Scientific Journal of Impact Factor(SJIF): 3.134
e-ISSN(O): 2348-4470
p-ISSN(P): 2348-6406
International Journal of Advance Engineering and Research Development
Volume 2,Issue 7, July -2015

STUDY OF SUB CRITICAL, SUPER CRITICAL AND ULTRA SUPER CRITICAL THERMAL POWER PLANT

KN Subrahmanyam[1], Dr. Shah Alam[2]

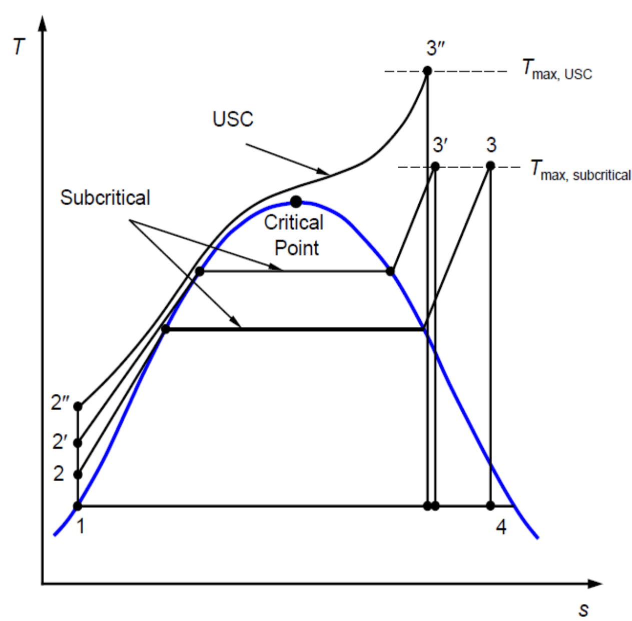
[1]*PG Student M. Tech (Thermal), AFSET, Maharishi Dayanand University*

[2]*Asst Prof. Mechanical Engineering section, Jamia Millia Islamia, New Delhi, Delhi*

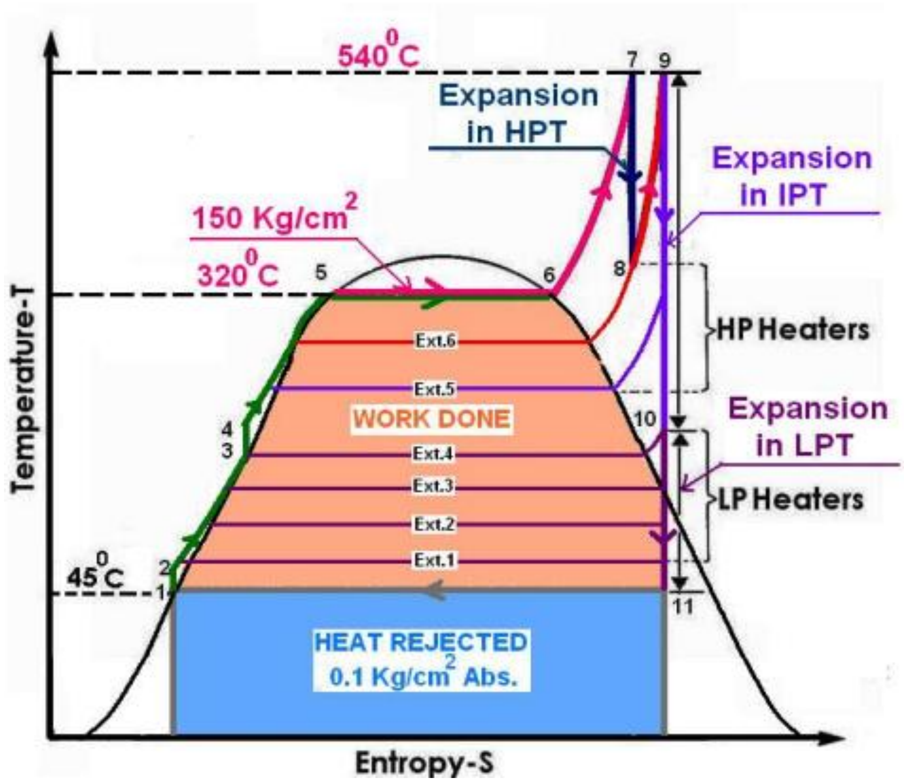
Abstract- *In this paper the technology study of subcritical, super critical and ultra super critical coal based thermal power plants have been done in term of electricity production. Power-producers are looking for improve the efficiency of power plant and also grow concerns about the environmental impacts of power generation without compromising their market competitiveness. To meet this challenge, this study demonstrates technology up gradation of pulverized coal fired power plant in the market. Introduction of these technologies on thermal power plants can changed in Rankine cycle working temperature and pressure and improve the performance of power plants. The analysis is carried out on 500 MW Subcritical 700 MW super critical and 850 MW ultra super critical thermal power plants. Ultra super critical technology is more efficient than supercritical technology and subcritical technology in term of performance efficiency and coal consumption.*

