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Green chemistry and sustainable development

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Abstract

It is important to note that the scope of these green chemistry and engineering principles goes beyond concerns about chemical toxicity hazards to include energy conservation, waste reduction, and life cycle considerations such as using more sustainable or renewable raw materials and designing for end-of-life or final product disposal. Green chemistry can also be defined using metrics. While no unified set of metrics has been created, many ways to quantify greener processes and products have been proposed. These metrics include metrics for weight, energy, reduction or elimination of hazardous substances, and life cycle environmental impacts. Green chemistry, which originated about two decades ago, is attracting a lot of attention. It reflects the efforts of academia and industry to address challenges related to the sustainable development of the chemical industry, and continuous progress is being made in both academia and industry. In short, green chemistry is the application of a set of principles to reduce or eliminate the use or creation of hazardous substances in the design, manufacture and applications of chemical products. Green chemistry is a multidisciplinary field and covers areas such as synthesis, solvents, catalysis, feedstocks, products and efficient processes as shown in the figure. the aim of this paper is Green Chemistry and Sustainable Development.

Keywords: - Green chemistry and sustainable development, Principles of green chemistry , Sustainable Chemistry Education and Conclusion

I. Introduction :-

The concept of green chemistry has developed in the business and regulatory communities as a natural evolution of pollution prevention initiatives. In our efforts to improve crop protection, commercial products and medicines, we have also caused unintended damage to our planet and people. By the middle of the 20th century, some long-term negative effects of these advances could no longer be ignored. Pollution has choked many of the world's waterways, and acid rain has worsened the health of forests. There were measurable holes in Earth's ozone. Some commonly used chemicals have been suspected of causing or directly related to human cancer and other adverse effects on human health and the environment. Many governments have begun to regulate the generation and disposal of industrial wastes and emissions. The United States created the Environmental Protection Agency (EPA) in 1970, charged with protecting human and environmental health by setting and enforcing environmental regulations. Green Chemistry takes EPA's mandate a step further and creates a new reality for chemistry and engineering by asking chemists and engineers to design chemicals, chemical processes, and commercial products in ways that at least prevent the generation of toxic substances and waste. Green chemistry is not politics. Green chemistry is not a public relations gimmick. Green chemistry is not a dream. We are able to develop environmentally friendly chemical processes and products that prevent pollution in the first place. Through the practice of green chemistry, we can create alternatives to hazardous substances. We can design chemical processes that reduce waste and reduce demands on dwindling resources. We can use processes that use less energy. We can do all of this and still maintain economic growth and opportunity while providing affordable products and services to a growing world population. This is a field open to innovation, new ideas and revolutionary progress. This is the future of chemistry. This is green chemistry.

Definition of Green Chemistry:-

Sustainable and green chemistry in very simple terms is just another way of thinking about how chemistry and chemical engineering can be done. Over the years, various principles have been proposed that can be used when thinking about the design, development and implementation of chemical products and processes. These principles enable scientists and engineers to protect and benefit the economy, people, and planet by finding creative and innovative ways to reduce waste, conserve energy, and discover substitutes for hazardous substances.

Green chemistry and sustainable development :-

Important examples of green chemistry include: phasing out the use of chlorofluorocarbons (CFCs) in refrigerants, which played a role in creating the ozone hole; developing more effective ways to make drugs, including the well-known pain reliever ibuprofen and the chemotherapy drug Taxol; and the development of cheaper and more efficient solar cells. The production of chemical compounds, especially organic molecules (composed mainly of carbon and hydrogen atoms), is the basis of a vast multinational industry from perfumes to plastics, agriculture to substances and dyes to drugs. In a perfect world, they would be prepared from cheap, renewable resources in one practical, efficient, safe and environmentally friendly chemical reaction. Unfortunately, with the exception of chemical processes occurring in nature, most chemical processes are not completely efficient, require multiple reaction steps, and create dangerous byproducts. While in the past, traditional waste management strategies focused only on the disposal of toxic by-products, today efforts have shifted to eliminating waste from the very beginning by streamlining chemical reactions..This modification has partly led to the onset of more sophisticated and efficient catalytic reactions that reduce the amount of waste. 2001 Nobel Laureate in Chemistry Ryoji Noyori emphasized that catalytic processes are "the only methods that offer rational ways to produce useful compounds in an economical, energy-saving and environmentally friendly way". Green chemistry will be one of the most important fields in the future. Although the field has developed rapidly over the past 20 years, it is still in its early stages. Promoting green chemistry is a long-term task and many challenging scientific and technological problems need to be solved; these relate to chemistry, materials science, engineering, environmental science, physics and biology. Scientists, engineers and industrialists should work together to support the development of this field. There is no doubt that the development and implementation of green chemistry will greatly contribute to the sustainable development of our society.

