

## MAGNETO HYDRO DYNAMIC POWER GENERATION (MHD)

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**Abstract**-The electricity requirements of the world including India are increasing at alarming rate and the power demand has been running ahead of supply .fossil fuels and other conventional resources, presently being used for generation of electrical energy, may not be sufficient or to keep pace with ever increasing demand of the electrical energy of the world. The recent severe energy crisis has forced the world to develop new and alternative methods of power generation. MAGNETO HYDRO DYNAMIC (MHD) power generation is a new unique method of power generation.

Magneto hydrodynamics (MHD) is the academic discipline which studies the dynamics of electrically conducting fluids. The field of MHD was initiated by Hannes Alfvén , for which he received the Nobel Prize in Physics in 1970. MHD power generation is a new system of electric power generation which is said to be of high efficiency and low pollution

**Keywords**:- MHD Generator , energy, power, plasma, electromagnetic field, Superconducting magnet.

### 1. INTRODUCTION

we all are aware of power generation using hydel, thermal and nuclear resources. In all the systems, the potential energy or thermal

energy is first converted in to mechanical energy and then the mechanical energy is converted in to electrical energy. The conversion of potential energy in to mechanical energy is considerably high (70 to 80%) but conversion of thermal energy in to mechanical energy is considerably poor(40 to 45%).In addition to this the mechanical components required for converting heat energy in to mechanical energy are large in number and considerably costly.This requires huge capital cost as well as maintenance cost also. Thus scientist developed a new system which is said to be of high efficient and cause low pollution known as MHD power generation.

80 % of total electricity produced in the world is hydal, while remaining 20% is produced from nuclear, thermal, solar, geothermal energy and from magneto hydro dynamic (mhd) generator. MHD power generation is a new system of electric power generation which is said to be of high efficiency and low pollution. In advanced countries MHD generators are widely used but in developing countries like INDIA, it is still under construction, this construction work in in progress at TRICHI in TAMIL NADU, under the joint efforts of BARC (Bhabha atomic research center), Associated cement corporation (ACC) and Russian

technologists. As its name implies, magneto hydro dynamics (MHD) is concerned with the flow of a conducting fluid in the presence of magnetic and electric field. The fluid may be gas at elevated temperatures or liquid metals like sodium or potassium-SEEDING.

## **PRINCIPLES OF MHD POWER**

**GENERATION:-** When an electric conductor moves across a magnetic field, a voltage is induced in it which produces an electric current. This is the principle of the conventional generator where the conductors consist of copper strips. In MHD generator, the solid conductors are replaced by a gaseous conductor, an ionized gas. If such a gas is passed at a high velocity through a powerful magnetic field, a current is generated and can be extracted by placing electrodes in suitable position in the stream. The principle can be explained as follows. An electric conductor moving through a magnetic field experiences a retarding force as well as an induced electric field and current.

**VARIOUS MHD SYSTEMS:** -The MHD systems are broadly classified into two types.

1. OPEN CYCLE SYSTEM

2. CLOSED CYCLE SYSTEM:-

a) Seeded inert gas    b) Liquid metal

**ADVANTAGES:** The conversion efficiency of a MHD system can be around 50% much higher compared to the most efficient steam plants. Large amount of power is generated. It has no moving parts, so more reliable. The closed cycle system produces power, free of pollution. It has ability to reach the full power level as soon as started. The size if

the plant is considerably smaller than conventional fossil fuel plants.

**FUTURE PROSPECTS:** It is estimated that by 2020, almost 70 % of the total electricity generated in the world will be from MHD generator.

