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## RESEARCH ARTICLE

# IMPACT OF GREEN CHEMISTRY AND ITS SUSTAINABLE APPLICATION ON MODERN HUMAN ENVIRONMENT

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### ABSTRACT

The green chemistry revolution is providing an enormous number of challenges to those who practice chemistry in industry, education and research. So, green chemistry is one of the most explored topics these days. Major research on green chemistry aims to reduce or eradicate the production of harmful bi-products and maximizing the desired product in an eco-friendly way. The green chemistry is required to minimize the harm of the nature by anthropogenic materials and the process applied to generate them. Green chemistry involves 12 set of values which minimize or eliminates the use or production of unsafe substances. Scientists and chemists can significantly minimize the risk to environment and health of human by the help of all the valuable ideology of green chemistry the three main developments in green chemistry include use of super critical carbon dioxide water as green solvent, aqueous hydrogen peroxide as an oxidizing agent and use of hydrogen in asymmetric synthesis. In order to reduce carbon footprint the customary method of heating are increasingly replaced by microwave heating. The principles of green chemistry can be achieved by the use environmental friendly harmless, reproducible and solvents and catalysts during production of medicine and in researches. This paper explain ideology certain examples and application of green chemistry in everyday life, in industry, the laboratory and education.

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## INTRODUCTION

The green chemistry revolution provides an enormous number of opportunities to discover and apply new synthetic approaches using alternative feedstock Eco friendly reaction conditions, energy minimization and the design of less toxic and inherently safer chemicals. The origin and basis of green chemistry for achieving environmental and economic prosperity is inherent in a sustainable chemistry is commonly defined as the chemical research aiming at the optimization of chemical process and products with respect to energy and material consumption, inherent safety, toxicity, environmental degradability and so on. While considering progress has been made in environmental chemistry, green chemistry and the environmental assessment of chemical products, however, the societal aspect of sustainable chemistry remains to be fully recognized in all branches of chemical research, One prerequisite for this is the inclusion of sustainable chemistry into chemical education from the very beginning. Green chemistry is the utilization of set of principles that reduces or eliminates the use or generation of hazardous substances in

design, manufacture and application of chemical product. Pharmaceuticals Industries are using toxic chemical and extra difficult process which produces comparatively a large amount harmful substance. These harmful substances cause bad impact on surroundings and nature. Main emphasis of green chemistry scientists is design of safer chemicals and chemical processes to replace the use of hazardous substances. The approach of Green Chemistry provides environmentally friendly way to replace harmful solvents and Technologies so prevent pollution.

**History of Green Chemistry:** The U.S. environment law "The Pollution Prevention Act of 1990" stated that the first choice for preventing pollution is to design industrial processes that do not lead to waste production. This act helped create a modus operandi for dealing with pollution in an original and innovative way. This paved the way to the green chemistry concept. Paul Anastas and John Warner coined the two letter word "Green Chemistry" and developed the twelve principles of green chemistry. So called Paul Anast as known as the Father of Green Chemistry has given the term green chemistry in 1991. In 2005 Ryoji Noyori identified three key developments in green chemistry use of supercritical carbon dioxide as green solvent aqueous hydrogen peroxide for clean

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oxidations and the use of hydrogen in asymmetric synthesis (Anastas and Warner 1998).

