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Increasing Power generation by increasing efficiency of merged operation of Hybrid Solar and Biomass Plant

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***Abstract*—** In most of the countries, Electricity Power is a major concern. Specially for the developing countries like India. For Electricity Power generation from Fossil fuels will not be last long, as well as they cause pollution in environment. There are other factors that can be count for Power generation can be generating the Power from agriculture waste, also heat energy can be stored through various technology for generating power form it when it's required. In this paper there is literature review of Increasing the Power generation by increasing the efficiency of Biomass plant, thermal plant, Solar plant or by the combination of all these in appropriate way. Possible methods are assumed for two plants. One is combination of solar and Biogas plant, which can be operated on steam as well as gas turbine as it can increase the efficiency by 50%. In another system there is thermal storage system, with the help of molten salt as Solar can provide the energy during day time only, but the thermal storage system it can generate energy when sun radiations are not available.

***Keywords*—** *Solar plant, Biomass plant, efficiency*

I. INTRODUCTION

India has rich source potential of solar energy as well as Biomass energy. These two are both renewable sources of energy. The fuel cost in both plants is null. The integration of both sources has a great effect on the Indian economy and also on the maintainer of the environment. As India has solar energy availability through the whole year, this solar energy can produce a great amount of electricity, which influence to less dependence on fossil fuels for energy generation [8] (like thermal plant uses coal for production of electricity).

The studying for its efficiency improvement will lead to great achievement, as per unit production of energy from the hybrid solar and biomass is already very less. The amount of power generated from a renewable source of energy is almost 23% of the total production of power that means the rest of the power is still dependent on the non-renewable sources. With the efficiency improvement of these plants, it will result in an increase in power generation from renewable sources. The solar plant efficiency improvement is going at a fast pace. In this paper the possible measure used for efficiency improvement is considered:

i The heat energy from solar radiation is used to produce steam, by the combined operation of the steam turbine and gas turbine the electricity production can be increased by 50%.

ii Along with it, the storage device can decrease the dependency on biomass plants even in the night time period.

Rest of the paper is organized as follow, Section 2 contains the Hybrid Solar Biomass plant description, which shall describe the effect of combined operation of gas and steam turbine on efficiency, Section 3 contain Methodology which shall describe the working schedule of both Solar and Biomass plant in Combined operation with possible measure, Section 4 contain Technical data summary which will summaries the various factors that can affect the input fuel to both the plants, for solar the sunlight and for biomass mass various available fuel, Section 5 contains Economic Analysis, which shall illustrate the figures of economic affect with cost analysis of both plants, Section 6 contains Environmental Analysis, which shall describe the effect of both plants on environmental conditions, Section 7 contains Discussion which shed light on various existing such plants and their research work as well as outcome from these plants, Section 8 contains Conclusion which conclude the paper work.

II. HYBRID SOLAR BIOMASS PLANT

In hybrid solar and biomass plants, the gas turbine is operated from biomass fuel and steam turbines can be operated by using solar rays as heat resource to convert water into steam. As shown in the figure 1 the concentrating solar

parabolic field is used to collect the solar energy and heat is used for producing steam from water. From this steam electricity is produced by sending this steam to the steam generator as shown in the figure, the left steam from the solar steam generator is sent to the Heat recovery steam generator. On the same phase, the biomass fuel is burnt to operate the gas turbine.

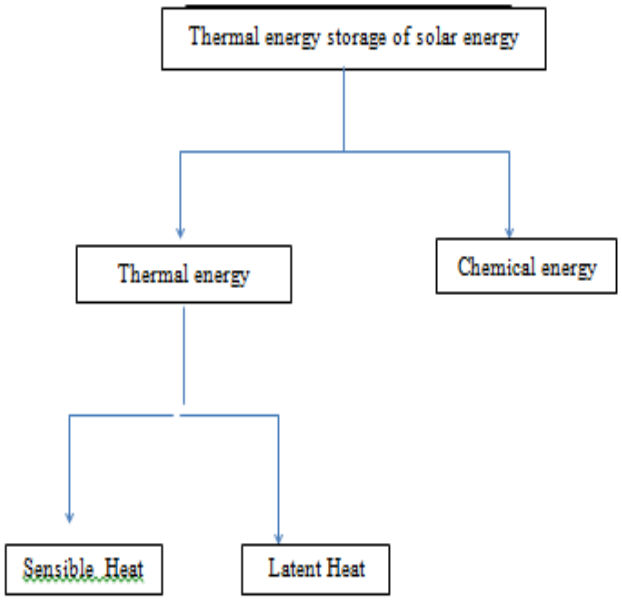

Fig. 1

he gas turbine burns fuel at high efficiency. This heat produced by the gas turbine is sent to the heat recovery steam generator where this heat is used for further heating of the used steam and this reutilized steam again sends the steam turbine at the bottom side, which is again used for electricity production. After reusing the steam is sent to condenser, where this steam is condensed into vapour then this water is again pumped to Solar Steam Generator where it is again converted into the water [2].

