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# Review on "Current Approach to Design Green Chemistry "

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**ABSTRACT**
The 12 green chemistry principles are explained in this paper. The phrase "green chemistry" refers to the development of chemical processes and products that minimise the use and output of hazardous materials. There are various major ways to achieve the claims of green chemistry for securing the land. Some of these include bio-catalysis, the utilisation of necessary ordinary raw materials (biomass), necessary response outcomes, necessary response conditions (microwave oven activation), and innovative photocatalytic processes. Keeping natural resources on Earth while avoiding the use of harmful tools is another goal of green chemistry. One of the key goals of green chemistry is to reduce pollution and hazardous waste, and this goal is being achieved by altering consumption and product patterns. Furthermore, it was This book gives information on the 12 green chemistry principles. Green chemistry is a phrase used to describe the development of chemical processes and products that lessen the use and output of hazardous materials. Achieving the claims of green chemistry for securing the landscape may be done in a few key ways. Some of these include bio-catalysis, the utilisation of necessary unremarkable raw materials (biomass), necessary response outcomes, necessary response conditions (microwave oven activation), as well as novel photocatalytic reactions. The basic goal of green chemistry is to preserve natural resources without applying harmful additives. It is possible to eliminate pollution and hazardous waste, which is seen to be one of the key claims of green chemistry, by altering consumption and product patterns.
**Keyword:**Green chemistry, Microwave ,Applications.

## I. INTRODUCTION

Today's rapid advancements in science and technology have fueled global economic growth, but they have also contributed to environmental deterioration, which is seen in the form of ozone hole problems, climate change, and the buildup of non-destructive organic pollutants in all biospheres.

The discipline of synthetic chemistry is now going to depend heavily on green chemistry.

In order to develop more eco-friendly and productive products with less waste, green chemistry, a new branch of chemistry, brings together tools and techniques that aid chemical engineers in research on the development of chemical products and processes that reduce or eliminate the use of hazardous chemicals. The discipline of synthetic chemistry is now going to depend heavily on green chemistry.

Pharmacy Practice and Pharmaceutical Sciences Journal Green chemistry is a relatively new field of chemistry that combines tools and techniques to help chemical engineers in their research on the development of chemicals as well as products and processes that use fewer or no harmful chemicals. This is done in order to create safer, more efficient, and less wasteful products. Green chemistry will now play a significant role in the field of synthetic chemistry[1].

**Definition of Green Chemistry:**

Pharmaceutical Sciences and Pharmacy in the World Journal In order to develop safer, more effective, and less wasteful products, green chemistry is a relatively new area of chemistry that involves combining tools and techniques to aid chemical engineers in their research. Green chemistry aims to develop chemical products and processes that use fewer or no harmful chemicals and less harmful and toxic products. In the realm of synthetic chemistry, green chemistry is now going to be a crucial instrument.

**History:**

The recurring US presidential green chemistry challenge was announced in 1995. The International Union of Pure and Applied Chemistry's working group on green chemistry was established in 1996. The Royal Society of

Chemistry published the first green chemistry book and periodicals in 1990. Clean Chemistry Atom Economy is one example of a novel technique of combining, processing, and using chemicals that reduces hazards to human health and the environment.harmless chemical for the environment.

Careful planning of chemical synthesis and molecular design to minimiseunfavourable effects is the hallmark of green chemistry. One may establish synergy through appropriate design as opposed to merely trade-offs. They exclusively employ chemical products and chemical methods that do not harm the environment. It is centred on creating molecules, reactions, materials, and processes from scratch that are safer for the environment and for human health. Nearly all branches of chemistry, including inorganic, organic, biochemistry, polymer, environmental, and toxicological, are involved in green chemistry processes. Through the employment of safe alternatives such as renewable feedstock (biomass), reaction solution (such as water, ionic liquids, and supercritical liquids), reaction conditions (microwave irradiation), and numerous prevalent trends of the green programme, such as catalysis, bio-catalysis, and new synthesis[2].

