Increasing the thermal Efficiency of Steam Power Plant with the Help of Solar Energy

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Abstract- **In today's world, the electricity is mostly generated by steam power plant. The main working fluid of steam power plant is water, and water is easily available on earth. To increase the effectiveness of steam power plant the solar energy could be use which is one of the most available sources of renewable energy. The availability of solar energy is free of cost which means the external energy we provided to heat the fluid will not increase the running cost of power plant. This paper establishes that the efficiency of a steam power plant can be enhanced by integrating solar energy to increase the temperature of the feed water entering the boiler. As a result, the amount of fuel needed to heat the feed water inside the boiler to produce steam is reduced.**

I.INTRODUCTION

The annual solar irradiation on the earth provides more than 8,000 times the world's energy requirements. Mathematically speaking, about 1% surface area of Sahara Desert is sufficient in order to meet the world's electricity requirements with solar thermal power plant. Moreover the availability of fossil fuels such as coal, oil and natural gas is decreasing day by day and generation of power is also decreasing. At present, also the cost of fossil fuel is being increased which is creating a bigger problem. Renewable energy is naturally replenished energy which comes from natural resources. Solar thermal power is the best prospective renewable energy resource [1]. The power generation using renewable source of energy is reduces the overall cost of power plant. In solar thermal power plants, concentrating collectors are used to prepare high-temperature heat for the power plant block. This can completely replace fossil fuel operation. In this paper proposal is given to integrate solar energy with our existing power station to increase the efficiency with reduced fuel cost.

II. STEAM POWER PLANT

A steam or thermal power plant, in which water is generally converted into steam at high temperature to rotate the steam turbine at a required rpm to generate electricity. To convert mechanical energy to electrical energy a Steam Power Plant consist of many components, mainly boiler, low and high pressure turbine, pre-heater, economizer, super heater, condenser, feed water pump, feed water heater etc. Firstly the water is heated, turns into steam and rotate a steam turbine which is connected to electrical generator. In this power plant air from the atmosphere is heated in preheater by flue gas to increase the thermal efficiency of the process. The heated air and fuel are supplied to the boiler for combustion where water is boiled and converted into steam, super heater increases its temperature to eradicate moisture. Required steam is then passed to high pressure steam turbine where it is reheated and again passed to the low pressure turbine where it is connected with alternator for generating electricity. The condenser absorbs steam and it is transformed into water which is passed to the feed water heater to economizer to prepare water for reuse and send to the boiler for cycle continuation.

III. CONCENTRATED SOLAR POWER

Concentrating solar power (CSP) is almost unique amongst renewable energy technologies in that it can supply controllable power on demand to consumers [2]. Through the integration of thermal energy storage, excess solar energy can be stored during daytime and used to extend power generation during cloud passages or at night. The dispatch able nature of (CSP) plants makes them ideally suited to form the backbone of a future low-carbon electricity grid, providing reliable generation capacity to support other renewable technologies. Concentrating Solar Power (CSP) systems use lenses and tracking systems to focus a large area of sunlight into a small beam. A wide range of concentrating technologies exists, the most developed are the parabolic trough, the compact linear Fresnel reflector, the parabolic dish and the solar power tower.

The Linear Fresnel Reflectors use long, thin segments of lenses to focus sunlight onto a fixed absorber located at a common focal point of the reflectors. These lenses are capable of concentrating the sun's energy to approximately 30 times its normal intensity [3]. The heat produced by concentrated sunlight may be used as a heat source for a conventional power plant which is discussed in this paper. Compact Linear Fresnel Reflector (CLFR) concept is appropriate for large scale solar thermal electricity generation plants as the temperature obtained from the concentrated sunlight may be 3200 C [4].

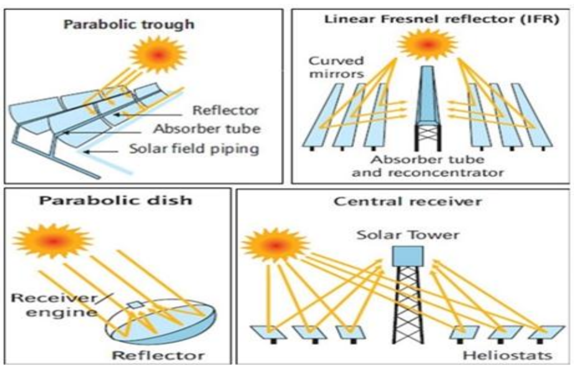

Fig.1 current CSP types

IV. SOLAR INTEGRATED STEAM POWER PLANT

Solar thermal power plant technologies are very significant thoughts for providing a major share of the clean and renewable energy. Solar thermal power stations are among the most cost-effective renewable power technologies as they promise to become competitive with fossil-fuel plants within the next decade.

