Future Perspective to Green Chemistry: A Review

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Abstract – Green Chemistry is defined as environmentally benign chemistry. The synthetic schemes are designed in such a way that there is least pollution to the environment. As on today, maximum pollution to the environment is caused by numerous chemical industries. The cost involved in the disposal of the waste products is also enormous. Therefore, attempts have been made to design synthesis for manufacturing processes in such a way that the waste products are at minimum, they have no effect on the environment and their disposal is convenient. For carrying out reactions it is necessary that the starting materials, solvents and catalysts should be carefully chosen. For example Benzene (C6H6) as a solvent must be avoided at any cost since it is carcinogenic in nature. If possible, it is best to carry out reactions in the aqueous phase. With this view in mind, synthesis methods should be designed in such a way that the starting materials are consumed to the maximum extant in the final product. The reaction should also not generate any toxic by-products.

Keywords: Safer Chemicals, Hazardous Wastes, Chemical Education, Environmental Objectives.

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1.1 INTRODUCTION:

Since 1991, Green Chemistry has grown into a significantly internationally engaged focus area within chemistry. Research programs and centers located in America, Europe, Asia/Pacific and Africa are focusing efforts around the principles of Green Chemistry; the breadth of this research is very wide and incorporates area such as:

Bio-based Renewables: The utilization of benign, renewable feedstock is needed for addressing the global depletion of resources. Bio-based products hold great promise for achieving the goals of sustainable development and implementing the principles of industrial, ecological and Green Chemistry. Achieving a sustainable chemical industry dictates switching from depleting finite sources to renewable feed stock. Research has focussed on both, the micro and molecular levels.

Agriculture waste → Useful Chemical intermediates → Alcohol

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Carboxylic acid Ketones Levulic acid

(i) The carbohydrate economy provides a rich source of feedstock for synthesizing commodity (Lynel et. al., 1999). And for example:

(ii) Shells from crabs and other sea life serve as a valuable and plentiful source of chitin, which can be processed into chitosan a biopolymer with a wide range of potential applications that are being currently explored for use in the oil-drilling industry (Kumar et al., 2000).

(iii) Genetic engineering produces valuable chemical products via non-traditional pathways.

(iv) Glucose yields Catechol and adipic acid (Draths and Frost, 1999)

(v) Saccharomyces yeasts convert both glucose and xylose, present in cellulogic biomass, into ethanol (Ho et. al., 2000).

(vi) CO_2 is also a renewable feedstock that has been incorporated into polymers (Chong et. al., 2000).

Glucose → Catechol and adipic acid

2.1 DISCUSSION:

2.1.1 Green Chemistry in day to day life:

2.1.2 Dry cleaning of cloths: Dry cleaning is any cleaning process for clothing and textiles that use a chemical solvent rather than water. it is used to clean fabrics that degrade in water, and delicate fabrics that cannot withstand the rough and tumble of a washing machine and clothes dryer.

Perchloroethylene (perc) has been the leading dry cleaning solvent used in the dry cleaning industry and is still being used by the majority of dry cleaners in many countries. However, the health risks of perc as a dry cleaning solvent has spurred interest in alternative solvents to replace its use.

Green dry cleaning refers to any dry cleaning method that does not involve using perc, a liquid chemical used for commercial degreasing and deodorizing to clean fabrics without shrinkage or fading. Although efficient at degreasing and deodorizing textiles, perc has been shown to cause cancer as well as kidney and liver damage in animal studies. Other symptoms of short term exposure include dizziness, headaches and unconsciousness. Perc is classified as a Toxic Air Contaminant by the Environment Protection Agency (EPA) and is being phased out of the dry cleaning process.

As the health risk associated with perc is causing public concern and cleaners face increasingly restrictive and costly regulations, safer dry cleaning solvent alternatives are required to replace its use. There are a number of safer alternatives which are nontoxic and currently available in the market, such as professional wet cleaning, which uses water and special equipment that gently washes, dries and restores fabrics; or liquid carbon dioxide (CO_2) cleaning, in which carbon dioxide is pressurized into a liquid solvent that safely cleans clothing. There is a trend towards a green dry cleaning alternative using liquid silicone, known as decamethylcyclopentasiloxane (D5).

