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E-Content

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Subject: Green Chemistry (CHEM/504/DSE-2)

Topic: Introduction and Principles of Green Chemistry

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Green Chemistry

- Green chemistry is the use of chemistry for pollution prevention.
- Design of chemical products and processes that are more environmentally benign.
- Reduction or elimination of the use or generation of hazardous substances associated with a particular synthesis or process.
- Green chemistry looks at pollution 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 supports the invention of more environmentally friendly chemical processes which reduce or even eliminate the generation of hazardous substances.

Green Chemistry is about

- Waste Minimization at Source.
- Use of Catalysts in place of Reagents.
- Using Non-Toxic Reagents.
- Use of Renewable Resources.
- Improved Atom Efficiency.
- Use of Solvent Free or Recyclable Environmentally Benign Solvent systems.

Importance of Green Chemistry

- With the increase in production and use of chemical compounds, man has become more exposed to the deterious effects. It is clear that the knowledge of toxicology is essential for the management and prevention of the adverse effects and toxicity of chemicals.
- 2 billion lbs. of chemicals were released to air, land and water (USEPA) in 1994.
- Data includes only 365 of 70,000 chemicals available in commerce.
- Environmental and hazardous wastes operations => economic burden
  - environmental expenditures : cost of doing business
  - 100-150 billion $ / year for remediation in US alone
  - shift financial resources from costs to research & development
- Promise of Green Chemistry to lower overall costs associated with environmental health and safety.

Green chemistry, is also called Benign chemistry or clean chemistry for sustainability

- Refers to the field of chemistry dealing with:

1. Synthesis (the path to making chemicals).
2. Processing (the actual making of chemicals)
3. Use of chemicals that reduce risks to humans and impact on the environment.

Why do we need Green Chemistry?

- Chemistry is undeniably a very prominent part of our daily lives.
- Chemical developments also bring new environmental problems and harmful unexpected side effects, which result in the need for ‘greener’ chemical products.
- A famous example is the pesticide DDT.
- Hundreds of tons of hazardous waste are released to the air, water and land by industry every hour of every day. The chemical industry is the biggest source of such waste.
- In recent years, pollution control board regulated to reduce harmful emissions , effluents and workers safety.

The 12 Principles of Green Chemistry (1-4)

1. **Prevention**

   It is better to prevent waste than to treat or clean up waste after it has been created.

2. **Atom Economy**

   Synthetic methods should be designed to maximise the incorporation of all materials used in the process into the final product.

3. **Less Hazardous Chemical Synthesis**

   Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to people or the environment.

4. **Designing Safer Chemicals**

   Chemical products should be designed to effect their desired function while minimising their toxicity.

The 12 Principles of Green Chemistry (5-8)

5. **Safer Solvents and Auxiliaries**

   The use of auxiliary substances (e.g., solvents or separation agents) should be made unnecessary whenever possible and innocuous when used.

6. **Design for Energy Efficiency**

   Energy requirements of chemical processes should be recognised for their environmental and economic impacts and should be minimised. If possible, synthetic methods should be conducted at ambient temperature and pressure.

7. **Use of Renewable Feedstocks**

   A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

8. **Reduce Derivatives**

   Unnecessary derivatization (use of blocking groups, protection/de-protection, and temporary modification of physical/chemical processes) should be minimised or avoided if possible, because such steps require additional reagents and can generate waste.

The 12 Principles of Green Chemistry (9-12)

9. **Catalysis**

   Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

10. **Design for Degradation**

    Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

11. **Real-time Analysis for Pollution Prevention**

    Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

12. **Inherently Safer Chemistry for Accident Prevention**

    Substances and the form of a substance used in a chemical process should be chosen to minimise the potential for chemical accidents, including releases, explosions, and fires.

Thank You