



Dienes

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First stage

Number of lecture:3

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What are Dienes?

A Diene is an unsaturated hydrocarbon containing two double bonds between carbon atoms and the double bonds may or may not be adjacent to each other.

The arrangements of these double bonds can have varying affects on the compounds reactivity and stability.

General formula of Diene - C_nH_{2n-2}

They are Isomeric With Alkynes but the behaviour is quite different from each other.

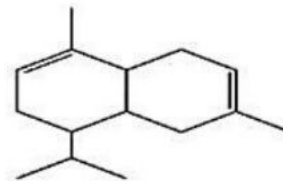
Unsaturated hydrocarbons containing:

two double bonds: diene

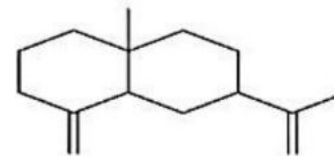
three double bonds: triene

four double bonds: tetraene

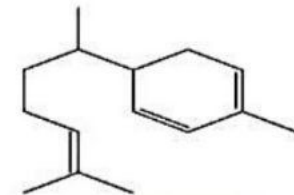
many double bonds: polyene



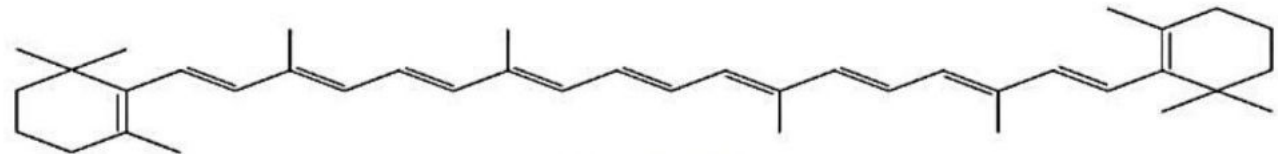
α -cadinene
oil of citronella
a diene



β -selinene
oil of celery
a diene



zingiberene
oil of ginger
a triene



β -carotene
a polyene

They are classified into three main types, based on the position of the double bonds:

1. Cumulated Dienes (Cumulenes) The two double bonds are adjacent (share a common carbon atom).

Example: Allene ($\text{CH}_2=\text{C}=\text{CH}_2$)

Structure: $\text{C}=\text{C}=\text{C}$

The central carbon is connected by two double bonds → very reactive.

Example:

$\text{CH}_2 = \text{C} = \text{CH}_2 \rightarrow$ Propadiene (Allene)

2. Conjugated Dienes

The two double bonds are separated by one single bond ($-\text{C}=\text{C}-\text{C}=\text{C}-$).

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The π -electrons are delocalized, making these dienes more stable and reactive in special ways (like in Diels–Alder reactions).

Example:

$\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2 \rightarrow$ 1,3-Butadiene

3. Isolated (or Non-conjugated) Dienes

The two double bonds are separated by two or more single bonds ($-\text{C}=\text{C}-\text{CH}_2-\text{CH}_2-\text{C}=\text{C}-$).

They behave like two separate double bonds, without interaction.

Example:

$\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{CH} = \text{CH}_2 \rightarrow$ 1,5-Hexadiene

What is the diel alder reaction?

- • Diel Alder Reaction is a reaction between a
- substituted alkene and a conjugated diene to
- form a substituted cyclohexene derivative.
- • It is a type of pericyclic reaction.

What are the applications of dienes?

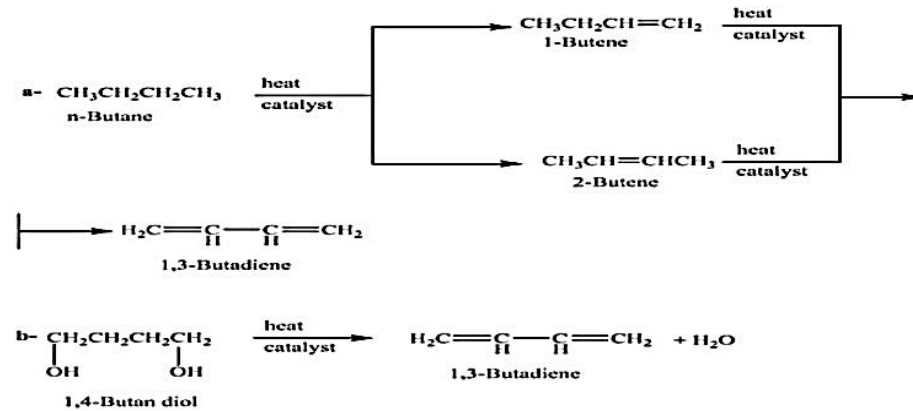
- • Dienes are widely used in industries as monomer
- subunits of complex polymers.
- • 1,3 Butadiene polymerises to form buna rubber used
- in tyres.
- • Isoprene polymerises to form natural rubber.
- • Dienes are also used in organic synthesis.

Why are conjugated dienes more stable?

- • Conjugated Dienes are more stable than non-conjugated dienes
- because of the delocalisation of electron clouds on Carbon
- atoms.
- • E.g. In conjugated 1,3 Butadiene, all four pi electrons are
- delocalised over all four Carbon atoms.
- • The delocalisation of pi electrons makes the compound more
- stable.

3- Preparation and properties of dienes

Dienes are usually prepared by the same methods used to make simple alkenes, for example the most important diene ; 1,3-Butadiene : has been made by cracking process ; or by dehydration of an alcohol containing two OH group as below :-



- The chemical properties of a diene depend upon the arrangement of its double bonds. Isolated double bonds exert little effect on each other; and hence each reacts as though it were the only double bond in molecules. Except for the consumption of larger amounts of reagents , then the chemical properties of the non- conjugated dienes are identical with those of the simple alkenes .
- Conjugated dienes differ from simple alkenes in three ways:-
 - (a) They are more stable
 - (b) They undergo 1,4-addition
 - (c) Toward free radical addition , they are more reactive.

DIENES

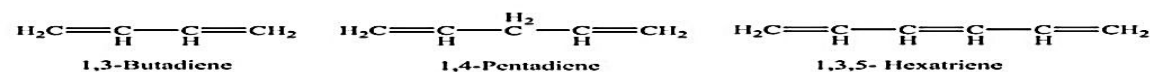
1. Structure and Nomenclature of dienes

Dienes are simply alkenes that contain two carbon – carbon double bonds. Therefore they have essentially the same properties as the alkenes. And we shall say applied equally well to compounds with more than two double bonds.

2. Nomenclature of dienes

Dienes are named by the IUPAC system in the same way as alkenes, except at the ending diene is used, with two numbers to indicate the positions of the two double bonds. This system is easily extended to compounds containing any number of double bonds.

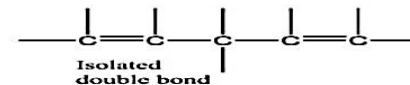
Example :-



- Dienes are divided into three classes :-

The two important classes according to the arrangement of the double bonds are as follows :-

- a- Double bonds that alternate with single bonds are said to be **Conjugated**.
- b- Double bonds that are separated by more than one single bond are said to be **Isolated**.



- c- The third class of dienes of increasing interest to organic chemists, contain cumulated double bonds. These compounds are known as **allenes**.

