HYDROCARBONS

PREPARATION

From unsaturated hydrocarbons

$CH_2=CH_2 \xrightarrow[H_2]{Pt/Pd/Ni} CH_3—CH_3$

From alkyl halides

$CH_3—CH_2—Cl \xrightarrow[H^+]{Zn} C_2H_6 + Na$

Wurtz RX

$2CH_3—Cl + Na \xrightarrow[\text{dry ether}]{} CH_3CH_3$

From carboxylic acids

$CH_3COO^-Na^+ + NaOH \xrightarrow[\Delta]{CaO} CH_4 + Na_2CO_3$

Kolbe's Electrolytic Method

$2CH_3COO^-Na^+ + 2H_2O \xrightarrow{\text{electrolysis}} CH_3—CH_3 + 2CO_2 + H_2 + 2NaOH$

CHEMICAL PROPERTIES

Substitution Reaction — Halogenation

1. Initiation

$Cl_2 \xrightarrow{h\nu} \dot{Cl} + \dot{Cl}$

2. Propagation

$CH_4 + \dot{Cl} \longrightarrow \dot{C}H_3 + HCl$

$\dot{C}H_3 + Cl—Cl \longrightarrow \dot{C}H_2Cl + \dot{Cl}$

3. Termination

$\dot{Cl} + \dot{Cl} \longrightarrow Cl_2$

$\dot{C}H_3 + \dot{Cl} \longrightarrow CH_3Cl$

$\dot{C}H_3 + \dot{C}H_3 \longrightarrow CH_3\text{-}CH_3$

Combustion

$C_xH_y + (x + \frac{y}{4})O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

Controlled Oxidation

$CH_4 + O_2 \xrightarrow[100\ atm]{Cu/523\ K} 2CH_3OH$

$CH_4 + O_2 \xrightarrow{Mo_2O_3} HCHO + H_2O$

Isomerization

$\xrightarrow[HCl]{Anhyd.\ AlCl_3}$

Aromatic Reforming

$\xrightarrow[773\ K]{Cr_2O_3\ /\ V_2O_3,\ 10\text{-}20\ atm}$

Reaction with Steam

$CH_4 + H_2O \xrightarrow[\Delta]{Ni} CO + 3H_2$

Pyrolysis

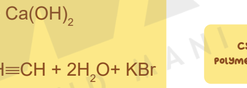
$C_6H_{14} \xrightarrow{773\ K} C_6H_{12} + H_2$

$C_6H_{14} \xrightarrow{773\ K} C_4H_8 + C_2H_6$

$C_6H_{14} \xrightarrow{773\ K} C_3H_6 + C_2H_4 + CH_4$

ALKANES C_nH_{2n-2}

Sawhorse Projection



Newman Projection

Conformers

Alkanes are hydrophobic

Generally, non-polar in nature

Physical properties

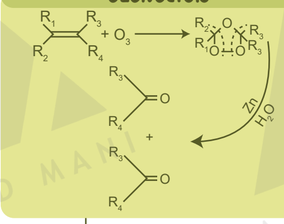
- Boiling point increases with increase in the chain length
- Boiling point decreases with increase in branching

ALKENES

Electrophilic reactions

- $CH_3—CH=CH_2 \xrightarrow{\text{cold conc.}} CH_3—\underset{O—SO_2H}{CH}—CH_3$
- $CH_3—CH=CH_2 \xrightarrow[H^+]{H_2O} CH_3—\underset{OH}{CH}—CH_3$

Ozonolysis



Oxidation

$CH_2=CH_2 + H_2O \xrightarrow[273\ K]{dil.\ KMnO_4} \underset{OH}{CH_2}—\underset{OH}{CH_2}$

Polymerization

$n\text{-}(CH_2=CH_2)\text{-} \xrightarrow[\text{High pressure catalyst}]{\text{High temp.}} \text{-}(CH_2—CH_2)\text{-}_n$

Aromatic reforming

$CH_2=CH_2 + Br_2 \longrightarrow \underset{Br}{CH_2}—\underset{Br}{CH_2}$

Markovnikov's rule

"Negative part of the addendum gets attached to the carbon containing lesser number of hydrogens".
(I) is major product.

