Analysis on Performance of Magneto Hydro Dynamics Power Generation

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Abstract : **Magneto Hrdro Dynamic Power generation process is broadly based on the physics background of space plasma. At present a plenty of energy is needed to sustain industrial and agricultural production and the existing conventional energy sources like coal, oil, uranium etc., are not adequate to meet the ever increasing energy demands. Consequently, efforts have been made for harnessing energy from several non-conventional methods like MHD systems.**

The principle of MHD generator is based on Faradayz law of electromagnetic induction. When an electric conductor moves across magnetic field, an emf is induced in it, it produces electric current. Lorentz force on the charged particle

F = Q(V*B) Where,

V- velocity of the particle
Q- charge of the particle B-magnetic field

Types of Mhd's :
(1)Open cycle System

(2)Closed cycle System (i)Seeded inert gas system (ii) Liquid metal systems

Open Cycle Mhd System :

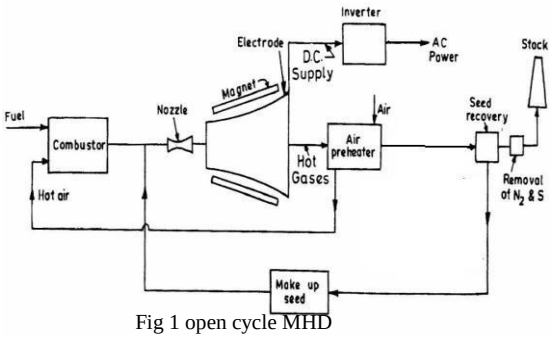
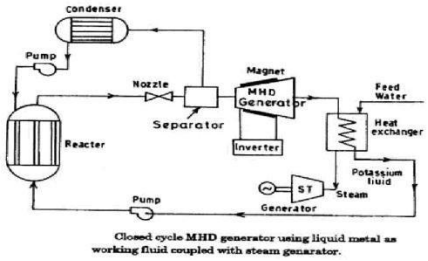


Fig 1 open cycle MHD

Open cycle MHD System

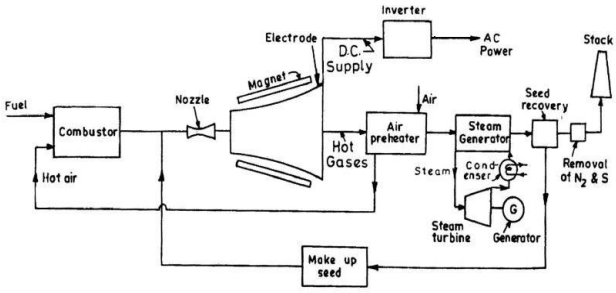
Closed Cycle Mhd System :



Closed cycle MHD generator using liquid metal as working fluid coupled with steam generator.

Fig 2 Closed Cycle MHD

Hybrid Mhd Steam Part Open Cycle **:**

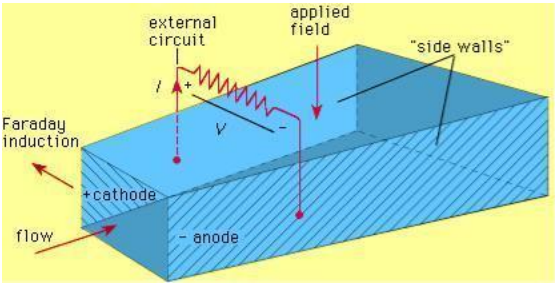


Hybrid MHD - Steam Part Open Cycle

Fig 3 Hybrid MHD

Faradays Generator

A simple Faraday generator would consist of a wedge-shaped pipe or tube of some non-conductive material. When an electrically conductive efluid flows through the tube, in the presence of a significant perpendicular magnetic field, a charge is induced in the field, which can be drawn off as electrical power by placing the electrodes on the sides at 90 degree angles to the



Magnetohydrodynamic Power Generation

The magneto hydro dynamic power generator is a device that generates electric power by means of the interaction of a moving fluid (usually a ionized gas or plasma) and a magnetic field. As all direct conversion processes the MHD generators can also convert thermal energy directly into electricity without moving parts. In this way the static energy converters, with no moving mechanical part, can improve the dynamic conversion, working at temperature more higher than conventional processes. The typical
configuration of MHD generator

Hall Generator

The most common answer is to overcome the problems of faradys generator is the Hall effect to create a current that flows with the fluid. The normal scheme is to place arrays of short, vertical electrodes on the sides of the duct. The first and last electrodes in the duct supply the load. Each other electrode is shorted to an electrode on the opposite side of the duct. Losses are less than that of a Faraday generator, and voltages are higher because there is less shorting of the final induced current.

