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MAGNETIC HYDRO DYNAMICS POWER GENERATION TECHNIQUES

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Abstract – The demand of electricity is going to be increased day by day. The recent survey, demand and force the world to generate alternative source for power generation. Magnetic Hydro Dynamic is one of them. The MHD power generation technology provides attractive generation potential to the electric power utilities. In this paper discuss on MHD technology including principle of operation, types, power extraction method. This paper also discusses the recent developments taking place in MHD power generation.

Keywords**: -** MHD, Types, Power Extraction Method, Recent Development

I. INTRODUCTION

Due to increasing cost and decreasing availability of natural gas and fuel oil, Coal play an important role in energy resources. There are many ways by which coal can be used, but the most promising way is with the magneto hydrodynamic system. From a long year we are going to search direct conversion from thermal to electrical energy but it is not available till date. Conversion from thermal to mechanical and then mechanical to electrical contain less efficiency (less than 12%) The most prominent way is the direct burning coal in a MHD generator. The

Potential of the magneto hydrodynamic system was first assessed in 1959 for commercial power generator applications. Avacon and group of Electrical utilities entered into an cooperation for investigation the development of MHD system.

II. Principle of operation of MHD

The MHD power generation technology deals with the production of electricity using a high temperature conducting plasma that passed through the intense magnetic field. The heat rejected by the MHD system can also be used to drive the conventionally used steam turbine system. The operating principle of MHD generator is as depicted in the Fig.1.An MHD can be designed to use different types of fuel such natural gas, fuel, coal and nuclear. Coal is mainly used as energy resource in MHD system. In case of MHD generator a pressure difference is needed to force the gas through the field when the current is drawn. The observed force of moving plasma to focus on plasma atoms

$$\mathbf{F = J .B}$$

Where J shows the density of plasma circuit and B shows magnetic flux of density vector. Thermodynamically, the operation of generator is similar to that of the turbine. Useful work is extracted from the gas flow at the expanse of the pressure and enthalpy drop and its efficiency can be observed for the different gas flow. It has no highly stressed moving part of closed tolerance. Its walls are cooled at below the temperature of the working fluid.

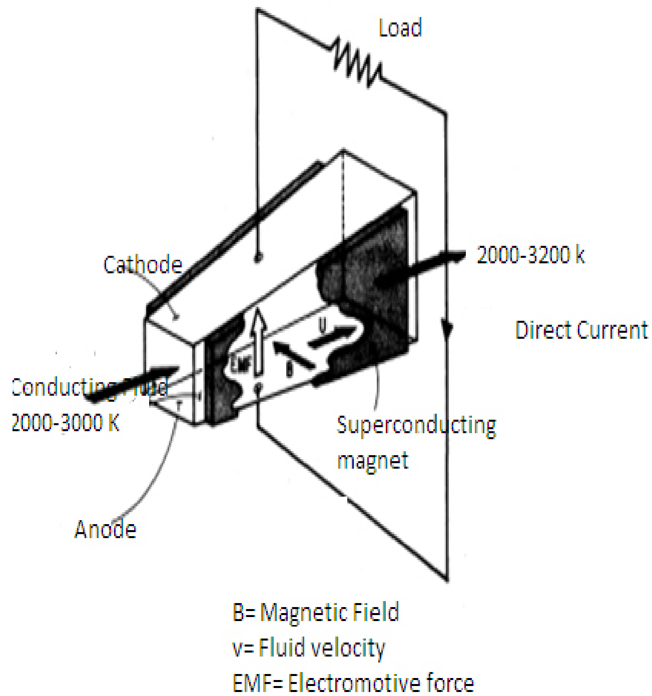

Fig.1. Principle of operation of MHD Generator

The biggest problem lies in the concept of MHD is conduction of electricity by the gas particles. The electrical conductivity in the gas is function of temperature and is being dependent on the one or more species in gas having low ionization potential. The potential difference is obtained by

$$U = V . B . d$$

Where d is the distance between two electrodes, V as the average speed of plasma and B is density of magnetic flux it is found that for MHD generator the electrical conductivity of combustion product is too low even at a temperature of 5000 F. To deal with this difficulty a material having low ionization properties is being added which is known as seed which gives

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us better result[4].Temperature from 2000 to 3200 is adequate for conductivity in combustive gases.

III. TYPES OF MHD

MHD generator is classified in three different ways:

- Faraday generator.
- Hall generator.
- Disk generator.

1. Faraday generator:

It consists of a non-conductive wedge-shaped pipe or tube. When ionized plasma flows through the tube in the presence of a magnetic field than current is induced, which can be extracted by placing electrodes on the sides of wedged shaped pipe or tube at perpendicular to magnetic field. The main practical issue with faraday generator is differential voltages and currents in the fluid short through the electrodes on the sides of the tube.