Thus by the hybrid operation of the solar steam turbine and biomass plant the efficiency of the plant is improved, this would reduce the fuel consumption, as well as the reduction in environmental pollution, can be possible. The gas turbine produces heat with less technical and mechanical losses. The heat produced by the gas turbine is highly efficient.

For further improvement of efficiency of a plant, a storage unit can also be installed the storage unit can be used for the thermal storage of heat for night hours and cloudy days, the biomass fuel supply the demanded supply of Power may not be sufficient therefore for such demand supply the storage unit can be used. In this case, molten salt is used for thermal storage, which can store energy 142^{o}C to 540^{o}C. The Heat capacity is 1550J/kg K and 1560J/kg K [6].

III. METHODOLOGY

The generation of power during day time is mainly due to the solar energy available and the biomass plant contribution is less during day time, but in night time the generation is due to the biomass plant, in case there is availability of storage

Scheme 1. Different ways of Heat storage

unit with combination of solar plant as shown in figure 2, then the storage unit is first priority for power generation during night time. The storage unit can store as much heat that it can generate power for 5-8 hours of time.

1. In case of without storage plant

The biomass power plant is always designed to operate from half load to full load condition. The condition of equal sharing occurs in the day time at maximum available solar radiation in the solar noon time. The full load condition for biomass plants will be reached in the night, sunrise and sunset timings. The Biomass plant will operate at part load condition form [4].

2. In case of storage plant

The biomass plant and storage operates in a collateral manner. During the night hour, the storage unit is preferred to operate first, the biomass plant is operated when the demand load is increased otherwise the thermal storage should be sufficient to supply the average demand load and the Biomass plant should be operated only when the thermal storage heat is completely utilized. The plant Efficiency can be increased by increasing the boiler pressure as there is an increase in power [9] [1].

2.1. Different storage material

Table 1: Heat storage capacity of different materials

Medium	Liquid type	Temperature range (^{o}C)	Density (Kg/m^3)	Heat capacity (J/kg K)	Thermal Conductivity (W/m^{o}C)
Water	-	0 - 100	1000	4190	0.63 at 38^{o}C
Caloria HT 43	Oil	-10 - 315	-	2300	-
Dowtherms A	Oil	12 - 260	867	2200	0.112 at 260
Thermional 66	Oil	-9 - 343	750	2100	0.106 at 343
Hitec	Molten Salt	142 - 540	1680	1560	0.61
Engine Oil	Oil	Up to 160	888	1880	0.145
Draw Salt	Molten Salt	220 - 540	1733	1550	0.57
Lithium	Liquid salt	180 - 1300	510	4190	38.1
Sodium	Liquid salt	100 - 760	960	1300	67.5
Ethanol	Organic liquid	Up to 78	790	2400	-
Butanol	Organic liquid	Up to 118	809	2400	-
Isobutanol	Organic liquid	Up to 100	808	3000	-

Octane	Organic liquid	Up to 126	704	2400	-

Heat storage can be in possible in two ways as shon in Scheme 1 [5]. The sensible heat can be stored in liquid material manifestations which are explained in Table 1:
Out of all these material a current study of Masdar Institute of Science and Technology, an independent, research-driven graduate-level university has some research which affirms that Desert sand from the UAE can be considered a possible thermal energy storage material which can store energy up to 1000°C.

IV. TECHNICAL DATA SUMMARY

The main factors which affect the hybrid power generation of solar and Biomass are discussed as, in case of Solar Power generation, the generation is mainly affected by the amount of sunlight received which vary with day and night period, also which the variation of weather (as it's amount is very less in cloudy days) and also affected by Direct incidence radiation [7]. In Biomass plant the production greatly influenced by the fuel available and moisture content in the fuel. India has 370 million tons of biomass fuel every year The annual biomass fuel available in India is listed as follow:

Table 2: Different biomass fuel production in india

Biomass fuel (type)	Annual availability in India (in million metric ton)
Rice Straw	112
Rice Husk	22
Wheat straw	110
Sugarcane Tops	98
Sugarcane Bagasse	101
Maize Stover	23
Maize cob	4
Maize husk	3
Cotton Stalk	19
Chilli Stalk	0.6
Jowar Stoves	16
Ragi stalk	4.6
Bajra stalk	12
Pulse Residues	19
Oilseed Residues	58
Bamboo Residues	5.4

V. ECONOMIC ANALYSIS

As both solar power generation and biomass power generation are renewable energies, both the plants help in protecting the environment as both reduce the Carbon dioxide production which is mainly caused by Fossil fuel combustion for running the thermal plants. About 2.2 million tons of carbon dioxide combustion can be reduced in the upcoming 30 years. Moreover, the agriculture waste is better to utilize in biomass plants, which lead to the neat and clean surrounding, Also the ash collected by burning fuel in Biomass plant has a rich content of valuable compound such as Potassium. Thus this ash can be further utilized for Fertilizer processing, as potassium is a necessary mineral for crops.

