

## **CHAPTER 3- PART 2**

### **1. Hydrogen Introduction**

The electrical energy is the most convenient form of energy as it can be easily transported, controlled and converted to other useful forms. However, the major shortcoming of the electrical energy is its inability to be stored in large quantities. To address this shortcoming hydrogen fuel can be phenomenal. Hydrogen fuel can be stored in large quantities but has risk of being highly inflammable and requires special handling methods for safety concerns. Hydrogen is a secondary fuel that requires primary energy sources for production. Hydrogen can be produced from any energy source such as solar or hydro power. Also organic materials such as plants and fossil fuels are also source of hydrogen (Singal, 2011).

Hydrogen can be stored in compressed form in high pressure, It can also be stored in liquid form in low temperatures. Hydrogen form hydrides with various metals which can also be used to store and recover hydrogen as required. Hydrogen has the benefit of having high energy content per unit mass. It can be used as fuel directly in gas turbine or spark ignition engines. It can be used as fuel for transportation of vehicles which also reduces the problem of pollution. Hydrogen can be used in fuel cell to produce electricity. Hence the scope and potential of hydrogen is huge and is increasing at rapid rate in the world.

### **2. Hydrogen Production and Storage**

Majority of hydrogen being used in world is being used for production of Ammonia. Other major usage of hydrogen has been for purification of fuels such as diesel by removing sulfur from it and for improving low quality “heavy” crude oil.

#### **2.1. Advantages of hydrogen**

##### **2.1.1. Negligible pollution**

The combustion of hydrogen yields only water. However, depending on the flame temperature, traces of nitrogen oxides may also form in negligible amount. Some hydrogen production processes may result in pollution.

##### **2.1.2. Controllability**

At normal temperatures, the reaction of hydrogen with oxygen is very slow. Catalysts can be used to control the reaction speed over high range of temperature.

### 2.1.3. Safety

- Hydrogen is relatively safe compared to its counterpart conventional fuels such as diesel or petrol.
- Being lightest of all gases, it rises and disperses quickly, while liquid fuel forms pools that spread the fire.
- Being small molecule in size, the hydrogen gas can escape easily through cracks hence reducing the risk of being accumulated through leakage in explosive concentrations.
- Due to its low density, a given volume of hydrogen contains small amount of energy compared to natural gas or petroleum, hence possess reduced risks for storage.
- The self-ignition temperature of hydrogen is greater than gasoline, which reduces the risk of accidental fire.
- Hydrogen air mixtures with less than 4.1% fuel will not catch fire, while the flammability limit for gasoline is 1%
- A pure hydrogen flame radiates little energy, allowing firemen to approach much more closely the site of a fire.
- Hydrogen is totally nontoxic.

## 2.2. Production of Hydrogen

Hydrogen production can fall into one of several categories, among which one can list:

- Production of hydrogen in massive amounts at stationary plants as, for instance, in the production of ammonia.
- Production of hydrogen in small amounts by compact on-board plants for use in fuel cell vehicles.
- Production of hydrogen in modest amounts for the food industry and other small consumers.
- Production of hydrogen for use in compact residential or local electricity (and hot water) generation.

At present, approximately 96% of all hydrogen used is produced by chemical means, through the reformation of diverse hydrocarbons, and only 4% is produced by electrolysis of water. In 2019, the largest electrolyzer plant had a capacity of 10 MW, and a 20 MW electrolyzer plant, capable of producing around 3000 tons of hydrogen annually, was under commissioning in Canada by the end of 2020.