Republic of Iraq

Ministry of Higher Education and Scientific Research

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Green Chemistry

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A historical perspective:

There is no doubt that human civilization has a huge impact on the global environment and is often negative. Today, there is an urgent need for efforts to make major changes in all kinds of human activities in order to slow climate change, prevent pollution and conserve scarce natural resources. Much of the burden of these changes lies with the chemical industries responsible for producing most of the polluting and depleting substances for the largest share of natural resources. Therefore, companies working in this field seek to adopt new principles of manufacturing, non-polluting and non-depleting resources known as the principles of green chemistry.

Green chemistry is a specialized field that promotes smarter and more sensitive production processes in industries that use chemicals on a large scale. Its objectives are to increase the safety of final chemical products, reduce the production of hazardous wastes and reduce the use of non-renewable resources for chemical production. Green chemistry is also known as sustainable chemistry, a scientific field that grows at a relatively slow pace for two decades.

The approach to this new branch of chemistry was only the result of a reaction to the many prejudices created by conventional chemistry since the nineteenth century. Marine biologist and author Rachel Carson (1907-1964) wrote her famous book "Silent Spring" in 1962 and explained the serious damage chemicals do to local ecosystems. This book was a wake-up call to the public, scientists and decision-makers alike. But the basic principles of green or sustainable chemistry took shape only about four decades later, in 1998, when American chemists Paul Anastas and John Warner formulated the 12 principles of green chemistry known as the culmination of a scientific movement that swept the global chemistry community during the 1990s

The 12 principles represent the main objectives of green chemistry: to make chemicals safer during production and use, disposal and non-establishment of hazardous wastes if safe processes are available. And avoid using limited resources for renewable resources. In addition to auditing the chemical processes

to verify their safety and environmental impact. These principles are primarily aimed at chemists and professional chemical engineers and provide them with general concepts such as preference for reusable raw materials on non-renewable materials (principle 7) and very specific chemical practices, such as the use of selective catalysts rather than chemical reagents). In general, the most prominent of the 12 principles is that they address the problem of hazardous chemicals and environmental damage at all levels. The concept of "atomic economy" is also introduced to reduce waste production at the level of individual chemical reaction (Principle 2). At the same time, these principles call for the monitoring of industrial chemical reactions in a timely manner to avoid formation or release of hazardous or polluting substances (Principle 11)

The victory of some scientists in the Nobel Prize in Chemistry as a culmination of their research in the fields of chemistry, which was largely seen as green chemistry in 2001 (Knowles, Newbury, Charbels) and 2005 (Schöven, Grupps, Schroeck) Green chemistry has helped to create greater awareness among scientists that the future of chemistry must be greener.

The 12 Principles of

GREEN CHEMISTRY

Green chemistry is an approach to chemistry that aims to maximize efficiency and minimize hazardous effects on human health and the environment. While no reaction can be perfectly 'green', the overall negative impact of chemistry research and the chemical industry can be reduced by implementing the 12 Principles of Green Chemistry wherever possible.

1. WASTE PREVENTION

Prioritize the prevention of waste, rather than cleaning up and treating waste after it has been created. Plan ahead to minimize waste at every step.

2. ATOM ECONOMY

Reduce waste at the molecular level by maximizing the number of atoms from all reagents that are incorporated into the final product. Use atom economy to evaluate reaction efficiency.

3. LESS HAZARDOUS CHEMICAL SYNTHESIS

Design chemical reactions and synthetic routes to be as safe as possible. Consider the hazards of all substances handled during the reaction, including waste.

4. DESIGNING SAFER CHEMICALS

Minimize toxicity directly by molecular design. Predict and evaluate aspects such as physical properties, toxicity, and environmental fate throughout the design process.

5. SAFER SOLVENTS & AUXILIARIES

Choose the safest solvent available for any given step. Minimize the total amount of solvents and auxiliary substances used, as these make up a large percentage of the total waste created.

6. DESIGN FOR ENERGY EFFICIENCY

Choose the least energy-intensive chemical route. Avoid heating and cooling, as well as pressurized and vacuum conditions (i.e. ambient temperature & pressure are optimal).

7. USE OF RENEWABLE FEEDSTOCKS

Use chemicals which are made from renewable (i.e. plant-based) sources, rather than other, equivalent chemicals originating from petrochemical sources.