Disk Generator

The third, currently most efficient answer is the Hall effect disk generator. This design currently holds the efficiency and energy density records for MHD generation. A disk generator has fluid flowing between the center of a disk, and a duct wrapped around the edge. The magnetic excitation field is made by a pair of circular Helmholtz coils above and below the disk

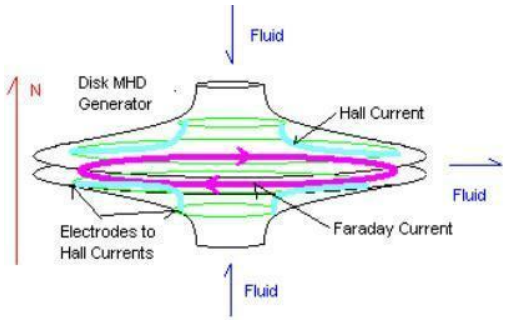


Fig 4 Disk Generator

The force F acts on the particle at right angles tobothmagnetic field and gas velocity.Gas particles flow in the direction of the electric field . Current intensity between the electrode connected externally in perpendicular direction is given by,

$$V\,(u.B.\delta) - V\,E = E + E = u.B - \delta =$$

B=Magnetic field($w/m2$) u=Gas velocity(w/m)

E=Electric field($volts/m$)

δ=Distance between the electrode(m)

The following assumptions are made in the analysis of the MHD generator.

1. gas flowing at constant velocity and pressure
2. magnetic flux generated remains constant
3. no heat transfer to the surroundings
4. gas flow is uniform

The elecrical energy is extracted from the thermal energy of the gases keeping axial velocity constant. The electrical energy is produced when the condutive gas cuts the magnetic lines of force. The gas is accelerated to restore its velocity with decrease of temperature and axial velocity held constant, large power is developed if the applied magnetic flux density and gas velocity are high. The lorentz force induced on electrons acts in the direction of retarding the gas flow. The direction of Lorentz force is opposite to the velocity of conducting gas.

$$E = u\ B$$

The elecromagnetic force acting on the gas particle in the presence of electric field E is given by

$F=Q(E+E\ )=Q[E+u.B]$

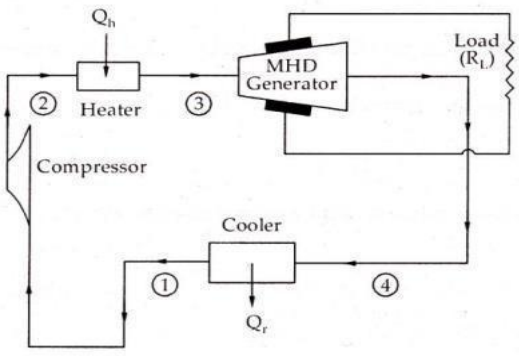


Fig 5 Power source

MHD generator replaced the gas turbine used in conventional cycle is shown in Figure 5. A compressor is used to elevate the

pressure and then heat is added to increase the gas temperature which is sufficient to ionize the gas.Then the gas flow is ccelerated by passsing through the nozzle before entering MHD generator.The gas passing through the MHD generator is deaccelerated and electrical energy is generated

Advantages of MHD

1) Conversion efficiency of about 50% .
2) Less fuel consumption.

3) Large amount of pollution free power generated .
4) Ability to reach full power level as soon as started.
5) Plant size is considerably smaller than conventional fossil fuel plants
6) Less overall generation cost. No moving parts, so more reliable

Disadvantages Of MHD

1) Suffers from reverse flow (short circuits) of electrons through the conducting fluids around the ends of the magnetic field.

2) Needs very large magnets and this is a major expense.

3) High friction and heat transfer losses.

4) High operating temperature.

5) Coal used as fuel poses problem of molten ash which may short circuit the electrodes. Hence, oil or natural gas are much better fuels for MHDs. Restriction on use of fuel makes the operation more expensive.

Application

1) Power generation in space craft.
2) Hypersonic wind tunnel experiments.
3) Defense application.

CONCLUSION

The MHD power generation is in advanced stage today and closer to commercial utilization. Significant progress has been made in development of all critical components and sub system technologies. Coal burning MHD combined steam power plant promises significant economic and environmental advantages compared to other coal burning power generation technologies. It will not be long before the technological problem of MHD systems will be overcame and MHD system would transform itself from non-conventional to conventional energy sources.

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