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A Review on Overview of Green Chemistry

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Abstract: *Green chemistry is an approach to the design , manufacture and use of chemical products to internationally reduce or eliminate chemical hazards . it focuses on the reduction, recycling/ eliminations of the use of toxic and hazardous chemicals in production processes by finding creative , alternative routes for making the desired products that manimize the impact on the environment sustainable economic growth requires safe, sustainable resources for industrial production . This article describes an introductory account of the basic tanets on which the concept of the green chemistry is based .*

Green chemistry which is the latest and one of the most researched topic now days has been in demand since 1990's . Majority of research in green chemistry aims to reduce the energy consumption required for the production of desired products whether it may be any drug , dyes and other chemical compound. It aims to reduce or even eliminates the production of any harmful bio-product and maximizing the desired products without compromising with the environment . The goal of green chemistry (GC) is the design (or redesign) of product and manufacturing processes to reduce their impact on human health and the environment. Fundamental to the GC concept is the idea of sustainability _ reducing environment impacts and conserving natural resources for future Green generation . Although many of the principales of green chemistry are not new , the extend to which they have been organized into a coherent approach and the degree to which they are being applied have resulted in an intensified attention on this topic among the academic , industrial , and regulatory communities.

The use of toxic, poisonous, hazardous and bio-accumalative chemical substance is reduced or eliminated in green chemistry , which involves the design of chemical processes and product. It is a fresh take on scientifically based environmental protection and in essential to preventing climate change , acid rain , and global warming . It's basic tenet increases efficacy , selectivity , and minimises waste creation , making it a crucial instrument in the fight against pollution.

Keywords: *introduction , definition , history , scope , source , importance , principle , selection of appropriate solvent , industrial interests in green chemistry , industrial applications in green chemistry , green chemistry in education , advantage , disadvantage , uses , review literature , conclusion.*

Green chemistry is generally aimed at :
Producing chemicals which are safe for biotic as well as abiotic environment .
Using cost and energy effective method and procedures .
Designing processes that reduces or eliminate the use and production of toxic materials .
Minimizing the production of wastes.
Avoiding the production of non - biodegradable materials / products
Maximizing the use of raw - materials from renewable resources .

I. INTRODUCTION

Green chemistry is a science - based philosophy of designing chemical , products , and processes with the intention of making them less hazardous and more sustainable .Green chemistry is a non- scientific method of creating chemical processes and goods that minimises or completely dose away with the usage and manufacturing of potentially harmful ,

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toxic , and bio- accumalative chemicals by humans . It comprises developing chemicals' raw materials that will be utilised later and are healthier for the environment and people health . It helps researchers and scientists build a useful world where people use everything via the biogeochemical cycle , resulting in better lives for all people and sustainable development . Green chemistry tries to solve these environmental issues bydeveloping safe , alternative technology , in contract to environmental chemistry , which identifies source , clarifies mechanisms and quantifies problems in the earth's environment .

The accelerated progress In science and technology now a day has led to economic development in world , but such economic development also cause environmental degradation which is mainfested bi climate change , the issue of ozone holes and accumulation of non destructive organic pollutants in all parts of biospheres . Green chemistry is new branch of chemistry involves pulling together tools . Chemistry as a separate discipline took its shape in the beginning of 17th century also referred to as "age of reasons" . Since then the properties and use of different components has fascinated many scientist .

DEFINITION

Green chemistry , also called sustainable chemistry , is an area of chemistry and chemical engineering focused on the design of products and processes that minimize or eliminate the use and generation of hazardous substances. It is the design of chemical products and processes that reduces or eliminate the use or generation of hazardous substances . Green chemistry is the process of thinking about and applying current knowledge to lessen the negative environmental impact of pollution .

