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ALTERNATIVE TOOL FOR REDUCING POLLUTION BY USING SUSTAINABLE CHEMISTRY

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Abstract:

Green chemistry is the new rapid emerging branch of chemistry. The present review work focuses on the importance and economic development of green chemistry. The beginning green chemistry is considered as a response to the need to reduce the damage of the environment by man-made materials and the process used to produce them all chemical wastes should be disposed of in the best possible manner without causing any damage to the environment and living beings. The green chemistry revolution is providing an enormous number of challenges to those who practice chemistry in industry, education and research. It is the design of chemical processes and products which reduce or eliminate the use and generation of toxic, poisonous, hazardous and bio-accumulative chemical substance. Green chemistry is also called as sustainable chemistry. The over arching goals of green chemistry namely, more resource efficient and inherently safer design of molecules, materials, products, and processes can be pursued in a wide range of contexts.

KEY WORDS: *- Green chemistry, Sustainable chemistry, Environment, Economic development, Resource-efficient.*

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INTRODUCTION:

The green chemistry is defined as a branch of science which utilizes a set of principles for the invention, design, development and implementation of chemical products and processes that reduce or eliminate the use and generation of hazardous substances .Green chemistry is different from environmental chemistry because environmental chemistry identifies source, elucidates mechanism and quantifies problems in the earth environment while green chemistry seeks these environmental problems by creating alternative and safe technology. So the present situation required the solution to balance the use of natural resources and environmental conservation. From last two decades awareness for environmental protection has increased by using the concept of "Green Chemistry"[1]. The new laws and regulations have an Aim to protect the ecosystem from harmful chemicals and develop new compounds by the approach of Green chemistry which is less dangerous to human health and the environment. The main challenge for different industries and research organizations is to develop new methods of developing non-hazardous products under green chemistry. In India various national and international programs have been organized for promoting green chemistry and collecting views of different research workers about this particular field. We require governmental, non-governmental bodies, academic and industrial co-operations for achieving the desired goal.

ORIGIN AND HISTORY OF GREEN CHEMISTRY

Green chemistry is defined in the Linthorst articles as having three major time periods of development. Before 1993, the early origins of pollution control and hazard awareness of pollution was observed. In this time period, Environmental protection agency was evolved with strict command and control with end of the pipeline technology to active efforts to prevent pollution before happened with risk analysis early on in the process. The next time period is between 1993and 1998. In this time frame a chemical philosophy evolved. The third time period is form is form 1999 to now which has seen an explosion of green chemistry based scientific articles .In 1980s, the chemical industry and the EPA concentrated mainly on pollution and harmful toxins. However , a significant shift occurred among chemists as scientists stared spreading environmental awareness and researching avenues to prevent pollution.[2] In1999, paul Anastas published a paper that talked about the importance of green chemistry and postulated 12 principles of green chemistry.[3]

The term green chemistry was first given by Paul.T. Anastas in 1991 in special program launched by the US environmental Protection Agency (EPA) to implement sustainable development in chemistry, chemical technology by industry ,academia and government. In 1995 the annual US presidential green chemistry challenge was announced. In 1996 the working party on green chemistry was created, acting within the framework of International Union of Pure and Applied Chemistry. The first book and journals on the subject of green chemistry were introduced in 1990 by the royal society of chemistry. The organization for Economic Co-operation and Development [OECD], an international body consisting of about 30 industrialized countries, held meeting and made recommendation based on a cooperative changes in existing chemicals synthesis process and the prevention pollution [4]. Green chemistry includes a new approach to the synthesis, processing and application of chemical substances in such a manner to reduce scourge to health and environment like:

