# Strategies to Optimize Auxiliary Power Consumption in Coal Based Thermal Power Plant

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*Abstract*— In the present scenario total installed electricity generation capacity of India is 388849 MW, out of which 201995 MW generated by Coal & 6620 MW is generated by Lignite (1). Almost 50% of total energy generated is consumed by the industries alone .Auxiliary power in coal fired power station accounts for 7% to 12% of the gross generated power at the full plant load. This AP can be optimized by 4.5% to 9% for the same capacity range (2). The reason of excessive AP consumption is outdated technology, poor operation and maintenance, internal leakage, ingress of foreign material into equipment, ageing of equipment. Apart from this coal quality, amount of steam to be generated, load variation also affects the AP requirements. Higher AP consumption creates significant gap in power generated and power supplied to grid, due to which not only government norms are violated but it also accounts loss to the generating company. To compensate AP consumed within plant there is two methods. First is minimizing the electricity consumption and second is more power generation. The second method is not cost effective. This paper discusses in details the maintenance strategy and some design aspects to improve the AP consumption.

***Keywords:*** Thermal Power Plant, Auxiliary Power, Pump, Fan, Mills, Maintenance

## I. INTRODUCTION

The power consumption of any country indicates the socioeconomic growth. India has grown rapidly as power generator and power consumer after independence. Electricity has been covered in the concurrent list of constitution of India.

In 1947, total installed electricity capacity was 1362 MW, as of now (30/09/2021) it has been grown up to 388849 MW, in which coal based thermal power plant accounts 201995 MW. As per current data of CEA coal based thermal power plant accounts 51.9% in total electricity generation in India. (1)

Auxiliary Power is the quantum of power consumed by equipment of the power plant. According to thermal power and Technology Development Division of CEA, Auxiliary Power Consumption should be in the range of 5.75% to 11%.(2)

| | APC as % of Gross Generation | |
|---|---|---|
| | Without IDCT | With IDCT |
| 200 to 270 MW unit generating station | 8.5% | 9% |
| 300 to 800 MW unit generating station (With steam turbine driven boiler feed pump) | 5.75% | 6.25% |
| 300 to 800 MW subcritical units (electric motor driven boiler feed pump) | 8% | 8.5% |
| 300 to 800 MW supercritical units (with electric motor driven boiler feed pump) | 9% | 9.5% |

Table 1: APC for Coal Based Thermal Power Plant

If tube and ball mills are used in thermal power plant then additional 0.7% of Auxiliary Power is consumed.

APC is inversely proportional to economy of the plant. If APC is more economy will be less & Vice versa. If APC is less then only we can supply more power. In this paper detailed analysis of APC has been done and at last idea to optimize the Auxiliary Power is supplied.

### *A. Objective of Saving Auxiliary Power:*

Auxiliary power reduction provides an opportunity to sustain in the competitive power market. If APC is less then power plant would be able to sell more power and generate more revenue.

The major advantage of minimizing APC is listed here:-

1) Revenue increases and it helps to sustain in the competitive market.
2) Positive impact in the bottom line of balance sheet.
3) Less APC means we have to generate less power because demand is same so less CO2 emission.

### *B. Auxiliaries of Thermal Power Plant:*

There are number of auxiliaries used in the thermal power plant but here I have covered only large power consuming machineries. But in this paper I have covered following auxiliaries.

These machineries are listed below:-

1) Boiler Feed Pump (BFP)
2) Induced Draft Fan (ID Fan)

Forced Draft Fan (FD Fan)

Primary Air Fan

#### *1) Boiler Feed Pump:*

A major part of auxiliary power is consumed by BFP in the thermal power plant. Some observations and suggestion related to BFP given below:-

| | APC as % of Gross Power Generation |
|---|---|
| 300 to 800 MW (Sub Critical) with steam turbine driven BFP | 6.25 % |
| 300 to 800 MW sub critical) with electric motor driven BFP | 8.50% |

Table 2: Coals Based Thermal Power Generating Stations

It is clear from above furnished data that using steam driven BFP instead of electric motor driven BFP saves auxiliary power by 2.25% which is a huge saving.

Affinity law for pumps

$Q \alpha N$ Q- Flow Rate

$P \alpha N^3$ N- Revolution of Impeller per Minute

 

P- Power Input to Pump

From affinity law it is clear that with the variation in feed water demand speed of the pump changes. Since power input to the pump is directly proportional to the cube of speed of the pump therefore small variation in speed makes great change in power input to the pump motor. So if we install variable frequency drive then at low demand condition large power can be saved.

If there is water or steam leakage then flow will increase to compensate those losses so with the increment in flow, pump speed also increases and so the power input will be more. To avoid such condition proper maintenance should be carried out to ensure no loss of steam or water or both.

### *C. Induced Draft Fan:*

Induced draft Fan is used to exhaust flue gases from furnace to chimney by creating negative pressure.

