PROPERTIES AND USES OF BORANES

Properties : (i) The boranes are volatile compounds.

(ii) All the hydrides of boron are decomposed to boron and hydrogen on red heat.

$$B_2H_6 \longrightarrow 2B + 3H_2$$

(iii) All the boranes are readily oxidised by air or oxygen and form explosive mixture.

$$B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O; \Delta H = -2165 \text{ kJ}$$

(iv) The boranes are decomposed by alkalies.

$$B_2H_6 + 6NaOH \longrightarrow 2Na_3BO_3 + 3H_2$$

But at 0°C it reacts with concentrated solution of KOH to give potassium hypoborate and metaborate.

$$B_2H_6 + 2KOH \longrightarrow K_2(B_2H_6O_2)$$

$$K_2(B_2H_6O_2) + 2H_2O \longrightarrow 2KBO_2 + 5H_2$$

Some other examples are :

$$B_4H_{10} + 4KOH + 4H_2O \longrightarrow 4KBO_2 + 11H_2$$

$$B_6H_{12} + 6KOH + 6H_2O \longrightarrow 6KBO_2 + 15H_2$$

(v) Boranes are easily decomposed by water liberating H_2. The rate of reaction varies widely. For example,

B_2H_6 is decomposed very rapidly.

$$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$$

(vi) They react with halogens under controlled conditions, to form a mixture to partially halogenated products.

$$B_2H_6 + X_2 \longrightarrow B_2H_5X + HX \ (X = \text{halogen})$$

$$B_2H_6 + 3Cl_2 \longrightarrow 2BCl_3 + 3H_2$$

(vii) These hydrides form adducts with Lewis bases.

$$B_2H_6 + 2(CH_3)_2O \longrightarrow 2[(CH_3)_2O \rightarrow BH_3]$$

$$B_2H_6 + 2(CH_3)_2S \longrightarrow 2[(CH_3)_2S \rightarrow BH_3]$$

(viii) By the reaction of alkyls, alkyl derivatives are formed.

(ix) All boranes react with halogen acids to form mono-haloborane.

$$B_2H_6 + HCl \xrightarrow{AlCl_3} B_2H_5Cl + H_2$$

$$B_2H_6 + HBr \xrightarrow{AlBr_3} B_2H_5Br + H_2$$

(x) Diborane reacts with methyl alcohol to form dimethoxyborane which disproportionates easily into diborane and trimethyl borate.

$$B_2H_6 + 4CH_3OH \longrightarrow B_2H_2(OCH_3)_4 + 4H_2$$

$$3B_2H_2(OCH_3)_4 \longrightarrow B_2H_6 + 4B(OCH_3)_3$$

(xi) Decaborane reacts with Lewis bases such as CH_3CN, C_5H_5N, $(CH_3)_2S$ etc. to give hydrogen.

$$B_{10}H_{14} + {}_2CH_3CN \longrightarrow B_{10}H_{12}.2CH_3CN + H_2$$

(xii) When B_2H_6 is treated with sodium or potassium amalgam corresponding adducts are formed.

$$2Na\text{-}Hg + B_2H_6 \longrightarrow B_2H_6.2Na + 2Hg$$

$$2K\text{-}Hg + B_2H_6 \longrightarrow B_2H_6.2K + 2Hg$$

(xiii) B_2H_6 adds to alkenes and alkynes in ether at room temperature to give organo-boranes which is called hydro boration reaction.

$$6RCH{=}CH_2 + B_2H_6 \longrightarrow 2B(CH_2CH_2R)_3$$

(xiv) B_2H_6 reacts with ionic hydride (LiH, NaH, BeH_2, MgH_2) in ether to form metallic borohydrlde .

$$B_2H_6 + 2MH \xrightarrow{\text{Ether}} 2M[BH_4] \ (M = Li, Na)$$

$$B_2H_6 + M'H_2 \xrightarrow{\text{Ether}} M'[BH_4]_2 \ M' = Be, Mg)$$

B_2H_6 reacts with organometallic compounds MR_x in ether to form metallic borohydride.

$$2\ B_2H_6 + 3LiC_2H_5 \xrightarrow{\text{Ether}} 3Li[BH_4] + B(C_2H_5)_3$$

B_2H_6 reacts with $LiAlH_4$ to form borohydrides of Li and Al.

$$2\ B_2H_6 + LiAlH_4 \longrightarrow Li[BH_4] + Al[BH_4]_3$$

Uses:

Diborane is the only among the boranes which is frequently used. Diborane is used:

(i) As a catalyst in polymerisation reactions.

(ii) As a reducing agent in organic reactions.

(iii) For welding torches.

(iv) For preparing substances which are used as high energy fuels and propellents. This is due to liberation of a large amount of heat during oxidation.

$$B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O,\ \Delta H = -2165\ kJ/mole$$