## Literature Review

- The Stockholm conference occurred in Sweden in 1972 and it was attended by representatives from a number of countries including members of the United Nations (UN) and non-governmental organizations. Where environmental law was also considered in the legal field. From this conference the world began to be alerted on the environmental damages that the depletion of the ecosystem could cause to humanity (Jungstedt 2002)
  - The 1980 were marked by numerous world conferences on the Environment. After an evaluation of the 10 years of the proposed actions at Stockholm conference the UN created the world commission on Environment and Development in 1983 to produce a report on world development and environment. This commission was established at a time of unprecedented pressure on the global environment and a growing recognition that much of the development was not sustainable. This report as published Brundtland report.
  - Marcondes 2005, express the Brundtland report also emphasized the dangers of Ozone depletion and the effects on global warming, stating that scientists' ability to evaluate and propose solutions were lower than the speed of climate change.
  - In 1985 during a meeting of the Environment Ministers of the countries of the organization for Economic co-operation and Development (OECD), several decisions were made on three main themes –
    - Economic Development and Environment
    - Pollution prevention and control
    - Environmental Information and National Reviews.
  - These decisions persisted until the year 1990. Interventions based on these main themes were control to issues of chemical product risk reduction and pollution prevention and environment the health and safety of workers (Responsible Care 2017).
  - Since the 1940 environmental issues began to emerge in relation to the growth of industrial activities. In the face of environmental problems and concerns, companies have changed their position on conventional production and product development habits through conferences political agreement and advance in chemical research and ecological engineering adopting sustainable processes to the present.
  - In the 1990 Paul Anastas and John Warner postulated the 12 principles of Green Chemistry still in use today, that duly on the minimization or non-use of toxic solvents in chemical processes and analyzes, as well as the non-generation of wastes from these produces.
  - In 1999 Anastas explain these principles propose environmentally favorable action from the planning of the product to its synthesis, processing, analysis and its synthesis, processing, analysis and its destination after use. The main objective is to minimize the environmental and occupational hazards inherent in industrial activities (Anastas 1999, Lenardao et.al 2003, Prado 2003)
  - Thus, one of the most active areas of Research and Development of analytical methodologies. New methods and techniques that are able to reduce the use and generation of hazardous substances in all stages of chemical analysis are the main goals of the so called Green Analytical Chemistry (Anastas 1999, Sanseverino 2000, Nolasco et.al 2006, Guardia and Armeuta 2012).
  - In this context, Galuszka, Migaszewski and Namienski in the year 2013 adopted the 12 principles of Green chemistry to better fit the Green Analytical chemistry.
  - The European chemical Industry council (CEFIC) in 1994 showed that the populations' views on the chemical industry were not favorable. In general, the population was more attentive to the pharmaceutical and plastics sectors because of the benefits associated with their needs (Pandey 2015)
  - In 1999 Clark explain – opinions generated dislikes about the transportation, safety and waste of these industries, making opinions more favorable to the oil, gas, electricity, wood and paperindustries.
  - The U.S. Government in 1995 announced the presidential Green chemistry challenge programs are awarded annually in five different categories – Academic, Small Business, Alternative synthetic Routes Reactive Alternative conditions and safer chemical Designs.
  - In 1997 the Green Chemistry Institute (GCI) was created as a non- profit corporation to promote through the knowledge experience and capacity, moves of the chemical company toward Sustainability which advanced in the applications of green chemistry.
  - Jointly GCI and American Chemical Society (ACS) in 2001 to address global issues in the meeting of chemistry and environment through research work has integrated green chemistry in every aspect such as industries, business, education, Planning conferences as well as organizing efforts with international networks (ACS Chemistry 2017)
  - ACS chemistry 2017 showed the book the 12 principles of green chemistry are clearly out lined with a philosophy that has always encouraged academic scientists and industries to pursue environmentally correct actions.
  - Governmental and non-governmental organizations, large companies, sectoral associations, delegations and journalists attended this meeting to assign a single objective to discuss the solutions proposed in Agenda 21, so that not only the government can apply them, but the general population in addition to implementing what had been discussed in ECO – 92 (Mar codes 2005, Sequinece 2002)
- The International Union of pure and Applied Chemistry (IUPAC) together with ACS and GCI held four conferences on green chemistry between 1997 and 2011. The conferences include topics such as green products and processes to the environment production energy renewable sources of chemical waste in addition to adopting green policies and education in green chemistry.

## Green Chemistry Concept

- The Green Chemistry has emerged as research program in the US. which arises from collaborative effects of University unit, self- governing research crowd, business, technical community and legislative agencies to decreasing pollution.

- Pollution Prevention Act in 1990 was passed in the United States, This act helped create a modus operandi for dealing with pollution in an original and innovative way. This paved the way to the green chemistry concept. Paul Anastas and John Warner coined the two letter word "Green Chemistry" and developed the twelve principles of green chemistry.
- The New approach introduces in green chemistry synthesis, dealing out and relevance of chemical material in such away as to minimize the risk to environment and health of human. This advanced access is as well called.
  - Eco-friendly chemistry
  - Clean chemistry
  - Atom wealth
  - Benign design chemistry

**Definition of Green Chemistry:** Green Chemistry is utilization of a set principle that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical product.

**Significance of Green Chemistry:** A novel approach that blends the application of chemistry with economic growth and environmental preservation.

- Achieve conservation of limited resources through cost effectiveness and pollution prevention.
- To develop strategy for sustainable chemical process industries.
- Therefore basic axiom of green chemistry is to design product and processes that reduce or eliminate the generation of all wastes.

