Alzheimer disease. Now a day tamarind seeds kernel power has been used as an effective and economic agent to purify water as alum.

4.8 Organic light emitting diode:

LED is an example of producing more light with lower energy consumption.

4.9 Operation of unleaded petrol:

Octane number determine the quality of petrol the quality is directly proportionate to octane number to increase the quality of petrol methyl tertiary butyl ether is added instead of lead component (tetra ethyl lead) which supplies oxygen for petrol and hence reducing the formation of per-oxy compound [22].

4.10 Natural insects repellent:

Many insects are repelled by different chemicals these chemicals are mixed with air which makes unhealthy environment to avoid such type of situation there are some essential oils that work well against biting insects

- Cinnamon oil (mosquitoes)
- Lemon eucalyptus oil (mosquitoes, tics, and lice)
- Citronella oil (mosquitoes and biting flies)
- Caster oil (Mosquitoes)

Safe carrier oils/alcohols:

- ❖ Olive oil
- ❖ Sunflower oil

Mix 10-25 drops of essential oils with 2 table spoons of carrier oil\/alcohols.

4.11 Auto regenerating:

The modern synthetic polyester decrease the quantity of foam used in the seats of the car reducing its weight. It also helps to reduce the consumption of fuel and evaluation of carbon dioxide.

4.12 Green Carpets:

EcoWorx replaces conventional carpet tile backins that contain bitumen, polyvinylchloride, or polyurethane with polyolefin resins which have low toxicity. This has better adhesion, does not shrink and can be recycled.

4.13 Rain water harvesting technique:

This method is used to Store rain water into reservoir for reuse rather than allowing it to run off. Stored water can be used to various domestic purposes.

V. CONCLUSION

Governments and scientific communities throughout the world recognised that the practice of green chemistry not only leads to a clean and more sustainable earth but also is economically beneficial with many positive social impacts. It is the need of the hour because of increasing pressure from both society and government. So with help of green approach we can produce eco-friendly products and provide the way to reduce waste and prevent entering of toxic substances into the environment.

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