The strategy in chemistry is focused on safeguarding the environment and human health, and it marks a substantial shift from the conventional techniques previously employed. Prior to green chemistry, the primary goal was to reduce exposure to chemicals; however, green chemistry places a strong emphasis on designing and producing chemicals that are safe for both humans and the environment. It has been used in a broad variety of industrial and consumer products, including dry cleaning, electronics, paints, dyes, fertilisers, insecticides, plastics, pharmaceuticals, and dry washing.

Chemicals' molecular structures determine their qualities, which can be altered by altering the chemical structures. Green chemistry tackles the numerous dangers that chemicals might provide, such as physical dangers (such as being explosive or flammable) or toxicity dangers (such as being fatal, cancer-causing, or carcinogenic) (climate change or stratospheric ozone depletion). As a result, green chemistry allows for the safe synthesis of a variety of chemicals.

The biggest obstacle facing many sectors and research institutions is the need to create innovative processes for creating non-hazardous goods using green chemistry. Various national and international initiatives have been set up in India to promote green chemistry and get opinions from various researchers regarding this specific area. To fulfil our needs,collaborations between non-governmental organisations, academia, and industry to achieve the desired result. [3]

**Basic Principles and Concept of Green Chemistry :**

**1. Prevention of Waste:**

One of the Twelve Principles of Green Chemistry is the avoidance of waste. It is preferable to avoid the accumulation of garbage than to clear it up after the fact. Wastes include the creation of any substance with unrealized potential for use and the loss of energy that is not put to good use. As was already said, garbage may come in a variety of shapes and sizes, and it can have a variety of environmental effects based on its composition, toxicity, amount, or release method. A process will inescapably produce waste, which is by definition unwanted, when significant amounts of the initial raw materials employed in the process are lost due to the process's original design.

Roger Sheldon first proposed the idea of the Environmental Impact Factor, or E-Factor, in 1992. This idea has now gained widespread acceptance. This measurement aids in determining how much trash is produced per kilogramme of product. It is a method of evaluating a manufacturing process's "environmental acceptability."

When byproducts are unavoidable, various creative solutions should be taken into account. One of them is to pursue an industrial ecology strategy, in which waste may be transformed back into a new raw material with considerable value for another operation as it enters the life-cycle. Currently, this strategy is being used to produce biofuel. [4]

**2.Atom economy**

Atom economics (AE), often referred to as atom efficiency, was first proposed by Barry Trost in 1990 and relates to the idea of optimising the utilisation of basic materials. In the case of WanisaAbdussalam-Mohammed, the end product has the greatest possible proportion of atoms from the reactants. All of the reactants' atoms would be included in the perfect reaction. The molecular weight ratio of the desired product to all of the reactants employed in the reaction is used to calculate the AE. It is an idealised value designed

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to quickly determine how effective a reaction will be.

**3. Less Hazardous Chemical Syntheses:**

Toxic reagents are used in the majority of chemical synthesis processes, which often occur in several phases. Although the product doesn't include these hazardous materials, there is a chance that it may be contaminated, and green chemistry is responsible for revamping these processes. So Less Toxic Materials Synthesis promotes the development of synthetic techniques for the use and synthesis of compounds that are less or completely dangerous to both humans and the environment, wherever this is possible. Many industrial processes may be made safer and more affordable by using biological enzymes in place of hazardous chemicals.

**4. Designing of Safer Chemicals :**

The production of safe compounds (non-carcinogenic, mutagenic, and neurotoxic) aims to strike a balance between the best possible performance and the intended use of the chemical product, assuring that safety and risk are minimised to the greatest extent feasible. In other words, if possible, unfriendly materials should be used instead of harmful ones.possible, but should consider their effectiveness. Novel pesticides and herbicides that are particular to their target organisms—i.e., poisonous to those creatures only—and breakdown into ecologically safe compounds are developed using this approach. Another illustration is the usage of very hazardous metal chemical compounds (Sn), which were formerly coated on the exterior to stop the capture of plankton and seaweed. The product Sea-Nine, which is fully biodegradable and non-toxic, has taken the role of these chemical substances. The creation of an oxidative stimulator for hydrogen peroxide is another illustration. This enables the use of hydrogen peroxide in place of chlorine bleaches, which deplete the ozone layer, in the paper-making process. [5]