I. INTRODUCTION

Pulverized coal based thermal power plant working base on Rankin cycle. The ideal cycle for vapor power cycles many of the impracticalities associated with the Carnot cycle can be eliminated by superheating the steam in the boiler and condensing it completely in the condenser at turbine outlet, as shown schematically on a T-s diagram in Figure 1. The cycle that results is the Rankin cycle, which is an ideal cycle for vapor power plants. The ideal Rankin cycle does not involve any internal irreversibility and consists of the following four processes, 1. Isentropic compression in a pump; 2 Constant pressure heat addition in a boiler; 3 isentropic expansion in a turbine; 4 Constant pressure heat rejection in a condenser

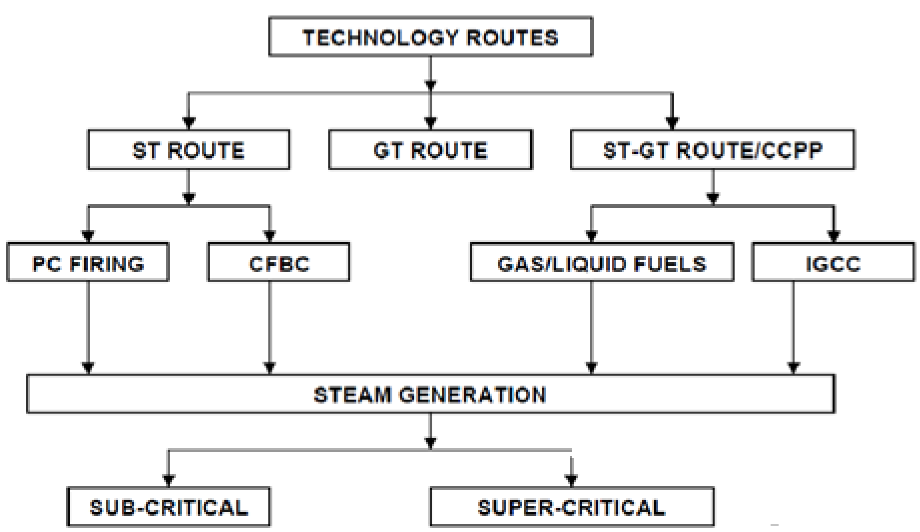


"Figure 1.T-S diagram for subcritical, supercritical and ultra super critical"



"Figure 2.Steam conditions in Rankin cycle"

Technology routes of coal based thermal power plant in electricity production industry are given below.