Principles of green chemistry :-

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

Atom Economy: Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

Less Hazardous: Chemical Syntheses Whenever possible, synthetic methods should be designed to use and generate substances that have little or no toxicity to human health and the environment.

Designing safer chemicals: Chemical products should be designed to effect their desired function while minimizing their toxicity.

Safer solvents and excipients: Use of excipients (e.g.

Proposal for energy efficiency: The energy requirements of chemical processes should be recognized in terms of their environmental and economic impacts and should be minimized. If possible, synthetic methods should be carried out at ambient temperature and pressure.

Use of renewable raw material: A raw material or feedstock should be renewable rather than consumed whenever technically and economically feasible.

Reduction of derivatization: Unnecessary derivatization (use of blocking groups, protection/deprotection, and temporary modification of physical/chemical processes) should be minimized or avoided if possible, as such steps require additional reagents and may generate waste.

Catalysis: Catalytic agents (most selective) are better than stoichiometric agents.

Design for degradation: Chemical products should be designed to break down into harmless degradation products at the end of their function and not remain in the environment.

Real-time analysis for pollution prevention: Analytical methodologies need to be further developed to enable continuous real-time monitoring and control before hazardous substances are formed.

Inherently safer chemistry to prevent accidents: The substances and form of substance used in a chemical process should be chosen to minimize the possibility of chemical accidents, including spills, explosions and fires.

Five simple things you can do to make your lab more sustainable.

★ Close hoods when not in use to reduce energy consumption.
★ Conduct micro-scale experiments to reduce waste.
★ Switch to green solvents: Use 2-methyltetrahydrofuran instead of methylene chloride, and use cyclopentyl methyl ether instead of tetrahydrofuran, 1,4-dioxane, and ether.
★ Neutralize alkaline phosphate-buffered HPLC waste or acidic HCl waste to pH 7 and discard.
★ Recycle electronics, ice packs, packaging materials, toner cartridges, pipette tip boxes and water purification cartridges.

Green chemistry is spreading from academic laboratories to industry as a way to reduce costs as well as environmental, health and safety risks. Applications of the 12 guiding principles can be found on small and large scales, from selecting ingredients for reactions that minimize waste and risk to metrics that quantify waste and process efficiency. The principles of engineering and process design lead green chemists to monitor energy consumption during production, find sustainable raw materials, and create biodegradable or recyclable products to avoid waste.

Elements of achieving sustainable regional production include:

Linking indigenous knowledge with good clinical and manufacturing practice. Identifying technologies that are elegant in their simplicity. Designing a "green footprint" for advanced manufacturing technology. Utilizing process analytical technologies in a way that guarantees quality, in addition to robust and robust manufacturing. However, green chemistry is still not widely implemented. Current estimates indicate that green chemical products account for only 1% of chemical sector products. Several obstacles prevent the adoption of green chemistry in the United States. The challenge of developing sustainability metrics prevents companies from evaluating their processes and incorporating green chemistry into business decisions. Regulations regarding drug production and investments tied to existing chemical plants hinder the development and introduction of new technologies. The interdisciplinary nature of green chemistry also challenges specialized knowledge gained through current training and work experience in industry. In the US, government policies that encourage knowledge sharing or provide economic incentives can help spur green chemistry innovation. Thus, a new vision of chemistry education, including many new dimensions as indicated in the figure, appears to be needed if it is to address the challenges of environmental sustainability.