**5.Safer Solvents and Auxiliaries :**

The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used. Chromatographic separations, where large quantities of solvents are used, are problematic due to environmental pollution. Most conventional organic solvents are toxic, flammable and corrosive.and corrosive. Their recycling is linked to energy efficient distillation with considerable losses and therefore the development of environmentally-friendly solvents is necessary. Safer Solvents and Auxiliaries recommends that the process of synthesis be maximally reduced and, whenever possible, avoid the use of auxiliary chemical substances (eg solvents, separating agents, etc.) When used they should be harmless.[5]

**6.Design for Energy Efficiency:**

Energy Synthesis methods should be respected for their benefits to the environment and to business, and should be kept to a minimum. Synthetic styles, however, must to be performed if at all feasible at room temperature and pressure.

**Green chemistry methods are less time consuming:**

A Variety of Microwave-Assisted Diels Alder reactions have been performed as part of green chemistry for energy-efficient processes. The example below is one of these. Under normal circumstances, the conversion rate from Br to CN is around 75% in 72 hours at 100 °C. At 200 °C, 100% conversion may be achieved in about 10 minutes when using a microwave. Traditional procedures are being updated and replaced with more energy-efficient ones. Since high pressures and temperatures are particularly energy-intensive, catalysts are now being developed to enable processes to operate at low temperatures and pressures. Similar to how ethanol may now be purified at room temperature rather than by distillation due to the invention of molecular sieves[6]

The major renewable energy source on Earth, solar energy is regarded as a substitute for fossil fuels. Designing chemical systems that transform solar radiation in voltaic energy has taken a lot of work. Due to their improved efficiency, synthetic, inorganic, and hybrids solar cells have attracted interest as well. The fundamental workings of such cells depend on how well the substance is likely to digest photonic energy from sun light. Excited states are created as a result of absorption, and these excited states can be transmitted to produce electronic current. In the same vein, developing materials that effectively convert light into electricity is still a difficult task and is essential to the success of this strategy.

**7.Renewable Feedstock:**

International Journal of Pharmaceutical Research and Applications
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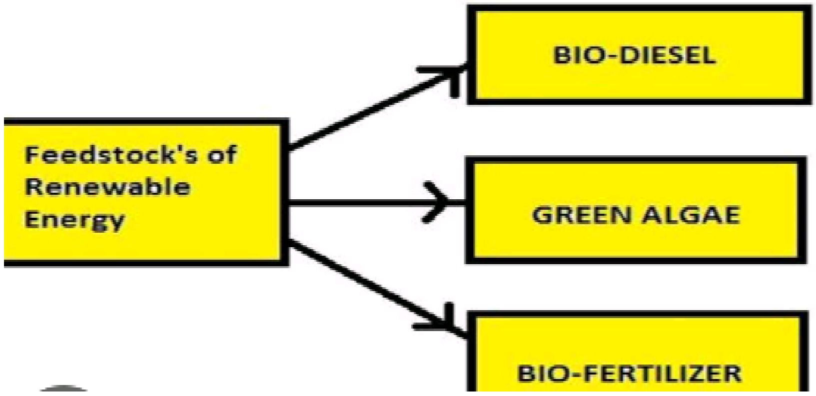
The foundation of several prosperous sectors, like the pulp and paper and wood products industries, is renewable biomass feedstock. The essential feedstock for these enterprises is provided by crops farmed for fibre, oils, or other resources. Biomass sources of hydrogen include water, fossil fuel, crude oil, hydrocarbons, and organic fossil fuels. Hydrogen is also a renewable resource. Recently, the availability of glycerin as a by-product of the manufacturing of bio-diesel has increased, and this regenerative feedstock has boosted the synthesis of epichlorohydrin, a chemical that is frequently employed in the production of epoxy resins Other solvents that can be cleaned up, distilled, and reused, such acetone, methanol, ethanol, and acetonitrile, are regarded as green solvents.

