

### [ Answer No. - 5(a) ]

Advantage of MHD generation :-

- 1) It is robust without moving parts hence more reliable.
- 2) The conversion efficiency is high (60-65%) because of higher operating temperature.
- 3) Capital cost can be lower than conventional power plant.
- 4) Large amount of power can be generated.

### [ Answer No. - 5(b) ]

Principle of MHD power generation :-

The MHD (magneto hydro dynamic) power generation technology is the production of electric power utilizing a high temperature conducting plasma moving through an intense magnetic field.

Principle :- Suppose we have a charged particle (having charge  $q$ ) moving at a velocity  $v$  towards right and perpendicular magnetic field (pointing into the paper) is applied. A magnetic force  $F$  acts on the

charged particle. This effect is result of Faradays law of electric magnetic induction. This induced emf is given by

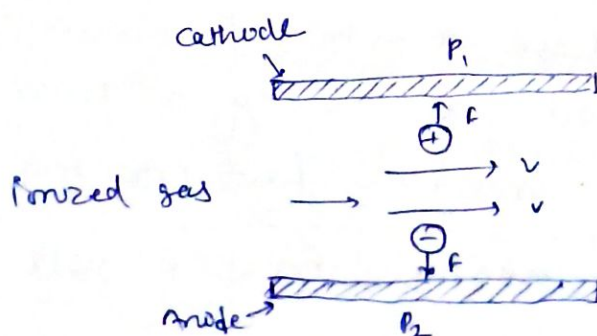
$$\vec{F} = Q(\vec{v} \times \vec{B})$$

where  $F$  = force  $B$  = magnetic flux density.  
 $v$  = velocity

A positive charged particle is forced upward and a negatively charged particle is forced downward.

If the particle is replaced by a mass of ionized gas molecule, moving at a velocity in the positive ions would be accelerated towards the upper plate  $P_1$  and the negative ions would be accelerated towards the plate  $P_2$ . If the plates  $P_1$  and  $P_2$  are externally connected through a resistance, a current would flow through the resistance. Thus, mechanical energy is extracted from the gas and converted into electrical energy. This is the principle of MHD generation. It is a reversible process.

If, instead of resistance, an emf is applied in a direction opposite to the direction of the flow of above current, energy would be supplied to the gas and the gas particles would be accelerated.



(motion of a charged particle in magnetic field).



from an energy point of view the movement of force through a displacement is converted to electrical work by means of the electromagnetic induction principle. This is a work energy conversion and is not limited by the Carnot principle.

The electromagnetic induction principle need to be limited to solid conductors, the movement of a conducting fluid through a magnetic field may also be employed for electric energy conversion when a fluid is used, the energy conversion technique is called the magneto hydro dynamic (MHD) energy conversion.

