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Applications of green chemistry

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Abstract
Green chemistry is rapidly emerging branch of chemistry which is environmentally benign. It leads the designing of chemical substance in such a way which minimizes the production of hazardous chemical products and by products, in part no adverse effect on environment and reduced health risk. Green chemistry plays an important role in pharmaceutical industries in developing innovatory drug synthesis which are less toxic for human health, useful for patients, with minimum side effects. This paper presents principles of green chemistry and its enormous applications in everyday life.

Keywords: green chemistry, sustainability, pharmaceuticals

Introduction
Chemistry plays a prominent role in our daily lives in production of food products, medicines and other useful things like cosmetics, dyes agrochemicals, paints, polymers etc. but during the synthesis of these useful products some unwanted harmful substances are also formed in large quantity. They impart adverse effects on environment and on human health. Thus clean or green chemical substances are needed. Concept of Green chemistry incorporates a new approach to synthesis, processing and application of substances in such a manner so as to minimize the hazards to health and environment. This green approach may be called as eco friendly chemistry, Environmentally benign chemistry, clean chemistry, benign design chemistry. First initiative was carried out by environmental protection agency of US (EPA) in 1991 for sustainable development. Green chemistry has been proved to be an advanced and challenging branch of chemistry with negligible threats to life and environment.

Basic principle of green chemistry
Paul T. analyst formulated twelve principles which provide guidance and directions to chemistry to execute green approach in different fields involving chemical synthesis.

- **Prevention of waste products:** Formation of waste products is prevented.
- **Atom Economy:** Maximum incorporation of starting material and reagents in final products.
- **Minimization of hazardous products:** Utilization of reagents and designing of synthesis decreasing hazard and producing ecofriendly products.
- **Designing safer chemicals:** Chemicals synthesized by green approach should be safe to use with minimum toxicity.
- **Design for energy efficiency:** Energy requirement for any green synthesis should be minimum.
- **Safer solvents and Auxiliary:** Reaction should be carried out in solid phase or solvent less reaction should be preferred immobilized and safe solvents must be used. Auxiliaries must be avoided whenever unnecessary.
- **Use of appropriate, renewable starting material:** Sustainable crude materials should be used.
- **Shorter route of synthesis:** Unnecessary protection, de-protection of groups should be avoided reducing the number of combination and hence derivatives.
- **Catalysis:** Use of catalysts should be preferred as they improve selectivity, lower the temperature requirements and diminish the production of waste.
- **Design for biodegradation:** At the end of function products should break down into harmless entities or biodegradation products. They should not persist in the environment.
- **Design for pollution prevention:** Analytical methodology to allow in process monitoring and control of hazards substances.
- **Design for accident prevention:** Prevention of accidents in manufacturing industries should preferred plants should be designed to eliminate toxicity, explosions, fire etc.

Green chemistry in day to day life
1. **Green dry cleaning of clothes:** Perchloroethylene (PERC) used for dry cleaning of clothes is now known to contaminate ground water and suspected to be carcinogenic. Micelle technology developed by Joseph De Semons, Timothy R mack and James Mc Clain introduced use of liquid CO_2 and a surfactant thus eliminating the use of halogenated solvents.
2. **Versatile bleaching agents:** Paper is manufactured from wood (Contains 70% Polysaccharides and 30% lignin). To obtain good Quality Paper lignin should be removed completely.
3. **Turbid water clear:** 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 increase 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 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. 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 such as $K_2SO_4AL_2(SO_4)_324H_2O$ (potash alum).

4. **In production of chemicals from glucose:** Glucose is alternative for product chemicals. Biotechnological strategies are used to control the production of fragrant compounds. Compounds inclusive of catechol, hydroquinone, and adipic acid, every compounds of which be able to be vital, may be synthetic.
5. **Polysaccharide Polymers:** They are an essential group of compounds that include widespread packages. They have got their dangerous consequences. The big range of compounds can be exploited. Polysaccharide because the feedstock have to be used as beginning materials due to the fact that it's far extra environmentally feedstock.
6. **Solar Array:** One of the best known examples of green technology would be the solar cell. A solar cell directly converts the light energy into electrical energy through the process of photovoltaics, thus reducing green house gases.
7. **Reusable water bottle:** Another simple invention that can be considered green is the reusable water bottle. Drinking lots of water is healthy. Reducing plastic waste is great for the environment. Trendy reusable water bottles are health- promoting, eco-friendly, and green.
8. **Green building technology:** Green buildings use various environmentally friendly techniques to reduce their impact on the environment. Reclaimed materials, passive solar design, natural ventilation and green roofing technology can allow builders to produce a structure with a considerably smaller carbon footprint than normal construction. These techniques not only benefit the environment, but they can produce economically attractive buildings.
9. **Pharmaceutical Applications:** Ibuprofen is nonsteroid and anti inflammatory drug used to relieve pain in arthritis, muscle champs, headache & dental pain. Original & conventional methods of Synthesis of ibuprophene lead to lot of unwanted by products and atom economy of the synethesis was 60% but the new green route of this drug lead less by products & atom economy was 77% Setraline used as antidepressant, was conventionally prepared by coupling of benzophenone with diethyl succinate but green & smart method of its preparation involves isolation of tetrolone using simulated moving bed chromatography followed by racemization of unwanted enantiomer & conversion of racemic tetralone into desired enantiomer by using green solvent. sitaglipin used to treat type 2 diabetes is also being synthesized by practicing metal catalysts by biocatalysts, thus safer to environment. Pyridenyl imidazole based drugs acting as protein kinase inhibitor is now-a-days being synthesized by dimethyl acetone-1,3- dicarboxylate which is cheaper, recoverable & recyclable.

Conclusion

Green chemistry approach will contribute in sustainable development. Many industries like textile, dyes, plastic, paint, pharmaceutical agro are practicing green chemistry. Many examples in various fields are obtained which follow the basic principles of green chemistry. It is providing us a platform to overcome the unwanted harmful impacts of chemistry. It presents wide scope for researches for more efficient technologies. New chemists need to be introduced & trained about it.

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