Green Chemistry implies:

- Prevention of pollution rather than treatment of pollution
- Environmentally Benign Chemistry
- Sustainable Chemistry
- Ecofriendly Chemistry
- Clean Chemistry

HISTORY

As part of a unique initiative operated by the US Environmental protection agency (EPA) to encourage sustainable growth in chemical technology by business , academic , and government , poul . T .Anastas invested the term "Green chemistry" in 1991 . In 1995 , the US presidential green chemistry challenge was launched . The working.party on green chemistry was created by the international union of pure and applied chemistry in 1996 . The first book and two magazines on the subject of green chemistry were published in 1990 by the royal society of chemistry. In 1990 , the royal society of chemistry publication the first book and two periodicals in the topic of green chemistry . Green chemistry is a novel method for creating , processing , and applying chemical in order to lessen hazards to human health and the environment , such as :

Clean chemistry

Atom economy

Environmentally benign chemistry .[2-8]

SCOPE

This focus area involves designing and implementing a novel , green pathway to produce a new or existing chemical substance . Chemistry Plays an important and useful role towards the development and growth of a number of industries .

Green chemistry provides a unique forum for the publication of innovative research on the development of alternative green and sustainable technologies .

Green chemistry is at the frontiers of this continuously- evolving interdisciplinary science and publishes research that attempts to reduce the environmental impact of the chemical enterprise by developing a technology base that is inherently non - toxic to living things and the environment . Submissions on all aspects of research relating to the endeavour are welcome .

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Need of green chemistry

Green chemistry either degrade to innocuous products or are recovered for further use . 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 ecosystem . Green chemistry looks atpollution prevention on the molecular scale and is an extremely important area of chemistry due to the importance of chemistry in our world today and the implications it can show on our environment .

The green chemistry program support the invention of more environmentally friendly chemical processes which reduce or even eliminates the generation of hazardous substances . Green chemistry is undeniablya very prominent part of our daily lives .

Green chemistry looks at pollution prevention on the molecular and larger scale .

It program support the invention of more environmentally friendly chemical processes which reduce or even eliminates the generation of hazardous substances . Chemistry is a very prominent part of our daily lives . Chemistry developments also bring new environmental problems and harm ful unexpected side effects , which results in the need for ' greener' chemical products.

Important

Green chemistry either degrade to innocuous products or are recovered for further use . Plants and animals suffer less harm from toxic chemicals in the environment . One of the key principles of green chemistry is to reduce the use of derivatives and protecting groups in the synthesis of Target molecules .

Green chemistry has many applications are our day - to - day life . Following are the uses of green chemistry . It is used in the process of coating , consumer products , pharmaceuticals , preservatives , etc . Dry cleaning of clothes - In the early years, we used tetrachloroethylene as a solvent for dry cleaning . This compound is carcinogenic and also pollutes the groundwater . Green chemistry means designing chemical products and processes that use and produce fewer or no polluting or hazardous materials . For example , you could use green chemistry in developing new catalysts or substitutes for volatile organic compounds used in solvents and adhesive .

_Design safer chemicals & products
_use renewable feedstocks
_use catalysts , not stoichometric reagents
_ maximize atom economy
_ increase energy efficiency
_ design chemicals and products to degrade after use
_ analyze in real time to prevent pollution
_ minimize the potential for accidents

Twelve principles of green chemistry have been developed by poulAnastas , speaks about the reductionof 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 .[9-10]

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Principles of Green chemistry

Fig :- Principle of green chemistry 12 principles of green chemistry are listed below:

1. Prevention
2. Atom Economy

3.Less Hazardous Chemical Synthesis 4. designing Safer Chemicals 5.Safer Solvents andAuxiliaries 6.Design for Energy Efficiency 7.Use of Renewable Feedstocks 8.Reduce Derivatives 9.Catalysis 10.Design for Degradation 11.Real-time Analysis for Pollution Prevention 12.Inherently Safer Chemistry for Accident Prevention.