Anti-Markovnikov effect / Kharash effect/ Anti-peroxide effect

This mechanism proceeds via free radical mechanism and the minor product via Markovnikov effect becomes major product.
(II) is major product.

Addition of hydrogen halides

Symmetrical alkene

$CH_2=CH_2 + HBr \longrightarrow BrCH_2—CH_3$

Asymmetrical alkene

$CH_3—CH=CH_2 + HBr$

(I) $CH_3CH_2BrCH_3$ (II) $CH_3CH_2CH_2Br$

Preparation

From acidic dehydration of alcohols

$HO—CH_2—CH_3 \xrightarrow[\Delta]{conc.\ H_2SO_4} + H_2O$

From vicinal dihalides

$Br—CH_2—CH_2—Br \xrightarrow{Zn} + ZnBr_2$

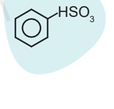
From alkyl halides

$CH_3—CH_2—X \xrightarrow{alc.\ KOH} + Hx$

From alkynes

$R_2C\equiv CR_1 + H_2 \xrightarrow{Pd/C}$

Chemical properties



Physical properties

- Alkenes have a strong odour
- First few members are gases and rest are liquids & solids.
- Alkenes are insoluble in water but soluble non-plar solvents
- Increase in branching leads to decrease in boiling point

ALKYNES C_nH_{2n-2}

$HC\equiv CH$

Physical properties

- First few members of alkynes are gases.
- Boiling point of alkene increases as the chain length increases.
- Boiling point decreases with increase in the branching.
- Soluble in non-polar solvents and insoluble in water.
- Most of them are odourless except for ethyne.

Chemical properties

$HC\equiv CH$

- $\xrightarrow[Pt,\ Pd,\ Ni]{H_2} CH_2=CH_2 \xrightarrow{H_2} CH_3—CH_3$
- $\xrightarrow{Br_2} CH(Br)=CH(Br)$
- $\xrightarrow[Hg^{2+},\ H^+]{H_2O} CH_2=\underset{OH}{C}—H$
- $\xrightarrow{HCl/CH_3COOH} CH_2=CHCl$

Polymerisation

- Cyclic polymerisation — Red hot iron tube, 873 K
- Linear polymerisation — High temp./ High pressure → $+CH=CH-CH=CH+$

Preparation

From Calcium Carbide: $CaO + 2H_2O \longrightarrow C_2H_2 + Ca(OH)_2$

From Vicinal dihalides: $BrCH_2—CH_2Br \xrightarrow[\Delta]{alc.\ KOH} CH\equiv CH + 2H_2O + KBr$

ARENES

Preparation

Decarboxylation of carboxylic acids

$\xrightarrow[\Delta]{NaOH} + Na_2CO_3$

Reduction of Phenol Using Zn Dust

$\xrightarrow[\Delta]{Zn} + ZnO$

Chemical properties

Electrophilic substitution reaction

- $\xrightarrow{Conc.\ HNO_3,\ Conc.\ H_2SO_4\ (323\text{-}333\ K)}$
- $\xrightarrow{Conc.\ H_2SO_4 + SO_3}$
- $\xrightarrow{Anhyd.\ AlCl_3 + Cl_2}$
- $\xrightarrow{Anhyd.\ AlCl_3 + CH_3Cl}$
- $\xrightarrow{Anhyd.\ AlCl_3 + CH_3COCl}$

Addition reaction

- $\xrightarrow[3H_2,\ Ni]{\Delta}$
- $\xrightarrow[500\ K]{3Cl_2,\ UV}$

Physical properties

- Immiscible in water but completely soluble in polar
- Characteristic Smell
- Highly volatile in nature
- Burn with a Sooty flame

Huckel's rule of aromaticity

1. Planarity
2. Delocalisation of of π-electrons
3. Presence of $(4n + 2)$-π electrons

Carcinogenicity and toxicity

1. 2-benzanthracene
1. 2-benzpyrene

Aromatic compounds are toxic in nature and most of them are classified as carcinogens.

ANAND MANI