Hybridization of Thermal Power Plant using Solar Energy

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Abstract: – In *today's growing world, demand of electricity is increasing from all sectors. Natural sources used to generate electricity are going to be exhausted in future. Now-a-days renewable sources are getting demand. Thermal power plants generate electricity using coal energy. This paper proposed that fuel saving in thermal power plant using concentrated solar energy. Solar energy – one of the easily available renewable energy source. Parabolic trough collectors are used to focus solar energy on absorber to increase temperature of feed water to the boiler. As a result, amount of coal required will be reduce and eventually overall cost too. This also helps to reduce CO2 emission due to firing of coal as well as ash produced.*

***Key Words*: Solar energy, Parabolic Trough collectors, Renewable energy source.**

1. INTRODUCTION

Electricity is becoming basic need of everyone. Generation of electricity is increasing day-by-day to fulfil its demand. Initially, Thermal power plants and hydropower plants are one of the major source of electricity generation. But now-a-days, along with thermal generation and others, Solar power plant are becoming more popular. Solar power has many advantages over conventional sources of electricity generation.

2. WORKING OF THERMAL POWER PLANT

A power generation plant mainly consists of alternator runs with help of steam turbine. The steam is obtained from high pressure boilers. Generally in India, bituminous coal, brown coal and peat are used as fuel of boiler. The bituminous coal is used as boiler fuel has volatile matter from 8 to 33% and ash content 5 to 16%. To increase the thermal efficiency, the coal is used in the boiler in powder form.

In coal thermal power plant, the steam is produced in high pressure in the steam boiler due to burning of fuel (pulverized coal) in boiler furnaces. This steam is further supper heated in a super heater. This supper heated steam then enters into the turbine and rotates the turbine blades. The turbine is mechanically so coupled with alternator that its rotor will rotate with the rotation of turbine blades. After entering in turbine the steam pressure suddenly falls and corresponding volume of the steam increases.
After imparting energy to the turbine rotor the steam passes out of the turbine blades into the condenser. In the condenser the cold water is circulated with the help of pump which condenses the low pressure wet steam. This condensed water is further supplied to low pressure water heater where the low pressure steam increases the temperature of this feed water, it is again heated in high pressure.

3. FEED WATER HEATING BY SOLAR ENERGY

As explain above generation of electricity is very complex process having many stages include in it. Traditional thermal power plant uses coal fired boiler to convert water into the steam. After rotating the turbine blades, the steam has lost its high pressure, passes out of turbine blades and enters into a condenser. In the condenser the cold water is circulated with help of pump which condenses the low pressure wet steam. This condensed water is then further supplied to low pressure water heater where the low pressure steam increases the temperature of this feed water, it is then again heated in a high pressure heater where the high pressure of steam is used for heating. This cycle called as feed water cycle.

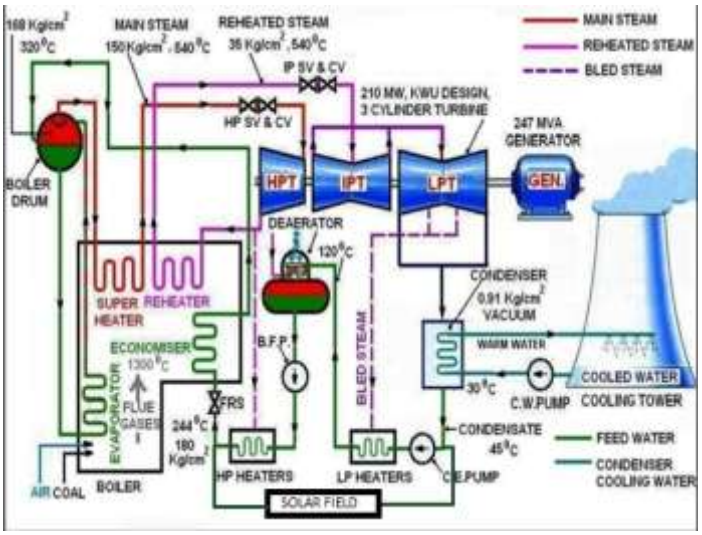

Fig -1: Solar Thermal Power Plant Using PTC

The feed water cycle consists of LP Heaters and HP Heaters. Condensate is then pumped by Condensate Extraction Pump (CEP) & passed through Low Pressure Heaters (LPHs) to Deaerator Tank. It is again pressurized by Boiler Feed Pump (BFP) & passed through High Pressure Heaters (HPHs). Finally Feed Water is sent to boiler drum via economizer. This paper suggests that feed water will be heated to desired temperature by solar energy during day time.

