CH2356 Energy Engineering

www.msubbu.in

Magneto Hydro Dynamics

Dr. M. Subramanian

Associate Professor
Department of Chemical Engineering
Sri Sivasubramaniya Nadar College of Engineering
Kalavakkam – 603 110, Kanchipuram (Dist)
Tamil Nadu, India
msubbu.in[AT]gmail.com

Introduction

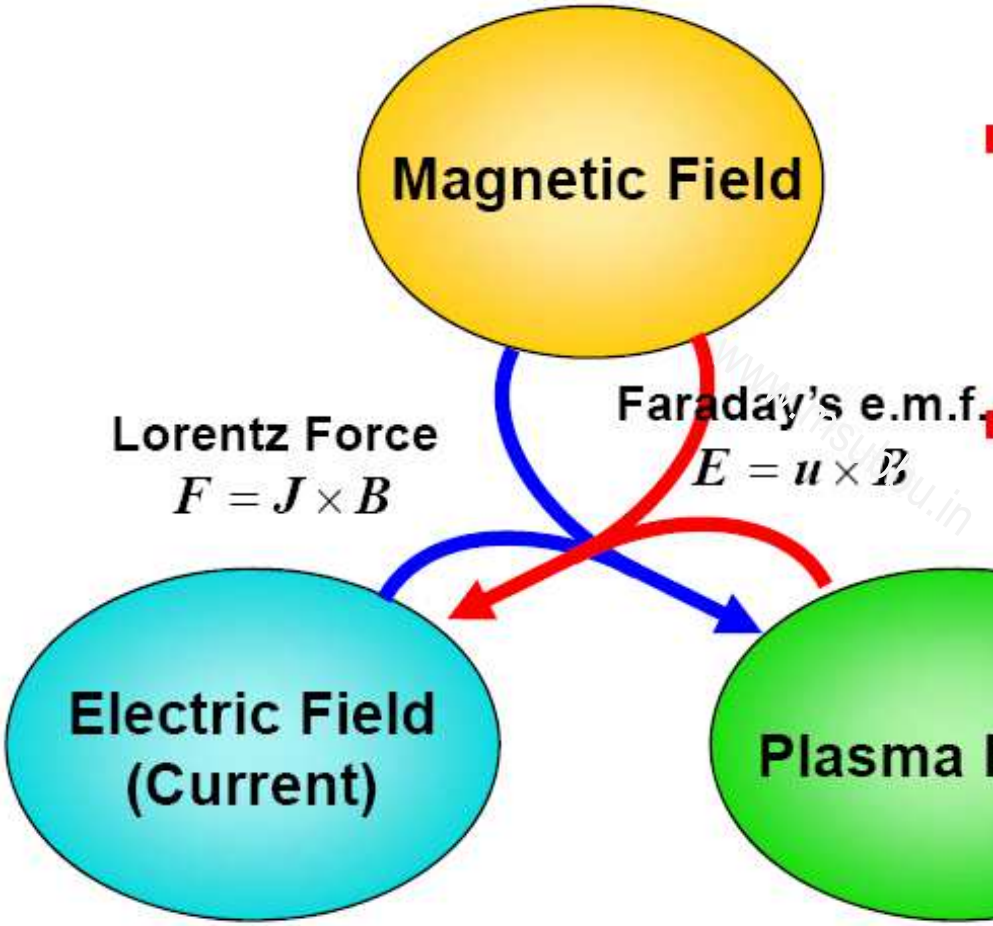
- The **MHD** (magneto hydrodynamic) **generator** transforms thermal energy or kinetic energy directly into electricity.

