MAGNETO-HYDRODYNAMIC POWER GENERATOR

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INTRODUCTION

- An Magneto-Hydrodynamic (MHD) generator, like a conventional generator, relies on moving a conductor through a magnetic field to generate electric current.

- The MHD generator uses hot conductive ionized gas (a plasma) as the moving conductor. Gas is generated from natural fossil fuel.

- It is a device for converting heat energy of a fuel directly into electrical energy without conventional electrical generator.

- Actually, the word Magneto-Hydrodynamic is derived from magneto meaning-magnetic field and hydro meaning-liquid and dynamo meaning movement.
INTRODUCTION: BASIC PRINCIPLE

- MHD power generation process governed by Faraday’s law of electromagnetic induction (If a electric conductor moves through a magnetic field it produces a electric field perpendicular to the magnetic field and (which produced) electric current.

- The flow of conducting plasma through a magnetic field at high velocity produces voltage to be generated across the electrodes, perpendicular to both plasma flow and magnetic field according to Fleming’s right hand rule.

Fig.1. Basic Principle of MHD generator
INTRODUCTION: BASIC OPERATION

- When an electric conductor moves across a magnetic field, a voltage is induced in it which produced electric current. This is the principle of conventional generator. In MHD solid conductor is replaced by gaseous conductor (such as ionized gas).

- If a gas is passed at a high velocity through a magnetic field, a current is generated and can be extracted by placing electrodes in suitable position in the stream. This operating principle is adopted for MHD generator.

Fig.2a. Operating process of MHD
A pressurized, electrically conducting fluid (ionized gas) flows through a transverse magnetic field in a channel or duct. Pair of electrodes are located on the channel walls at right angle to the magnetic field and connected a load.

Ionization is produced either by thermal means i.e. by elevated temperature or by seeding the substance like cesium or potassium vapor which ionizes at relatively low temperature.

Atoms of seed element split off electrons. The presence of negatively charged electrons make the gas an electrical conductor.

Electrodes in the MHD generator perform the same function as brushes in a conventional DC generator. The MHD generator develops DC power and the conversion to AC is done using an inverter.
INTRODUCTION: BASIC OPERATION

Fig.2b. MHD generator with load

MHD broadly classified in two types:

- Open cycle system
- Closed cycle system
CLASSIFICATION: OPEN CYCLE SYSTEM

- Fuel used may be oil or gasified coal.
- Fuel is burnt in the combustion chamber.
- Hot gases from combustor is then seeded with small amount of cesium or potassium vapor to increase the electrical conductivity of the gas (i.e. ionized gas).
- Gas is ionized at high temperature. To attain such temperature compressed air is used to burn the coal in combustion chamber.
- The hot pressurized working fluid living in the combustor flows through a convergent divergent nozzle. Using the nozzle the gas is directed to the MHD generator with high velocity.
- The hot ionized gas passed through the magnetic field of generator. During motion of gas +ve and –ve ion moves to the electrodes and produces electric current.
CLASSIFICATION: OPEN CYCLE MHD SYSTEM

Fig. 3. Open cycle system MDH
CLOSED CYCLE SYSTEM OPERATION (CONTINUES.)

- It is said closed loop as the working fluid, in a closed cycle, is circulated in a closed loop. closed cycle MHD system may be either a plasma converter or a liquid metal converter.

- The plasma converter uses an ionized gas (helium or argon seeded with cesium) and the liquid metal converter uses the vapour of the metal or the metal in a liquid form (the metal may be an alkali or some other metal).

- The complete system can be divided into three distinct but interlocking loops:
  - (i) External heating loop
  - (ii) MHD loop
  - (iii) Steam loop.
Classification: Closed Cycle System

Fig. 4. Closed Cycle MHD System
(i) EXTERNAL HEATING LOOP

- In this loop, coal is gasified and this gas is burnt in a combustor to generate heat.
- This heat is transferred to the working fluid (argon) of the MHD cycle in a heat exchanger ($HX_1$). The combustion products are discharged to the atmosphere through the air preheater and purifier.

(ii) MHD LOOP

- The hot argon gas is seeded with cesium and passed through the MHD generator that produces direct current (dc).
- This dc output is converted into ac by means of inverter and then supplied to the grid.
(iii) STEAM LOOP:

- Then this fluid is passed through the heat exchanger HX$_2$. In heat exchanger HX$_2$, the fluid imparts it heat to water and so generates steam.
- This steam is used partly for driving a steam turbine operating the compressor and partly expanded in a steam turbine driving a three-phase alternator.
- The working fluid is then passed through compressor and intercooler and then returned back to the heat exchanger HX$_1$. 
Fig. 4. Closed Cycle MHD System
Advantages of MHD Generation

- Here only working fluid is circulated, and there are no moving mechanical parts. This reduces the mechanical losses to nil and makes the operation more dependable.
- The temperature of working fluid is maintained by the walls of MHD.
- It has the ability to reach full power level almost directly.
- The price of MHD generators is much lower than conventional generators.
- MHD has very high efficiency, which is higher than most of the other conventional or non-conventional method of generation.
DIFFERENCE BETWEEN OPEN AND CLOSED CYCLE MHD:

**OPEN CYCLE SYSTEM**
- Working fluid after generating electrical energy is discharged to the atmosphere through a stack.
- Operation of MHD generator is done directly on combustion products.
- Temperature required is about 2300°C to 2700°C.
- More developed.

**CLOSED CYCLE SYSTEM**
- Working fluid is recycled to the heat sources and thus is used again.
- Helium or Argon (with Cesium Seeding) is used as the working fluid.
- Temperature required is about 530°C.
- Less developed.
REFERENCES

- **Power Plant Engineering**, G.R. Nagpal
- **Power Station Engineering & Economy**, William A Vopat