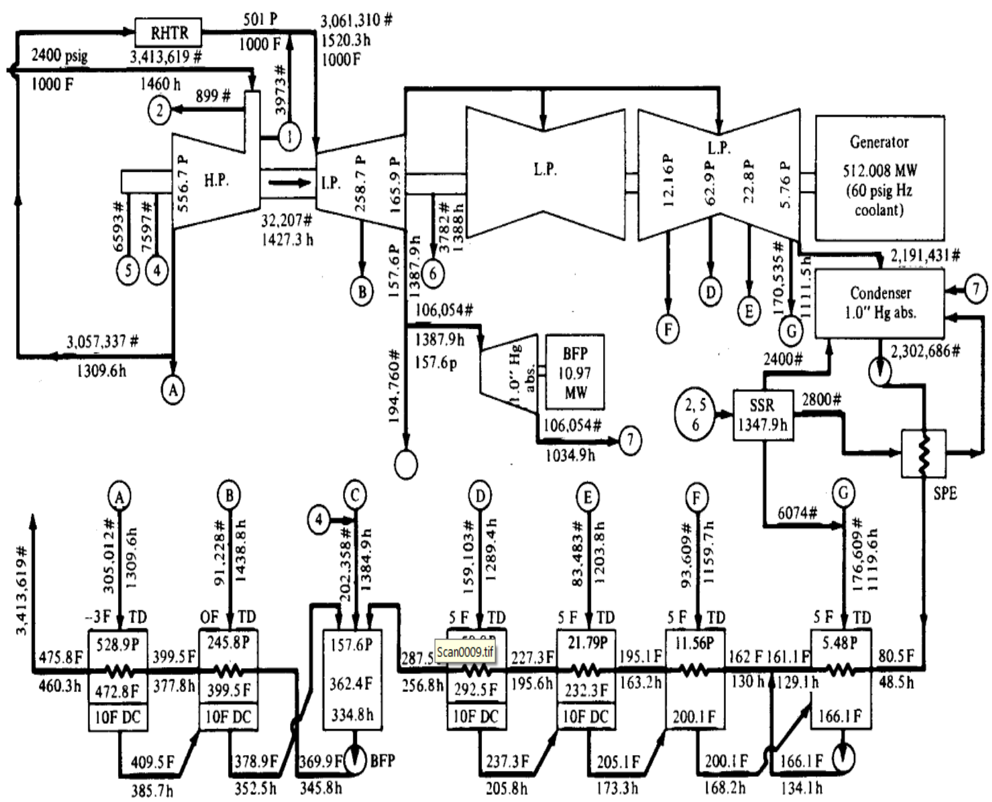


Volume 2,Issue 7, July -2015, e-ISSN: 2348 - 4470 , print-ISSN:2348-6406

II. METHODOLOGY

Above Rankin cycle steam outlet conditions are kept constant and playing on steam generation we all are knows subcritical steam generation thermal power plants with 170 bar and 540 / 540°C (SH / RH) operate at an efficiency of 38 %. technology this technology of steam generation is pool boiling in pool boiling 4 stages are shown below the region of C to D loss of heat due to sludge formation this reason required to steam blow of every shift in boiler operation indirectly loss of efficiency. Fluid heated to above the critical temperature 647 K and compressed to above the critical pressure 220 bar is known as a supercritical fluid. Supercritical units operating at 250 bar and 600/615°C can have efficiencies in the range of 42 %. This efficiency increased by removed steam blow of and heat transfer rate increased by removed sludge formation and also increased by turbine in let condition of temperature and pressure.

"Figure 3.Steam generation in 4 stages pool boiling"



"Figure 3(a).Subcritical heat balance diagram 500 MW"

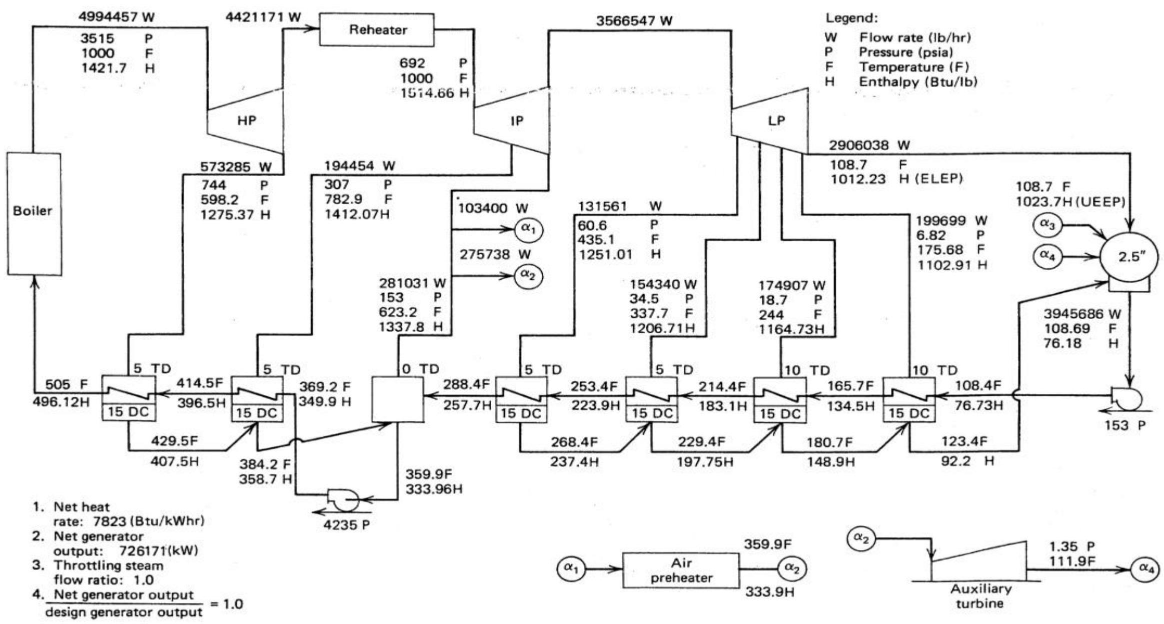


Figure 3(b).__Super critical heat balance diagram 700 MW__”