#### Objective of Study:

- The design of processes to maximize the amount of raw material that ends up in the product.
- To study the green chemistry used in daily life and awareness of the societies.
- Overview literature survey on the biological activity of human life and synthesis of New Non-poisonous component.
- The use of renewable material feedstock and energy sources.
- To study the use of safe, environmentally benign substances, including solvents, whenever possible.
- The design of energy efficient processes.
- Avoiding the production of waste which is viewed as the ideal form of waste management.
- This studies the atomic and energy economics occupy prominent places, as well as the use of renewable and innocuous raw materials.
- The main aim of this study is to develop novel, efficient, convenient, selective and environmentally benign synthetic methods in organic chemistry, which helps the drug discovery and medicinal chemistry and agrochemicals.

#### Principles of Green Chemistry:

- **Prevention:** It is better to prevent the production of waste than to treat or clean up waste after it has been created.

- **Atom Economy:** Engineered planning must intended to enhance the all supplies utilized as element of procedure into product.
- **Solvents and auxiliaries:** Chose the safest solvents available for any given step and avoid whenever possible.
- **Reduce derivatives:** Minimize the use of temporary derivation such as blocking group, protecting groups.
- **Safer chemistry for accident protection:** Choose and develop chemical procedures and substances that are safer and minimize the potential for chemical accidents explosions and fires. Here are some of the fields involved in everyday life where green chemistry has been applied to some extent.
- **Design for degradation:** Design chemicals that degrade and break down into harmless products which do not persist in environment at the end of their function.
- **Catalysis:** Catalytic reagents (as selective as possible) are superior Stoichiometric reagents.
- **Designing Safer Chemicals:** Chemical products should be designed to affect their desired function while minimizing toxicity.
- **Design for energy efficiency:** Its requirements of chemical processes should be recognized for their environmental and at low temperature and pressure.
- **Less Hazardous Chemical Synthesis:** Whenever practicable, synthetic methods should be designed to use and generate substance that possesses little or no toxicity to human health and environment.
- **Use of renewable feed stocks:** Use chemicals which are made from renewable (plant based) resources rather than chemicals originating from depleting resources.
- **Real time pollution prevention:** Monitor chemical reaction in real time in process and control prior to the formation of hazardous substance.

#### Global Recognition of Green Chemistry

- **U.S.A.** – United States Environmental Protection Agency (EPA)
- **U.K.** –In United Kingdom the Crystal Faraday Partnership, a non-profit group founded in 2001, awards businesses annually for incorporation of green chemistry.
- **JAPAN** – In Japan the Green & Sustainable Chemistry Network (GSCN) formed in 1999, is an organization consisting of representatives from chemical manufactures and researches.
- **ITALY** - Green Chemistry activities in Italy centre on interuniversity consortium known as INCA. In 1999, INCA has given three awards annually to industry for applications of Green Chemistry.

**CANADA** - The Canadian Green Chemistry Medal is an annual award given to any individual or group for promotion and development of green chemistry.

**AUSTRALIA** – The Royal Australian Chemical Institute (RACI) presents Australian Green Chemistry Challenge Awards.

**NOBEL PRIZE** - The Nobel Prize committee recognized the importance of Green Chemistry in 2005 by awarding Yveschacev Robert.

H. Grubbs and Richard R. Schrock the Nobel Prize for chemistry for "The development of the metathesis method in organic synthesis".

### **Application of Green Chemistry and Technology in human life:**

**Eco Friendly Dry clean-up of clothes:** Perchloroethylene (PERC) used for dry cleaning pollutes water resource and cancer-causing agent. To solve this problem Joseph De Simons, Timothy Romark and James Synthesized Micell which is made up of liquid CO<sub>2</sub> and a surfactant for cleaning garments, cleaning machines have now been produced utilizing this procedure Micell. This method is now being used commercially by some dry cleanliness. Technology has likewise developed a metal cleaning framework that utilizes CO<sub>2</sub> and a surfactant accordingly dispensing with the need halogenated solvents.

**Green Bleaching Agents:** Conventionally during manufacturing of good quality white paper, lignin from wood used for it, is removed by placing small pieces of wood into a bath of NaOH and Sodium Sulphide followed by its reaction with chlorine. Chlorine during the process also reacts with aromatic rings of the lignin to form Chlorinated dioxins and Chlorinated furans. These compounds being carcinogens, Cause health problems. Terrence Collins of Cambegie Mellon University developed a Green bleaching agent which involves use of H<sub>2</sub>O<sub>2</sub> into hydroxyl radicals that cause bleaching. This bleaching agent breaks down lignin in a shorter time and at much lower temperature. It can be used in Laundry and results in Lesser use of water.