VI. DISCUSSION

The thermal storage unit has a large impact on the efficiency of the hybrid operation. The storage unit size should be designed by considering a complete analysis regarding the power demand requirement in the present state an also in consideration with future demand increases. According to the storage unit size, the Solar panel field will also increase. The molten salt material which is commonly used as storage material can maximum store heat for maximum 15 hours according to the paper study on Griffith plant, New south wale in Australia. This can generate 160,300Mwh of electricity annually with a hybrid plant of Concentrating Solar power plant, Biomass plant, and Thermal plant.

The combined operation of steam turbine and Gas turbine can increase the power output by 50%. When the shaft of the Gas turbine when connected with the steam turbine, it can reduce the mechanical losses and the efficiency of the plant can be increased. Also by reusing the steam in the Heat recovery unit, the fuel combustion will reduce which results in more efficiency.

The Heat fluid flow rate also affects plant efficiency. By increasing the boiler pressure, the Power from the turbine will increase, but the excess increase in boiler pressure will increase the temperature, therefore at temperature maximum point, the plant efficiency can be maximized, by maintaining all these parameter complete analysis and supervision of the plant.

In the case of the study of biomass fuel, a large amount of fuel is burning in the field, as the farmer doesn't have the awareness that how much importance of agriculture waste in power generation. If some of them asked for the reason, why they are burning the stalk and husk infield, then they have a common reply that ‘The process of extraction of these waste from the field fetch them costlier'. So the government should make some policies and plan for this

problem. So that these agriculture waste can be utilized as biomass fuel as maximum as possible and this solution will alternate to increase in the fertility of the land, which is being reduced by the burning of agriculture waste.

VII. CONCLUSION

Solar energy and Biomass energy both are free fuel plants and combined operation of both will give us a lot of benefits, as energy requirement can be fulfilled in the small fare as well as the dependence on fossil fuel will decrease. These are proofing as future resources of power, because of usage of these plant will lead to the reduction of fossil fuels. And from an environmental point of view, it will protect the environment from carbon emission content in the atmosphere. The fuel which is burnt in Biomass plant leaves ash, and this ash can be utilized for making manure and fertilizer as this ash has a rich content of potassium, which increases the fertility of the land. The solar energy power plant has almost zero impact on the environment. In an economic point of view, both the plants are proofing great benefits if used in possible merged operation.

A. Figures and Tables

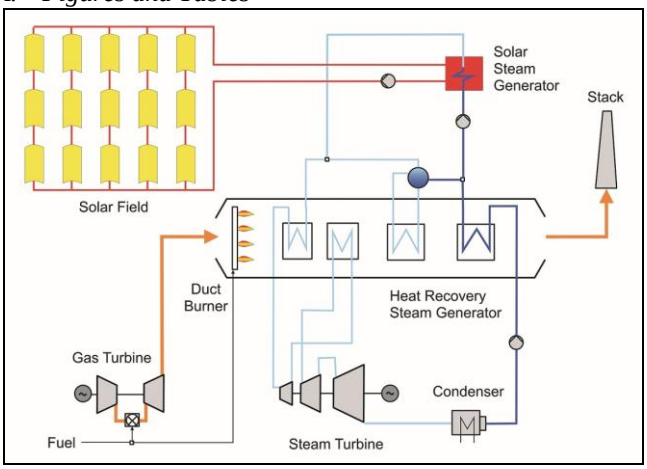

Fig. 1: Combined steam and gas turbine powerplant

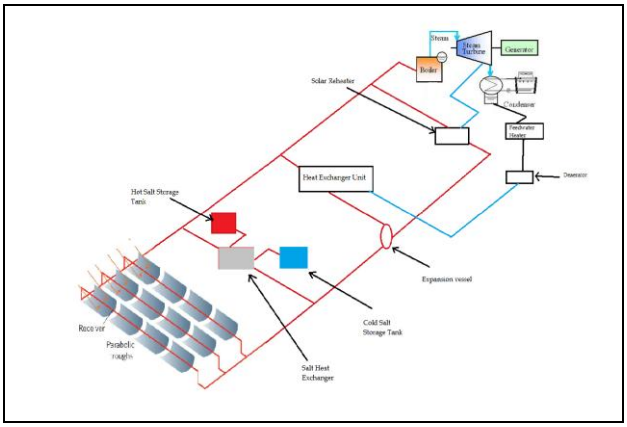

Fig. 2: Solar plant with storage system of molten salt

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