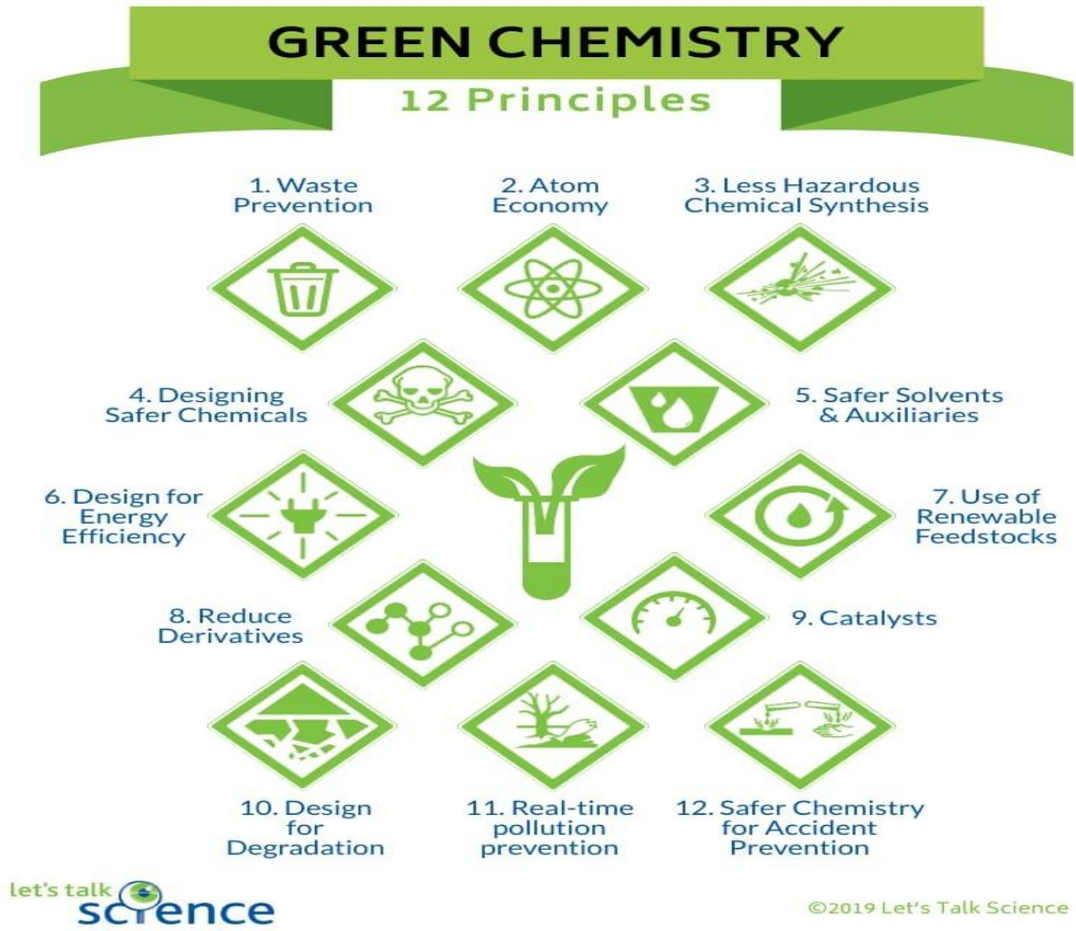
- Clean Chemistry
- Atom Economy
- Environmentally benign chemistry. [5-11]

Twelve principles of Green chemistry have been developed by Paul .T. Anastas, speaks about the reduction of dangerous or harmful substances from the synthesis, production and application of chemical products. When designing a green chemistry process it is impossible to meet the requirements of all twelve principles of the process at the same time, but it attempts to apply as many principles during certain stages of synthesis. [12-13]

PRINCIPLES:

1. **PREVENTION:** It is better to prevent waste than to treat or clean up waste after it has been created.
2. **ATOM ECONOMY:** Design the chemical processes in such a way that the final product contains maximum proportion of the reactant or the starting raw materials and leaving a few numbers of atoms of raw materials.
3. **LESS HAZARDOUS CHEMICAL SYNTHESIS:** The synthetic method should be designed to use and generate substances that process little or no toxicity to human health and the environment.
4. **DESIGN BENIGN CHEMICALS:** Chemical processes and products should be designed in such a way that, it is highly selective in nature and affect their desired functions and minimizing their toxicity, bio-accumulation and bio-transformation.[14]
5. **SAFER SOLVENTS AND AUXILIARIES:** The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made whenever possible and innocuous when used.
6. **DESGIN FOR ENERGY EFFICIENC:** It is necessary to design the chemical processes /products in such a way that it utilizes less energy to form desired product, this can accompanied by keeping the chemical processes at ambient temperature and pressure in the presence of suitable catalyst.
7. **USE OF RENEWABLE FEEDSTOCK'S:** A raw material of feedstock should be renewable.
8. **REDUCE CHEMICAL DERIVATIVES:** During a chemical processes, waste product are formed or generated if additional chemical reagent are used to block or protect any groups, so avoid such type of blocking, protecting groups or even any modifications, if possible.[15]
9. **CATALYSIS:** Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
10. **DESIGN FOR DEGRADATION:** 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. **REAL-TIME ANALYSIS FOR POLLUTION PREVENTION:** 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. . **INHERENTIY SAFER CHEMISTRY FOR ACCIDENT PREVENT:** The substances used in the chemical process should be chosen to minimize the potential for chemical accidents, explosion and fires. This principle can motivate

chemistry at all levels like research, education and public perception.[16]



ADVANTAGES OF GREEN CHEMISTRY

1. CLEAN AIR TO BREATH – Non-hazardous material are release into the environment which leads to cleaner air and causes less damage to the lungs. Also the usages of such environment friendly materials are a boon against air pollution.
2. CLEAN WATER TO DRINK- Source of drinking water like rivers and ponds etc, are saved from being polluted by non-hazardous and nill pollution creating chemical materials. Minimized release of hazardous materials leads to control of water pollution.
3. INCREASE IN SAFETY OF WORKS IN THE CHEMICAL INDUSTRY- Due to use of non-accidental and non-hazardous chemical materials industry worke5rs are saved from accidental explosion and health damages due to long exposure to hazardous materials which can be life saving boon for the industry and also for the worker.
4. HEALTH CONSUMER PRODUCTS- Healthy consumer products will be available for the people which will be safer than the phasing out products.
5. Such products will be made from less waste materials and will be free of pesticides and cleaning products.
6. LESS DEGRADATION AND SPOLLING OF FOOD PRODUCTS- Food products will be safer from insects and worms and will be healthier and nutrition and will take more time to rot and become spoiled and useless.
7. DECREASE IN THE RATE OF GLOBAK WORMING – Due to usage of non-polluting and non-hazardous, non-toxic materials the global warming will become slow. Environment will be free of toxic gases and there will be less production of waste materials that cannot be disposed of and degraded or recycled.
8. RECOVERY OF OZON LAYER- Ozone layer stop the harmful UV Rays of the sun and protects us from various life taking diseases like skin cancer etc.
9. Reduction in the production of greenhouse gases that create global warming will start the recovery of depleting ozone layer.
10. HIGHER PRODUCTION- Green chemistry is very helpful for the growth of agriculture sector. It helps in creation and development of materials that are more environmental friendly.
11. Petroleum products create a lot of air pollution. They are also responsible for the increased levels of greenhouse gases that cause global warming.[17]

DISADVANTAGES OF GREEN CHEMISTRY

1. Pests and weeds may develop hazards-- cross pollination between genetically modified organisms may result in new species that can be hazardous.
2. Mono culture is employed—big tracts of land must be available for mono culturing which is often not possible and brings many hardships to farmers.[18]

BENEFITS OF GREEN CHEMISTRY:

HUMAN HEALTH:

- CLEANER AIR: Less release of hazardous chemical to air leading to less damage to lungs.
- CLEANER WATER: Less release of hazardous chemical wastes to water leading to cleaner drinking and recreational water.

ENVIRONMENT:

- Plants and animals suffer less harm from toxic

chemicals in the environment.
- Lower potential for global warming, ozone depletion, and smog formation.
- Less chemical disruption of ecosystems.
- Less use of landfills, especially hazardous waste landfills.