The 7th environmentally benign principle encourages the use of renewable sources wherever it is both technically and financially feasible. Utilizing renewable raw materials rather manufacturing various plastic products, for instance, and then disposing of the trash is more practical. Because of this, creating biodegradable plastics is very popular. The food business has a place for biodegradable packaging. The evolution of biodegradable packaging is undoubtedly influenced by a wide range of issues, including politics, legislative changes, and the need for fuel and food resources globally .

Utilizing renewable resources: Wherever technically and economically practicable, component parts and resources should be regenerative and not exhausted[7].




## 8. Reductionof derivatives

Many processes might be developed to require fewer extra chemicals and produce less waste as a consequence. A compound of a molecule that has groups that are not required in the finished product but make the synthesizing or separation process easier is frequently required. However, these derivatives have a worse atom economy since they add atom that are not used in the final product and instead become trash. Chemists are presently putting their research efforts towards developing substitutes for several processes that typically need protective groups.

## 9.Catalysis

The catalysis principle encourages the use of sustainable catalysts, which show reduced energy usage, minimizing the use of polychlorinated composites, and decreasing the use of water or lower waste water, in order to cover the terrain. Like other catalysts, enzymes work by reducing the activation energy of a single reaction, which causes it to accelerate up to a million times. This permits the enzyme to remain constant during the period of the reaction it impacts, allowing it to return to its original state when the response has ended. Additionally, neither the associated responses nor the relative potential between the products and reactants are impacted by enzymes. nevertheless, which enzymestheir specificity in terms of chirality, chemical selectivity, and particularity make them stand out above all other catalysts. Given the pace of reaction, catalytic particularity, reduced cost, etc., biocatalysts offer a significant advantage over non-biological catalysts, although they are not heat sensitive and have poor durability.

From benzene , the traditional catechol combination is derived in phases with strong reactions that result in undesired derivations. It is substituted by a biocatalytic conflation of D-glucose (renewable raw materials) in the existence of genetically altered Escherichia coli, which is carried out in a single response step and requires no derivations to produce a commercially viable product .

International Journal of Pharmaceutical Research and Applications
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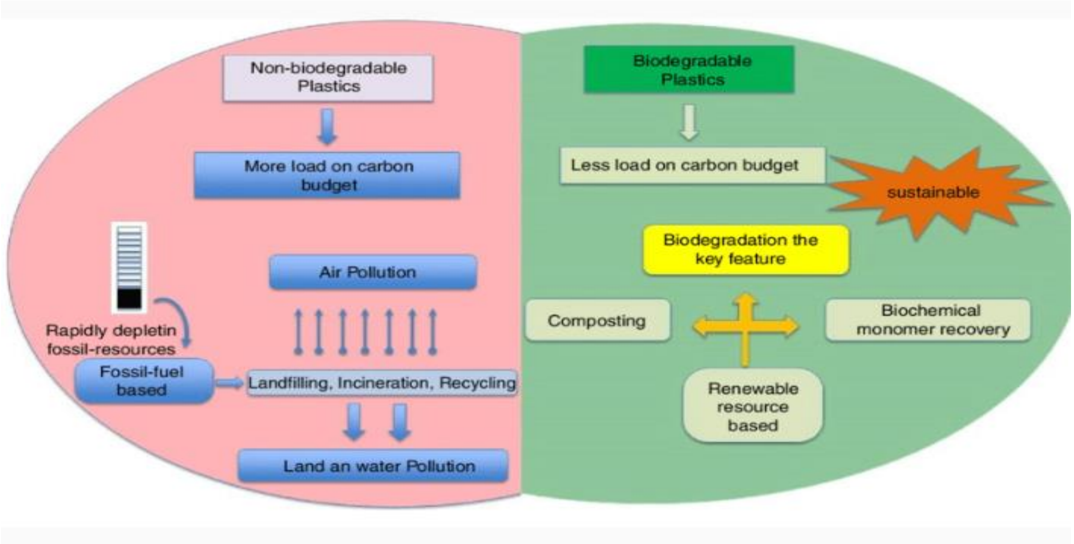
## 10. Biodegradation

