

14.1 SATURATED HYDROCARBONS

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Learning outcomes

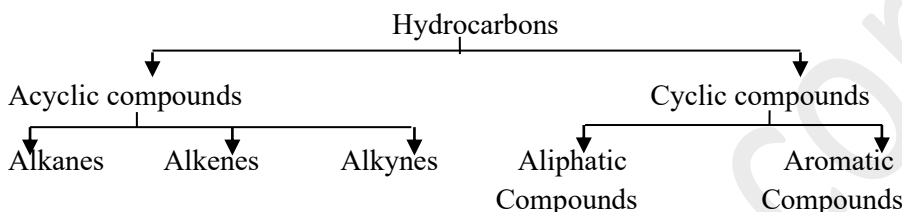
By the end of this chapter, Students should be able to:

14.1 Define and describe saturated hydrocarbons (Alkanes).

14.2 Show preparation of alkanes from haloalkanes (Reduction and Wurtz reaction), Decarboxylation, Catalytic hydrogenation of alkene and alkyne.

14.3 Explain the chemical properties of alkanes,

12.4 Classification of organic compounds



Alkanes

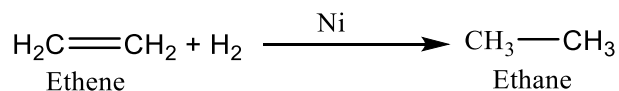
Alkanes are the simplest hydrocarbons, having carbon-carbon single bonds. These are called saturated hydrocarbons as they cannot add more hydrogen. Also called *Paraffins*, as they are unreactive.

General formula: C_nH_{2n+2}

General methods of preparations

1. From alkenes and alkynes (by catalytic hydrogenation)

Unsaturated hydrocarbons (alkenes and alkynes) undergo addition with hydrogen in the presence of finely divided Nickel (Ni), Platinum (Pt), or Palladium (Pd) as a catalyst at a temperature of about 200-300°C producing alkanes.



2. From haloalkanes

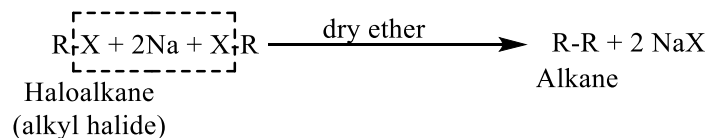
a. Reduction

Haloalkanes are reduced to alkanes with Lithium aluminium hydride (LiAlH_4). e.g.,

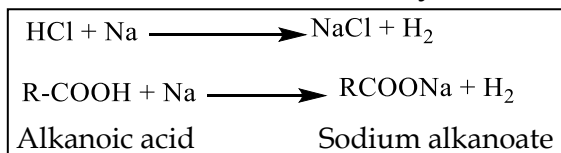


b. Wurtz reaction

When a haloalkane is heated with sodium in dry ether, an alkane with a double number of carbon atoms is obtained; this is called the Wurtz reaction.

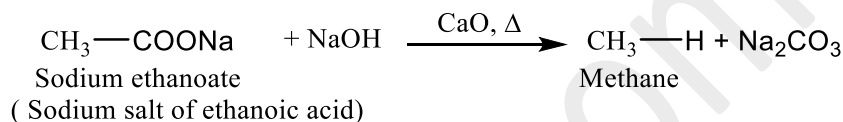


3. From Sodium salt of carboxylic acids



By soda lime decarboxylation

The sodium salt of a carboxylic acid (sodium alkanoate) is heated with soda and lime (i.e., NaOH and CaO), and an alkane with one less carbon is obtained, e.g.,



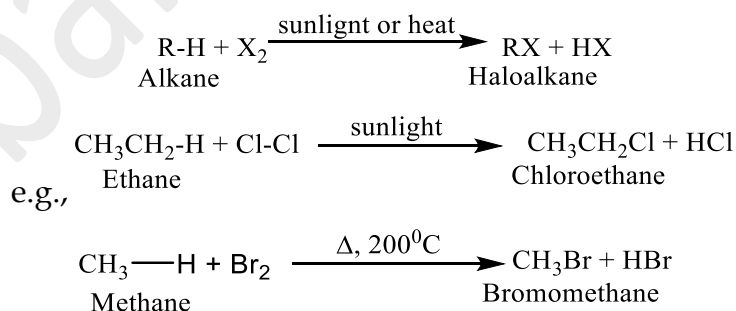
Chemical properties

Alkanes are highly unreactive organic compounds because of strong and nonpolar carbon-carbon bonds. Even carbon-hydrogen bonds are only very slightly polar. So **these do not react easily**. But these undergo a few reactions when exposed to heat or light.

1. Substitution reactions

Halogenation

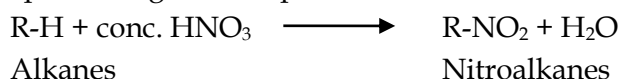
When alkanes are treated with a limited amount of halogen in the presence of sunlight, halogen atoms successively replace the hydrogen atoms. E.g.,

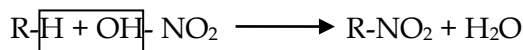


The iodination of alkanes is reversible. The yield is increased in the presence of conc. HNO_3 .

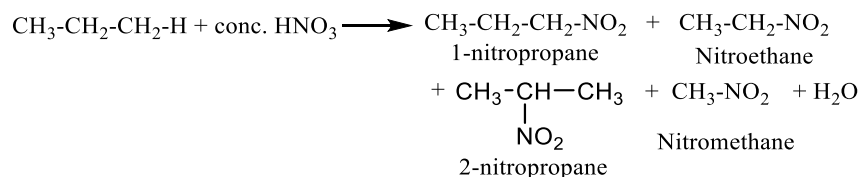
Nitration

Alkanes, when boiled with concentrated nitric acid, yield nitroalkanes. Introducing the nitro ($-\text{NO}_2$) group in an organic compound is called nitration.



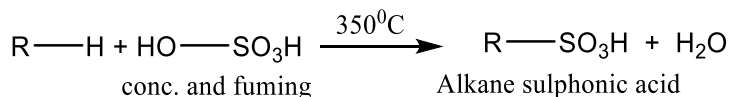


A mixture of all possible nitroalkanes is obtained by C-C bond fission.



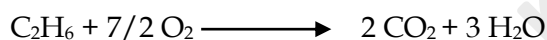
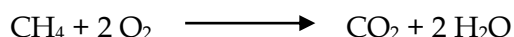
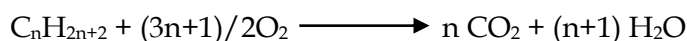
Sulphonation

Branched-chain alkanes and higher alkanes with 6 or more carbon atoms undergo sulphonation with concentrated and fuming sulphuric acid, giving alkane sulphonic acid.



2. Oxidation (Combustion)

Alkanes are quite inert towards common oxidising agents and do not decolourise alkaline KMnO_4 . However, when burnt in excess air, alkanes are completely oxidised into CO_2 and H_2O with the evolution of a large amount of energy. This is called combustion.



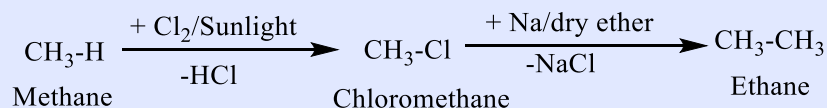
In a limited supply of air, some CO and even Carbon are formed.

Worked Conversion Example

1. Convert Methane to Ethane.

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Solution:



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