

Heavy water:

- Heavy water was discovered by Urey.
- Heavy water is Deuterium oxide
- Source of heavy water is normal water
- Natural water contains 1 part of heavy water in 6000 parts of ordinary water.
- Heavy water is also found in Himalayan snow melting areas and in the leaves of banyan trees, rain water.
- Theoretically possible number of water molecules by using all the 3 isotopes of hydrogen and all the 3 isotopes of oxygen (O^{16} , O^{17} , O^{18}) are 18.

Theoretically possible number of heavy water molecules are six.

They are D_2O^{16} , D_2O^{17} , D_2O^{18} , HDO^{16} , HDO^{17} , HDO^{18} .

T_2O is super heavy water.

Preparation of D_2O

Preparation of D_2O can be obtained by two methods. They are

a) Exhaustive electrolysis of alkaline water.

b) Exchange process.

- Heavy water is prepared by the exhaustive electrolysis of water containing $N/2$ NaOH.
- In the preparation of heavy water by electrolytic method, the cathode is steel vessel and anode is a perforated cylindrical Nickel sheet.
- 30 litres of water on electrolysis gives 1 ml. of D_2O .

Electrolysis occurs in 7 stages.

At the end of 1st stage, volume becomes 1/6. Alkali present in the water is neutralised by passing CO_2 gas.

During electrolysis bonds in H_2O are broken 18 times faster and H_2 gas is released about six times faster than that of D_2 .

In the electrolysis, H_2 and D_2 are liberated at cathode and O_2 is liberated at anode.

At the end of 7th stage, 99% D_2O is obtained.

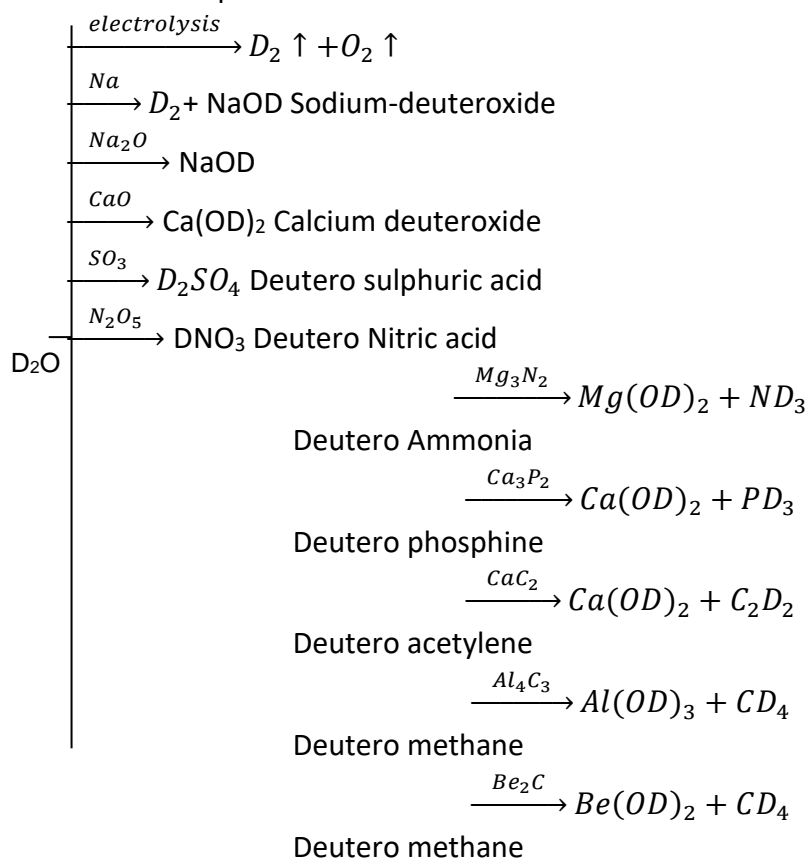
- D_2O can be prepared by exchange reactions. When H_2S gas is passed through hot water, the hydrogen atoms in H_2S exchange with deuterium from D_2O present in water. Thus H_2S becomes D_2S . On passing D_2S through cold water, the deuterium from D_2S and Hydrogen from H_2O exchange and the cold water becomes richer in D_2O . The process is repeated.
- The reaction in which interchange of the isotopes of an element take place between two compounds is known as an isotopic exchange reaction. Isotopic exchange reactions occur more readily with compounds containing active or labile Hydrogens.

Eg.: $HCl + D_2O \rightarrow HDO + DCl$

$NaOH + D_2O \rightarrow NaOD + HDO$

- $NH_4Cl + D_2O \rightarrow NH_3DCl + HDO$
- The reaction of salt with D_2O is known as Deuterolysis
- Eg.: $AlCl_3 + 3D_2O \rightarrow Al(OD)_3 + 3DCl$

- Salts like $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ are known as deuterated salts or salt deuterates.
- Heavy water is toxic to micro organisms.
- Both H_2O and D_2O are associated liquids due to Hydrogen (or Deuterium) bonds. But the boiling point of water is less than that of D_2O . This is because the molecular weight of D_2O is greater than that of H_2O .
- Chemical Properties of D_2O :



Uses of D_2O :

- D_2O is used as a moderator in nuclear reactors to slow down the neutrons.
- As tracer in studying reaction mechanisms.
Ex.: Mechanism of electrophilic substitutions of Aromatic compounds, Metabolic processes.
- The basicity and structures of H_3PO_2 & H_3PO_3 are studied by the exchange reactions of D_2O .
- D_2O is used in the preparation of Deuterium.