Chemicals ought to be made such that they degrade into harmless byproducts without endangering the environment. The aim is to develop posable compounds and goods that, after their use is finished, should be able to degrade into environmentally safe byproducts. Recovery is used to accomplish the goals of preventing the creation of dangerous compounds and returning as much trash as possible to the manufacturing process. The issue of persistence has long been recognised and first surfaced during the early phases of industrial growth. , which is deposited into the water supply as a result of an incomplete breakdown, was utilised as a surfactant for laundry detergents in the 1950s. Water would frequently bubble as it came out of the tap since the situation was so dire. A linear carbon chain that diminishes bio-persistence was discovered to be the quick fix for substituting the methyl branched chain. As ongoing environmental contamination issues show, designing biodegradable materials and chemicals is not a simple feat. Following decades of data collecting, trends have been identified. ght help designers create products that are environmentally friendly.




## 11.Real-time analysis for pollution prevention

To enable real-time, in-process monitoring and control prior to the formulation of harmful compounds, analytical approaches must be further improved. Monitoring a chemical reaction as it occurs helps prevent the accidental or unexpected release of harmful and polluting compounds. Real-time monitoring allows for the detection of warning indicators so that the reaction may be halted or regulated before the event takes place. A provision should be made to analyse and gauge the level of product conformation and describe any undesirable byproducts that pose a hazard to the environment.

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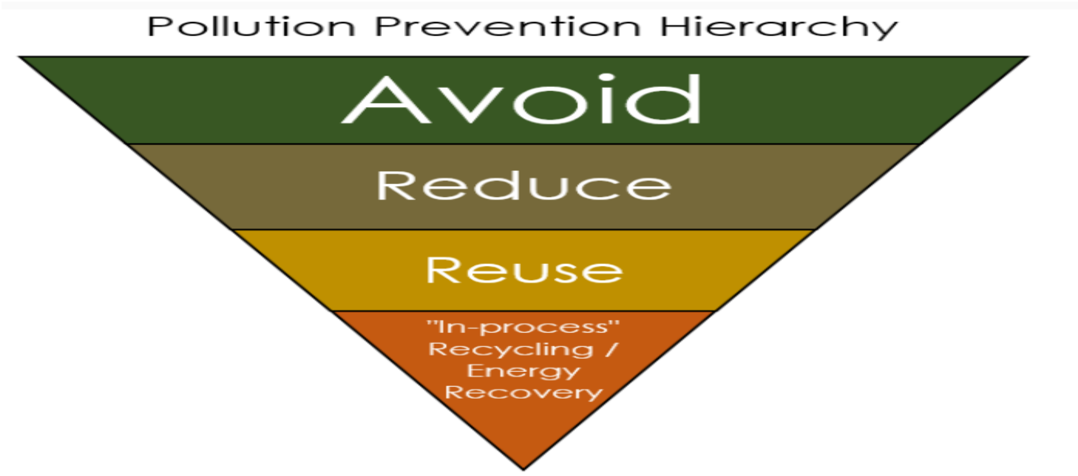


## 12. Inherently safer chemistry for accident prevention

Avoiding highly reactive compounds that might possibly cause mishaps during the reaction is extremely important. It is important to choose the material and form of the composition used in a reaction mechanism in order to reduce the possibility of chemical mishaps, such as toxic escapes, blasts, and fire creation. An explosion may unintentionally happen from water, the most common outcome medium, running it in to a tank methyl isocyanate gas and causing a significant amount of methyl isocyanate to be released into the surrounding region. Alkalimetals are surrounded by other well-known accessories, which typically have devastating overgrowth reactions to water. However, if a necessary reaction had been created that didn't require this, the threat of an explosion actually causing fatalities would have been lessened.

Same inflow chemistry approaches significantly reduce the response volume, the response time, and the catalyst demand. They also intensify the processes by increasing the space/time yield, open new process windows for the application of extreme temperature and pressure conditions, and, in fact, enable the execution of many dangerous reactions in a safe manner. Additionally, the functioning of inflow chemistry in microreactors also demonstrates a method to get beyond the traditional drawbacks of processes powered by microwave ovens, comparable to the limited depth of penetration of broilers into absorbing media[8].

