Organic Chemistry

Chapter 8

Cyclic Hydrocarbons

8.1 Introduction

In the cyclic compounds, the carbon atoms are arranged to form rings. Cycloalkane for example, is an alkane, and in general acts like one. But the cyclic nature of some of these compounds confers very special properties on them.

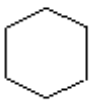
The formula do not fit the general one, a cyclic compound must necessarily contain two hydrogen atoms fewer than its corresponding straight-chain compound.

The cyclic alkanes tend to boil at slightly higher temperature than their straight-chain counterparts.

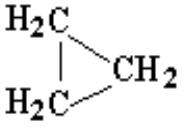
8.2 Nomenclature

Cyclic aliphatic hydrocarbons are named by prefixing **cyclo-** to the name of the corresponding open-chain hydrocarbon having the same number of carbon as the rings. For example:

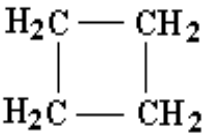
Cyclopentane



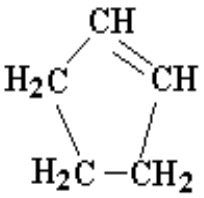
Cyclohexane



Cyclopropane

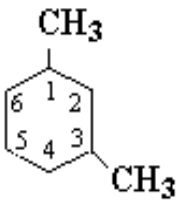


Cyclobutane

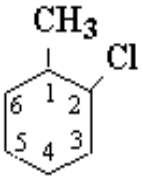


Cyclopentene

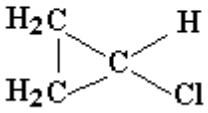
Substituents on the ring, alkyl groups, halogens are named and their positions are indicated by numbers. We assign position 1 to a particular carbon and then number either clockwise or counterclockwise around the ring; we do all this in such a way to give the lowest combination of numbers. For example:



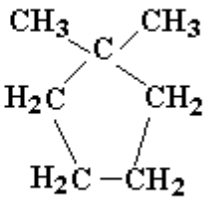
1,3-Dimethylcyclohexane



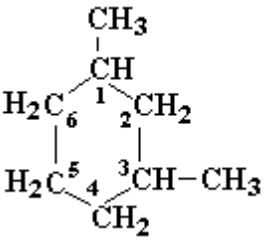
2-Chloro-1-methylcyclohexane



Chlorocyclopropane

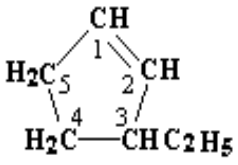


1,1-Dimethylcyclopentane

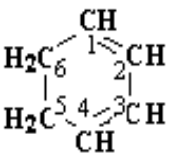


1,3-Dimethylcyclohexane

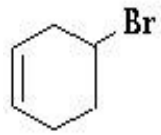
In simple cycloalkenes and cycloalkynes, the doubly and triply bonded carbons are considered to occupy positions 1 and 2. For example:



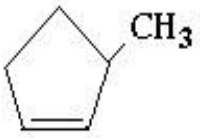
3-Ethylcyclopentene



1,3-cyclohexadiene

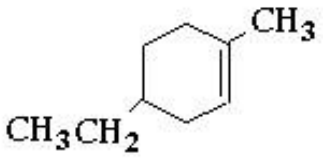


4-Bromocyclohexene



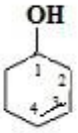
3-Methylcyclopentene

1,3-Cyclopentadiene

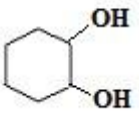


4-Ethyl-1-methylcyclohexene

Cyclopentanol



3-Cyclohexenol



1,2-Cyclohexanediol

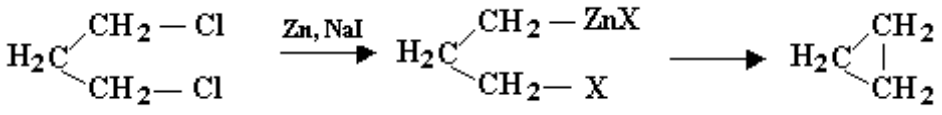
Polycyclic compounds contain two or more rings that share two or more carbon atoms. We can illustrate the naming system with *norboranane*, whose systematic name is bicyclo[2.2.1]heptane: (a) *heptane*, since it contains a total of seven carbon atoms; (b) *bicycle*, since it contains two rings, that is, breaking two carbon-carbon bonds converts it into an open-chain compound; (c) [2.2.1], since the number of carbons between bridgeheads (shared carbons) is two (C-2 and C-3), two (C-5 and C-6), and one (C-7).