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

Power Generation

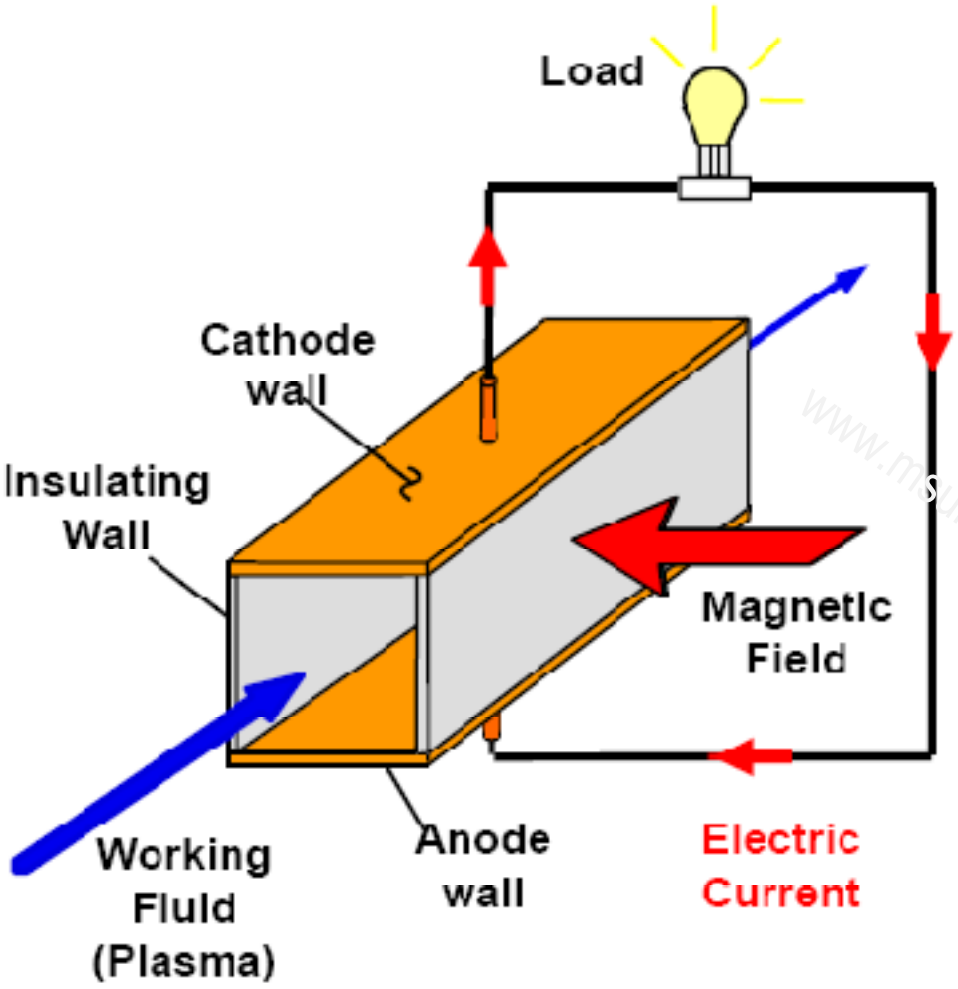
- The heating of a gas to plasma or the addition of other easily ionizable substances like the salts of alkali metals accomplishes this increase in conductivity.

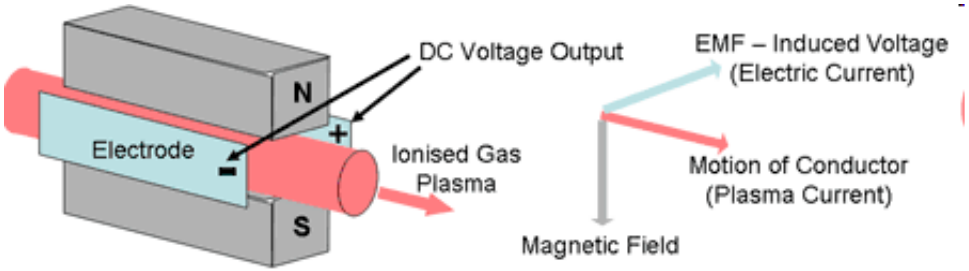
- In practice a number of issues must be considered in the implementation of a **MHD generator**: Generator efficiency, Economics, and Toxic byproducts. These issues are affected by the choice of one of the three MHD generator designs. These are the Faraday generator, the Hall generator, and the disc.



- Interaction Magnetic field, Electric field and Plasma flow
- Magnetic field and Plasma flow produce Electric field
  → Faraday's E.M.F.
- Electric field (Current) and Magnetic field produce Flow
  → Lorentz Force

