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Review on the MHD Power Generation Technology

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***Abstract* –**

The MagentoHydroDynamic power generation technology provides attractive alternative generation potential to the electric power utilities. In this paper review on MHD technology including its principle of operation, Open cycle MHD and Closed cycle MHD is presented. This paper also discusses the recent developments taking place in MHD power generation in India.

Keywords: - MHD; Open Cycle MHD*; Closed Cycle MHD*

I. INTRODUCTION

Due to the decreasing availability and increasing cost of natural gas and fuel oil, Coal is likely to play an important role in nations energy scenes. There are many promising ways in which coal can be used, but the most promising way is with the magneto hydrodynamic system. The most promising way is the direct burning coal in a MHD generator. The Potential of the magneto hydrodynamic system was first assessed by in 1959 for commercial power applications. Avaco and group of Electric utilities entered into an cooperation for investigation of development of MHD.

II. PRINCIPLE OF OPERATION OF MHD

The MHD power generation technology deals with the production of electricity using a high temperature conducting plasma passed through the intense magnetic field[1].The heat rejected by the MHD system can 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 various types of fuel such natural gas, fuel, coal and necular. Mostly the coal is used as energy resource in MHD [2] .In case of MHD generator a pressure difference is needed to force the gas through the field when the current is drawn. 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 computed for the different gas flow. It has no highly stressed moving part of closed tolerance. Its walls can be cooled below the temperature of the working fluid used[3].

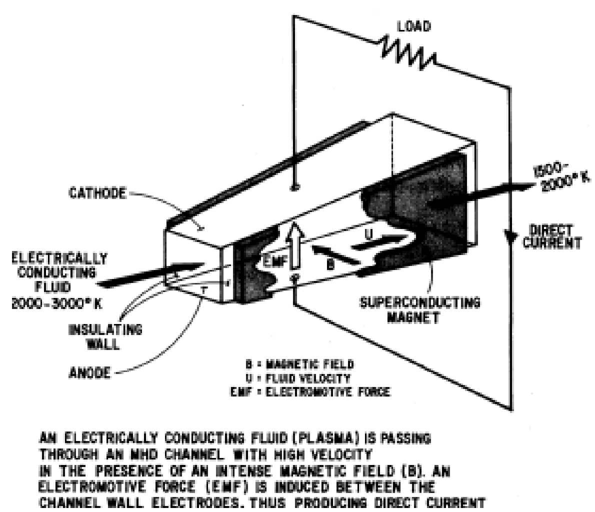

Fig.1. Principle of operation of MHD generator [2].

The principle difficulty lies in the concept of MHD is conduction of electricity by the gas .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. From an case study 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

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material having low ionization properties is being added which is known as seed which gives us better result[4].Temperature between 2000 to 3200 is adequate for conductivity in combustive gases.Fig.2 shows conductivity of JP4(kerosene)-oxygen flame seeded with one percent potassium as function of a temperature at atmospheric pressure.

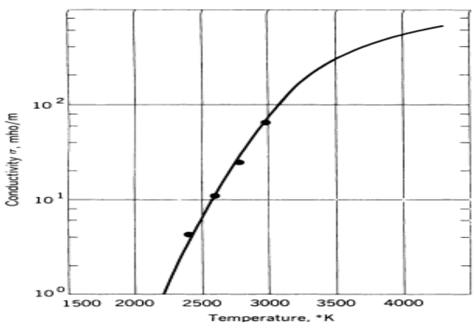

Fig.2. Conductivity of JP4 (kerosene)-oxygen seeded with 1% potassium[3]

III. TYPES OF MHD

There are two major concepts for MHD:

A). Open Cycle MHD
B). Closed Cycle MHD

A).Open Cycle MHD

In Open Cycle MHD, the electrically conducting exhaust

Gases are released from MHD channel to the atmosphere. Coal is burned in the Combustion chamber at high temperature with oxygen to form conducing plasma [5]. To Increase the conductivity of working fluid a small seed material such as potassium carbonate is added. In addition to the cost of MHD, the seed recovery and reprocessing efficiencies as well as their cost are added in economic and feasibility study of MHD [6].

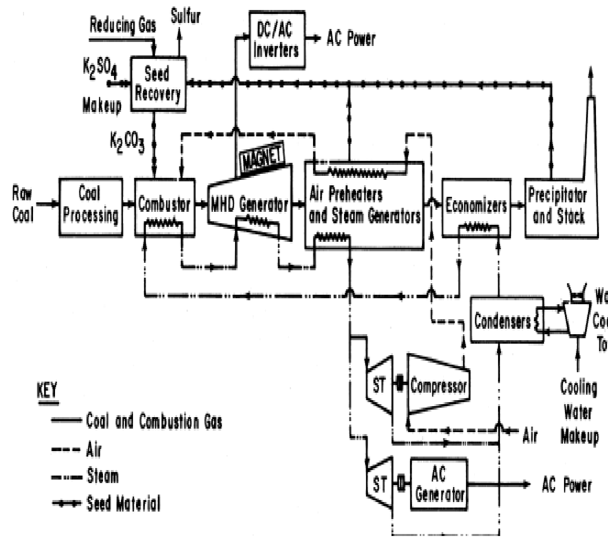

Fig. 3. A Schematic Diagram For open Cycle MHD [7].