**Putting out Fires The Green Way:** The conventionally used chemical firefighting foams used worldwide discharge toxic substances into environment contaminating water and deleting Ozone layer. A new foam called pyrocool has now been invented to put out fires effectively without producing toxic substances as in other firefighting materials.

**Turning Turbid water clear In Green Way:** Conventionally, municipality and industrial waste water in made clear by the use of Alum. Alum is found to increase toxic in treated water which causes Alzheimer disease. On the opposite hand Kernel powder is not poisonous and is perishable and price effective for the study, four flocculants specifically tamarind seed Kernel powder, mixture of the powder and starch, starch ad alum were used. Flocculants with slurries were ready by combining measured quantity of day and water. The results showed aggregation of the powder and suspended particles were a lot of porous and allowed water to exudates and become compact a lot of simply and shaped larger volume of clear water. Starch flocks on the opposite hand were found to be light-weight and fewer porous and thus did not enable water to taste it simply. The study establishes the powders potential as associate degree economic flocculants with performance shut more matured flocculants like K<sub>2</sub>SO<sub>4</sub>Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>24H<sub>2</sub>O (Potash Alum)

**Biodegradable Plastics:** Large dumps of non-biodegradable waste plastic. Many companies have been working in this direction. For example Nature works of Minnetonka, Minnesota is making food containers from polylactic acid branded as Ingeo. A method has been discovered by the Scientists at Nature Works in which microorganisms convert cornstarch into a resin just as strong as the petroleum based

plastic presently used for making containers, water bottles etc. All company is trying to use the raw material from agricultural waste. In another example BASE developed a biodegradable polyester film called as Ecoflex. This film is used along with cassava starch and calcium carbonate to make fully biodegradable bags called as Ecovio. The bags are certified by the Biodegradable products Institute as completely biodegradable into water CO<sub>2</sub> and biomass industrial composting systems. These bags are also found to be tear resistant, puncture resistant, waterproof printable and elastic so can be used in the place of conventional plastic bags.

**Computer Chips:** Many chemicals, huge amounts of water and energy are required to manufacture computer chips. At the Los Alamos National Laboratory Scientists have developed a method where supercritical carbon dioxide is used in one of the steps of chip preparation which appreciably decreases the amounts of chemicals energy and water required to manufacture chips. At the University of Delaware, Richard Wool, formerdirector of the Affordable composites form Renewable Sources program established a method of make use of chicken feathers to manufacture computer chips the protein, Keratin of the feathers was worn to make a fiber form that is light but tough enough to with stand mechanical and thermal stresses.

**Solar Array:** One of the best known examples of Green technology would be the Solar cell. A Solar cell directly converts the energy in light into electrical energy through the process of Photovoltaics. Generating electricity form solar energy means less consumption of fossil fuels, reducing pollution and greenhouse gas emission.

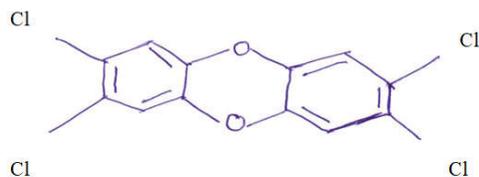
**Rain Water Harvesting System:** Rain collector system are extremely simple mechanical systems that connect to a gutter system or other rooftop water collection network and store rain water in a barrel or cistern for later non-potable use (like flushing toilets, irrigation and watering plants). These systems are extremely inexpensive.

**Insulation of House:** Based on EPA estimates 10% of household energy usage a year is due to energy loss from poor insulation we will get an excellent return on investment from sealing our home to prevent energy escape.

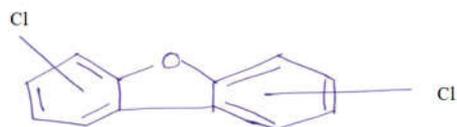
**Building with Green Technology:** Green building make use of a variety of environmentally friendly techniques in order to reduce their impact on the environment. Use of domesticated materials, reflexive solar design, natural ventilation and green roofing technology may allow builders to construct a building with significantly smaller carbon footprint than normal construction. These techniques are beneficial for the environment as well as they can produce cost- effective buildings which are healthier for the occupants too. Green ventilation techniques reduce the need for traditional air conditioning by allowing natural air flow.