1. Prevention:

treating or cleaning is preferable to controlling or avoiding the synthesis of hazardous, poisonous, explosive, bio-accumulative, and waste chemical products.[12]

EX : 1. Prevent the manufacturing of nuclear and non- nuclear weapons , explosives, and dangerous biochemical in a variety of industrialised and developing nations since they contribute to a variety of environmental pollutions . [13]

2. Check for and / or stop the overuse of natural resources like coal and petroleum , as these fuels produce toxic gases during combustion that leads to acid rain and global warming .[14]

2. Atom economy

Plan the chemical reaction so that the end product has the highest possible concentration of the reactant or initial raw material, with just a small amount of raw material atom remaning. [15]

EX : One mole of anhydride , two moles of carbon dioxide , and two moles of water are formed when one mole of benzene reacts with 4 1 /2moles of oxygen . [16]

Atom economy= Mass of atom in desired products/ mass of atomic reactant ×100

=99/222×100

=44.1%

3. Less hazardous chemical synthesis

create chemical processes and products that are designed to prevent environmental degradation and human harm by ensuaring that the usage and synthesis of chemical compound do not beyond the critical limit of toxicity.

EX : 1.Avoid the synthesis of chemical like organ mercurial's compounds; which caused Minamata disaster. [17]

2. Methyl isocyanate (MIC) prepration should be prevented because it contributed to the Bhopal gas disaster . [15]

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4. Designing safer chemicals chemical goods and processes should be created with the least amount of toxicity ,bioaccumulation ,and biotransformation possible while yet having a highly elestive character that affects their intended activities.

EX : 2, 4-D: it is a selective pesticide which selectively kills only broad leaf weeds .[18]

5. Safer solvent and auxillarise when utilization auxiliary compound as solvent , separation agent ,or extraction agent , they should not causes cancer , be non -explosive , non-toxic , non-bio accumulation , or induce mutation. EX : Super critical carbon dioxide is a better solvent because it is a non - toxic and non - explosives fluid . [19]

6. Design for energy efficiency

In order to create the intended outcome,chemical process and products must be designed to use the least amount of energy possible.this may be achieve by maintaining the process at room temperature and pressure while using an appropriate catalyst .

EX :formation of ammonia from Haber process . [20]

7. Use of renewable feed stocks

Avoiding the use of non renewable natural resource such as coal ,oil and natural gas is preferable xforsustenable development . But utilising renewal resources per it's continuous development does not pose much of a problem as it is replenished through natural processes and bio - chemical cycles . Example:Bio based plastics made for renewable feed stocks.Furfural production from bagasse and leftover biomass from the wheat and rice plants [21]

8. Reduce derivatives

During a chemical process, waste product are formed or generated if additional chemical reagent are usedto block or protect any groups, so avoid such type of blocking , protecting group or even any modifications,if possible.

Ex : the commercial production of semi - synthetic antibiotics like ampicillin and Amoxicillin uses enzymes to circumvent protecting groups and the cleaning procedure . [22]

9. Catalysis catalyst is a chemical that is used in small amount to speed up reaction by lowering activation energy and self -regenerating after the process is finished. Sterio chemistry reagents are utilised in various chemical processes , albeit they just serve as a catalyst and do not complete the reaction . [24]

10. Design for degradation

The design of chemical processes and product should ensure that both the final goods and the waste items they produce can decompose naturally.by using physical, chemical ,and biological processes, the intended products disintegrate into innocuous tiny compound and disappear into the surrounding environment. The product sholdn't exhibit biomagnifications or be bio accumulative in any way. EX : biodegradable and bioactive thermoplastic aliphatic polyester polylactic acid (PLA) . [25]

11. Real-time analysis for pollution prevention

To regulate the creation of desired product and prevent the production of any hazardus or waste materials as byproduct , it is crucial to understand the event of product formation throughout a chemical process at varying temperature, pressure, and time.[26]

12. Inherently safer chemistry for accident prevention

Chemical accidents , such as explosions , fires and smoke produced by chemical released into the enviroment , can be reduced or completely avoided by designing chemical processes, products , and their physical state, such as solid , liquid , and gaseous .