8. REDUCE DERIVATIVES

Minimize the use of temporary derivatives such as protecting groups. Avoid derivatives to reduce reaction steps, resources required, and waste created.

9. CATALYSIS

Use catalytic instead of stoichiometric reagents in reactions. Choose catalysts to help increase selectivity, minimize waste, and reduce reaction times and energy demands.

10. DESIGN FOR DEGRADATION

Design chemicals that degrade and can be discarded easily. Ensure that both chemicals and their degradation products are not toxic, bioaccumulative, or environmentally persistent.

11. REAL-TIME POLLUTION PREVENTION

Monitor chemical reactions in real-time as they occur to prevent the formation and release of any potentially hazardous and polluting substances.

12. SAFER CHEMISTRY FOR ACCIDENT PREVENTION

Choose and develop chemical procedures that are safer and inherently minimize the risk of accidents. Know the possible risks and assess them beforehand.

Green chemistry can be defined as the practice of chemical science and manufacturing in a manner that is sustainable, safe, and non-polluting and that consumes minimum amounts of materials and energy while producing little or no waste material. The practice of green chemistry begins with recognition that the production, processing, use, and eventual disposal of chemical products may cause harm when performed incorrectly. In accomplishing its objectives, green chemistry and green chemical engineering may modify or totally redesign chemical products and processes with the objective of minimizing wastes and the use or generation of particularly dangerous materials. Those who practice green chemistry recognize that they are responsible for any effects on the world that their chemicals or chemical processes may have. Far from being economically regressive and a drag on profits, green chemistry is about increasing profits and promoting innovation while protecting human health and the environment.

To a degree, we are still finding out what green chemistry is. That is because it is arapidly evolving and developing subdiscipline in the field of chemistry. And it is a very exciting time for those who are practitioners of this developing science. Basically, green chemistry harnesses a vast body of chemical knowledge and applies it to the production, use, and ultimate disposal of chemicals in a way that minimizes consumption of materials,exposure of living organisms, including humans, to toxic substances, and damage to the environment. And it does so in a manner that is economically feasible and cost effective. In one sense, green chemistry is the most efficient possible practice of chemistry and the least costly when all of the costs of the practice of chemistry, including hazards and potential environmental damage are taken into account.

Green chemistry is sustainable chemistry. There are several important respects in which green chemistry is sustainable:

• Economic: At a high level of sophistication green chemistry normally costs less in strictly economic terms (to say nothing of environmental costs) than chemistry as it is normally practiced.

• Materials: By efficiently using materials, maximum recycling, and minimum use of virgin raw materials, green chemistry is sustainable with respect to materials.

• Waste: By reducing insofar as possible, or even totally eliminating their production, green chemistry is sustainable with respect to wastes.

Pharmaceuticals Industries are using toxic chemicals and extra difficult process which produces comparatively a large amount harmful substance. These harmful substances cause bad impact surroundings and nature.

The approach of Green chemistry provides environmentally friendly way to replace harmful solvents and technologies, so prevent pollution

Green Chemistry concept :

The green chemistry has emerged as research program in the US which arises from collaborative efforts of university unit, self-governing research crowed, business, technical community and legislative agencies, to decreasing pollution.

The new approach introduces in green chemistry synthesis, dealing out and relevance of chemical material in such a way as to minimize the risk to environment and health of human. This advanced access is as well called:

1. Eco-friendly chemistry

2. Clean chemistry

3. Atom wealth

4. Benign design chemistry

PRINCIPLES OF GREEN CHEMISTRY

Green science is an exceedingly compelling way to deal with contamination aversion as it applies creative logical answers for certifiable natural circumstances. The accompanying 12 standards of Green Chemistry give an approach to scientific experts to execute green chemistry

1. Waste Control

It is perfect to forestall squander than to take care of waste after it has been produced.

2. Atom effectiveness

Engineered planning must intended to enhance the all supplies utilized as element of procedure into product

3. Application of non- destructive of reagents

This incorporates the utilization of reagents and manufactured strategies that decreases the hazard and delivers eco-accommodating items that has no awful effect on human and atmosphere.