## **2. HISTORY**

The conversion process in MHD was initially described by Michael Faraday in 1833. However the actual utilization of this concept remained unthinkable. The first known attempt to develop an MHD generator was made at Westing house research laboratory (USA) around 1938. The first MHD-steam power plant U-25 was put into operation was of 75MW unit in USSR of which 25MW is generated by MHD means in early 1970's & this work has been progressing fruitfully. The first pilot plant was set up in Tiruchirapalli (by BARC). A five year plan was signed in February 1975 which included 22 spheres of applied science and technology connected with the MHD energy generation. The Japanese program in the late 1980s concentrated on closed-cycle MHD. In 1986, Professor Hugo Karl Messerle at The University of Sydney researched coal-fueled MHD. The Italian program began in 1989 with a budget of about 20 million \$US, and had three main development areas:

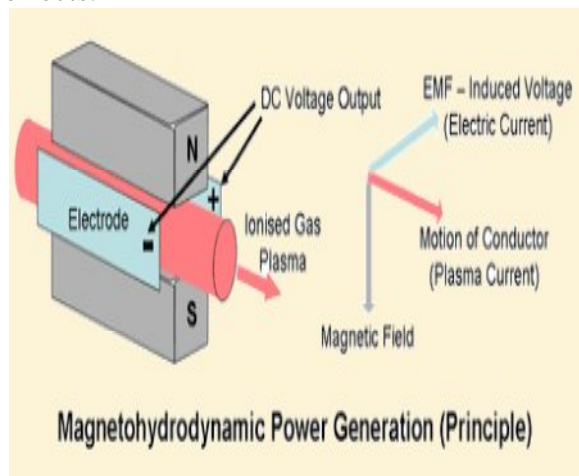
➤ MHD Modeling.

➤ Superconducting magnet development.

## **3. PRINCIPLES OF MHD POWERGENERATION :**

The electromagnetic induction principle is not limited to solid conductors. The movement of a conducting fluid through a magnetic field can also generate

electrical energy. When a fluid is used for the energy conversion technique, it is called MAGNETO HYDRO DYNAMIC (MHD), energy conversion. The flow direction is right angles to the magnetic fields direction. An electromotive force (or electric voltage) is induced in the direction at right angles to both flow and field directions, as shown in the nextfig.The MHD generator can be considered to be a fluid dynamo. This is similar to a mechanical dynamo in which the motion of a metal conductor through a magnetic field creates a current in the conductor except that in the MHD generator the metal conductor is replaced by a conducting gas plasma. When a conductor moves through a magnetic field it creates an electrical field perpendicular to the magnetic field and the direction of movement of the conductor. This is the principle, discovered by Michael Faraday, behind the conventional rotary electricity generator. Dutch physicist Antoon Lorentz provided the mathematical theory to quantify its effects.



The Lorentz Force Law describes the effects of a charged particle moving in a constant magnetic field. The simplest form of this law is given by the vector equation.

$$\mathbf{F} = Q \cdot (\mathbf{v} \times \mathbf{B})$$

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where

- **F** is the force acting on the particle.
- **Q** is the charge of the particle,
- **v** is the velocity of the particle, and
- **B** is the magnetic field.

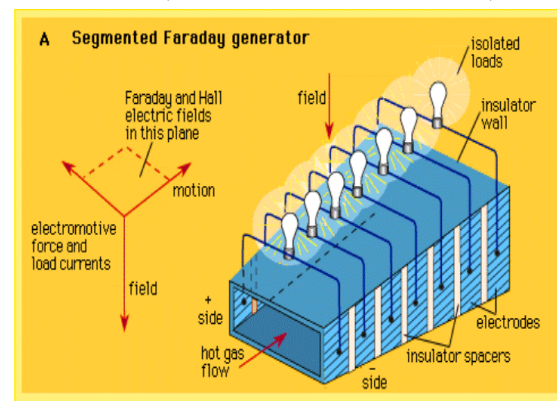
The vector **F** is perpendicular to both **v** and **B** according to the right hand rule.

### HOW AN MHD GENERATOR WORKS???

Electrically conducting gas at a very high temperature is passed at high velocity through a strong magnetic field at right angles to the direction of flow. There by generating electrical energy. The electrical energy is then collected from stationary electrodes placed on the opposite sides of the channel. The current so obtained is direct current which can be converted into ac by an inverter.