2. Hall generator:

The Faraday field in hall generator across each sector of the channel is short-circuited and the sectors are series connected. This allows the connection of a single electric load between the ends of the channel. Consideration of the electric potentials at different points in the channel leads to the observation that an equi potential runs diagonally across the insulating walls and that electrodes may be appropriately staggered to match the equi potential. The series connection of these electrodes in this diagonal generator permits a single electric load to be used.

3. Disk generator

This design currently grasps the efficiency and energy concentration records for MHD generation. A disc generator has plasma (ionized gas) or fluid flowing between the centre of a disc, and a duct wrapped around the edge. The magnetic excitation field is made by a pair of circular Helmholtz coils under the circular disk. There are two major types of Fluid cycle in MHD Generator:

1. Open Cycle MHD
2. Closed Cycle MHD

A) Open Cycle MHD

In Open Cycle MHD, the electrically conducting Gases are released from MHD channel to the atmosphere. Coal is burned in the Combustion chamber required high temperature with oxygen to form conducing plasma. The conductivity of working fluid increased by a small seed material (potassium carbonate) is added. The resulting mixture having an electrical conductivity about 10 siemens/m is expanded through nozzle, so as to have a high velocity and then passed through the magnetic field . During the expansion of the gas at high temperature, the positive and negative ions move to the electrodes and thus produce an electric current. The gas is then exhaust through the generator. Since the same air cannot be reused again hence it forms an open cycle . In addition to the cost of MHD, the seed recovery and reprocessing efficiencies as well as their cost are added for economic and feasibility of MHD

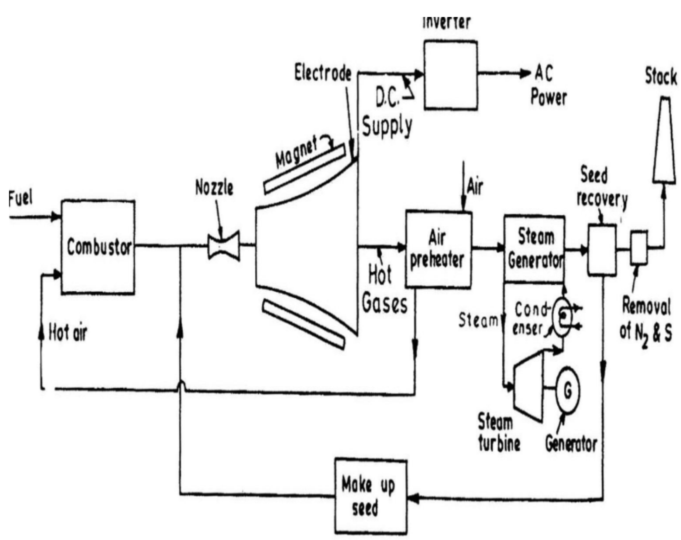

Fig. 2. A Schematic Diagram For open Cycle MHD

B) Closed Cycle MHD

In a Closed Cycle MHD, Working gas is not mixed with combustor material. Gases like helium or argon is heated by the regenerative heat exchanger, Caesium is mainly used as seed material to increase the ionization capacity of the gas. In the open cycle Magnetic Hydro Dynamics both seed material and inert gases are recovered with small makeup required. Major advantage of closed cycle MHD are simple operation and do not require seed processing facility. As the name suggests the working fluid in a closed cycle MHD is rotated in a closed loop. So, in this case inert gas or liquid metal is used to transfer the heat. The liquid metal has typically the advantage of high electrical conductivity, hence the heat provided by the combustion material does not required too high. Where as in the open loop system there is no inlet and outlet for the atmospheric air. Hence the process is simplified to a great extent, as the same fluid is circulated timely and again for effective heat transfer.