8.3 Preparation of Cyclic Hydrocarbons

Preparation of alicyclic compounds from other aliphatic compounds generally involves two stages: (a) conversion of some open-chain compound or compounds into a compound that contains a ring, a process called cyclization; (b) conversion of the cyclic compound thus obtained into the kind of compound that we want: for example, conversion of a cyclic alcohol into a cyclic alkyl halide, or a cyclic alkene into a cyclic alkane.

1- Cyclization

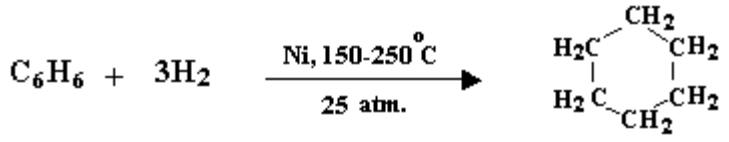
A dihalides can bring about coupling between two alkyl groups that are part of the same molecule.



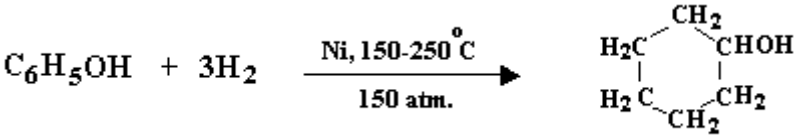
1,3-Dichloropropane **Cyclopropane**

2- Hydrogenation (Industrial source)

Addition of hydrogen to aromatic compounds yields cyclic aliphatic compounds, specifically cyclohexane derivatives. An important example of this is the hydrogenation of benzene to yield pure cyclohexane.



Benzene **Cyclohexane**



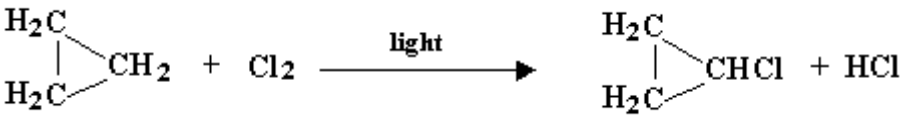
Phenol **Cyclohexanol**

8.4 Reactions of Cyclic Hydrocarbons

Cyclic hydrocarbons show similar chemical properties to the open-chain compounds of the same structure. Cycloalkanes, like alkanes are quite unreactive toward most reagents.

1- Substitution reaction

Cycloalkanes undergo chiefly free-radical substitution reaction.

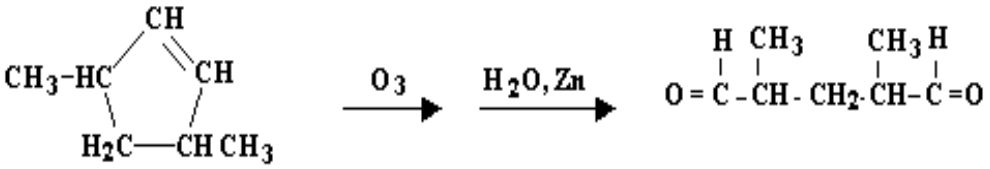


Cyclopropane **Chlorocyclopropane**

Cycloalkenes undergo chiefly addition reactions, both electrophilic and free-radical; like other alkenes, they can also undergo cleavage and allylic substitution.

Cyclohexene **1,2-Dibromocyclohexane**

1-Methylcyclopentene **1-Iodo-1-methylcyclopentane**



3,5-Dimethylcyclopentene **A di-aldehyde**

With best Wishes