Date :
Page No. :

Green Chemistry

(1) Green Chemistry (Sustainable Chemistry) is a philosophy of chemical research & engineering that encourages the design of products & process that minimise the use & generation of hazardous substances.

Hazard ↑ Risk ↑ Cost ↗

* Green Chemistry reduces W H M R E C

W → Waste, M → Materials, E → Energy

(2) Principles of Green Chemistry -

(i) Prevention of waste (or by products)

$$A + B \longrightarrow P + (W)$$

Eg: Synthesis of allyl alcohol -

Traditional Route: Alkaline Hydrolysis of allyl chloride which generates HCl as by-product

$$CH_2=CHCH_2Cl + H_2O \longrightarrow CH_2=CHCH_2OH + (HCl)$$

Greener Route: To avoide chlorine -

$$CH_2=CHCH_3 + CH_3COOH + \tfrac{1}{2}O_2 \longrightarrow CH_2=CHCH_2OCOCH_3 + H_2O$$

$$\downarrow$$

$$CH_2=CHCH_2OH + \underbrace{CH_3COOH}_{\text{can be reused for Step-1.}}$$

$\Rightarrow$ [No unwanted by product]

(ii) Maximum incorporation of reactants into the final product

$$\% \text{ yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

$$\% \text{ Atom Economy} = \frac{\text{Molecular Weight of final products}}{\text{Molecular Weight of al. reactants}} \times 100$$

Note: (a) Addition & Rearrangement Reactions are 100% atom economical.
(b) Write balanced equation for calculating AE

(iii) Less Hazardous Chemical Synthesis
2 Eg: In the manufacture of polystyrene foam sheet packing material, CFC's which contribute to O_3 depletion, global warming have now been replaced by CO_2 as the blowing agent.

(iv) Design chemical products to preserve efficacy of function while reducing toxicity
2 Eg: properties of super critical CO_2 makes it possible to be used as a good effective solvent

(v) Use of auxiliary substances (eg: solvents, separation agents, etc) should be made unnecessary wherever possible.
2 Eg: principle applied in development of dry reaction techniques

(vi) Energy Efficiency

2. energy requirements should be small
2. For eg: ionic solids work as an excellent solvent under ambient conditions. Such methods can lead to reduction in energy requirements.

(vii) Use of renewable feedstock

2. Eg: biodiesel

(viii) Derivatization should be minimised

(ix) Use of catalysts

2. enhance the selectivity of a reaction, reduce the temperature of a transformation, reduce reagent-based waste

(x) Design for degradation

2. Design products in such a manner that they degrade automatically within sometime.
Eg: use of DDT as insecticide.

(xi) Analytical methodologies need to be further developed to allow real time, in-process monitoring & control prior to formation of hazardous substances.

(xii) Safety Issues

2. Substances used in a chemical process should be chosen to minimise potential for chemical accidents, explosions, fires etc

Date :
Page No. :

(3) Alternative Solvents or green solvents are the one which follow principles of green chemistry. Eg: water & supercritical CO_2

Eg of non-green solvents: Benzene & tetrachloroethylene

(4) Dry media reaction -
- Solid state reaction / Solvent less reaction
- reaction in the absence of a solvent.

(5) Super critical CO_2 -
- fluid state of CO_2 where it is held at or above its critical temperature & pressure.
- has properties midway b/w a gas & a liquid.