B).Closed Cycle MHD

In a Closed Cycle MHD, The 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 open cycle MHD both seed material and inert gases are recovered with little makeup required. Major advantage of closed cycle MHD are its possibility for simple operation and it do not require seed processing facility[8].Fig.4.Shows a Schematic diagram for Closed Cycle MHD.

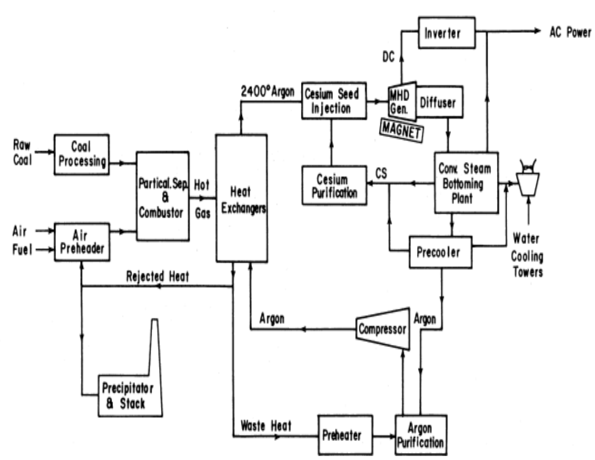

Fig. 4. A Schematic Diagram For open Cycle MHD [9].

The Retrofit Approach to utilize the MHD technology consists of the installation of an MHD

Topping cycle coupled to an existing steam generating facility so need of bottoming unit is not required, Various configuration can be obtained depending on the existing boiler configuration used. The MHD retrofit Concept is useful method to increase the both the thermal efficiency and capacity of existing thermal power plant [2]. In the future, MHD systems may also be used to renovate 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. From the national point of view, there are numerous existing generating units that are potential candidate sites for MHD retrofitting [3]. Once the retrofit concept has been confirmed, utilities can begin to investigate the feasibility of converting some of their existing generating units to MHD operation. It is the opinion of the authors that the acceptability of the MHD technology depends heavily on the commercial availability and cost of major components that, in turn, depend On the learning curve of the manufacturers [6]. An MHD system designed for large-scale base-load applications could achieve efficiency as high as 50%. A small MHD system (100 to 300MW] might only achieve an efficiency in the range of 35-40% due to the reduced volume of the MHD generator. However, for the initial retrofit facility, it was only required that the combined efficiency of the total facility (MHD and the bottoming unit) should not be lower than that of the existing bottoming plant [10].

IV. ADVANTAGES OF MHD

An MHD system offers numerous advantages that are attractive to the electric utility industry. An MHD system with a conventional bottoming unit designed for large scale base-load application is capable of having a thermal conversion efficiency of up to 50% at a cost of electricity (COE) between 27 and 48 mills/kWh [11]. This high efficiency will result in lower fuel cost to electric utilities. As shown in the Phase 2 Energy Conversion Alternatives Study (ECAS), it is estimated that the total capital cost for MHD is $720/ kWe and a COE of 31.8 mills/ kWh[12]. 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 over 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 50% [6]. The reason that MHD power generation is not popular in use today is because numerous technological advancements are still needed prior to the commercialization of MHD systems. Most of these are related to material problems created by the presence of high temperatures and a highly corrosive and abrasive environment. The presence of coal slag can degrade the MHD channel unless proper materials are utilized [7].

V.MHD DEVELOPMENT PROGRAM IN INDIA

India has rich amount of coal reserve .Coal is biggest source of fuel for electrical power generation. 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. For the Base power utility the MHD can be an alternative for the power generation. A 5MW pilot Project has been set up at MHD centre in Tirchirapalli. This LPG fired pilot plant houses all the required special components of MHD topping cycle, via .combustor, nozzle,
Channel, magnet, diffuser, high temperature true air repeaters and high temperature valves. This system is comparably with similar systems set up in developed nations .This has been successfully commissioned in the year 1985. Many experiment runs were further conducted with varying parameters. All these experiments generated a good amount of data and good operating experience [13].To Commercialize the MHD a Retrofit Concept is used which involve MHD topping cycle Component to be retrofitted with the existing Thermal power Plant. This Concept would be effective and economical alternative for Commercial projects .Technical advantages of MHD retrofit include existing

infrastructural facilities will be fully utilized. The following equipments are fully utilized:

1. Two condensers
2. Condensate pump
3. Cooling water pumps
4. Drain cooler
5. Deaerato r
6. Boiler feed pump
7. HP and LP h e a t e r s
8. HP and LP turbines
9. Turbo-alternator [2].

VI. CONCLUSION

The MHD generator is ideally suited for the bulk generation
of electric power in large sizes unit. With combustion heat sources, there are no fundamental problems remaining in generator operation. Recent developments in MHD technologies have made the MHD system closer to reality. In order to accelerate the acceptance of this technology by utilities, extensive operational and maintenance experience must be acquired in a timely manner.

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