Hazardous substances are

Poisonous (toxic)

Flammable

Radioactive

Explosives

Corrosive

- To read labels and safety data sheet.
- To learn about dangerous and required safety provision .
- Inspect the sufficient air flow .
- Remove anything from the workspace that could burn or react with a chemical or product that is harmful . [27]

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Application

Textile and tannery industry designing safer chemicals production waste minimization in drug discovery designing safer chemicals production polymer industry food and industry . - Green technologies in the pharmaceutical industry green chemistry in agrochemicals waste minimization in drug discovery.

Minimization of hazardous/toxic products

This is one of the important aspects in green chemistry which advocates the minimization of toxic products in processes. A product may be regarded as a hazardous, if it is associated with toxicity, flammability, has explosion problems and gets accumulated with in the environment. The impact of hazardous products should be minimized on the workers by use of protective clothing, googles, respirators. The risk of hazard can be reduced on the workers working in factories producing such chemicals, by just reducing the time of exposure. The harm being caused by the exposure is given as: Risk = (function) Hazard x Exposure

From the above relation it is clear that to reduce the risk, we need to reduce either hazard or exposure or both. The reduction of hazard is regarded as a green chemical approach to minimize the risk. However if only the time limit of exposure is reduced, it means although little a harm can occur once exposed. If however no exposure is there, it completely eliminates the risk of the hazard.

Designing safer chemicals:

Chemical products to be synthesized should be safe to use. Thalidoimide presents an example of a typically unsafe drug, used for reducing the nausea and vomiting in pregnant women. The children born to such women suffered birth defects, which necessatiated the ban on the use of this drug. Manipulation of molecular structures has helped in lot in the design of safer chemicals. A well-known example of retrometabolic design is that of ethylene glycol, which is used as an antifreeze and has been replaced by propylene glycol which is less hazardous. Ethylene glycol once ingested in to body gets converted in to glyceraldehyde, glyoxylic acid and oxalic acid which are toxic to body, as against propylene glycol which gets metabolized into normal body metabolites like lactic and pyruvic acid. The lethal dose of ethylene glycol for man is 1.4 ml/kg while as the lethal dose of propylene glycol for man is 7 ml/kg. Thus propylene glycol is a comparatively safer chemical than ethylene glycol.

Selection of appropriate solvents: (Green solvents)

Chemists generally use any organic solvent of their choice in synthetic reactions. Most often these solvents are the volatile organic solvents (VOCs) and have a major environmental concern, as they are able to form low-level ozone and smog through free-radicals air oxidation processes. They are also highly flammable and cause adverse effects like eye-irritation, headaches and allergic skin reactions in human biengs. These facts have made it necessary to use green alternative solvents. However if possible the use of solvents should be avoided. If however there is no choice and use of solvent becomes

imperative, it is recommended to use such solvents which are inert, have low toxicity, easy to recycle without contaminating the products. The solvent selected should not have any negative impact on the environment or human health. e.g. halogenated solvents like CHCl3, CCl4 are suspected carcinogens and to avoid their use, green alternatives like water, ionic liquids, liquid CO2 have been used. To avoid the problems associated with the conventional VOCs, immobilized solvents have been harnessed. Such solvents maintain the solvency, are non-volatile and do not pose any environmental problem.

1. H2O as Green Solvent:

Water is regarded as the best solvent for the reactions to be carried out. Water however has a number of advantages but at the same time so many disadvantages as well. Water is naturally occurring, non-toxic, non-explosive solvent as against the VOCS . However at the same time water is difficult to heat or cool rapidly, its distillation is energy expensive, the contaminated waste streams are difficult to treat.

Although chemical reactions in human systems occurs within the water, but in lab synthetic reactions hardly occur in it. However at higher temperatures the density decreases while the ionic product of water increases. At temperatures of

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more than 200 0C water becomes as good as an organic solvent. It is believed that water behaves like acetone at a temperature of 300 °C. This is possibly because higher temperature removes hydrogen bonding in the water. In some reactions a significant amount of rate enhancement has been observed when the reaction is carried out using water. A typical example of this is the Diel's alder reaction between cyclopentadiene and butane. It has been found that this reaction occurs 700 times faster in water compared to the isooctane.