ECONOMY AND BUSINESS:
- Reduced waste, eliminating costly remediation, hazardous waste disposal, and end of the pipe treatments.
- Allow replacements of a purchased feedstock by a waste product.
- Improved competitiveness of chemical manufacturers and their customers.
- Better performance so that less is needed to achieve the same function.[19]

THE POLLUTION PREVENTION ACT [1990]
Its focus is the prevention of pollution at the source rather than the treatment of pollutants after they are formed. This goal became a formal objective of the environmental protection agency [EPA] in 1991. Anastas coined the term 'green chemistry' the same year. Two of the most prominent and early advocates of green chemistry were Kenneth Hancock of the National Science Foundation [NSF] and joe Breen, who after twenty years of service at the EPA then became the first director of the Green Chemistry Institute [GCI] during the late 1990s.

CAUSES:
POLLUTION: The change in the environment caused by natural or artificial input of harmful contaminants into the environment, and may cause instability, disruption or harmful effects to the ecosystem. Thus, pollution is essentially the introduction of toxins into the natural setting that causes negative changes. Pollution can take the form of biochemical substances or energy, such as noise, heat or light. Contaminants, the constituents of pollution, can be one or the other, foreign substances/ energies or naturally found pollutants.

WATER POLLUTION:
Water pollution occurs when harmful substances often chemicals or microorganism. Contaminate a stream, river, lake, ocean, aquifer, or other body of water, degradation water quality and rendering it toxic to humans or the environment.

TYPES OF WATER POLLUTION:
1. GROUND WATER
2. SURFACE WATER
3. OCEAN WATER
4. POINT SOURCE

GROUND WATER: - When rain falls and seeps deep into the earth, filling the cracks, crevices, and porous spaces of an aquifer [basically an underground store house of water], it becomes ground water one of our least visible but most important natural resources. Nearly 40 percent of Americans rely on groundwater, pumped to the earth's surface, for drinking water. For some folks in rural areas, it's their only freshwater source.

SURFACE WATER: - Covering about 70 percent of the earth, surface water is what fills our oceans, lakes, rivers, and all those other blue bits on the world map. Surface water from freshwater sources [that is, from sources other than the ocean] accounts for more than 60 percent of the water delivered to American homes.

OCEAN WATER: - Ocean pollution is also called as 'marine pollution'. Eighty percent of ocean pollution originates on land- whether along the coast or far inland.Contaminants such as chemicals, nutrients, and heavy metals are carried from farms, factories, and cities by streams and rivers into our bays and estuaries; from there they travel out to sea. Meanwhile, marine debris- particularly plastic is blown in by the wind or washed in via storm drains and sewers. Our seas are also sometimes spoiled by oil spills and leaks-big and small and are consistently soaking up carbon pollution from the air. The ocean absorbs as much as a quarter of man- made carbon emission.

POINT SOURCE: - When contamination originates from a single source, it's called point source pollution. Examples include wastewater [also called effluent] discharged legally or illegally by a manufacturer, oil refinery, or wastewater treatment facility, as well as contamination from leaking septic systems**,** chemical and oil spills**,** and illegal dumping**.**[20]

EXAMPLES OF GREEN CHEMISTRY
1. **USE OF GREEN SOLVENTS:** With the advancement in technology, we have come up with such as solvents and chemicals that are non toxic and do not cause pollution. Earlier, the chemicals or solvents used were known to have chlorine and were toxic to the environment.
2. **BLEACHING OF PAPER:** Hydrogen Peroxide has replaced chlorine in the process of bleaching paper. Chlorine that was used earlier was harmful for the environment.
3. **DRY CLEANING:** Earlier tetrachloro ethylene was used as a dry-cleaning agent which was very toxic and polluted ground water. It was a carcinogenic and caused diseases. This has now been replaced by liquefied co-2 and a detergent. This process ensures that the waste production is leaste toxic as the waste product produced in this case is liquid carbon dioxide. [21]

