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Green Chemistry: The Future Pillars

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Abstract: As the natural resources are used up in the world, Chemists and Biotechnologists have taken up with innovative methods in which renewable Resources can be used to replace non-renewable resources. For this, Green Chemistry principles must be applied to the industry.Green chemistry represents the pillars that hold up our sustainable future. It is clear that many industries and research of many academics recognize the significance of green chemistry. Chemistry is really very helpful to us as its applications are used worldwide for several purposes. We cannot really imagine a world without chemistry. However, we should now concentrate on green chemistry, or sustainable chemistry, which refers to reducing or stopping the damage done to the environment around us. Hence, green chemistry could include anything from reducing waste to even disposing of waste in the correct manner. All chemical wastes should be disposed off in the best possible manner without causing any damage to the environment and living beings. This article presents a brief description on green chemistry principles and their applications to basic and applied research.
Keywords: Green chemistry, twelve principles, sustainable development.

Introduction

Chemistry has provided valuable materials in the form of medicines, food products, cosmetics, dyes, paints, agrochemicals, biomolecules, polymers, liquid crystals and nano particles. Today many complex products can be synthesized readily. However the chemical process not only produce the required products but also large quantities of undesired and harmful substances in the form of solid, liquid and gases and have become the biggest challenge that chemistry has to face. So the pressing need for the synthetic chemists is to minimize chemical pollution. The science of chemistry is central to addressing the problem facing the environment. Green chemistry and sustainability essentially go hand in hand. Sustainable development is meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.

Green chemistry embodies two main components. First, it addresses the problem of efficient utilisation of raw materials and the concomitant elimination of waste. Second, it deals with the health, safety and environmental issues associated with the manufacture, use and disposal of chemicals. During the last three decades much work is going on in this direction. The numerous educational materials, available currently on market and on the Internet, are very useful in everyday teaching of green chemistry principles. The term **Green Chemistry** was coined[1-4] in 1991 by **Paul T. Anastas**. The purpose is to design chemicals and chemical processes that will be less harmful to human health and environment. Green chemistry protects the environment, not by cleaning up, but by inventing new chemical processes that do not pollute the environment.

Green Chemistry- The future Pillars:

Chemists from all over the world are using their creative and innovative skills to develop new processes, synthetic methods, reaction conditions, catalysts etc., under the new Green chemistry concepts. Commercial applications of green chemistry have led to novel academic research to examine alternatives to the existing synthetic methods[5-14]. Some of these are:

- The use of phosgene and methylene chloride in the synthesis of polycarbonates has been replaced by diphenylcarbonate.
- The most polluting reaction in industry is oxidation. Implementation of green chemistry has led to the use of alternative less polluting reagents viz., metal ion contamination is minimized by using molecular O_2 as the primary oxidant and use of extremely high oxidation state transition metal complexes.
- A convenient green synthesis of acetaldehyde is by Wacker oxidation of ethylene with O_2 in presence of a catalyst, in place of its synthesis by oxidation of ethanol or hydration of acelylene with H_2SO_4.
- Conventional methylation reactions employing toxic alkyl halides or methylsulfate leading to environmental hazard are replaced by dimethylcarbonate with no deposit of inorganic salts.
- In 1996, Dow Chemical won 1996 Greener Reaction award for their 100% carbon dioxide blowing agent for polystyrene foam production. Polystyrene foam is a common material used in packing and food transportation.Traditionally, CFC and other ozone depleting chemicals were used in the production process of the foam sheets, presenting a serious environmental hazard. Dow Chemical discovered that supercritical CO_2 works equally as well as a blowing agent, without the need for hazardous substances, allowing the polystyrene to be more easily recycled. The CO_2 used in the process is reused from other industries, so the net carbon released from the process is zero.
- Propylene oxide (**PO**) is a chemical building block for a variety of products including detergents, polyurethanes, food additives. Traditional PO production uses chlorohydrin which leads to coproducts such as t-butyl alcohol, styrene monomer, or cumene. Its manufacture creates by-products, including a significant amount of waste. Dow and BASF have jointly developed a new route to make propylene oxide with hydrogen peroxide and propylene that eliminates most of waste. Dow and BASF have jointly developed a new route to make propylene oxide with hydrogen peroxide and propylene that eliminates most of waste.
- Akzo Nobel has developed a readily biodegradable chelating agent that is manufactured principally from a renewable feedstock. This new chelate, called tetrasodium L-glutamic acid, *N*,*N*-diacetic acid (GLDA), will replace phosphates in automatic dishwashing detergents. Most significantly, GLDA is readily biodegradable and will reduce pollution by replacing phosphates in dishwashing detergents.
- Spinosad, is a low-risk pesticide in widespread use on crops. Clarke launched Natular in the U.S. market in December 2008. Natular, a spinosad based mosquito larvicide that provides excellent control in aquatic environments. It is 15 times less toxic than the organophosphate alternative, does not persist in the environment and is not toxic to wildlife.
- A continuous process and apparatus converts waste biomass into industrial chemicals, fuels and animal feed. Another process converts waste biomass such as municipal solid waste, sewage sludge, plastic, tires and agricultural residues to useful products, including hydrogen, ethanol and acetic acid.
- A fermentation method for the production of carboxylic acids.
- A cost-effective method of producing ethyl lactate, a non-toxic solvent derived from corn.
- A new environmentally friendly technology in mixed metals recovery from spent acid wastes has been used to recover zinc and ferrous chloride from pickle liquor.

- The demand for non-ionic surfactants is growing and a new example of this is alkly glycoside, which is made from saccharide. This product can be used as a replacement for alkylaryl sulphonate anionic surfactants in shampoos. Sodium silicate can be used as a more environmentally benign replacement for phosphorus-containing additives in washing powder. Three coconut oil soap bases for liquid cleansing applications have been developed. One of these products has very light color and low odor, making it suitable for introducing dyes and fragrances.
- Feedstock recycling of plastic wastes into valuable chemicals useful as fuels or raw materials.
- The first bio-pesticide for sugarcane, called BioCane, has recently been launched in Australia. The product is based on a naturally-occurring fungus that has been cultured on broken rice grains to provide a medium for distribution. Biocane granules are claimed to be particularly effective against greyback cane grub.

Conclusions

Our future challenges in resource, environmental and societal sustainability demand more efficient and benign scientific technologies for working with chemical processes and products. Green chemistry addresses such challenges by inventing novel reactions that can maximise the desired products and minimize by-products. Green chemistry is not a new branch of science. It is a new philosophical approach for a sustainable development.Presently it is easy to find in the literature many interesting examples of the use of green chemistry rules. Great efforts are still undertaken to design an ideal process that starts from non-polluting materials. It is clear that the challenge for the future chemical industry is based on production of safer products and processes designed by utilizing new ideas in fundamental research.

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