Sustainable Chemistry Education

It is clear that sustainable chemistry education involves different methodologies in teaching basic chemical concepts, thereby introducing new concepts and new philosophies. The core topic of thermodynamics needs to be discussed in terms of the energy efficiency of chemical processing and production alongside the energy and spontaneity of chemical reactions. The main topic of kinetics needs to be discussed in terms of selective catalysts that maximize product yield by reducing by-product formation. Such discussions connect basic knowledge of chemistry with the principles of green chemistry and form the basis on which the sustainability of the chemical enterprise is developed. As a result of such inclusion in the chemistry curriculum, a number of new terms appear, such as "input" replacing "reactant" and "E-factor", which is the ratio of the mass of "waste" compared to the mass of "product". . The latter is a simple empirical measure of the "greenness" of a chemical process, and therefore its sustainability.

Similarly, a discussion of "renewable energy" must be preceded by a discussion of current primary energy sources, specifically fossil fuels, in order to address climate change; they argue that these must be gradually replaced by clean, green and renewable energy sources such as solar energy.

Sustainable chemistry also includes environmental chemistry, with basic chemical concepts such as the p-block elements—C, N, O, P, and S—called "nutrients" and "salts" responsible for the "salinity" of soils and surface waters. Pollutants disrupt natural nutrient cycles and salinity reduces the quality of soil and fresh water with overall degradation of the natural environment. Similarly, the increasing acidity of rivers and oceans disrupts aquatic ecosystems and is a direct result of increased levels of carbon dioxide in the atmosphere. In addition, the increasing toxicity of the environment due to chemical waste in the soil, air and surface water is the biggest problem in terms of solving environmental sustainability. Sustainable chemistry intuitively includes involvement in the generation of new smart materials, and therefore nanotechnology and its anticipated links to global clean energy demands. The rapidly developing field of nanochemistry is perhaps the most significant example of cutting-edge sustainable chemistry, focusing on the development of new smart materials for energy storage, production and conversion, for increasing agricultural productivity, water purification and desalination, food processing, building, construction, health monitoring and pest control. From these applications, rapid advances in the production of photovoltaic devices and carbon nanotube solar cells are accelerating the solar energy industry. Similarly, the development of nanocatalysts for hydrogen production coupled with carbon nanotube hydrogen storage systems supports hydrogen as a viable, alternative clean energy source. Thus, sustainable chemistry through nanochemistry directly addresses environmental sustainability by providing processes and products that directly benefit humanity without harming the environment.

However, all these dimensions of sustainable chemistry pose enormous challenges for chemistry education, both in terms of future direction and scope. It is clear that 'sustainable chemistry' cannot be considered as a single academic course, but requires that the concept and philosophy of sustainability be progressively introduced into all chemistry courses, both at secondary and post-secondary/tertiary levels. In addition, the complexity of sustainable chemistry and the diversity associated with its implementation require flexible teaching methodologies such as Problem Based Learning supported by multimedia anchors, leading to carefully designed learning outcomes (research that is embryonic at best).

II. Conclusion :-

In conclusion, as 'sustainability' and 'sustainable development' are complex, multidimensional' concepts, sustainable chemistry is also multidimensional in nature and includes disciplines not normally associated with it, such as economics, accounting, humanities, sociology, cultural studies. , health sciences, food and agriculture. Thus, successfully engaging chemistry education in sustainability involves developing partnerships with these disciplines to create a unified educational platform for moving toward environmental sustainability. Fundamentally, sustainable chemistry education is a strong philosophy integrating "chemistry" into the "sustainable future" syndrome and offers challenging educational opportunities to achieve identifiable sustainable outcomes.It is important to note that the scope of these green chemistry and engineering principles goes beyond concerns about chemical toxicity hazards to include energy conservation, waste reduction, and life cycle considerations such as using more sustainable or renewable raw materials and designing for end-of-life or final product disposal. Green chemistry can also be defined using metrics.

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