



Advance thermal power plant technology to reduced environmental pollution

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General Note

 Article is recommended to print as color version in recycled paper. *Save Trees, Save Climate.*

ABSTRACT

The objective of this paper is to analyse performance of various power generation plant, issue of environmental degradation and effect on climate. In this paper, examine about innovative technique to improve thermal efficiency of thermal power plant. Mainly electric power generated by coal and it is around 69.06% of coal utilized from coal fired thermal power plant for power generation in India. But now a day these type of coal fired thermal plant is diffuse environmental pollution and enhancement of ozone layer depletion. Other issue is requirement of fossil fuel is day by day progressive. The key roles play of power generation in economic growth of country. So super critical technology increase the thermal efficiency (around 5 to 10%) of plant and decrease the environmental pollution around 5 to 10%.

Keywords: supercritical technology, thermal efficiency, power generation capacity, subcritical thermal power plant.

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1. INTRODUCTION

All India installed capacity (in MW) of power stations located in the regions of main land and islands. The total electric power generation capacity is installed in India as on 30 June 2014 = 249488.31MW as per central electricity authority. The total electricity generation capacity in India as per central electricity authority listed below:

Table 1 Power Scenario in India [1]

S. No.	Type of using fuel for power production	Over all Capacity in MW	%
1.	Thermal	Coal	172286.09
		Gas	
		Diesel	
2.	Nuclear	4780.00	1.92
3.	Hydro	40730.09	16.32
4.	RES(Renewable Energy Sources)	31692.14	12.70
Total		249488.31	100.00

Consumption of electric power at present scenario is one of the most important activities for production of electricity by coal in fossil fuel depends upon economics across the globe. In India, total generating capacity is 249,488.31 (Mega Watt) (as on 30 June 2014), in which share of thermal, hydro, nuclear and renewable power generation is 69.06%, 16.32%, 1.92% and 12.70%, respectively from table no.1 (Central Electricity Authority, 2014, 1, 2, 3, 4) [1]. The electrical distribution and power generation system must dependable relevance of economic and environmental concerns.

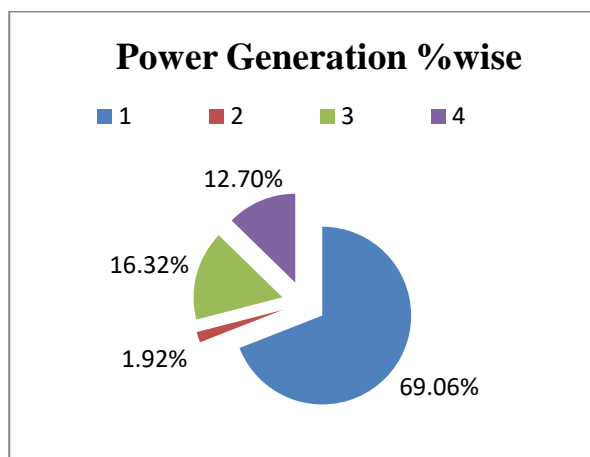


Figure 1 Power Generation Plant Wise in Percentage.

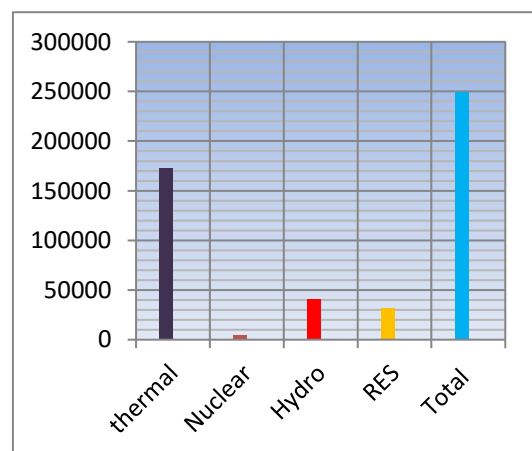


Figure 2 Power Generation Plant Wise in MW

It seems that, in India, the performance of coal fired thermal power plants is play of vital role in enhancement of power availability in the country. With an objective to provide power to all and to increase competition, Indian power sector was opened up for independent power producers (IPP) in 1991. Since then a series of regulatory as well as structural reforms have been initiated with the sole objective to reduce losses and enhance operating capacity and Nearly 19 years have since been passed but reforms have not yet been able to check the ever widening demand supply gap [5]. The arrival of supercritical power generation units with higher cycle efficiencies has made it possible to decrease the cost of electricity considerably.

