



Biomass Cogeneration Plant

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cogeneration, biomass, MHD generator, thermoelectric generator.

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ABSTRACT Rush to biomass power generation is increasing day by day due to the rising demands of power. Biomass used today is raw material either in primary or secondary processing industries. Hence by utilizing these residues will lead to more efficient plants and in this article biomass cogeneration is done with MHD generator. The flue gases which are obtained by burning of raw material in boiler is fed to MHD along with seeding material (to increase electrical conductivity of gas); the hot exhaust gas of MHD is again fed to boiler thereby increasing the efficiency of boiler. Hence with cogeneration the reliability & efficiency increases. Further the flue gases are fed to Thermoelectric Generator (TEG) which is based on the Seebeck effect. The output of this is used by the plant itself like in cooling fans, etc; thereby reducing the power consumption and saving is also done.

INTRODUCTION

Energy plays a very important role in everyday life and with the modernization & urbanization its demand is increasing. These demands can be fulfilled through energy generation resources. Due to lack of non-renewable resources emphasis is laid on finding alternatives using renewable resources like wind, hydro, solar, biomass etc. Keeping in view the three objectives of economic viability, sustainability and safety; biomass has a bright future. Biomass is a renewable source which has wide area of availability and with a constrained of nearness of availability of raw material the plant setup is near rural areas. [1] Biomass has large scope and with the cogeneration the efficiency of the plant increases more.

Cogeneration is the simultaneous generation of two different forms of useful energy from a single primary source of energy. It takes place through thermodynamic degradation of a single medium e.g. expansion of steam in a steam turbine followed by condensation or cooling down of hot gases.[3] Depending on the quality of process head required, cogeneration may be based on topping cycle or bottoming cycle.

BIOMASS-FIRM UTILITY RESOURCE

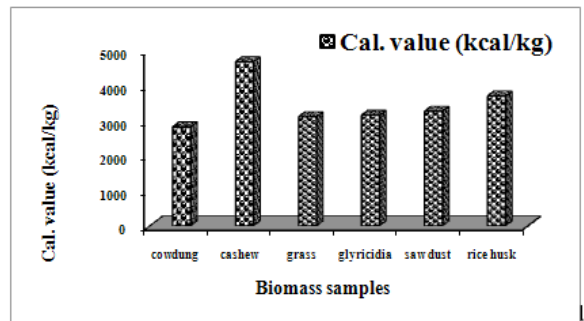
All organic matters are called biomass and when they are burned the energy released from them is called biomass energy. Since Punjab is an agricultural state, biomass availability is abundant. Because of its public acceptance and availability in agricultural, industrial and urban settings it is also the perfect renewable fuel for combined heat and power (CHP) applications. As a general rule for biomass power, capital cost per MW and operation & maintenance cost per MWH go down as plant size goes up while fuel cost per MWH goes up as plant size goes up. [4]

Biomass is renewable source of energy and it plays dual role in greenhouse gas mitigation both as energy source and carbon sink. It is available in the form of wood, agricultural residues and food grain. Solid biomass is commonly used as fuel for cooking and other thermal process in small industries, fuel for boilers, but it can be transformed into gaseous and liquid fuel in the form of ethanol and bio diesel. [5]

In this paper different kinds of biomass fuels can be used as raw material and fed to the boiler. The energy released during burning of biomass is called biomass energy and

is in the form of combustible gases (CO , CH_4 , and H_2). The steam generated in boiler is then fed to turbine and thus resulting in the power generation which is formerly supplied in the power grid. Biomass fuel heating values are given in the table below:-

TABLE – 1 BIOMASS FUEL HEATING VALUES



Source: www.google.com/calorific-values-of-biomass-samples

DESIGN OF MHD GENERATOR

MHD is basically magneto hydrodynamic generator based on the principle of Faraday's law that is electric field is generated when a conductor moves in magnetic field. The generated electric field intensity is proportional to the speed of the conductor and the strength of the magnetic field [5].

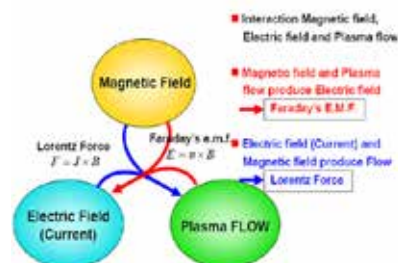


Fig 1:- Interaction of electric & magnetic flow with plasma

Source :- www.googleimagescom/MHD

Thus high electrical conductivity, speed of the conducting medium as well as strong magnetic field

are vital to generate high electric power. To obtain high conductivity and speed; the conducting medium is converted into plasma state. (In fig) Thus it is a conversion system which converts heat energy directly into electrical energy without any intermediate mechanical energy conversion.

It is based on simple faraday's law of electromagnetic induction which states that when a conductor and magnetic field moves relative to each other, then the voltage is induced in the conductor which results in the flow of current across the terminals. MHD generator is concerned with the flow of conducting fluid in the presence of magnetic and electric field. A pressurized, electrically conducting fluid flows through transverse magnetic field in a channel. Pair of electrodes is located on the channel walls at right angles to the magnetic field and connected through an external circuit to deliver power to load connected to it.