On heating of a gas, the outer electrons escape out from its atoms or molecules.

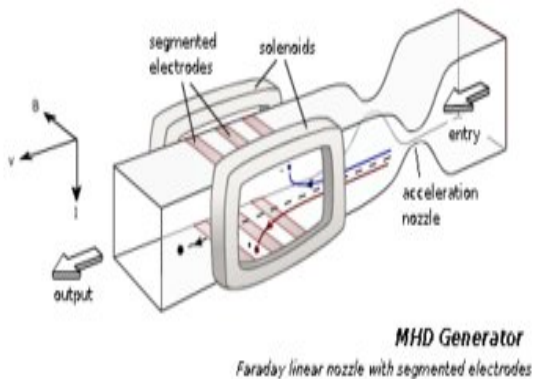
The particles acquire an electric charge and the gases passes into the state of plasma Air becomes highly ionized at temperatures of 5,000 to 6,000°C.



## 4. CONSTRUCTION

Its construction is very simple. MHD generator resembles the rocket engine surrounded by enormous magnet. It has no moving parts & the actual conductors are replaced by ionized gas (plasma). The magnets used can be electromagnets or superconducting magnets. Superconducting magnets are used in the larger MHD generators to eliminate one of the large parasitic losses. As shown in figure the electrodes are placed parallel & opposite to each other. It is made to operate at very high temperature, without moving parts. Since the plasma temperature is typically over 2000 °C, the duct containing the plasma must be constructed from non-conducting materials capable of withstanding this high temperature. The electrodes must of course be conducting as well as heat resistant.

Because of the high temperatures, the non-conducting walls of the channel must be constructed from an exceedingly heat-resistant substance such as yttrium oxide or zirconium dioxide to retard oxidation. It can be considered as fluid dynamo similar to mechanical dynamo. The key component is Superconducting Magnets

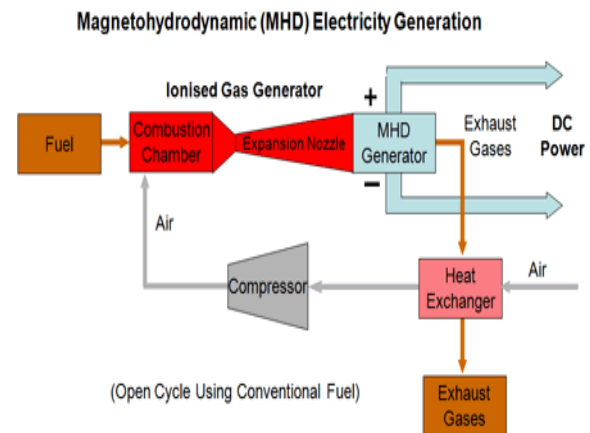


Superconducting magnets are used in the larger MHD generators to eliminate one of the large parasitic losses: the power needed to energize the electromagnet. Superconducting magnets, once charged, consume no power, and can develop intense magnetic fields 4 teslas and higher. The only parasitic load for the magnets are to

maintain refrigeration, and to make up the small losses for the non-supercritical connections.

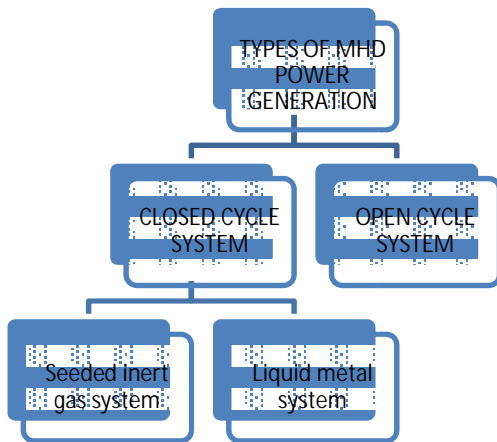
## 5. WORKING PROCEDURE

It is the generation of electric power utilizing the high temperature conducting plasma (stream of high temp working fluid) moving through an intense magnetic field. It converts the heat energy of fuel



