Application of Green Chemistry in Daily Life

Sangeeta Kaul

Associate Professor
Department of Chemistry,
Sri Aurobindo College, University of Delhi, Delhi

***Abstract*: Green Chemistry is an application in chemical sciences wherein renewable raw materials are used, waste products are eliminated. Further use of toxic and hazardous reagents and solvents used in manufacturing and application of chemical products are totally by passed. Science of green chemistry works at the molecular level and aims to achieve sustainability.**

***Keywords*: Green Chemistry, Environmental Protection Agency (EPA), Carcinogenic, Sustainability, Green Chemistry Institute (GCI)**

Introduction:

The term green chemistry was coined by Paul T Anastas in 1991 in a program conducted by the U S Environmental Protection Agency to implement sustainable development in chemistry and chemical industries in particular. In 1996 a working committee on green chemistry was constituted which worked within the framework of International Union of Pure and Applied Chemistry. Within a year a Green Chemistry Institute (GCI) was created which had chapters in about twenty countries. The main goal of GCI was to facilitate contact between industries and government agencies to work out schemes which would not be harmful to environment, if put in operation .Grant to be given to research agencies to design technologies which would be environment friendly and economically viable. Since 1990 many conferences have been held by prestigious chemical societies like Royal Society of Chemistry where innovative approach to synthesis, processing and application of various chemical substances are discussed with an aim to reduce hazardous impact to environment and to human life .This novel approach is also known as the clean chemistry, environmental benign chemistry,benign by design chemistry or atom economy.

There are twelve key principles formulated which ought to be implemented by all chemists at all levels towards attaining the goal of good human health and clean environment. The twelve key principles formulated by P T Anastas and J C Warner and are:-

1. **Waste Prevention:** Rather than treating the waste produced at a later stage, the principle advocates that it is better to prevent waste formation at the very onset of the process. Waste is production of any by-product or material that has no use or value, even energy that cannot be harnessed or remains unutilized. Roger Sheldon has introduced a concept of E-factor also called the Environmental Impact Factor. The concept of E-factor is now widely accepted as a bench mark. E-factor is used to quantify the waste produced per kilogram of the final product.
2. **Atom Economy:** This refers to designing a process wherein raw materials are used to the maximum in such a way that the final product has the maximum number of atoms from the reactant.
3. **Less Hazardous Synthesis**: Synthetic methods wherever possible should be employed wherein reactants used and products generated have low human toxicity and also are environment friendly.

4&5. **Designing Safer Chemicals, Safer Solvents and Auxiliaries:**Products need to be designed in a way that toxicity is reduced whereas efficacy and function remains preserved. The American Chemical Society acknowledges that designing safe chemicals is one of the major challenges for the scientific community.

6. **Energy efficiency:** By conducting synthesis at ambient temperature and pressure, energy requirement of the synthesis can be minimized. Design parameters are considered better when synthesis is completed in fewer number of steps and use is made of low cost reactants
7. **Use of Renewable Feedstock:** Whenever and wherever possible feed stock or raw material should be renewable. The above is an interesting concept which initially appeared impractical.
8. **Reduce Derivatives:** One of the key points of green chemistry is to reduce the use of derivatives and protecting groups in the synthesis of target molecules. One of the ways to achieve this is by use of enzymes.
9. **Catalysis:** A catalyst is a substance that changes the rate of reaction without itself being changed in the process. It works by lowering the activation energy of the reaction, but itself does not get consumed. It implies that it can be used in minute quantities and can be recycled indefinitely.
10. **Design for Degradation:** Designing of chemical product is done in a way that they break down into innocuous degradation product in the end, which does not remain in the environment for long.
11. **Real time Analysis for Pollution Prevention:** Analytical method need to be updated for real time in-process monitoring and control before the formation of polluting substance starts. For proper functioning of chemical processes real time feedback is needed.
12. **Inherently safer chemistry for accident prevention:** Form of substance used in any chemical process should always be chosen in a way to minimize the chemical accidents due to its release, explosion or fires.