Due to blockage in air pre heater basket additional pressure drop occur which increases auxiliary power consumption. Cleaning of basket should be scheduled to ensure no additional APC.

| S.N. | Parameters | With VFD | Without VFD |
|---|---|---|---|
| 1. | Flue Gas Flow Rate t/h | 511.47 | 474.13 |
| 2. | Electrical Power input in KW | 867.15 | 1436.9 |

Table 3: ID Fan with or without variable frequency drive (500MW)

As we can see from above table that with the use of VFD in ID fan power input is reduced by 40% with more flue gas flow rate. Apart from less APC VFD also ensures smoother control in flue gas flow and better efficiency of ID fan over wide range of speed and flue gas flow range.

Due to debris pressure drop occur more than the design value in furnace, economizer and ESP, this leads to more APC (3). So by making proper maintenance scheduling debris from the Reheater, Superheater should be removed. By this we can save approximately 0.05% of power consumption by ID fan.

Hollow blade should be replaced with solid blade to avoid internal accumulation of Ash.(4)

### *D. Forced Draft Fan:*

Forced draft fan is used to supply secondary air to furnace for combustion. FD fan sucks air from atmosphere send it to air pre heater to raise the desired temperature and then it go to wind box from there it is distributed into the furnace. FD fan consumes about 0.35% of auxiliary power (3).

Pressure drop is the measure reason which support higher auxiliary power consumption in FD fan. The reason of pressure drop is contaminants present in air. So in an interval cold air duct should be cleaned to reduce the chances of pressure drop.

If flue gas flow is optimized, then air required for combustion will be less inside the furnace. And reduction in flow rate of secondary air leads to reduction in auxiliary power consumption.

For smooth operation and to reduce APC proper maintenance activity should be scheduled. FD fan maintenance work include Fan Cleaning and Inspection, silencer cleaning, SCAPH cleaning, servicing of motor, checking of lube oil and bearings, alignment of motor fan.

### *E. Primary Air Fan:*

Primary air is supplied by PA fan. Primary air mainly serves two purposes. First it tries to remove moisture from the coal and secondly it transport pulverized coal to the furnace. PA fan generally consumes 0.76% of auxiliary power of gross power generated for 500MW when it runs about 90% of peak load.

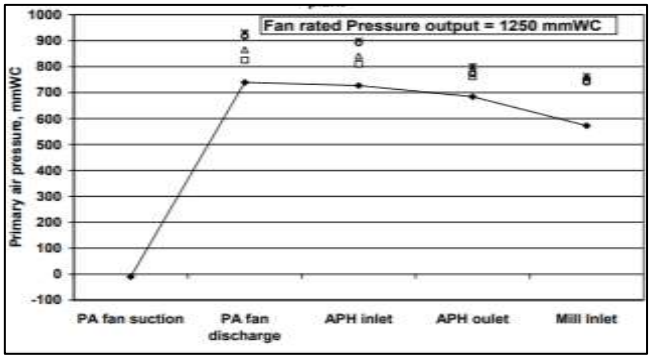


Fig. 1: Pressure Drop across Different Section of PA flow circuit(3)

Above figure shows pressure variations in PA flow circuit. If pressure drop is more auxiliary consumption will be more. To save power debris from cold air duct should be cleaned; APH basket should be cleaned during maintenance.

Other reasons for higher auxiliary power consumption are Moisture in Coal & leakage in air pre heater. These factor increases PA fan loading which consumes more power. Good quality of coal should be used to avoid such losses.

Equipment size should be optimized. Because oversized fan consumes more power.

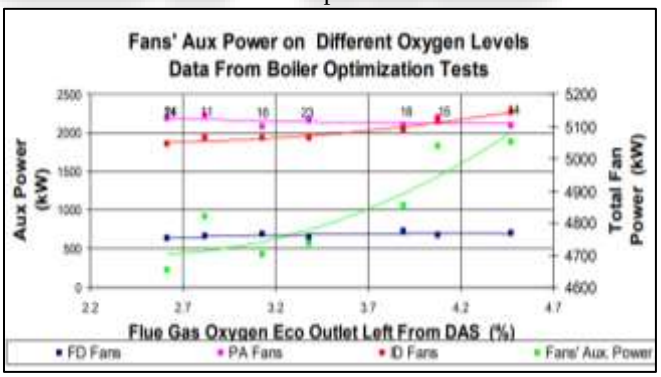


Fig. 2: Auxiliary Power Consumption in Different Fans for Different oxygen level

Above graph show how APC changes with change in oxygen content in flue gas.

## II. CONCLUSION:

The major conclusions derived from the study are as follows:-

1) BFP is major auxiliary in which AP can be saved by installing VFD. Installing VFD gives opportunities to run on variable speed and variable flow as per requirement of load.
2) Auxiliary power consumption is higher when plant run on partial load condition, to save power every possible

 

effort should be made to run the power plant in full load condition.

3) Pressure drop across various section of power plant is due to debris, contaminants in air. Due to pressure drop APC increases so cleaning of air ducts, cleaning of APH basket, cleaning of SH, RH should be done.
4) Design parameter should be optimized as per requirement; oversized equipment consumes more power and works less efficiently.
5) Proper maintenance should be done, burning checking, oil servicing, motor servicing, filter cleaning should be done as per plants environmental conditions.

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