Magneto hydrodynamics (MHD)

•**Magneto hydrodynamics** (**MHD)** is the study of the magnetic properties and behavior of electrically conducting fluids. The word "**magneto hydrodynamics**" is derived from magneto- meaning magnetic field, hydro- meaning water, and dynamics meaning movement.

•The fundamental concept behind MHD is that magnetic fields can induce currents in a moving conductive fluid, which in turn polarizes the fluid and reciprocally changes the magnetic field itself.

•The efficiency of conductive substances should be increased to increase the operational efficiency of a power generating device.

•The required efficiency can be achieved when a gas is heated to become plasma/fluid or adding other ionizable substances like the salts of alkali metals.

• To design and implement an MHD generator, several issues like economics, efficiency, contaminated hypo ducts are considered.

Principle of working of MHD Power plant

•The principal of MHD power generation is very simple and is based on Faraday's law of electromagnetic induction, which states that when a conductor and a magnetic field moves relative to each other, then voltage is induced in the conductor, which results in flow of current across the terminals.

•A magneto hydrodynamic (MHD) generator is a device that generates power directly by interacting with a rapidly moving stream of fluid, usually ionized gases/plasma.

•MHD devices transform heat or kinetic energy into electrical energy. The typical setup of an MHD generator is that both turbine and electric power generator coalesce into a single unit and has no moving parts, thus, eliminating vibrations and noise, limiting wear and tear.

•MHDs have the highest thermodynamic efficiency as it operates at higher temperatures than mechanical turbines.

•MHD generator is commonly referred to as a fluid dynamo, which is compared to a mechanical dynamo – a metal conductor when passed through a magnetic field generates a current in a conductor.

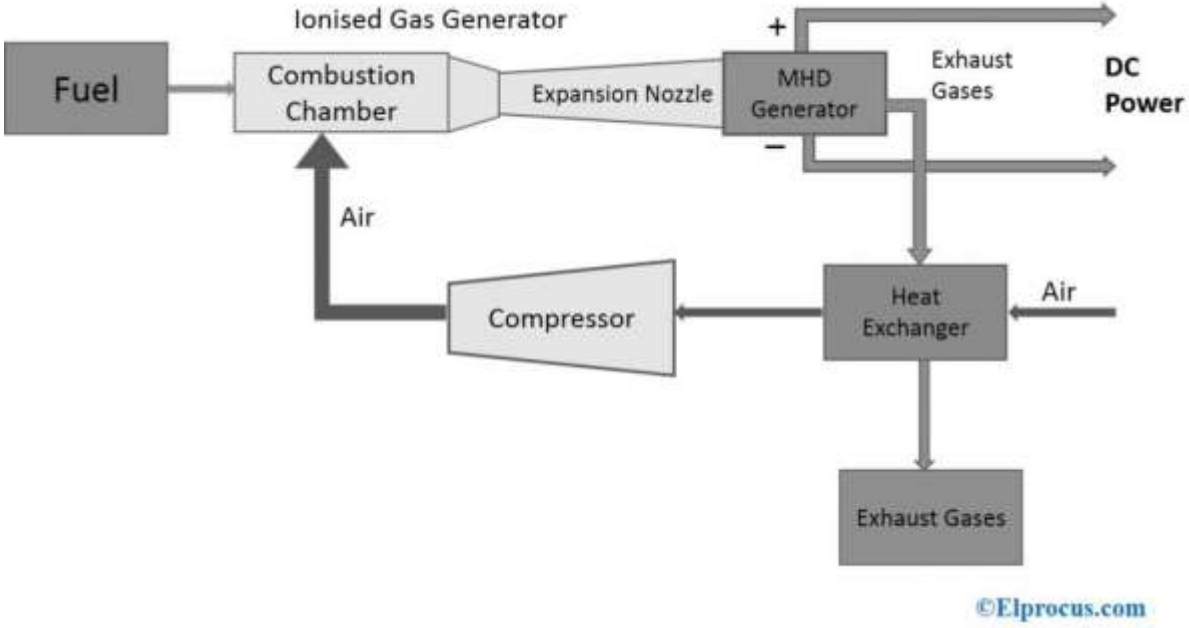
•However, in the MHD generator, conducting fluid is used instead of a metal conductor. As the conducting fluid (conductor) moves through the magnetic field, it produces an electrical field perpendicular to the magnetic field. This process of electric power generation through MHD is based on the principle of Faraday's law of electromagnetic induction.

When the conducting fluid flows through a magnetic field, a voltage is generated across its fluid and it is perpendicular to both the fluid flow and the magnetic field as per Fleming's Right Hand Rule.

MHD Generator Working

•The MHD generator requires a gas source of high temperature, which can be either a coolant of a nuclear reactor or can be high-temperature combustion gases produced from coal.

•As the gas and fuel pass through the expansion nozzle, it decreases the pressure of the gas and increases the speed of fluid/plasma through the MHD duct, and increasing the overall efficiency of the power output. The exhaust heat produced from the fluid through the duct is the DC power. It used to run the compressor to boost the fuel combustion rate.



Advantages, Disadvantages and Applications

Advantages

•The advantages of the MHD generator include the following.

•MHD generators convert heat or thermal energy directly into electrical energy

•It has no moving parts, so mechanical losses would be minimal

•Highly efficient Has higher operational efficiency more than conventional generators, therefore, the overall cost of an MHD plant is less compared to conventional steam plants

•Operational and maintenance costs are less

•It works on any type of fuel and has better fuel utilization

Disadvantages

The disadvantages of the MHD generator include the following.

•Aids in the high amount of losses that include fluid friction and heat transfer losses

•Needs large magnets, leading to higher costs in implementing MHD generators

•High operating temperatures in the range of 200°K to 2400°K will corrode the components sooner

Applications of MHD Generator

•The applications are

•MHD generators are used for driving submarines, aircraft, hypersonic wind tunnel experiments, defense applications, and so on.

•They are used as an uninterrupted power supply system and as power plants in industries

•They can be used to generate electric power for domestic applications

Fuel cell

•**Fuel cell**, any of a class of devices that convert the chemical energy of a fuel directly into electricity by electrochemical reactions. A fuel cell resembles a battery in many respects, but it can supply electrical energy over a much longer period of time.

•This is because a fuel cell is continuously supplied with fuel and air (or oxygen) from an external source, whereas a battery contains only a limited amount of fuel material and oxidant that are depleted with use.

•For this reason fuel cells have been used for decades in space probes, satellites, and manned spacecraft.

•A **fuel cell** is an electrochemical cell that converts the chemical energy of a fuel and an oxidizing agent into electricity through a pair of redox reactions.

• Fuel cells are different from most batteries in requiring a continuous source of fuel and oxygen (usually from air) to sustain the chemical reaction, whereas in a battery the chemical energy usually comes from metals and their ions or oxides that are commonly already present in the battery, except in flow batteries.

•Fuel cells can produce electricity continuously for as long as fuel and oxygen are supplied.

•There are many types of fuel cells, but they all consist of an anode, a cathode, and an electrolyte that allows ions, often positively charged hydrogen ions (protons), to move between the two sides of the fuel cell.

•A fuel cell has essentially the same kinds of components as a battery. Each cell of a fuel cell system has a matching pair of electrodes. These are the anode which supplies electrons, and the cathode which absorbs electrons.

•Both electrodes must be immersed in and separated by an electrolyte, which may be a liquid or a solid but which must in either case conduct ions between the electrodes in order to complete the chemistry of the system.