4. Safer Chemicals Scheming

Chemicals and reagents should accomplish their coveted ability while limiting their harmfulness.

5. Safer Solvents and Auxiliaries

Broadly utilized solvents in unions are lethal and unstable – liquor, benzene (known cancer causing), CCl_4, $CHCl_3$, perchloroethylene, CH_2Cl_2. These have now been supplanted by more secure green solvents.

6. Design for Energy Efficiency

Vitality requirements of synthetic procedures must perceive for their ecological and monetary effects and should to be limited.

7. Use of Renewable Feed stocks

It is wanted to use crude materials and feedstock that are sustainable, however in fact and monetarily practicable. Referring to the case of sustainable feedstock which incorporate agrarian items and exhausting feedstock incorporate crude supplies that are extracted from non-renewable energy sources (oil, gaseous petrol or coal).

8. Shorter combinations

Superfluous derivatization should be limited or managed a strategic space if possible and such strides require additional reagents and can produce squander.

9. Use of Catalytic instead of Stoichiometric reagents

Impetuses are utilized as a part of little sums and can complete a solitary response commonly as are desirable over stoichiometric reagents, which are utilized as a part of overabundance and work. This will improve the selectivity, lessen the temperature of a change, diminish waste produced by reagent and conceivably keep away from undesirable side responses prompting a spotless innovation

10. Design for dreadful conditions

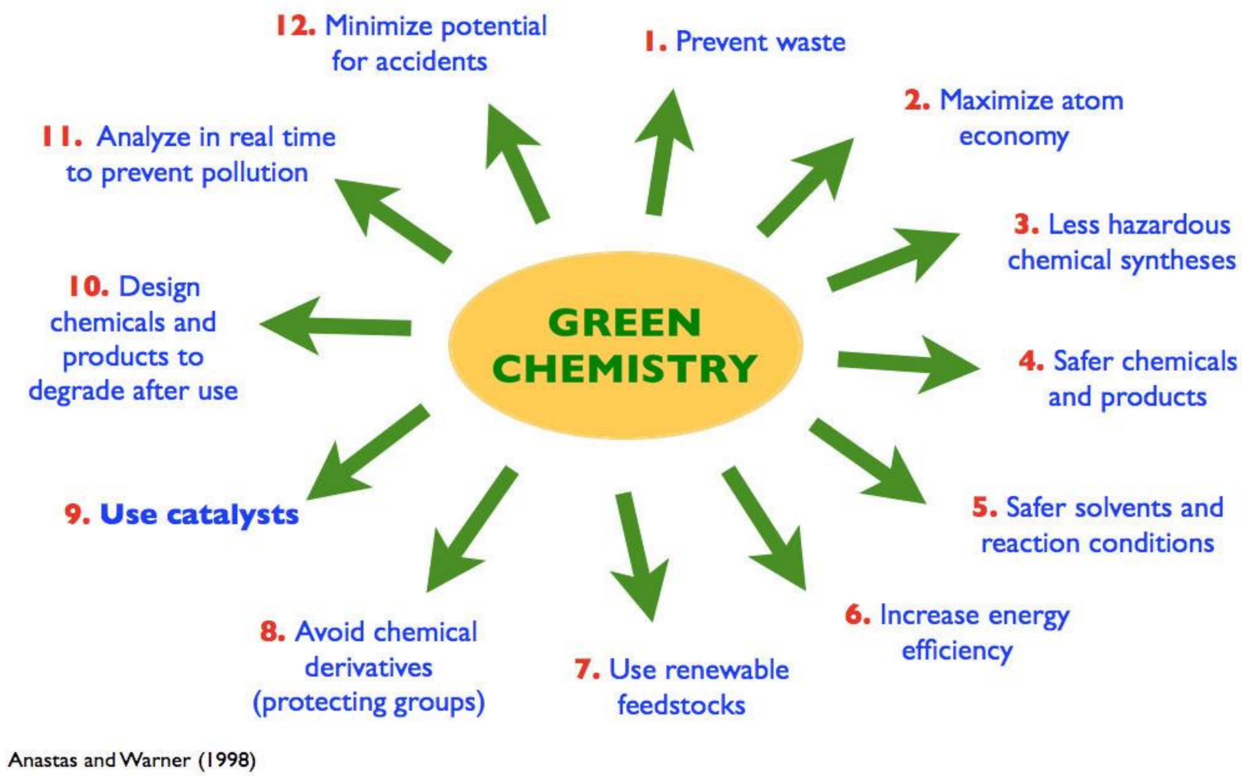
Compound items ought to be planned so that toward the finish of their capacity they separate into harmless corruption items and don't hold on in nature.