## Methods of Green chemistry synthesis

### Physicochemical methods :

### 1. Ball milling

Ball milling, a thermomechanical (tribochemical) manufacturing process that is widely utilised in organic chemistry in addition to conventional operations in inorganic solid-state procedures, can effectively drive chemical reactions by mechanical power. Retsch Planetary-Type High- Energy Ball Shop is used as an example of attire. Ball milling enables us to use less energy while also avoiding the use of harmful chemicals and detergents. These reactions happen at room temperature without the need of any detergents, much as the processes that the MW supports. Despite its significant potential, ball milling isn't often employed by druggists despite being a straightforward and ecologically benign instrument for chemistry.Ball milling is used to perform a variety of reactions, including those involving the use of sturdy oxidants and reducing agents for individual oxidation and reduction processes, dehydrogenative coupling, the fusion of polymer matrix, proteins, and growth factors, collaborative effort composites, mixes of "cellulose-plastic," and non - symmetric organic reactions utilising catalysts.

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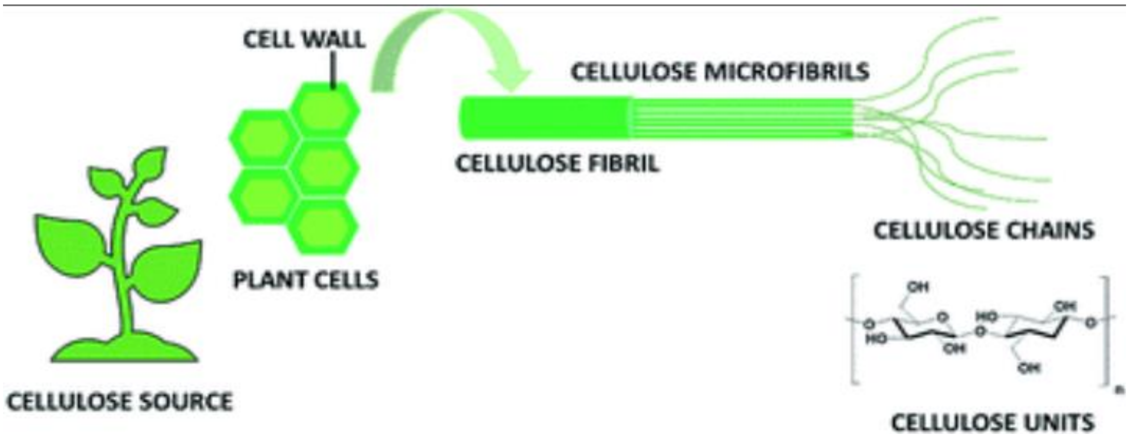
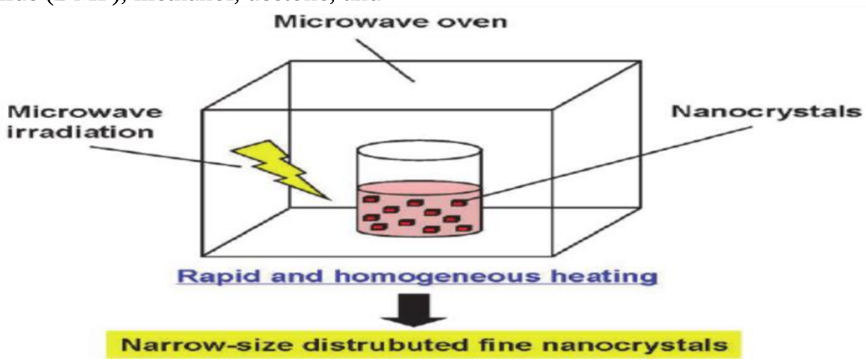