2. Ionic Liquids

An ionic liquid comprises of a large nitrogen containing organic cation and a small inorganic anion. Since one part is large and other is small, it creates asymmetry in the compound which makes it a low melting solid. Simple ionic liquids when mixed with the other inorganic salts result in the production of a multicomponent ionic liquid. Since the components of an ionic liquid are held by strong forces of attraction, it is found that they possess no or low vapour pressure rendering them non-volatile in nature. Further they are non-flammable and non-explosive which is an additional feature rendering them safe to use. They can also be used both as solvent as well as catalysts. Thus the properties of ionic liquids which make them ideal green solvents include: a) Lack of vapour pressure.
b) Non flammability and non-explosiveness.
c) Stable at high temperature which makes them better for carrying out reactions at high temperatures.
d)The property of these ionic liquids can be changed by just changing their concentrations of cations/anions, varying the side chain length in cations

INDUSTRIAL INTEREST IN GREEN CHEMISTRY

Many forward - thinking businesses are embracing green chemistry since it frequently boosts their bottom lines as well as the environment and fosters positive public relations . According to estimates , US firms spend between $100 and $150 billion annually on compliance with environmental standards . Additionally , it will cost hundreds of billions of dollars to clean up hazardous waste sites . The cost of complying with environmental standards often outweighs the money spent on research in many business . Larger businesses set , aside about $ 1 billion annually for environmental compliance . If a business can considerably cut this expense , the money saved can be used in more profitable ways , which will boost the bottom line . Thus Green chemistry
(pollution avoidance) benefits industry as well as the environment . [28]

INDUSTRIAL APPLICATIONS OF GREEN CHEMISTRY

Green chemistry is not a lab - curiosity ; instead it aims at big objective of creating a sustainable tomorrow . Increasing number of green methodologies development by academic and industrial researchers enables companies to commercialization these ideas . Industry , from small businesses to large corporations , has already made strategic moves towards sustainability by adopting the principal of green chemistry . The development of less hazardous processes and commercial products , the shift from in efficient chemical routes towards bio - based synthesis , and the replacement of oil - based feed stock by renewable starting materials are only a few examples of the major decisions takes that will ultimately have vast consequences for the world chemical markets . Chemical manufacturing used green chemistry to reduce or eliminate their use of TRI solvent and reagent chemicals . Involves major chemicals , reagents , solvents catalysts and almost all types of organic reaction for synthesis of active pharmaceutical substance . Therefore , many chemical and chemical processes involved are hazardous , toxic and may show advance effects on human health and environment . Pharmaceutical companies can influence and improve the environmental performance with utilising green chemistry . Green chemistry is being employed to develop resolutionary drug delivery methods that are more effective and less toxic and could benefits of patients . Green chemistry has grown from a small idea into a new approach to the scientifically based environmental protection . By using green chemistry procedure , we can minimise 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 principal of green chemistry while designing the processes and choosing reagents .
Now that sustainability is on everybody's top - of - mind . Green chemistry is more important than ever .

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Just think about the amount of industries that reply on chemistry and whose activity has a great impact on the environment : pharma , agriculture , colorants , materials , consumer products

GREEN CHEMISTRY IN EDUCATION

Education is the first step in getting chemists to think more sustainably . In 1994 , the concept of teaching green chemistry in chemistry classes was first proposed . There aren't many Green chemistry textbook available . These books will be extremely useful to graduates , postgraduates , teachers , and researchers .

The necessity of introducing green chemistry into the classroom and the lab has been acknowledged by both the Environmental protection agency (EPA) and American chemical agency . Together , they have started a substantial initiative to create teaching resources for green chemistry and promote the " greening of the chemistry curriculum The integration of Environmentally friendly technology in academic and industry depends on student engagement with green chemistry principales and practices . By participating in at least three green chemistry activities throughout the academic year , ACS students affiliate chapter can be designated as " Green " chapters . The following are some ideas for these activities : hosting a speaker on green chemistry