Adhering to the above mentioned principles of green chemistry its advantages can be harnessed in daily life. Some of the examples are listed here:

Dry cleaning Process: Dry cleaning is a cleaning process for textiles or any material wherein a chemical solvent is used instead of water. Perchloroethylene (PERC) is the leading solvent used in the dry cleaning industry and is still being used by most of the dry

cleaners across the globe. PERC is very efficient for degreasing and deodorizing textiles, but is a known carcinogenic chemical. In the studies carried out on animals, it has shown to cause kidney and liver damages. Short term exposure causes dizziness, headaches and even unconsciousness in certain cases. Environmental Protection Agency (EPA) has designated PERC as Toxic Air Contaminant and ways are being devised to phase it out of the dry cleaning process. As a first step all dry cleaning machines in co-residential facilities will be prohibited to use PERC due to the health risks associated with PERC. Public at large is concerned about the ill effects of PERC thus, safer dry cleaning agents and methods are being researched.

The most cost effective and easy way is to use water, but with special equipment that gently washes, dries and restores fabric texture. Another way is to use liquid carbon-di-oxide (CO_2) cleaning in which carbon-di-oxide is pressurized into a liquid solvent that safely cleans the clothes..Decamethylcyclopentasiloxane (D5) is another green dry cleaning alternative using liquid silicone-D5 as a non-turbid, non-toxic silicone based solvent (siloxane). It is nonhazardous. It was in use in sun screens, hair sprays and deodorants. It has shown excellent properties for fabric care and is biodegradable hence, environmental friendly. It decomposes into sand (SiO_2), water and carbon-di-oxide leaving nontoxic residue. It has low surface tension that allows greater penetration into the fabric fibers to release dirt. It shows no chemical reaction with textile fabric or dyes as it is chemically inert. The problem of dye removal or dye bleeding does not occur and also there is very little abrasion or swelling of fabric fibers, thus no damages observed to trims and prints on the fabric.

Water Treatment: Well treated waste water has enormous potential as a source of water for crops, households and industry. It has been a common practice since long back to clean municipal water by treating it with Alum, which is aluminium based compound. It has been studied that aluminium ions when present in large quantity in water causes diseases like Alzheimer's . Easier way is to use biodegradable flocculants like tamarind seeds, kernel powder and mix of starch and alum. These have proved to be as efficient as alum and less harmful. Wastewater Industry persists in striving for enhanced environment friendly, economic, innovative research and development. Treatment plants have been designed, engineered, and manufactured which incorporates biological treatment using a jet aeration. Sand filters, four activated carbon filters and reactivated carbon storage vessel. Since carbon is reactivated and then reused, the organic waste is destroyed hence is an environment sound technique. The above has been an innovation of Siemens Water Technologies. Klean Earth Environmental Company has come up with a process known as Silica Micro Encapsulation (SME). Here neutralization or precipitation methods are not followed instead encapsulation of contaminant in a permanent silica matrix is allowed which can take place even under extreme environmental conditions. The encapsulated metals are effectively immobilized, minimizing the potential for environmental contamination and health hazards are also reduced. Various processes or treating wastewater have come up which vary according to the type of contaminant present.

Bleaching of Paper: Earlier for bleaching of paper toxic chemicals like Chlorine gas were used. Latest technology now uses hydrogen peroxide with a suitable catalyst which promotes the bleaching action .Chlorine reacts with aromatic rings of lignin to produce dioxins such as 2,3,4-tetrachlorodioxin and chlorinated furans. These compounds are carcinogenic and cause health hazards. These halogenated products find their way into the food chain and into products like fish, beef, pork etc. It is for this reason use of chlorine is discontinued although chlorine can remove all the lignin present so good quality white paper is obtained. Hydrogen peroxide gives good desired results. It is used with TAML activators. These activators allow hydrogen peroxide to breakdown more lignin in a short span of time at a lower temperature. Added advantage is that less quantity of water is used.

Green Chemistry is the path to create safer, better chemicals using safe efficient ways of synthesis and to reduce waste. Intrinsic hazards of chemicals or chemical processes can be reduced at all levels of a process. Reduction in damages is effective in toxicity, explosion, flammability and also global hazards like ozone layer depletion. Today the mankind is facing unprecedented environmental and medical challenges and is left with no option but to follow different principles of green chemistry.

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