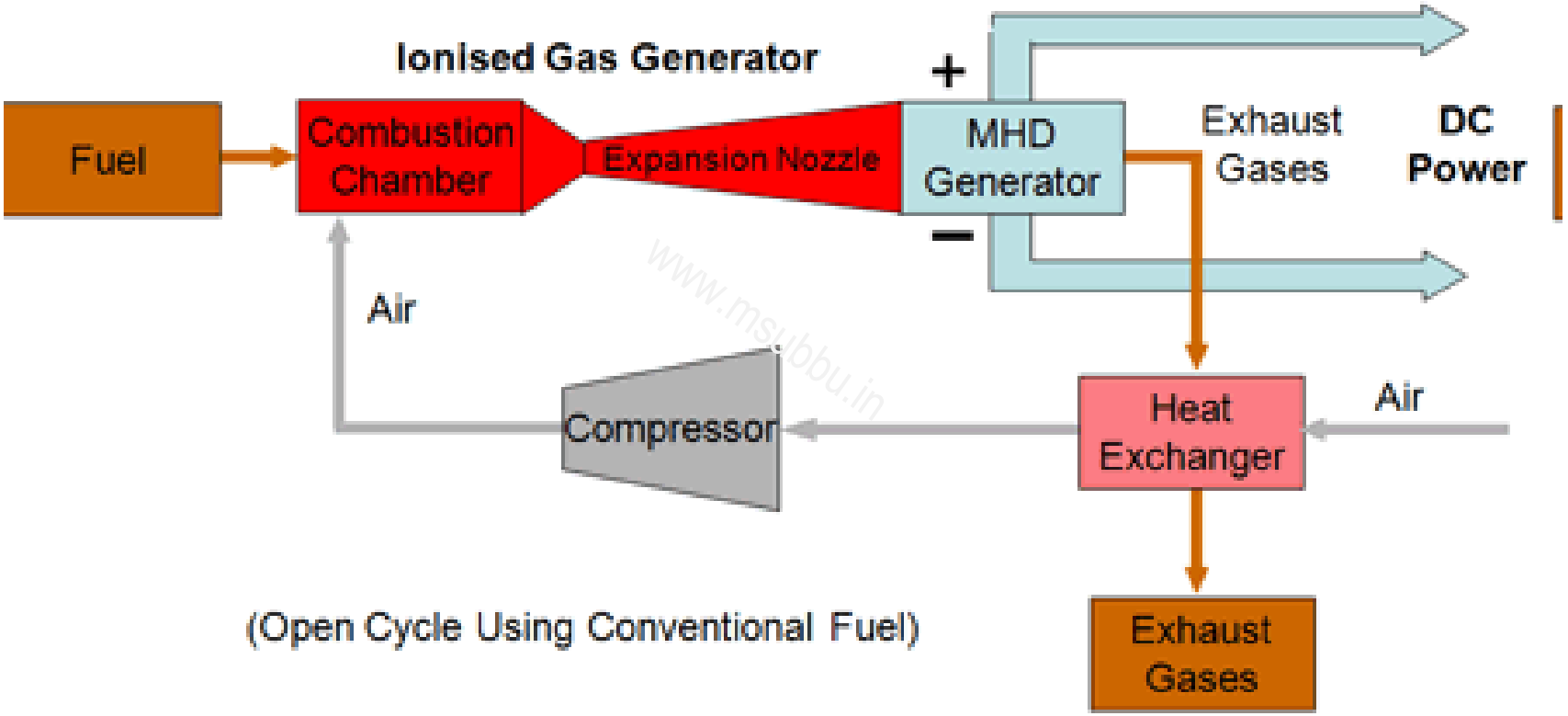
Operating Principle for MHD Generator





Magnetohydrodynamic Power Generation (Principle)

Magnetohydrodynamic (MHD) Electricity Generation



(Open Cycle Using Conventional Fuel)

MHD power generation

- **Plasma**: the prime system requirement is creating and managing the conducting gas plasma since the system depends on the plasma having a high electrical conductivity. Suitable working fluids are gases derived from combustion, noble gases, and alkali metal vapours.

- **Methods of ionizing the gas**:
  - various methods for ionising the gas are available, all of which depend on imparting sufficient energy to the gas. It may be accomplished by heating or irradiating the gas with X rays or Gamma rays.
  - It has also been proposed to use the coolant gases such as helium and carbon dioxide employed in some nuclear reactors as the plasma fuel for direct MHD electricity generation rather than extracting the heat energy of the gas through heat exchangers to raise steam to drive turbine generators.
  - Seed materials such as Potassium carbonate or Cesium are often added in small amounts, typically about 1% of the total mass flow to increase the ionisation and improve the conductivity, particularly of combustion gas plasmas.

MHD power generation

- ***Power output:*** the output power is proportional to the cross sectional area and the flow rate of the ionised plasma. The conductive substance is also cooled and slowed in this process. MHD generators typically reduce the temperature of the conductive substance from plasma temperatures to just over 1000°C. An MHD generator produces a direct current output which needs an expensive high power inverter to convert the output into alternating current for connection to the grid.

- ***Efficiency:*** Typical efficiencies of MHD generators are around 10 to 20 percent mainly due to the heat lost through the high temperature exhaust.

Advantages of MHD Power Generation

- **Simple Structure**
  - only MHD channel (electrodes, insulator) and Magnet
- **High Power density** ---- high electric field, current density
  - compact machine
  - small output applications
- **High temperature operation** ---- looking for suitable material
  - no turbine, and no rotating machine
  - ceramic material can be used
- **High Efficiency**
  - Save energy resources & Low Environmental Issues
- **No moving parts**
  - no turbine and no rotating generator
  - good for space applications

MHD Economics

- MHD generators have not been employed for large scale mass energy conversion because other techniques with comparable efficiency have a lower lifecycle investment cost.

Environmental Issues

- The alkali metals commonly used as MHD fluids react violently with water. Also, the chemical byproducts of heated, electrified alkali metals and channel ceramics may be poisonous and environmentally persistent.