**2. Microwave irradiation:**

A number of organic compounds have been reported as having been produced in this efficient, quick, cost-effective manner; this method is now acknowledged as a traditional synthetic chemistry tool and has significantly improved organic emulsion. Non-ionizing radiation, such as that found in Microwave energy, has no effect on the chemical structure of mixtures. In ntrastto ,aromatic, or alkanes, the Microwave coupling of a material is dependent on its dielectric, hence dimethylformamide (DMF), methanol, acetone, and water are all quickly destroyed when exposed to MW radiation. Heat created by the electromagnetic energy drives the interactions between mixtures. Since Micro wave irradiation and response parameters are directly related, just a little amount of energy is needed to heat it without extending the activity to the material of the furnace. Because of this, the temperature Conventionally made toast and MW-style toast have distinct lifetimes (in Micro wave the inside is warmer and the surface is cool)




**3.Photocatalysis**

Based on electronic activation, which affects the physicochemical characteristics of reagents in organic reactions, photochemical reactions under Ultraviolet rays are regarded as green chemistry interactions. A recent study on photocatalysis discusses singlet oxygen production and its function in photo-oxygenation (the incorporation of atmospheric oxygen into molecules), the combination of photochemical and enzyme catalytic processes, and the use of consistent streams or microreactors for the optimization of these processes. Asymmetrical oxidations catalysed by enzymes, the photocatalyzed trifluoromethylation of aromatics, the creation of N-containing heterocycles from furan derivatives, and the creation of numerous F-organic molecules are a few instances of these reactions.

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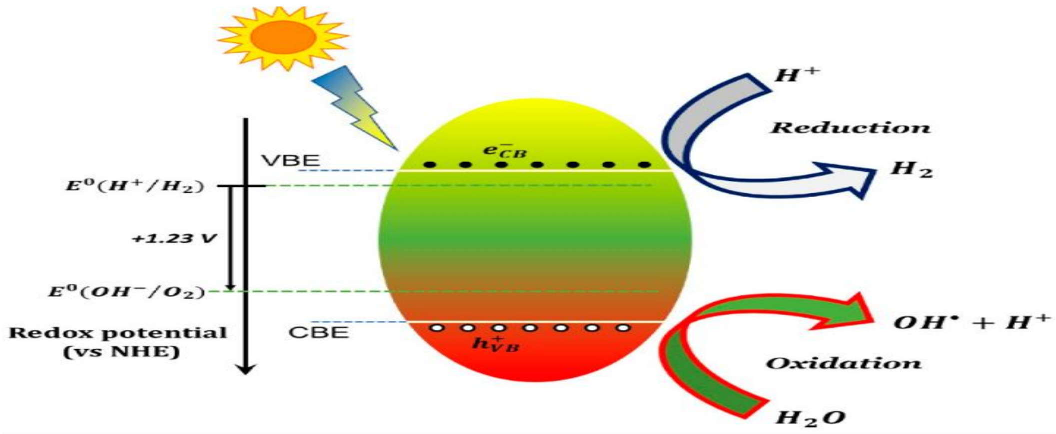


**4. Hydro(solvo)thermal synthesis**

At high energies (often up to 10 bar) and high temperatures (typically up to 300°C) in water or chemical solvent environments, chemicals are synthesised, crystallise, and build highly pure and polycrystals using a solution reaction-based technique. The autoclave, which is made of thick-walled steel cylinders with barrier protection inserts sometimes made of Teflon, platinum, titanium, quartz, gold, etc., is the key piece of equipment for the hydro(solvo)thermal technique. It contains the solvent (water), as well as any precursors that are soluble 'Mm - wave' equipment has been a staple in laboratories for the past 20 years. The major benefit of the hydrothermal approach is the potential for the production of crystalline phases that are brittle at the melting temperature of the desired combination; the main drawback is the need for costly equipment. By altering the pressure, temperature, solvent, reaction time, or ratio of the precursors, it is possible to adjust the morphology and crystallinity of the produced materials. Due to their environmental friendliness, hydrothermal reactions in water are seen as more suited for use in green chemistry and are frequently used to create a range of materials. This process provides for the least amount of reactant loss and typically results in greater product yields. It is particularly helpful for producing powders, films, and particularly one- to three-dimensional nanocrystals with appropriate shapeBandsize[9,10].