In this paper concentrated sunlight is integrated to the feed water before entering into the boiler of a steam power plant shown in Fig. 2. To achieve better performance, sun tracking mirrors may be introduced to follow the path of the sun [1]. In this paper, proposal is given to concentrate the sunlight with the help of two side mirrors, one center mirror and two Fresnel lens. Two Fresnel lens are used in between the side mirrors and center mirror. Mirrors are used to focus the sunlight on a larger area. Sun's ray falls on mirrors and Fresnel lens. Mirror reflects the rays to Fresnel lenses. Fig. 2 also may be redesigned according to the requirement of the concentrated sunlight.

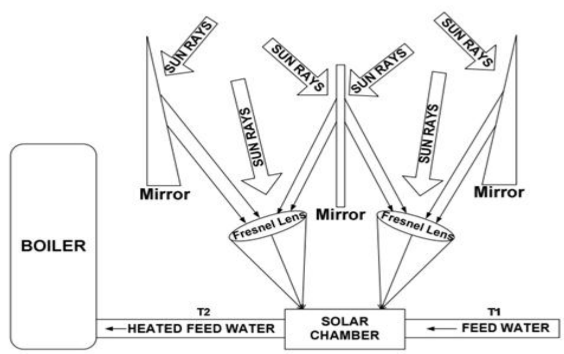

Fig.2 Solar integration to the feed water of a steam power plant

The Fresnel lens will concentrate the sunlight and heat up the entering feed water. The temperature of the feed water can be raised according to the intensity of the concentrated sunlight. Let the temperatures of the entering and leaving water of the solar chamber of Fig. 2 be T1 and T2 respectively.

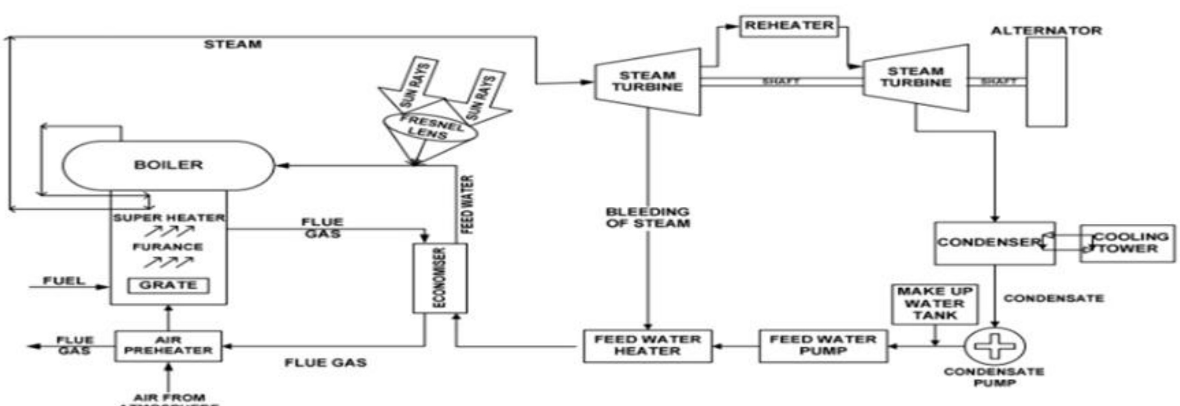

Fig.3 Schematic diagram of concentrated sunlight integrated steam power plant

In Fig. 3 a typical steam power plant is shown where the performance is enhanced by integrating concentrated sunlight.

So, the amount of heat supplied by the sunlight is given by,

$$H=M*S*(T2-T1)$$

Where,

M= mass of the entering water

S= specific heat coefficient of water

Integrating this part to the steam power plant will save the fossil fuel required to raise the temperature inside the boiler from T2 to T1 during day time. This saving of fuel not only saves the cost, but also produces less flue gas which is harmful for the environment as the steam power plant burns fossil fuels such as coal, natural gas or petroleum (oil) to produce electricity.

V. COST ANALYSIS FOR SOLAR INTEGRATED STEAM POWER PLANT

To analyze the cost, we have assumed that the Fresnel lens will be used to heat up the feed water to increase the temperature up to 300 degree Celsius steam before entering the boiler. High temperature feed water will enter into the boiler and increase the steam temperature to almost 500 degree Celsius. So boiler will need less fuel for combustion to reach its temperature (500 degree Celsius). A Fresnel lens of 50 inches will be added in between economizer and boiler.

The power of the sun focused by the Fresnel lens is equivalent to 877 watts per square meter.

VI. CONCLUSION

Electrical power generation is a big issue all over the world and with increasing demand of power generation, only depending on fossil fuels. We have to take advantage of every possible resource that are available to us. The proposal we have given here is for long term basis and we believe though the initial cost of building the whole system will be expensive but in future the profit gained from the increased efficiency and reduced environmental pollution will be much higher than the present high cost.

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