2015

STUDY OF STEAM TURBO BLOWER AND ITS AUXILIARIES

Submitted By
Himanshu Yadav

BHILAI STEEL PLANT

A Project report on

"Study of Steam Turbo Blower and its Auxiliaries"

Submitted to
Shri V.S Dewangan
(Assistant General Manager)
Power and Blowing Station, SAIL-BSP

Submitted by
Himanshu Yadav
Mechanical Engineering
IIT Jodhpur

CERTIFICATE

सेल SAIL

BHILAI STEEL PLANT

*This is to certify that report entitled "***Study of Steam Turbo Blower and its auxiliaries***", which is submitted by* **Himanshu Yadav,** *is a record of candidate's own work carried out by him under my supervision. The matter embodied in this project is original and has not been submitted for the award of any other degree.*

Shri V.S. DEWANGAN
(Assistant General Manager)
Power and Blowing Station SAIL-BSP

DECLARATION

I hereby declare that project work entitled "**Study of Steam Turbo Blower and its auxiliaries**" is an authentic record of my own work carried out at STB at Power and Blowing Station (PBS-2) of Bhilai Steel Plant under the supervision of **Mr. V.S. DEWANGAN** and the guidance of **Mr. ASHISH YADAV**, during 15th June 2015 to 18th July 2015.

Himanshu Yadav

PREFACE

The Project "Study of Steam Turbo Blowers and its Auxiliaries", deals with one of most important unit of Power and Blowing Station in Bhilai Steel Plant. PBS is involved with the Power production, Cold air blast production and Auxiliary steam production for use in different departments of BSP. The project involves the study of STB, Boiler and different auxiliaries in the new PBS-2 unit, which will be used for the production of cold air blast for the new Blast Furnace-8. The project tries to explain how the Cold air blast production is carried out in practice and the process and equipments involved in the production.

ACKNOWLEDGEMENT

I am highly indebted to my project head **Mr. V.S. Dewangan, Assistant General Manager, BSP** for providing me an opportunity to carry out the project work under him. I would like to thank him for his continuous support, supervision and motivation and guidance throughout the tenure of my project in spite of his hectic schedule. He truly remained the driving spirit in my project and his experience gave me the light in understanding and pursuing the objectives of my project work.

I would like to express my gratitude to my project guide **Mr. Ashish Yadav, Junior Manager, BSP** for his guidance, dedicated inspiration and patience from which I gained alot. I thank him for providing me with his valuable time and resources and for his regular interest towards my project.

I would like to thank all **BSP Employees** who were of great help, directly or indirectly, during my project work.

Date : 18th July 2015 Himanshu Yadav

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STEEL AUTHORITY OF INDIA LIMITED
BHILAI STEEL PLANT

Eleven time winner of the Prime Minister's Trophy for Best Integrated Steel Plant in country, Bhilai Steel Plant (BSP) is the flagship unit of Steel Authority of India Limited (SAIL), a Government of India undertaking. It produces high strength Rails, heavy structurals, wide and heavy steel plates of different grades, merchant products, wire rods etc. Bhilai became the first integrated steel plant in the country to surpass the 5 MT mark in crude production in the year 2005-06. Bhilai has unique distinction of producing **cleanest rail** in the world.

Product mix	Tonnes/annum
Semis	533,000
Rail & heavy structural	750,000
Merchant Products (angles, channels, Round & TMT bars)	500,000
Wire Rods (TMT, plain & ribbed)	420,000
Plates (up to 3600 mm wide)	950,000
Total saleable steel	3153,000

Production facilities at a glance

Coke Ovens Batteries 10 Nos	• 8 batteries of 4.35m height consisting of 65 ovens each • 2 batteries of 7m height consisting of 67 ovens each
Blast Furnaces : 7 Nos.	• 3 Blast furnaces each of 1033 cu.m volume • 3 Blast furnaces each of 1719 cu.m volume • 1 Blast furnace of 2355 cu.m volume
Sintering Plants : 3 Nos.	• SP-1 : 4x50sq.m hearth area • SP-2 : 3x75sq.m hearth area 1x80sq.m hearth area • SP-3 : 1x320sq.m hearth area

