Magneto - hydrodynamics

- The **MHD** (Magneto-hydrodynamic) **generator** or **dynamo** transforms thermal energy or kinetic energy directly into electricity.

- MHD generators are different from traditional electric generators in that they can operate at high temperatures without moving parts .

- Magneto- hydrodynamic (MHD) is the study of the dynamics of electrically conducting fluids. Examples are plasmas, liquid metals, and salt water or electrolytes.

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- The fundamental concept behind MHD is that magnetic fields can induce current in a moving conductive fluid, which in turn creates forces on the fluid and also changes the magnetic field itself.
- **Structure of MHD Generator**
- The simple magneto-hydrodynamic generator consists of a gas nozzle. The gas nozzle is a combustion chamber that injects a pulse of gas into the channel/duct. The walls of the channel act as an electrode.

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- The induced electric current is fed to the load by an external circuit that supplies the generated electricity to the desired destination.
- The MHD generators can be constructed in various designs like the Faraday generator, Hall generator and disc generator. Faraday generator was the first designed MHD generator.
- In the Faraday generator, a powerful electromagnet provides the magnetic field through which the plasma flows, and perpendicular to this field are installed the two electrodes on opposite sides of the plasma across which the electrical output voltage is generated.

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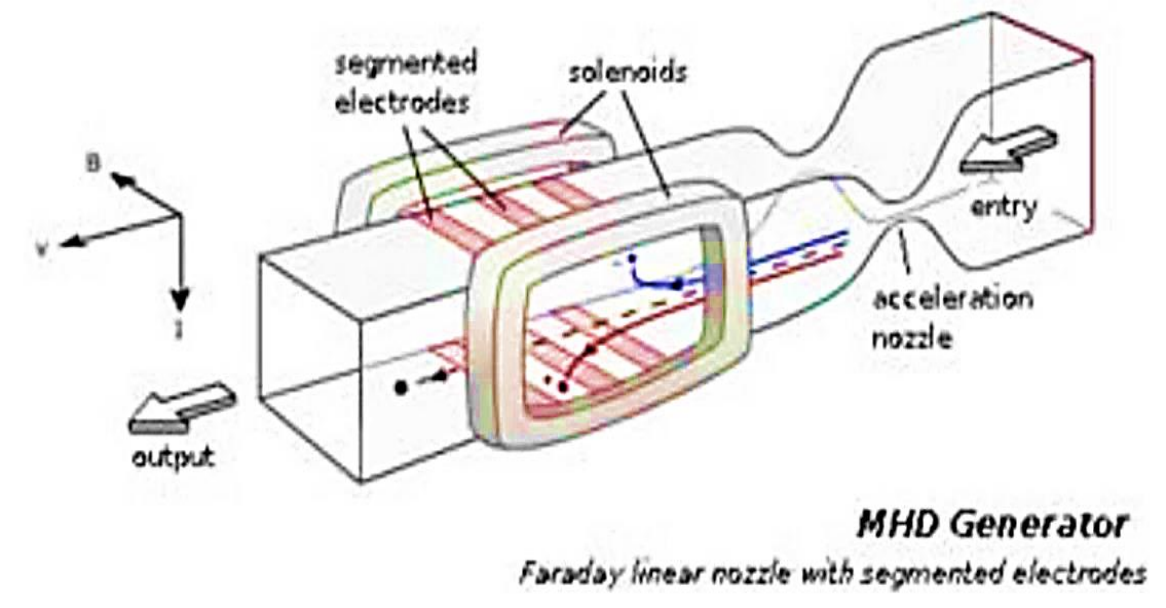
- The current flowing across the plasma between these electrodes is called the Faraday current. This provides the main electrical output of the MHD generator.



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- **MHD Working Principle**
- The principle of MHD generation is simple, based on Faraday's law of electromagnetic induction, i.e., when an electric conductor moves across a magnetic field, an e.m.f is induced in it, which produces an electric current.

- The conductor need not be a solid- it may be a gas or liquid. This is the principle of the conventional generator also, where the conductors consists of copper strips.

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- In a MHD generator the solid conductors are replaced by a gaseous conductor (high pressure, high temperature combustion gas), i.e. an ionized gas.

- If such gas is passed at high velocity through a powerful or strong magnetic field, i.e. suppose we have a charged particle (having charge q) moving at a high velocity v towards right and a perpendicular magnetic field is applied.

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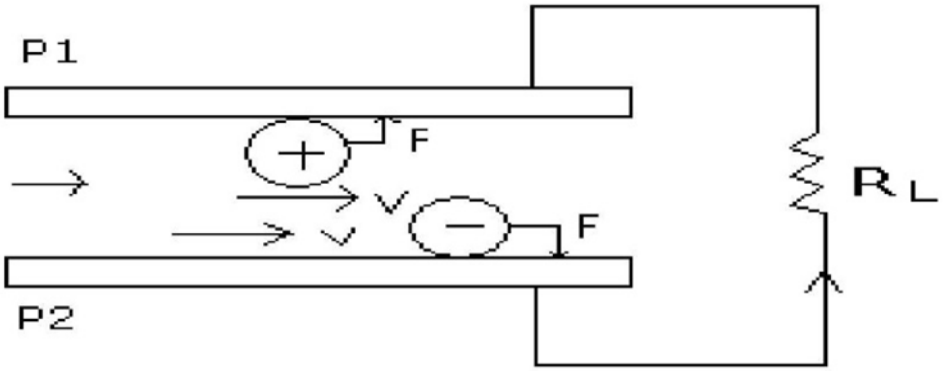
Consider, Plate P1 (cathode) and negative ions would be accelerated towards the lower plate P2 (anode). If the P1 and P2 are externally connected through the resistance, a current would flow through the resistance. Thus, gas energy is directly converted into electrical energy. This is the principle of MHD generator.



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- Lorentz Law describing the effects of a charged particle moving in a constant magnetic field can be stated as;

$$\mathbf{F = q.\ (v \times B)}$$

Where,

F the force (Lorenz force) of the acting (Charged) particle

v the velocity of the particle (vector)

q the charge of the particle (scalar)

B the magnetic field (vector)

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- The MHD generator needs a high temperature gas source, which could be the coolant from a nuclear reactor or more likely high temperature combustion gases generated by burning fossil fuels, including coal, in a combustion chamber.

- The Plasma in the MHD is created by a process called thermal ionization, where the temperature of the gas is raised to the point so that the electrons are no longer bound to the atoms of gas.