Feed water heating using solar energy will be done by bypassing low pressure heaters, high pressure heaters and economiser.

4. PARABOLIC TROUGH COLLECTOR

A parabolic trough is a type of solar thermal collector that is straight in one dimension and curved as a parabola in the other two, lined with a polished metal mirror. The sunlight which enters the mirror parallel to its plane of symmetry is focused along the focal line, where objects are positioned that are intended to be heated.

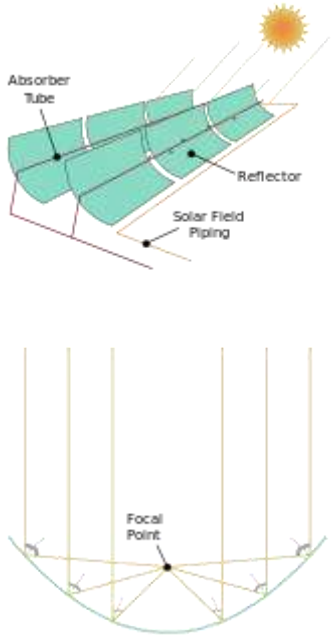

Fig -2: **A diagram of a parabolic trough solar collector**

A parabolic trough is made of a number of solar collector modules (SCM) fixed together to move as one solar collector assembly (SCA). In solar power plant parabolic trough can be installed considering both north-south axis and east-west axis. Generally, parabolic trough lined on a north-south axis and rotated by tracking mechanism to track the sun as it moves in the sky each day. It can be installed along east-west axis but this reduces the overall efficiency of the collector.

5. Advantages

I) Fuel Saving:

a) Low pressure heaters replaced by solar field:

In this case, presume solar feed water preheating from about 45°C to 130°C
T_1= temp. of LP heater inlet (assuming 45°C)
T_2= temp. of LP heater outlet (assuming 120°C)
S= 1Kcal/kg (water specific heat)
M= 1443 Ton/hr. (weight of feed water heater)
T= hr.
GCV of coal= 4671Kcal/kg
Now,

H_1 = 1443 *(120-45)*1 = 108225 Kcal = 23 Ton

b) High pressure heaters replaced by solar field:

In this case, presume solar feed water preheating from about 170°C to 250°C
T_1= temp. of LP heater inlet (assuming 170°C)
T_2= temp. of LP heater outlet (assuming 250°C)
M= 1443 Ton/hr. (weight of feed water heater)
T= hr.
GCV of coal= 4671Kcal/kg
Now,

H_2 = 1443 *(250-170)*1 = 115440 Kcal = 25 Ton

II) Economical:

Hybridization of thermal power plant with solar field increase the electricity generation compares to desired output.

$W_{net} = (W_{net\ solar\ hybrid} - W_{desired\ output})$

Revenue= $(W_{net\ solar\ hybrid} - W_{desired\ output})$*Tariff

For 500MW unit estimated saving on a 1% increase in input
5MWh=5*1000 kWh=5000 Units.
Tariff Rate=3.5-4Rupees (India)
Total Saving = (5000*3.5) = 17,500 Rs/hr.

III) Reduction of greenhouse gases

I) CONCLUSION

This model proposed the solar thermal power plant. In which LP and HP heaters are replaced by PTC solar field which use to heat feed water. Bypassing of LP and HP heaters, fuel saving take place is 23 and 25 ton coal/hr. respectively. Hybridization of thermal power plant with solar field increases the electricity generation up to 4-5MW which is almost 1% increase in output of 500MW thermal power plant.
This suggests that use of solar with conventional thermal power plant reduces the total fuel consumption. This helps organization in terms of profitability. It also compensation factor in case of rise in price of coal. Also this helps in reduction of greenhouse gases such as CO2.

REFERENCES

[1] D. Mills, "Advances in solar thermal electricity technology," Solar energy, vol. 76, pp. 19-31, 2004.

[2] D. R. Mills and G. L. Morrison, "Compact linear Fresnel reflector solar thermal power plants," Solar energy,vol. 68, no. 3, pp. 263-283, 2000.

[3] B R Pai, "Augmentation of thermal power stations with solar energy" Sadhana, Vol. 16, Part 1, pp. 59-74, June 1991.

[4] Prof. Mário Costa "Modelling, Simulation and Optimization of Hybrid Solar Power Plants: Solar augmentation for Coal Fired power plants"

[5] Dimityr Popov "An option for solar thermal repowering of fossil fuel fired power plants" Solar Energy 85 (2011)344–349

[6] Renewable Energy technology: Cost Analysis series" volume1: Power Sector Issue 2/5 R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.