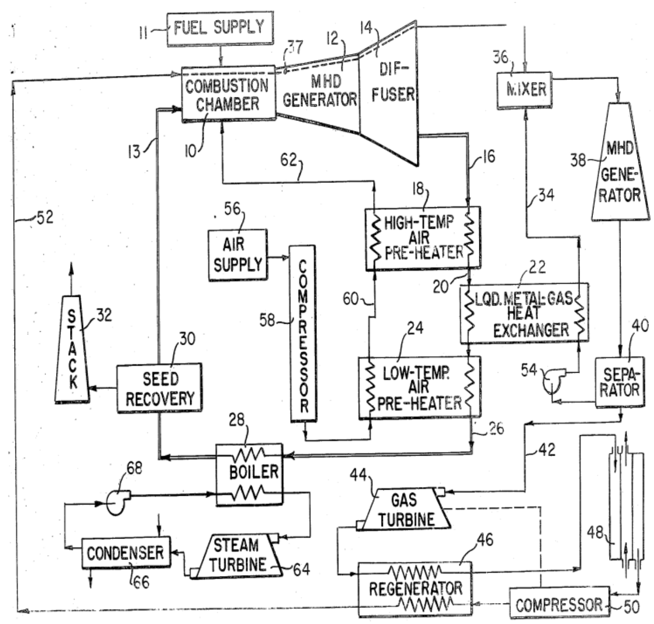

Fig. 3. A Schematic Diagram For open Cycle MHD

The Retrofit Approach to utilize the MHD technology consists of installation of MHD topping cycle coupled to an steam generating facility. The MHD retrofit Concept is useful method to increase efficiency and capacity of existing thermal power plant. In the future, MHD systems may also be used to upgrade obsolete fossil plants. Design and operating experiences gained from the retrofit approach may also be applicable to the construction of new large-scale MHD installations with improve efficiency. From the national point of view, there are no of existing generating units that are potential candidate sites for MHD retrofitting. Once the retrofit concept confirmed, utilities can begin to investigate the feasibility of converting some of their existing generating units to MHD operation. The acceptability of the MHD technology depends heavily on the commercial availability and cost of components (for economical purpose) which depend On the learning curve of the manufacturers. An MHD system designed for large-scale base-load applications could achieve efficiency upto 60-70%.The efficiency upto this level is acceptable and trying to improve upto 90%. A small MHD system (100 to 300MW) might only achieve efficiency in the range of 38-42% due to the reduced volume of the MHD generator. However, for the retrofit facility, it was only required that the combined efficiency of the total facility (MHD and the bottoming unit) should not be lower than the current bottoming plant.

IV. ADVANTAGES OF MHD

An MHD system offers various advantages that are attractive for the electric utility industry. An MHD system with a conventional bottoming unit designed for large scale base-load application and is capable of having a thermal conversion efficiency of up to 50% at a cost of electricity (COE) between 29 and 47 mills/kWh . This high efficiency will result in lower fuel cost to electric utilities. It is estimated that the total capital cost for MHD is $720/ kWh and a COE of 31.8 mills/ kWh. In addition, the reduced amount of coal that has to be mined and transported will offer additional societal and economic benefits as well as extending the availability of domestic coal reserves for a longer period. The more thorough heat utilization will also decrease the amount of waste heat that has to be discharged to the environment, and thus the cooling water requirements can be reduced by as much as 60% . The reason that MHD power generation is not popular because numerous technological advancements are still needed prior to the commercialization of MHD systems. One of them is related to material problems created by the presence of high temperatures and a highly corrosive environment. The presence of coal slag can degrade the MHD channel unless proper materials are utilized.

V. MHD DEVELOPMENT PROGRAM IN INDIA

India has rich amount of coal reserves .Coal is biggest source of fuel for electric power generation system. 65% coal generation is through the coal in India. The Conventional Coal fired plant has low thermal efficiency and it is around 29%.This low efficiency of energy conversion is due to the various losses that occur in the Generation of electricity through the thermal power plant which is going to increased regularly. For the Base power utility the MHD can be an alternative source for the power generation. In Tiruchirapalli , 5MW pilot Project has been set up in MHD centre. This LPG fired pilot plant houses all are required special components of MHD topping cycle through the combustor, Channel, nozzle, magnet, diffuser, high temperature air repeaters and high temperature valves. This system is comparable with similar systems set up in developed countries .This was commissioned in the year 1985. Many experiment runs were further conducted with varying parameters. All these experiments generated a good amount of data and excellent operating experience. To Commercialize the MHD a Retrofit Concept is used which consist of MHD topping cycle, component to be retrofitted with the existing thermal power Plant. This Concept would be highly effective, economical and alternative for commercial projects .Technical advantages of MHD retrofit include existing infrastructural facilities will be fully utilized. The list of equipments which are fully utilized:

- HP and LP heaters
- Turbo-alternator
- HP and LP turbines
- Two condensers
- Condensate pump
- Drain cooler

- Cooling water pumps

VI. Conclusion

The MHD generator is ideally suitable for the generation of electric power in large size unit with heat combustion, there are no fundamental problems remaining in operation of generator. Recent developments in MHD technologies have increased efficiency from 30-35 to 60-70%, made the MHD system closer to reality. In order to accelerate the consideration of this technology by utilities, extensive operational and maintenance experience must be acquired in a timely manner.

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