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Green chemistry and environmental technology applications in everyday life

T.Srikumar, M.C.Rao*

Department of Physics, Andhra Loyola College, Vijayawada-520008, A.P., (INDIA)

E-mail : raomc72@yahoo.com

ABSTRACT

The principles of green chemistry guide firms in designing new products and processes in such a way that their impact on the environment is reduced. Green chemistry is the new and rapid emerging branch of chemistry for the environment. It is really a philosophy and way of thinking that can help chemistry in research and production to develop more eco-friendly solutions. Green chemistry is a science based non-regulatory and economically driven approach to achieve the goals of environmental protection and sustainable development. All chemical wastes should be disposed of in the best possible manner without causing any damage to the environment and living beings. Another way to save the environment through sustainable chemistry is to make use of renewable food stocks. Chemical derivatives must be avoided as far as possible in any type of application as they often prove to be harmful. Large amounts of adipic acid are used each year for the production of nylon, polyurethanes. The glucose can be converted into adipic acid by an enzyme discovered in genetically modified bacteria. The use of supercritical fluids (SCFs) in chemical processes is becoming more and more prevalent. Carbon dioxide as a supercritical fluid is most frequently used as medium for reactions. It is inflammable, easily available and cheap. The discovery of supercritical carbon dioxide opened a way to new processes in textile and metal industries and for dry cleaning of cloth. This article presents selected examples of implementation of green chemistry principles in everyday life in industry and in domestic purpose.

KEYWORDS

Green chemistry atom economy;
Sustainable development;
Renewable food stocks.

INTRODUCTION

The term green chemistry[1] was first used in1991 by P.T. Anastas in a special program launched by the USA Environmental Protection Agency (EPA) to implement sustainable development in chemistry and chemical technology by industry, academia and government. United States Presidential green chemistry challenge was announced in 1995. The similar awards were soon established in European countries. In 1996 the working party on green chemistry was created, acting within the framework of International Union of Pure and Applied Chemistry. One year later the Green Chemistry Institute (GCI) was formed with chapters in 20 countries to facilitate contact between governmental agencies and industrial corporations with universities and research institutes to design and implement new technologies. The first conference highlighting green chemistry was held in Washington in1997. Since that time other scientific conferences have been soon held on a regular basis. The first book and journals on the subject of green chemistry were introduced in 1990, including the Journal of Clean Processes and Green Chemistry, sponsored by the Royal Society of Chemistry. The concept of green chemistry incorporates a new approach[2,3] to the synthesis, processing and application of chemical substances in such manner as to reduce threats to health and environment. This new approach is also known as: Environmentally benign chemistry, clean chemistry, Atom economy, Benign by design chemistry.

BASIC PRINCIPLES OF GREEN CHEMISTRY

Green Chemistry is commonly presented as a set of twelve principles proposed by Anastas and Warner. The principles comprise instructions for professional chemists to implement new chemical compound and new synthesis and technological processes. These principles can motivate chemistry at all levels: research, education and public perception.

1. Prevention; It is to prevent waste than to treat or clean up waste after it has been created.
2. Atom Economy; Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
3. Less Hazardous Chemical Synthesis; whenever practicable synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
4. Design of Safer Chemicals; Chemical products should be designed to affect their desired function while minimizing toxicity.
5. Auxiliary and Safer Solvents; the use of auxiliary substances should be made unnecessary wherever possible.
6. To enhance Energy Efficiency; Energy requirements of chemical processes should be recognized for their environmental and at low temperature and pressure.
7. Renewable Feed stocks; A raw material or feedstock should be renewable rather than depleting whenever technically and practicable
8. Reduce Derivatives; Unnecessary derivatization (use of blocking groups, protection, deprotection) should be avoided whenever possible.
9. Catalysis; Catalytic reagents (as selective as possible) are superior stoichiometric reagents.
10. Degradation products; Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.
11. Pollution prevention methods; Analytical methodologies need to be further developed to allow for real-time, in process monitoring and control prior to the formation of hazardous substances
12. Safe Chemistry for prevention of accidents; Substances and the form of a substance used in chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions and fire.

GREEN CHEMISTRY PRINCIPLES AND APPLICATIONS IN EVERYDAY LIFE

Based on the principles of green chemistry, a threat can be eliminated in a simple way, by Applying safe raw materials for production process. 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. For example, many vehicles around the world are fueled with diesel oil and the production of biodiesel oil is a promising possibility. 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.

DRY CLEANING OF CLOTHS

Perchloroethylene (PERC) is commonly being used as a solvent for dry cleaning. PERC contaminates groundwater and is a suspected carcinogen. A technology, known as Micelle Technology developed by Joseph De Simons, Timothy Romark and James McClain made use of liquid CO_2 and a surfactant for dry cleaning clothes, thereby replacing PERC. Dry cleaning machines have now been developed using this technique (Micelle Technologies, 1999).

BLEACHING AGENTS

Paper is manufactured from wood (which contains about70% 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 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-tetrachloropdioxinand chlorinated furans[4]. 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. In view of this, use of chlorine has been discouraged. Subsequently, chlorine dioxide was used. Other bleaching agents like hydrogen per oxide (H_2O_2), ozone (O_3) or oxygen (O_2) also did not give this the desired results. A versatile agent has been developed by Terrence Collins of Camegie Mellon University. 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 breakdown 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.

TURBID WATER IN TO CLEAR WATER

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 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. Four flocculants namely tamarind seed kernel powder, mix of the powder and starch, starch ad alum were employed. Flocculants with 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.

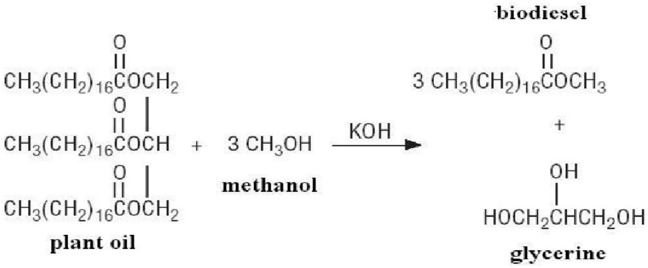

Figure 1 : Reaction for biodiesel oil production

CONCLUSION

Consumers and business purchasing departments can promote green chemistry by demanding safer, non-toxic products from manufacturers. This will help give a competitive advantage to those companies who screen the chemicals used in their products and demand safer substitutes from their suppliers. Such demand will also help increase the number of green chemistry courses in universities, training the next generation of chemists to consider life cycle impacts of the chemicals they design. Governments have a major role in adopting policies that promote green chemistry innovation and implementation in the commercial sector. At the same time the chemical industry has a duty to integrate the principles of green chemistry into their manufacturing processes while product manufacturers and retailers have a responsibility to demand chemicals from their suppliers that have been tested and shown to be inherently safe. Green economic innovation for the 21st Century will require green chemistry. Great efforts are still undertaken to design an ideal process that starts from non-polluting initial materials, leads to no secondary products and requires no solvents to carry out the chemical conversion or to isolate and purify the product. However, more environmentally friendly technologies at the research stage do not guarantee that they will be implemented on an industrial scale. Adoption of environmentally benign methods may be facilitated by higher flexibility in regulations, new programs to facilitate technology transfer among academic institutions, government and industry and tax incentives for implementing cleaner technologies. Furthermore, the success of green chemistry depends on the training and education of a new generation of chemists. Students at all levels have to be introduced to the philosophy and practice of green chemistry.

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