_ setting up a campus workshop on multidisciplinary green chemistry .
_ participating in a green chemistry initiatives with a nearby business .
_ creating a green chemistry activity in cooperation with a nearby school .
_ making an existing scientific experiment more Environmentally friendly .
_ planning a campus poster session on green chemistry sending out a green chemistry newsletter to the neighbourhood .
_ creating an eco - friendly chemistry website .[30]

ADVANTAGES

- Green chemistry reduces waste production .
- In green chemistry is a fresh strategy for protecting both the Environmental and human health .
- Conservation of energy and that consumption has a significant impact on the environment has long been acknowledged .
- Solid - State microwave irradiation is a technique that , in contract to how they have historically been carried out in liquid solution , is being employed to speed up chemical reactions .
- Microwave - assisted processes without solvent allow for the use of open containers , which lowers the danger of high pressure and increases the possibility that such reactions may be scaled u p .

The feasibility of microwave aided solvent free synthesis has been demonstrated by a number ofreal world transformation and the synthesis of heterocyclic system . [31-34]

- DISADVANTAGES

- creating chemical products and procedures that lessen or do away with dangerous chemicals is the fundamental task of green chemistry.
- This objective is also the most challenging for green chemistry , and it is particularly reflected in the amount of time , money, and information required to complete it . For example , switching from an outdated , conversation product to a new , " green " one is often difficult and expensive , and there is currently no consensus on what constitutes a safe level of chemical a raw materials input .
- Lack of green chemistry will result from the high implementation costs and lack of information , since there will be no defined option for using chemical raw materials or alternative technologies for green processes .
- Additionally , there is a shortage of human capabilities . The future of green chemistry is ionic liquids .
- Despite the fact that their value in chemical synthesis is undeniable .
- Ionic liquids do not primarily look like green chemical when the 12 criteria that characterize them are applied .
- Although it is commonly known that ionic liquids have a low vapour pressure and are therefore slightly volatile , this is only one of the many factors that contribute to a material being green.
- For instance , liquids based on ions , fluoro - anion , and imidazole are predicted to be toxic , but they cannot evaporate into the environment .

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- The issue is that the majority of ionic liquids are water soluble and can easily enter the biosphere through this route .[34-39]

USE

Green chemistry has many applications are our day - to - day life .

Following are the uses of green chemistry

- It is used in the process of coating , consumer products , pharmaceuticals , preservatives , etc .
- Dry cleaning of clothes In the early years, we used tetrachloroethylene as a solvent for dry cleaning .
-This compound is carcinogenic and also pollutes the groundwater .
- Nowadays , liquefied carbon dioxide with suitable detergent is used for the purpose of dry cleaning .
- It generates liquid carbon dioxide as a byproduct , which is less hazardous and hence causes less pollution .
- Bleaching of paper chlorine gas was used initially for this purpose , but now it has been replaced by hydrogen peroxide .
- Hydrogen peroxide is used along with a suitable catalyst that promotes it's bleaching action .
- It is also used in electronic and in many other electrical devices .
- Plants and animals suffer less harm from toxic chemicals in the environment .
- Lower potential for global warming , ozone depletion , and smog formation .
- Less use of landfills , especially hazardous waste landfills .
- Replaced by organophosphates , which degrade rapidly in the environment , but are much more toxic to mammals .
-Use compound that destroy only the target organisms .
-For example , an insecticide that mimics a hormone used only by molting insects : activating the natural defence mechanism against pests or disease .

II. CONCLUSION

Our ability to accomplish sustainable development with an effective bio - geochemistry cycle , a decrease in waste generation , and the prevention of environmental deterioration is made possible by the implementation of green chemistry and it's 12 principles in the design of chemical processes and products . In essence , it is sustainable chemistry that cleans our global of dangerous , poisonous , and hazardous compounds. Green chemistry s ultimate goal is to completely reduce the amount of chemical that are released in to the environment . The green chemistry research fields ' advancement and their application through consecutive techniques will undoubtedly result in safer speciality chemicals and significantly more satisfying processes for the chemical industry , despite the fact that this goal currently appears to be unachievable .

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