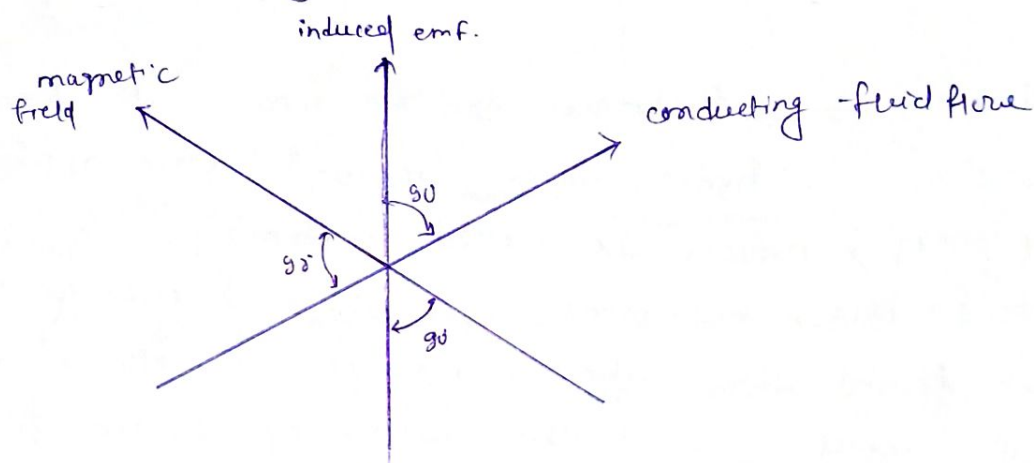


fig: Principle of magneto hydro dynamic conversion

→ The direct conversion of kinetic (or motion) energy into electrical energy by the flow of an electrically conducting fluid, usually a gas or a gas liquid combination, through a stationary magnetic field. If the flow direction is at right angles to the magnetic field direction, an electromotive force (if the flow direction is at right angles to both flow and field direction as shown in above figure).

→ This is the basic principle of MHD conversion.

## [ Answer No - 5(d) ]

Methods for production of hydrogen :-

There are some different method of hydrogen production as follow -

- 1) Reforming
- 2) Partial oxidation of coal and heavy oil
- 3) electrolysis (electrolytic production of hydrogen) :-
- 4) Solar energy method.

1) Reforming:- Hydrogen can be separated from hydrocarbons through the application of heat. This process is called reforming.

Steam reforming uses thermal energy to separate hydrogen from the carbon components in methane and methanol, and involves the reaction of these fuels with steam on catalytic surfaces. The first step of the reaction decomposes the fuel into hydrogen and carbon monoxide. Then CO and H<sub>2</sub>O changes to CO<sub>2</sub> and H<sub>2</sub>. These reaction occurs at temperature of 200°C or more.

working of reformer :-

- 1) The fuel is vaporized and mixed with steam.
- 2) Use catalysts to remove the hydrogen from the fuel, creating CO and CO<sub>2</sub>.
- 3) Uses the CO to make more hydrogen and CO<sub>2</sub>.
- 4) Filter is used to clean the gases of any impurities in the fuel. The hydrogen rich product can either be directly used or purified more and cooled to a liquid.