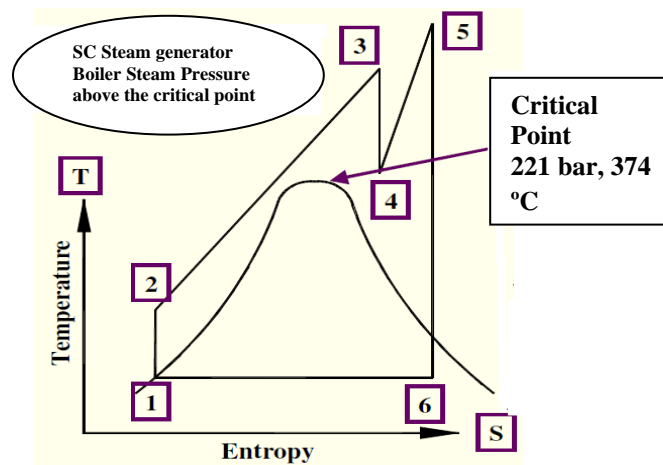
Per capita consumption of electricity in India is many folds lesser than Canada, USA, Australia, Japan, China and world average. Even though, total energy shortage and peaking shortage were recorded as 11.2% and 11.85%, respectively, in 2008–09 reflecting

non-availability of sufficient supply of electricity. Performance improvement of very small amount can lead to large contribution in financial terms, which can be utilized for capacity addition to reduced emend supply gap. Coal fired thermal power plants are main sources of electricity in India [5]. It means to increase the thermal efficiency of plant and decrease the environmental pollution as per rule of one percent increase in efficiency reduces by two percent, specific emissions of carbon dioxide, sulfur dioxide or other pollutants.

2. SUPER CRITICAL TECHNOLOGY

In which, to increase the efficiency of coal fired thermal power plants the basic method is to enhance the thermal efficiency by increasing the operating rankine cycle pressure. If the pressure of water is 200 bar then the latent heat of vaporisation is 584 kJ/kg and the boiling of water is 366°C.

As the above seems the pressure increases the boiling temperature increases and the latent heat of vaporisation decreases. A further increase in pressure and temperature of water leads at reach the point when the latent heat of vaporisation is zero, or there is no boiling. Or directly achieve steam at that point is called Critical Pressure and the Critical Temperature. For steam this occurs at temperature 374°C and pressure 220.6 bar. The once through boiler is suitable to above critical pressure is 221.6 bar and the supercritical pressure and temperature is < 241 bar and 538/560 °C to 566/593 °C respectively. Where the requirement of drum is not necessary because there is zero latent heat of vaporization and water heated at constant supercritical pressure is suddenly converted into steam. Entry of water at one end of a number of parallel paths but there should be transition section where water in order to accommodated the large volume and emerges at the exit as super heated steam.



- (1 – 2) Feed Water Pumping Process
- (2 – 3) Heat addition in the Feed Water Heaters & Boiler
- (3 – 4) Expansion in HP Turbine
- (4 - 5) Reheating in Boiler
- (5 – 6) Expansion in IP & LP Turbine
- (6 – 1) Heat rejection in Condense

Figure 3 Cycle of Supercritical Power Plant

3. BENEFITS OF SUPERCRITICAL THERMAL POWER PLANT

It is improve of thermal efficiency of power station and enhanced fuel tolerance. It is decrease of coal consumption and reduction of ash production and also minimizes the emission of CO₂, SO₂ and NO_x. It is Improvement of start-up time, sliding pressure operation and load following capability of power station.

4. ENVIRONMENTAL DEGRADATION

CO₂ emissions can be lowered by enhance the efficiency of coal fired thermal power plants. Increasing the temperature & pressure in boiler to passing through a steam turbine increases the efficiency of the Rankine vapor power cycle used in thermal power plant. Supercritical technology minimizes the amount of fossil fuel requirement and the emissions generated as compared to sub critical coal fired thermal power plant. Large amount of carbon-di-oxide (CO₂) emissions generated by sub critical coal fired thermal power plant, which contribute in a large measure to greenhouse effect and global warming [7]. Meeting the challenge of reducing CO₂ emission and increase efficiency of thermal power plant reaches at efficient cost. Law of Environmental protection < Pollution can be created but cannot be destroyed. Pollution control at one part environment may create pollution at another part of environment [2].