**Advantages of Green chemistry:**

Less trash is produced thanks to green chemistry. In actuality, green chemistry is a fresh strategy for protecting both the environment and human health. Long recognised as having a significant impact on the environment, energy consumption and conservation. In contrast to the way that chemical modification have traditionally been carried out in liquid solutions, microwave heating in the solid state is a technology that is being used to cause chemical transformations quickly. Chemicalless radiation aided reactions provide researchers the chance to operate in open vessels, reducing the danger of high pressure and raising the likelihood that such reactions may be scaled up. Numerous actual modifications and the manufacture of heterocyclic systems have shown the viability of microwave aided solvent free synthesis[11]

**Disadvantages of Green chemistry:**

Creating chemical products and procedures that lessen or do away with dangerous chemicals is the fundamental aim 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, conventional product to a new, "green" one is often difficult and expensive, and there is currently no agreement on what constitutes a safe level of chemical as well as intermediate goods input. Lack of environmentally friendly chemistry will result from the high implementation costs and lack of knowledge, since there will be no defined option for using chemical natural resources or modern techniques for green processes.Despite the fact that such are without a doubt useful in chemical synthesis. Nanofluids do not primarily seem green when the 12 criteria that identify green compounds are applied. The fact that ionic liquids have a low vapour pressure makes them mildly volatile, as is widely known, however this is just one of many factors that contribute to a substance's green colour. For example, it is predicted that liquids based on ions, fluoro-anion, and imidazole will be toxic, yet they cannot evaporate into the environment. The majority of ionic liquids are water-soluble, which means they may easily enter the biosphere through that route[12].

**Applications of Green chemistry :**

Green chemistry have several Applications as described below.

**Green Chemistry in Routine life.**

1. Cleaning of Garments:

It is also thought to be a contributor to cancer. In lieu of PERC and Carbon dioxide, Micell technology employs liquid Carbon dioxide as well as a surfactant to dry clean garments, eliminating the need for halogenated solvent.

2.BleachingAgents:

Wood is used in the paper's production. About 70% of the wood's composition might be polysaccharides, and 30% could be lignin. To produce high-quality paper, the wood's lignin content must be reduced. Many reagents, including chlorine gas, sodium sulphide, and sodium hydroxide, are employed to remove lignin. However, it is also contributing to environmental contamination and a number of other issues. Many more dangerous chemicals are produced as a result of the interaction between chlorine and lignin during its degradation. These byproducts of the chemical interaction between the aromatic lignin rings and chlorine. These products contribute to a variety of illnesses, including cancer. Later, chlorine dioxide took the role of chlorine gas.

3.To transform turbid water into a clear, environmentally friendly solution, alum salt is now used in municipal and industrial waste water treatment. Alum has been criticised for not being ideal for this usage since it increases the dangerous ions in wastewaters and may result in Alzheimer's diseases. As a result, agricultural waste that is released, such as taramind seeds and kernel powder, functions as a powerful agent to cleanse municipal and industrial wastewater water. 1Kernel powder is safe to use. In addition, it is more affordable and environmentally friendly than alum. For testing, four different flocculants were used, including tamarind seed powder, starch and alum mixtures, powder and starch mixtures, and kernel powder[13].

**Green chemistry in pharmaceutical industry:**

Green chemistry is a major force and a revolution in the pharmaceutical sector. Ibuprofen (a painkiller) is now produced by BASF, a chemical business, in three steps as opposed to the previous six. Simvastatin is a major medicine for curing high cholesterol that was traditionally made using a multi-step process involving large amounts of dangerous chemicals that produced a lot of harmful waste. Codexis, a bio-catalysis startup, created a novel method for producing the medication utilising a designed enzyme and a cheap feedstock. The yew tree's bark was extracted to make the chemotherapy medication paclitaxe, a process that required a significant amount of solvent to kill the tree. Now, tree cells are grown in a fermented vat to create the drug[14].

## II. CONCLUSION :

The goal of green chemistry is to develop products and manufacturing processes to reduce their detrimental impacts on the environment and public health. The foundation of the Green Chemistry idea is the idea of sustainability, which involves reducing adverse environmental consequences while protecting natural resources for future generations.

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