Design-The size and weight of MHD generator using external source may exceed from generator itself therefore MHD generator with permanent magnets is selected which do not require any external source and the condition where maximum power is generated.[6]. In this case we have used pulsed MHD generator to produce electrical power pulse generation. This MHD generator is fired by an independent high pressure & high temperature combustor to produce high velocity plasma. So this is a conventional kind of MHD generator and the pulse produced here is of 15 to 500 MW. MHD channel has electrical output of 510 MW and the channel dimensions; length of 4.5m, input area of 0.9*1.0m and output area of 1.6*1.0m.[7]

Hence, the output of generator can be augmented by:-

- i) Increasing the speed of plasma.
- ii) Selecting a load matching to generator characteristics.
- iii) Changing shapes and types of permanent magnets.
- iv) Employing the self excitation technique.

THERMOELECTRIC GENERATOR

It is simply a Seebeck generator that converts that convert heat (temp differences) directly into electrical energy. A thermoelectric produces electrical power from heat flow across a temperature gradient. As the heat flows from hot to cold junction, free charge carrier (electrons or holes) in the material are driven to the cold end. The resulting voltage is directly proportional to temperature difference via Seebeck coefficient. By connecting an electron conducting (n-type) and hole conducting (p-type) material in series and hence voltage is produced which is driven through the load. A good Seebeck material has Seebeck coefficient btw 100 to 300 micro volts per Kelvin. [8]

HYBRID CONCEPT

Presently ,biomass systems have been promoted around the globe on a very large scale but posing problems like biomass plants may save on carbon dioxide emissions, but it increases methane gases which are harmful to earth's ozone layer, high ash content, heat released into environment is a major problem affecting working of biomass

plant. So to get optimal generation conditions, the combined operation of heat energy and biomass is used as fuel so as to increase the efficiency, normally the efficiency of boiler is 25-35% but by using cogeneration plant the efficiency is increased to 65-85% as the flue gases which are obtained by burning of raw material is cycled again to boiler after passing through TED and MHD generator. That's why the boiler need less energy for increasing its temperature, thereby, increasing its efficiencies. The plant can provide power to grid using a combination of three units regardless of the time or weather. Combined power system is done generally to meet the increasing demands due to urbanization and also can provide clean environment by again using the left out fuels or gases which is further fed to MHD generator with the addition of seeding material. TEG is added to fulfill the plant power requirements for its working and leads to less power consumption. Therefore it will also promote employment to poor people. Hence cogeneration leads to many advantages and will promote a bright future.

Working:-The block diagram of hybrid plant is shown where the non renewable sources are used in the initial state and then with different material, their calorific values will be different and hence energy produced will also be different. With their burning steam is generated in the boiler which is fed to steam turbine and thus output is received which can later fed to grid for power supplies. The flue gases which are obtained by burning of raw material in boiler are fed to TEG and MHD generator.

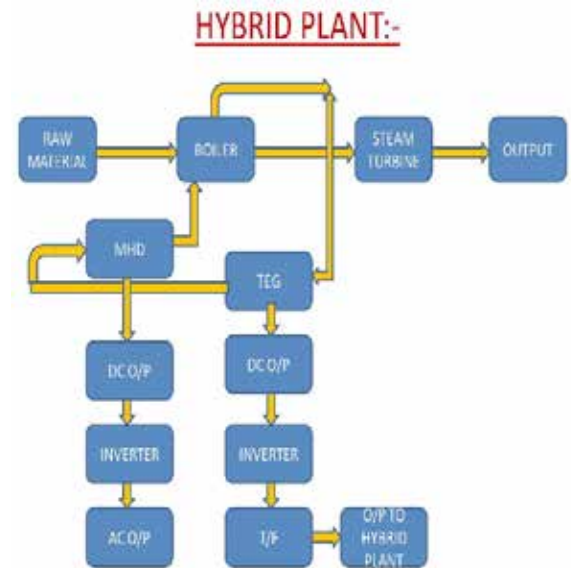


Figure 2:- Block diagram of hybrid plant

Now, the output from both generators is viewed. In MHD generator the flue gases are fed from the boiler along with seeding material and with faraday's law the output is received [6]. In this generator uses hot conductive plasma as moving conductor. MHD was developed because the hot gases of generator can heat the boiler resulting in increment of efficiency by 30%. Two outputs are obtained and thus reliability increases. The flue gases from boiler are also fed to TEG and through temperature difference DC output is received which can be converted into AC through inversion[7].The output received is in small amounts therefore by using step up transformers we can increase to large amount. This power is used by plant it-

self. Hence hybrid system has lots of advantages and future scope as it only depends on non renewable resources which can lead to boost in power development.

Advantages

The conversion efficiency of MHD system can be around 50% much higher as the reason behind is that it utilizes the energy of flue gases thereby, increasing its conducting value as compared to the most efficient plants. Still higher efficiencies are expected in future around 60-70%. Since power requirements of the plant are fed itself by the TEG, therefore power saving is done and helps in providing the continuous supply to run its own plant. Large amount of power is generated as three outputs are there, out of which two outputs are fed to power grid. Moreover, it has no moving parts consequently more reliable. It also helps in reducing the global warming and also promotes clean environment as the waste material is utilized. Also it can be set at every village as lot of waste material is there and can provide continuous supply to villages.

CONCLUSIONS

The hybrid plant can be operated as peak load plant having high output power. Due to this, distribution generation is there which means low transmission cost and high reliability. Since biomass is taken as raw material therefore there is a direct replacement for non renewable fossil fuel. Every village can have its own micro grid which can fulfill their power demands and can give continuous supply. At present vast research is going on MHD generator and hence it itself is an area of research.

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