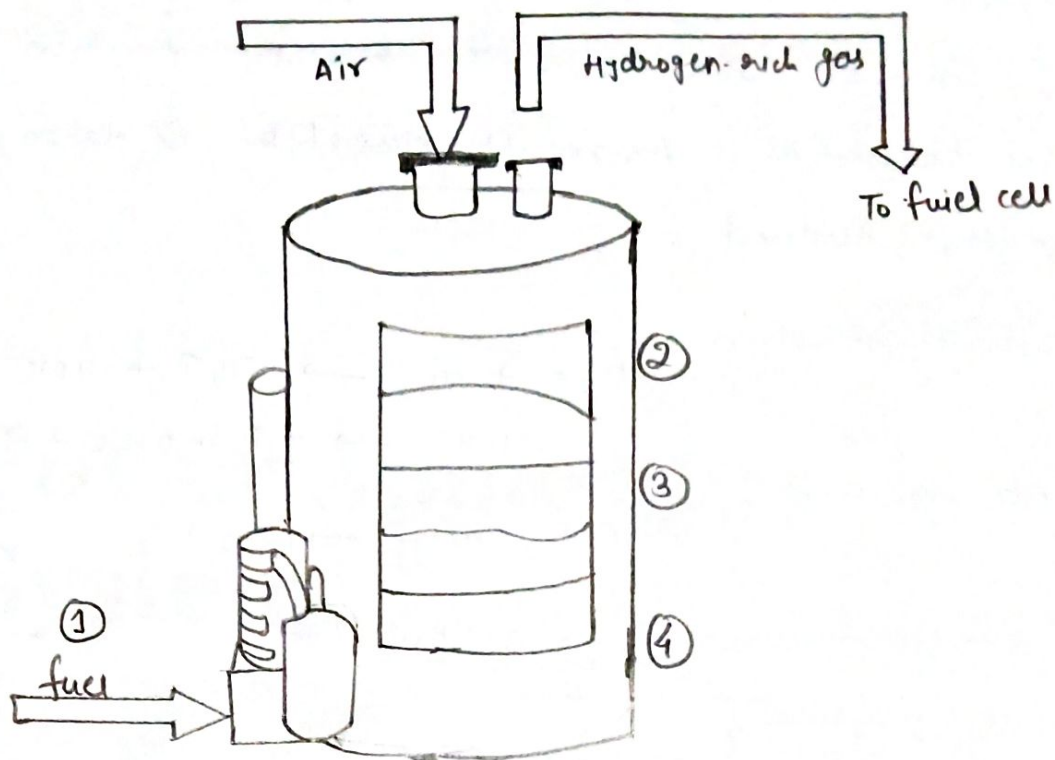


fig - Catalyst reforming process

2) Partial oxidation of coal and heavy oil :- The coal and heavy oil undergoes partial oxidation or gasification at  $1400^{\circ}\text{C}$  with  $\text{O}_2$  as gasifying medium. The  $(\text{CO})$  is converted into  $\text{CO}_2$  by two stage catalytic conversion process. This  $\text{CO}_2$  is removed by scrubbing. The energy content of  $\text{H}_2$  product gas if light or hard coal is used as feedback.

3) Electrolysis (electrolytic production of  $\text{H}_2$ ) :- electrolysis is the process of separation of two components by the use of electric current.

In this principle an electrolysis cell consists of two electrodes, commonly flat metal or carbon plates, immersed in an aqueous conducting solution called the electrolyte. A source of direct current voltage is

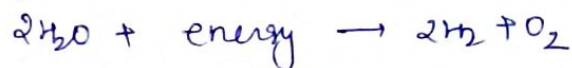
connected to the electrodes so that an electric current flows through the electrolyte from the positive electrode to the cathode. As result electrolyte is decomposed.

The reaction involved

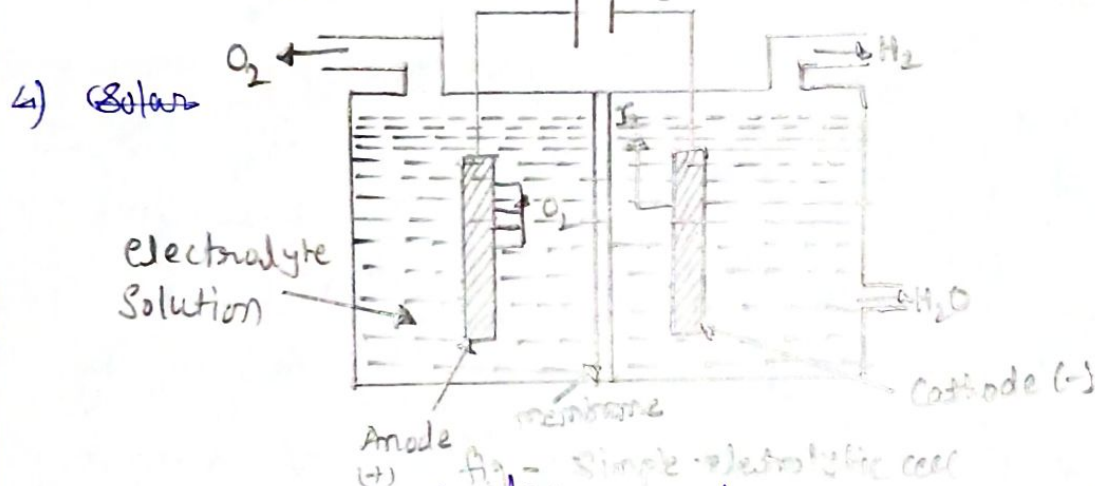
cathode reaction



Anode reaction



Energy requirement =  $3.5 \text{ kWh/m}^3$



4) solar energy methods: - Hydrogen can be produced using solar radiation by the following

process

1) Bio photolysis

2) photo electrolysis

1) Bio photolysis :-  $\text{H}_2$  can be produced very cheaply by using green algae ability to generate  $\text{H}_2$  gas from water and sunlight.

2) photo electrolysis :-  $\text{H}_2$  and  $\text{O}_2$  gas are liberated at the cathode and anode respectively by decomposition of water when both the electrodes are subject to sunlight.