USES OF GREEN CHEMISTRY
Green chemistry plays a vital role in our daily lives and has application in all the fields. Some uses of green chemistry are discussed below:
* It is used in consumer products, pharmaceuticals, and other industries.
* It is used to develop new processes that are less harmful for the environment and more efficient.
* It has a use in electronics and electrical industry too. [22]

IMPACTS OF GREEN CHEMISTRY
Green Chemistry is a proactive approach to pollution prevention.
Green Chemistry is based on principle like
1. Waste minimization at source
2. Use of catalyst in place reagent
3. Using non- toxic reagent
4. Use of renewable resources
5. Improved atom efficiency
6. Use of solvent-free or recyclables
7. Environmental benign solvent system.[23]

GREEN CHEMISTRY IN LABORATORY
A number of compounds are synthesised by using various green solvents by green procedure. Some of the green solvent and other reagents used are follows:

GREEN SOLVENTS

ESTER SOLVENTS: Speciality Solvents, Fusible Solids, Supercritical Gases- e.g. SCCO2

EASTERS: Iso Propyl laurate, Rapeseed methyl esters [biodiesel], Oleic acid propylene glycol mono esters, TOFA ethylene glycol mono esters, Butyl epoxy stearates, Glycerol tri acetate, Di basic esters.

SPECIALLY SOLVENTS: Glycerol carbamates, Capryl dimethylamide, Dioctyl ether, Dimerdiol carbonate, Ethyl lactate, 2-Ethylhexyl lactate.

FUSIBLE SOLIDS: Hydrogenated castor oil, Stearyl stearate, Tricapryl methyl ammonium chloride,1-Butyl-3-methyl imidazolium octyl sulphate.[24]

GREEN CHEMISTRY IN INDIA

The recently constituted Green chemistry chapter of India has already started working to popularize green chemistry in india. As a part of environmental movement, a National Symposium on green chemistry was organized by the Department of Chemistry, University of Delhi in January 1999 to bring together all who are practicing green chemistry in India for the first time. For green chemistry education, a refresher course was organized for college teachers by the Center for Professional Development in Higher Education in Educational in University of Delhi. Inspired by the overwhelming response of participants in these events, recently an IUPAC International Symposium on Green Chemistry was organized by the Department of Chemistry, University of Delhi., which proved to be an excellent event for scientists world over to interact on the one common platform.

The Green Chemistry Chapter of India was constituted recently to expand its domain. Some future activities under the banner of the Green Chemistry Chapter of India have been planned. Top on the priority list is to spread the awareness of green chemistry among researchers and young students by means of workshops, conference, scholarships, and Awards. Simultaneously, there is a need to encourage industries to collaborate with academic and government for effective practice of green chemistry. Another aim of the green chemistry chapter of india is to encourage global partnership for effective environmental management.[25]

APPLICATIONS OF GREEN CHEMISTRY

Green chemistry is being employed to develop revolutionary drug delivery methods they are more effective and less toxic and could benefit millions of patient.

Improved process conditions and economics, incorporating green chemistry into the synthesis of active synthesis of active pharmaceutical ingredients [APIs] and intermediates is of ongoing importance to the pharmaceutical industry.

Green chemistry methods produce no waste, reaction is a quick one-step reaction and a very little amount of catalyst is utilized.

Solvent reduction and replacement and biocatalysts are some of the tools used to optimize select API synthesis. **.**GlaxoSmithKline [GSK, London] developed the 'Eco-Design Toolkit' as a way to provide bench-level chemists and engineers with access to green-chemistry information and tools for process research and development and manufacture. **.**Green chemistry help to improved healthcare & reduced environment footprint.[26]

CONCLUSION:

The growth of green chemistry over the course of the past decade needs to increase at an accelerated pase if pharmaceutical science is to meet the challenges of sustainability. By using green chemistry procedures, we can minimize the waste of materials, maintain the atom economy and prevent the use of hazardous chemicals, Researchers and pharmaceutical companies need to be encouraged to consider the principles of green chemistry while designing the processes and choosing reagents.

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