(thermal energy) directly into electrical energy. The fuel is burnt in the presence of compressed air in combustion chamber. During combustion seeding materials are added to increase the ionization & this ionized gas (plasma) is made to expand through a nozzle into the generator. Magnetic field, a current is generated & it can be extracted by placing electrodes in a suitable stream. This generated EMF is DC 2500

## 6. TYPES OF MHD POWER GENERATION

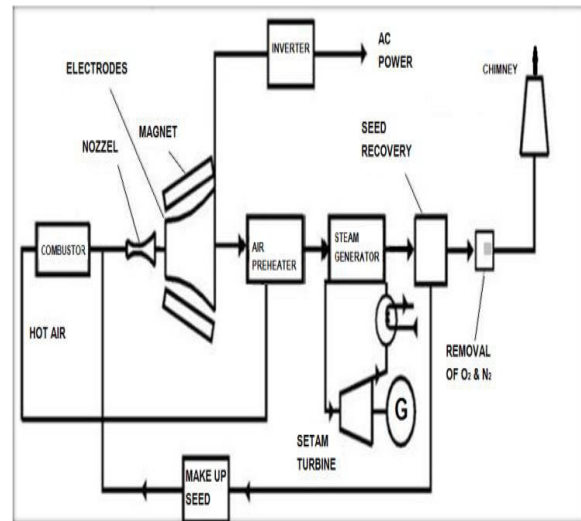


1) OPEN CYCLE MHD SYSTEM:-

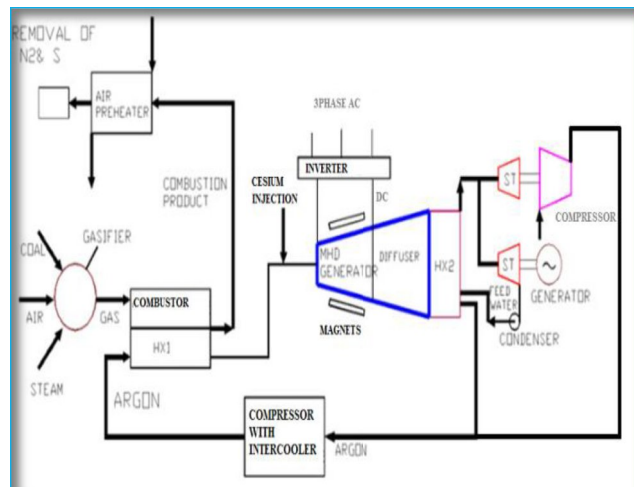
Working fluid-potassium seed combustion product. Temperature in OC MHD is about 2500oC. DC Superconducting magnets of 4~6Tesla are used. Here exhaust gases are left out to atmosphere & the capacity of these plants are about 100MW.

The fuel used maybe oil through an oil tank or gasified coal othrough a coal gasification plant The fuel (coal, oil or natural gas) is burnt in the combustor or ocombustion chamber. The hot gases from combustor is then seeded with a small amount of ionized alkali metal (cesium or potassium) to oincrease the electrical conductivity of the gas. The seed material, generally potassium carbonate is injected into the combustion chamber, the potassium is then ionized by the hot combustion gases at temperature of roughly 2300' c to 2700'c.

The MHD generator is a divergent channel made of a heat resistant alloy with external water cooling. The hot gas expands through the rocket like generator surrounded by powerful magnet. During motion of the gas the +ve and -ve ions move to the electrodes and constitute an electric current.



2) Closed cycle MHD system:



Working fluid-cesium seeded helium. Temperature of CC MHD plants is very less compared to OC MHD plants. It's about 1400oC. DC Superconducting magnets of 4~6Tesla are used. Here exhaust gases are again recycled & the capacities of these plants are more than 200MW.

A) SEEDED INERT GAS SYSTEM:

In a closed cycle system the carrier gas operates in the form of Brayton cycle. In a closed cycle system the gas is compressed and heat is supplied by the source, at