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Engineering Chemistry - II

Tutorial 1 - Green Chemistry.

Q. 1.) List the 12 principles of Green Chemistry and explain the principle "Prevent waste".

Ans The basic principles of green chemistry are :

- 1) Prevent waste.
- 2) Design safer chemicals and products.
- 3) Design less hazardous chemical synthesis.
- 4) Use renewable feedstock.
- 5) Use catalysts, no stoichiometric reagents.
- 6) Avoid chemical derivatives.
- 7) Maximize atom economy.
- 8) The use of auxiliary substances.
- 9) Increase energy efficiency.
- 10) Design chemical and products to degrade after use.
- 11) Analyze in real time to prevent pollution.
- 12) Minimize potential for accidents.

→ Prevent Waste :

It is better to design chemical synthesis to prevent waste rather than leaving no waste to treat or cleanup after it is formed. In most of the cases, the cost involved in the treatment and disposal of waste adds to the overall cost of production. The unreacted starting material also form part of the waste. The waste if discharged in the atmosphere, sea or land causes pollution and also requires expenditure for cleaning up.

Q. 2) Write a note on following Green Principles.

(i) Use Renewable feed stock.

(ii) Use catalyst not stoichiometric reagent.

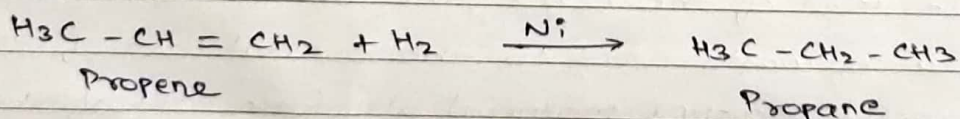
Ans i) Use Renewable feedstock:

Raw materials and feedstock should be renewable rather than depleting whenever technically and economically practicable. The starting material can be obtained from renewable or non-renewable materials. The materials obtained from agricultural or biological process are referred to as renewable materials. Depleting feedstock are made from fossil fuels or are mined.

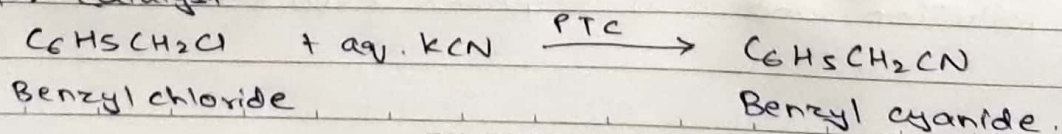
2) Use catalysts not stoichiometric reagents:

Minimize waste by using catalytic reactions. Catalysts are used in small amounts and carry out a single reaction many times. They are preferred to stoichiometric reagents which are used in excess and work only once. Catalysts are selective in their action. By using catalysts both starting material is enhanced and formation of waste is reduced. In stoichiometric process the product obtained is one mole for every mole of reagent used. The applications of catalyst are:

a) Hydrogenation of olefins in presence of nickel reagent.

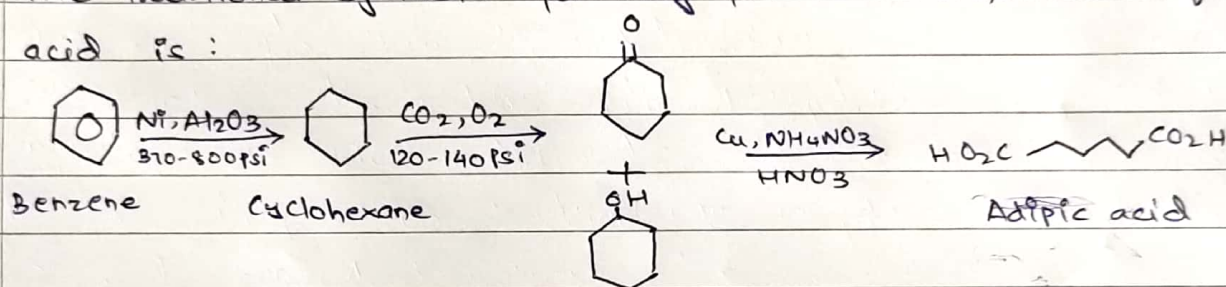


b) Conversion of benzyl chloride into benzyl cyanide with phase transfer catalyst.

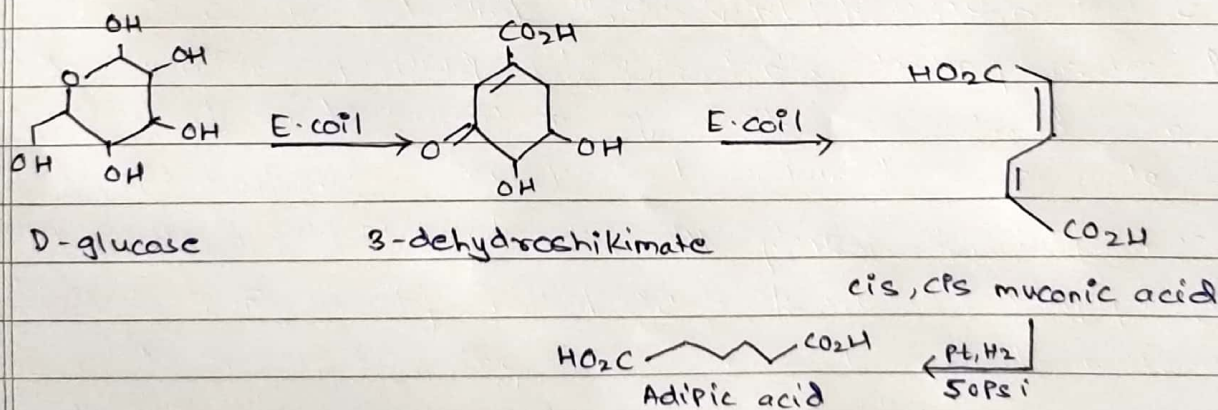


Q.3) With traditional and green synthesis of adipic acid, explain the green principle involved in it.

Ans For the manufacture of adipic acid, catechol and hydroquinone. Initially the substrate used was benzene which is carcinogenic. The continuous use of benzene affects human health. The traditional synthetic pathway for the manufacture of adipic acid is:



In the new synthetic pathway, traditionally used benzene is substituted by a new substrate glucose, a renewable feedstock. It is non-toxic and safer to use. The alternative greener pathway is -



The green principle involved in the above process is
 → Use renewable feedstock: Raw materials and feedstock should be renewable rather than depleting whenever technically and economically practicable.