Table 2 (CO₂) Emissions from Combustion in Several Power Sources

Several Power Sources	g-co ₂ /KWh
Coal Fired Thermal Power Plant	975
Oil Fired Thermal Power Plant	742
Natural Gas Thermal Power Plant	608
Natural Gas Combined Power Plant	519
Nuclear Power Plant	25
Solar Power Plant	53

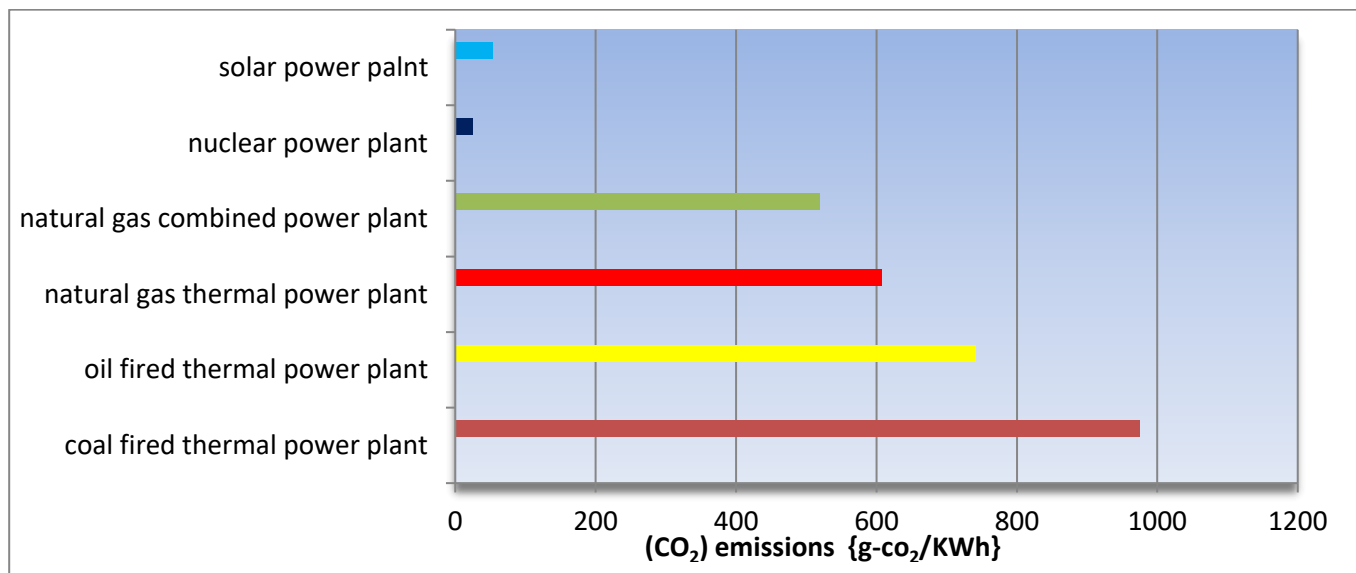


Figure 4 Lifecycle of CO₂ Emission from Various Power Generation Plants [2]

In above graph and table we have seen that the pollutants emitted at large amount from various power generation plant. If supercritical pressure power generation technology utilising, it is able to withstand high temperatures in the (566/593 °C) class and high pressure (24.1MPa, about 240 times greater than atmospheric pressure). This approach is resulting in the reduction of CO₂ emissions by 5% in supercritical power generation, compared with current sub-critical coal fired thermal power generation plant.

Comparison of various power generation plants with respect to plant performance parameter

Four various types of electricity generation plant technology were modelled. The pioneering various power production technologies are:

- Sub-critical pulverized coal fired power plant (Sub-PC)
- Super-critical pulverized coal fired power plant (SCPC)
- Integrated gasification combined cycle power plant (IGCC)
- Natural gas combined cycle power plant (NGCC)

There is four type of power plant has been made of listed of performances characteristics for performance analysis. But demand of power and availability of fuel is major role for selection of power plant establishment. Major portion of power generation by coal fired thermal power plant in India. Main comparison between Sub-PC and SCPC is required. We seen that Sub-critical pulverized coal fired power plants are suitable for power generation but pollutants emission rates at high and also the efficiency of sub-critical power plant is low (38.2%) as compared to super-critical pulverized coal fired power plant .

Super-critical pulverized coal fired power plants have lower emissions 6.31% with efficiencies of 40.7% than subcritical plants for a given comparison in table 3.