11.Techniques to control pollution

Different techniques require developing for actual-time, in-process monitoring and control formation of hazardous substances.

12. Use of Safer Chemicals and Process

Substances and the form of a substance used in a chemical process should be chosen so as to minimize the potential of chemical accidents, including releases, explosions, and fires



So Green chemistry isn't a brand new branch of science. it's a brand new approach that through application and extension of the principles of inexperienced chemistry will contribute to property development. they're applied not solely in synthesis, process and exploitation of chemical compounds. several new analytical methodologies ar|are} de-scribed that are complete in step with inexperienced chemistry rules. they're 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. Researchers and pharmaceutical corporations got to be inspired to contemplate the principles of inexperienced chemistry whereas 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

Applications of green chemistry:

"Green" Synthesis and Stabilization of Metal Nanoparticles

Over the past decade there has been an increased emphasis on the topic of "green" chemistry and chemical processes. These efforts aim at the total elimination or at least the minimization of generated waste and the implementation of sustainable processes through the adoption of 12 fundamental principles. Any attempt at meeting these goals must comprehensively address these principles in the design of a synthetic route, chemical analysis, or chemical process. Utilization of nontoxic chemicals, environmentally benign solvents, and renewable materials are some of the key issues that merit important consideration in a green synthetic strategy. In the present work, we present a totally green approach toward the synthesis and stabilization of metal nanoparticles. Metal and semiconductor nanoparticles are of importance due to their potential applications in emerging areas of nanoscience and technology. Size, shape, and surface morphology play pivotal roles in controlling the physical, chemical, optical, and electronic properties of these nanoscopic materials. Preparation of nanoparticles generally involves the reduction of metal ions in solutions or in high temperature gaseous environments. The high surface energy of these particles makes them extremely reactive, and most systems undergo aggregation without protection or passivation of their surfaces. Some of the commonly used methods for surface passivation include protection by self-assembled monolayers, the most popular being thiol-functionalized organics; encapsulation in the H2O pools of reverse microemulsions; and dispersion in polymeric matrixes. The three main steps in the preparation of nanoparticles that should be evaluated from a green chemistry perspective are the choice of the solvent medium used for the synthesis, the choice of an environmentally benign reducing agent, and the choice of a nontoxic material for the stabilization of the nanoparticles. Most of the synthetic methods reported to date rely heavily on organic solvents. This is mainly due to the hydrophobicity of the capping agents used. There have been approaches reported for the synthesis of H2O-soluble metal nanoparticles; however, to date a unified

green chemistry approach to the overall process of nanoparticle production has not been reported. In the present approach, H_2O is utilized as the environmentally benign solvent throughout the preparation. Although the use of alternative solvents such as supercritical CO_2 has been successful for the synthesis of nanoparticles, the use of CO_2-philic surfactants presents difficulty in isolation and recovery of the nanoparticles. There are also questions regarding the toxicity of the microemulsion components. The second concern in a green nanoparticle preparation method is the choice of the reducing agent. The majority of methods reported to date use reducing agents such as hydrazine, sodium borohydride ($NaBH_4$), and dimethyl formamide (DMF). All of these are highly reactive chemicals and pose potential environmental and biological risks. In the present method, the reducing sugar, â-D-glucose, is used as the reducing agent. With gentle heating, this system is a mild, renewable, inexpensive, and nontoxic reducing agent. The final, and perhaps most important, issue in the preparation of nanoparticles is the choice of the capping material used to protect or passivate the nanoparticle surface. There are several issues that should guide the choice of the capping agent, and these vary significantly from the required size ranges and morphologies of the nanoparticles to the targeted application. In the present preparation method, starch is selected as the protecting agent for several reasons. It is well known that solutions of polymeric materials contain size-confined, nanosized pools of inter- and intramolecular origin, which can be used for the synthesis of nanoparticles.