D5 is a clear, odorless and non-toxic silicone based solvent (siloxane) considered to be both non-toxic and non-hazardous. It is the lynchpin of the patented Green Earth Cleaning solution. D5 has long been used in the cosmetics industry in deodorants, sunscreen, hairsprays and skin care products. It is an excellent carrier for detergents, has ideal properties for fabric care and is better for the environment. According to Green Earth, D5 is completely safe and biodegradadble, it simply degrades into sand (SiO2), water and carbon dioxide, leaving no toxic residue if released into the atmosphere, making it safe for air, water and soil.

This silicon-based solvent is considered to be an efficient fabric cleaner due to its chemical properties: (i) it has a very low surface tension that allows a more effective penetration into the fabric fibers to release dirt; (ii) it is chemically inert and shows no chemical reaction with textile fabric or dyes during the cleaning process. This helps to eliminate problems associated with dye removal and dye bleeding, minimizes abrasion to and/or swelling of fabric fibers which results in less damage to plastic trims and printing, and minimizes shrinkage.

2.1.3 Diverse Bleaching agents:

It is common knowledge that paper is manufactured from wood (which contains about 70% polysaccharides and about 30% lignin). For good quality paper, the lignin must be completely removed. Initially, lignin is removed by placing small chipped pieces wood into a bath of sodium hydroxide (NaOH) and sodium sulphide (Na_2S). By this process, about 80-90% of lignin is decomposed. The remaining lignin was so far removed through reaction with chlorine gas (Cl_2). The use of chlorine removes all the lignin (to give good quality white paper) but causes environmental problems. Chlorine also reacts with aromatic rings of the lignin to produce dioxins, such as 2,3,4-tetrachloropdioxin and chlorinated furans. These compounds are potential carcinogens and cause other health problems. These halogenated products find their way into the food chain and finally into products, pork, beef and fish. It involves the use of H_2O_2 as a bleaching agent in the presence of some activators known as TAML activators that as catalysts which promote the conversion of H_2O_2 into hydroxyl radicals that are involved in oxidation (bleaching). The catalytic of TAML activators allow H_2O_2 to break down more lignin in a shorter time and at much lower temperature. These bleaching agents find use in laundry and results in lesser use of water.

2.1.4 Production of adipic acid:

Large amounts of adipic acid are used each year for the production of nylon, polyurethanes and lubricant sand plasticizers. Benzene (a compound with carcinogenic properties) is a standard substrate for the production of this acid. Chemists from State University of Michigan developed green synthesis of adipic acid using a less toxic substrate. Furthermore, the natural source of this raw material, glucose is almost inexhaustible. The glucose can be converted into adipic acid by an enzyme discovered in genetically modified bacteria. Such a manner of production of these acid guards the workers and the environment from exposure to hazardous chemical compounds.

2.1.5 Production of biodiesel:

Many vehicles around the world are fueled with diesel oil which is a well-known pollutant and the production of biodiesel oil is a promising possibility to be echo friendly. As the name indicates, biodiesel oil is produced from cultivated plants oil, e.g. from soya beans. It is synthesized from fats embedded in plant oils by removing the glycerin molecule. The advantages of using biodiesel oil are obvious. It's fuel from renewable resources and contrary to normal diesel oil.

2.1.6 Green Solution to Turn Turbid Water Clears:

Tamarind seed kernel powder, discarded as agriculture waste, is an effective agent to make municipal and industrial waste water clear. The present practice is to use Al-salt to treat such water. It has been found that alum increases toxic ions in treated water and could cause diseases like Alzheimer's. On the other hand kernel powder is not-toxic and is biodegradable and cost effective. For the study, four flocculants namely tamarind seed, kernel powder, mix of the powder and starch, starch and alum were employed. Flocculants with which slurries were prepared by mixing measured amount of clay and water. The result showed aggregation of the powder and suspended particles were more porous and allowed water to ooze out and become compact more easily and formed larger volume of clear water. Starch flocks on the other hand were found to be light weight and less porous and therefore didn't allow water to pass through it easily. The study establishes the powder's potential as an economic flocculants with performance close more established flocculants such as $K_2SO_4Al_2(SO_4)3.24H_2O$ (potash alum).

3. CONCLUSION:

The expansion of Green Chemistry over the course of the past decade needs to increase at an accelerated pace if molecular science is to meet challenges of sustainability. It has been said that the revolution of one day becomes the new orthodoxy of the next Green Chemistry is applied and must involve the successful implementation of more environmentally friendly chemical processes and product design. Most importantly, we need the relevant scientific, engineering, educational and other communities to work together for sustainable future through Green Chemistry.

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