Table 3 Comparison of Different Types of Power Plant on The Basis of Performance Characteristics [6]

	Unit	Sub-PC	SCPC	IGCC	NGCC
Net power output	MW	550	550	629	555
Capacity factor	%	85	85	80	85
Net plant efficiency	%	38.2	40.7	43.6	55.6
Fuel requirements	g/kWh	361	338	315	0.187 (m ³ /kWh)
CO ₂ emissions from power plant	g/kWh	856	802	723	365
Lifetime	years	30	30	30	30

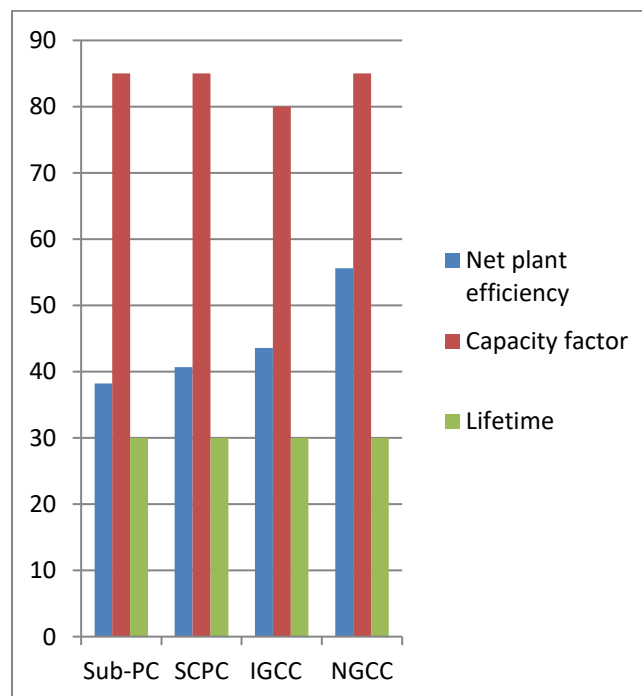


Figure 5 Comparison of net plant efficiency, capacity factor and lifetime from Various Power Generation Plants [6]

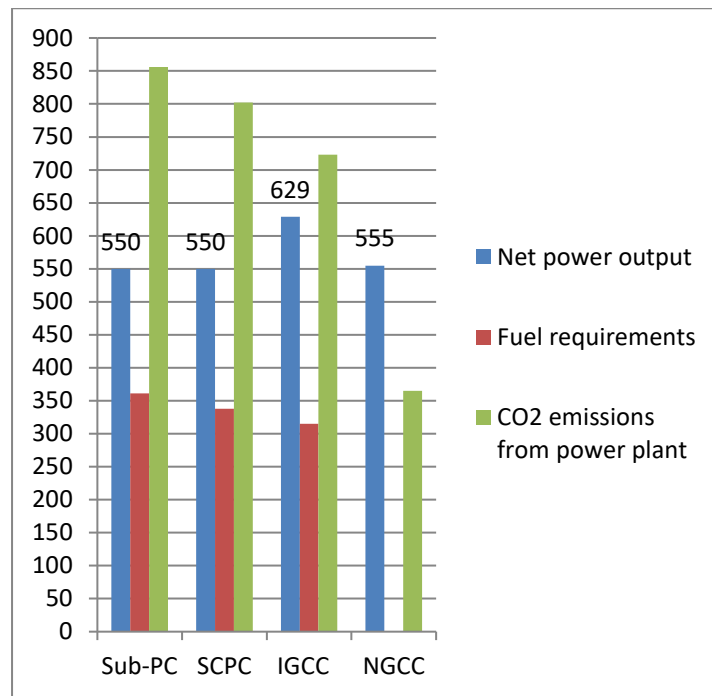


Figure 6 Comparison of net power output, fuel requirement and CO₂ Emission from Various Power Generation Plants [6]

An investigation has been made performance parameter of super-critical technology with the consumption of fuel, efficiency, CO₂ emission and capacity factor. All these parameter is better than sub-critical technology. Because the super-critical technology operate at high pressure and temperature so that its thermal efficiency increases and CO₂ emission is decreased as well as combustion developed in proper manner therefore consumption of fuel is minimized. It means supercritical technology would be more reliable and cost effective technology than sub-critical technology.

5. CONCLUSION

This paper was to provide a better understanding of enhanced plant efficiency associated with minimum environmental pollution. There is several power generation and distribution techniques have responsible for economic and environmental concerns. Analysing the performance characteristics of power plant according to present demand of electricity in India. From environmental point of view availability of CO₂ emission will increase in sub-critical power technology as compared to other technology shown in comparison. Although the power production has around 70% coal to utilized by power plant in India. Obviously in four power plants technologies has been investigated and then adopt the supercritical power plant technology according to the availability of fuel and demand. It is best in Indian scenario because it is more reliable, efficient, minimum fuel consumption and eco-friendly than sub-critical power plant. Most of the power plant in India is based on sub-critical power plant technology so in present decade super-critical and ultra-super-critical technology to introduce for power generation and super-critical technology is most suited to Indian power scenario.

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