**Eco-friendly paint:** Oil based alkyd paints give off large amount of volatile organic compounds (VOC) as it dries and cures. It VOCs have many environmental effects, Procter & Gamble and cork composites polymers established a mixture of soya oil and sugar to be used in place of petroleum petrochemicals derived paints resins and solvents which reduced the hazardous volatiles by 50% chernpol MPs paint formulation use these bio based solvents and create paint which

is safer to use. These paints give performance benefits of alkyls and low VOC content of acrylics.



2,3,7,8 – Tetrachlorodibenzo-P-dioxin



Chlorinated furans

Chlorinated furans

**Solar Water Heater:** Installing a solar water heater can be a great way to cut down on energy costs at a much lower initial expense. The costs associated with the installation of a solar water heater are actually recouped much faster than the costs associated with photovoltaic technology for power generation. This is due to the increased efficiency of solar water heating systems as well as their reduced expense when compared to the large solar array required for powering a home.

**Wind Generator:** The costs of a home wind generator vary greatly. Some have built their own wind generators with off-the-shelf parts from their local hardware stores. Others have purchased kits or paid for professional installation.

#### Green Chemistry in Day-to-Day Life:

- **Dry Cleaning of Cloths:** Perchloroethylene (PERC)  $\text{Cl}_2 = \text{CCl}_2$  is commonly being used as a solvent for dry cleaning. It is now known that PERC contaminates ground water and is a suspected carcinogen known as Micell Technology developed by Joseph De Simons, Timothy Romark and James Meclain made use of liquid  $\text{CO}_2$  and a surfactant for dry cleaning clothes, thereby replacing PERC. Dry cleaning machines have now been developed using this technique. Micell Technology has also evolved a metal cleaning system that uses  $\text{CO}_2$  and a surfactant thereby eliminating the need of halogenated solvents.
- **Versatile 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 of wood into a bath of Sodium Hydroxide ( $\text{NaOH}$ ) and Sodium Sulphide ( $\text{Na}_2\text{S}$ ). By this process about 80-90% of lignin is decomposed. The remaining lignin was so far removed through reaction with chlorine gas ( $\text{Cl}_2$ ). The use of  $\text{Cl}_2$  removes all the lignin (to give good quality white paper) but causes environmental problems. Chlorine also reacts with aromatic rings of the lignin (by aromatic substitution) to produce dioxins, such as 2,3,4 – tetrachloro-p-dioxin and chlorinated furans.

These compounds are potential carcinogens and cause other health problems.

- **Chlorinated furans:** These halogenated products find their way into the food chain and finally into products like dairy 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 peroxide ( $\text{H}_2\text{O}_2$ ), Ozone ( $\text{O}_3$ ) or Oxygen ( $\text{O}_2$ ) also did not give this the desired results. A versatile agent has been developed by Terrence Collins of Carnegie Mellon University. It involves the use of hydrogen peroxide as a bleaching agent in the presence of some activators known as TAML activators that act as catalysts with promote the conversion of hydrogen peroxide into hydroxyl radicals that are involved in oxidation/bleaching. The catalytic of TAML activators allows hydrogen peroxide to break down more lignin in a shorter time and at much lower temperature. These bleaching agents find use in laundry and result in lesser use of water.

#### Conclusion

Green Chemistry is not a brand new branch of science. It is a brand new approach that through application and extension of the principles of inexperienced chemistry will contribute to property development. They are applied not solely in synthesis, process and exploitation of chemical compounds. Several new analytical methodologies described that are complete in step with inexperienced chemistry rules. They are helpful in conducting chemical processes and in analysis of their effects on the setting. By exploitation inexperienced chemistry procedures, we are able to minimize the waste of materials, maintain the atom economy and forestall the employment of dangerous chemicals. Researches and Pharmaceutical corporations got to be inspired to contemplate the principles of inexperienced chemistry where as coming up with the processes and selecting reagents. Student the least bit levels need to be introduced to the Philosophy and apply of inexperienced chemistry. A lot of efforts are being undertaken to design non polluting starting materials and to get safer products without side products. The greatest challenge is to incorporate the green chemistry in day to day life. Many successful efforts have been made but still a lot has to be done. This can be achieved by training and educating new generation of chemists. Green Chemistry has to be introduced in the syllabus of the students at all levels of degree, so that each individual is made aware to choose greener path in his or her everyday life.

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