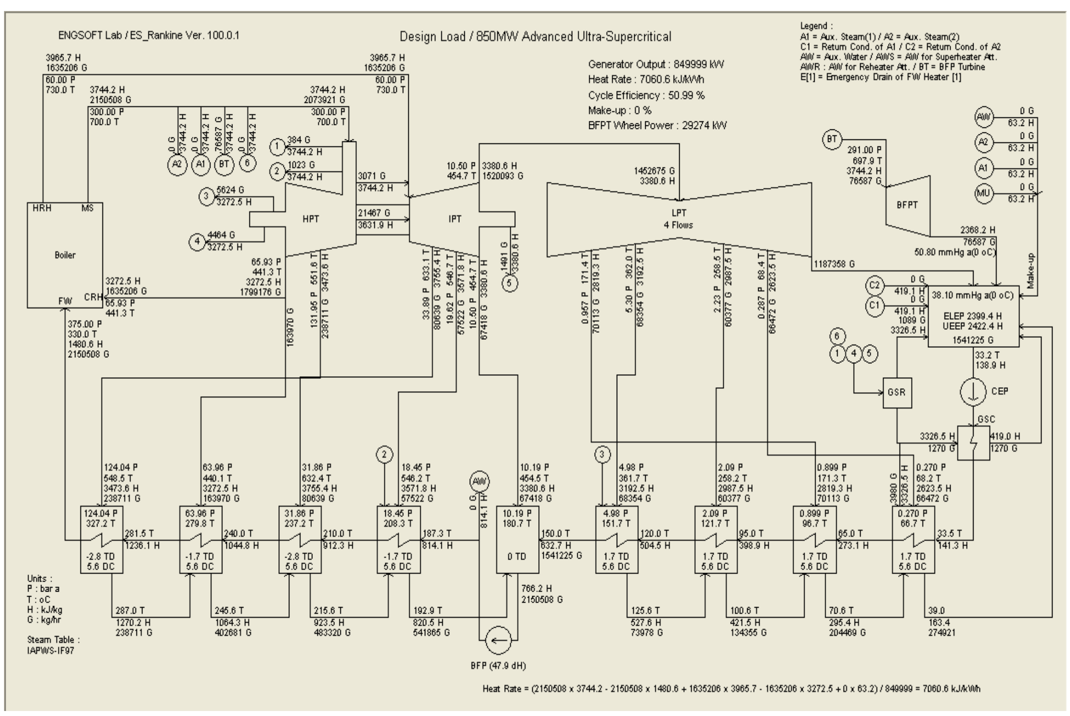


Figure 3(c).__Super critical heat balance diagram 850 MW__”

III. Analysis

"Table 1. Performance analysis of subcritical, super critical and ultra super critical thermal power plants".

Description	Subcritical (SubC)	Supercritical (SC)	Ultra supercritical (USC)
Basic unit size in (MW)	500	700	850
Capital cost (Crore INDR/GW for India)	4500	5000	5625
Calorific value of coal (K Cal/KG)	3000	3000	3000
Specific coal consumption (kg/kwh)	0.74	0.64	0.56
Plant load factor	0.8	0.8	0.8
Coal storage yard (Days)	21	21	21
Ash (%)	40	40	40
Bottom Ash (%) in total ash	20	20	20
Plant life (Years)	30	30	30
Ash dyke height (M)	10	10	10
Density of bottom ash (kg/m3)	1000	1000	1000
CIL Cost of coal (Rs/Ton)	1270	1270	1270
Steam quantity (Kg/Hr)	9326	8071	7058
MS pressure (Kg/cm²/°c)	168/537	247/537	306/700
Re heat steam pressure (Kg/cm²/°c)	35/537	48/537	61/700
Feed water temperature °c	246	262	327
Coal consumption	370	448	476
Bottom ash in TPH	74	89.6	95.2
Ash pond size			
Boiler structure height	50 M	75 M	75 M
Boiler structure	500 MT	500 MT	500 MT
Blow down in water evaporates it leaves behind the dissolved impurities of salt etc. over a period of time the tubes of the boiler develop a thick layer of depositions, which have lower heat conductivity, thereby reducing the heat transfer rate and hence blow downs are carried out to flush these impurities out of the system.	Required	Not required	Not required
Co exist in difference in phase	3%	0 to 1%	0 to 1%
Water			
Oil			
land			
Auxiliary power			
Efficiency	38.6	44.6	51
Cost saving on efficiency (crore/year) Compare to sub critical	-	64.8	133.92
NOX generation per KWH			
SOX generation per KWH			
CO2 generation per KWH			
Particle matter generated per KWH			

IV Conclusion

The purpose of this work was to demonstrate the various methods of steam generation and emission reduction, in connection with the cost of installation, operational cost and experience of operation as well as good environmental performance.

REFERENCES

1. 2980 MW NTPC Sipat India two stages stage-I 3 units of 660 megawatts Stage-II 2 units of 500 megawatts each. The thermal power generation in NTPC Sipat Stage-II is based on “Super Critical Boiler technology” which is advance technology in thermal power station.
2. Power plant engineering Black & Veatch Springer, 1996 – Technology & Engineering.
3. Government of India Ministry of Power Central Electricity Authority New Delhi.
4. Thermal power plant Simulation & Control by Damian Flynn
5. Power plant performance by AB Gill.
6. Central Electricity Generating Board Modern Power Station Practice.
7. Modern Power Station Practice.