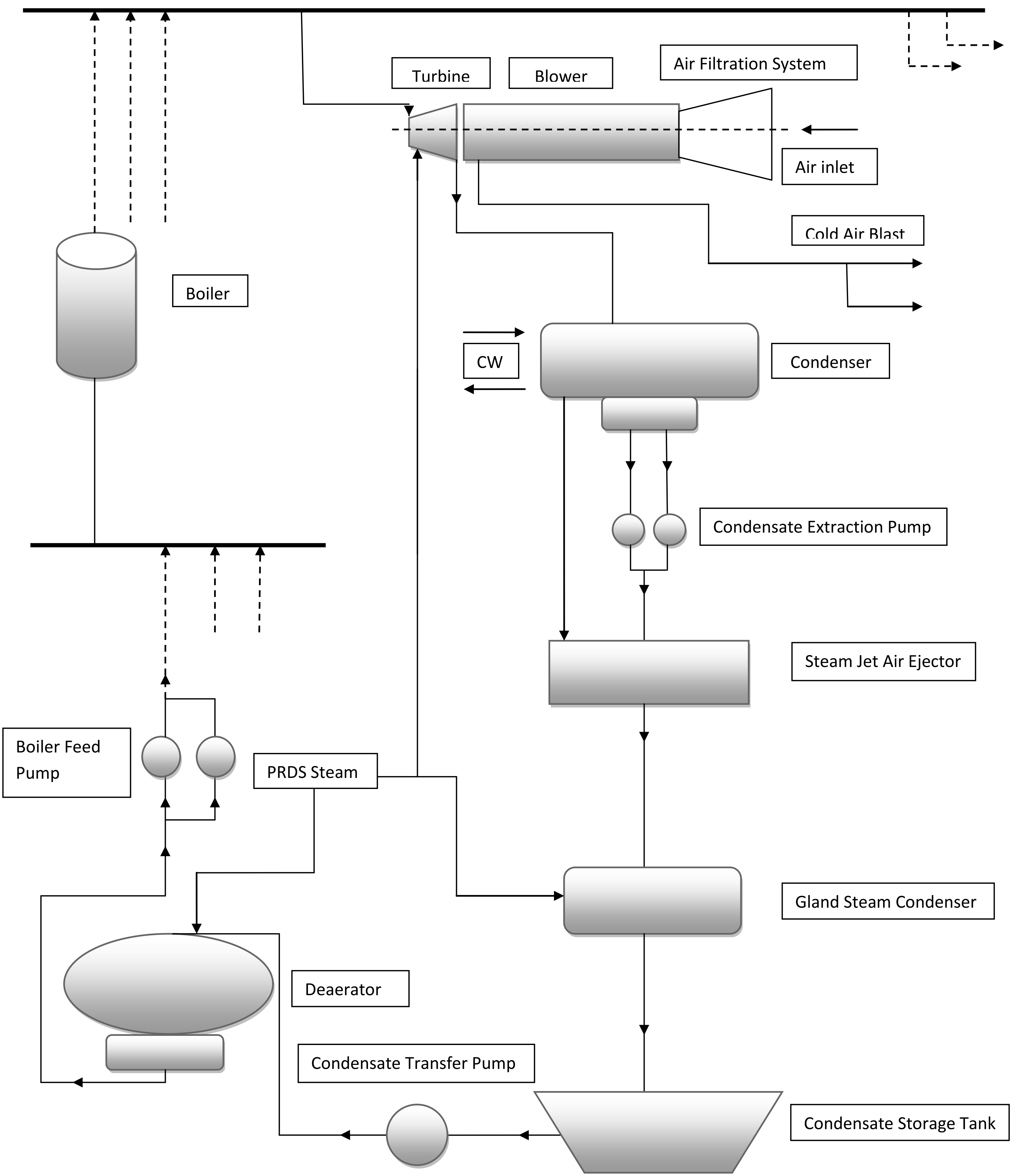
Steel Melting Shop-I	• 4 Twin Hearth Furnaces
Steel Melting Shop-II	**Convertor Shop :** • 3 BOF 110/130 T Convertors • Secondary Refining facilities : 1 VAD unit, 2 RH degassers, 2 Ladle furnaces **Continuous Casting Shop:** • 4 Slab Casters, 1bloom caster, 1Combi caster
Mills	• Blooming & Billet Mill • Rail & Structural Mill • Plate Mill • Merchant Mill • Wire Rod Mill
Auxiliary Units	• Two captive Power Plants - one captive and other in joint venture with 123 MW total power generation capacity • Two Oxygen Plants, Acetylene Plant, Propane Plant • Refractory Materials Plants for production of Mag Carb bricks, sinter, dolo, lime • Foundry & Engg. Shops for captive manufacture of spares, assemblies, mould, forging • Coal Chemicals units for recovery of various by-products from coal carbonization • Slag granulation plants

NEED OF STEAM TURBOBLOWERS IN BSP

Blast Furnaces can be considered as the heart of a Steel Plant. The blast furnace is the first step in producing steel from iron oxides. The purpose of a blast furnace is to chemically reduce and physically convert iron oxides into liquid iron called "hot metal". The raw materials such as iron ore, coke and limestone are dumped into the top and preheated air known as Hot air blast is blown into the bottom. The raw materials undergo numerous chemical reactions and descend to the bottom to become final product of liquid iron and slag. The hot air blast is produced by passing cold air blast trough a stove where residual blast furnace gases are burned. This cold air blast is provided by Turbo blowers form Power and Blowing Station.

Each blower installed on the new Power and Blowing station will provide on average 1500 Nm^3/min of cold air blast. There will be 3 Steam Turbine driven Turbo Blowers (2 working and 1 Standby) each with 50% capacity of maximum air blast requirement.

FLOW DIAGRAM OF STB AND AUXILLARIES



PROCESS OVERVIEW OF STB AND AUXILIARIES

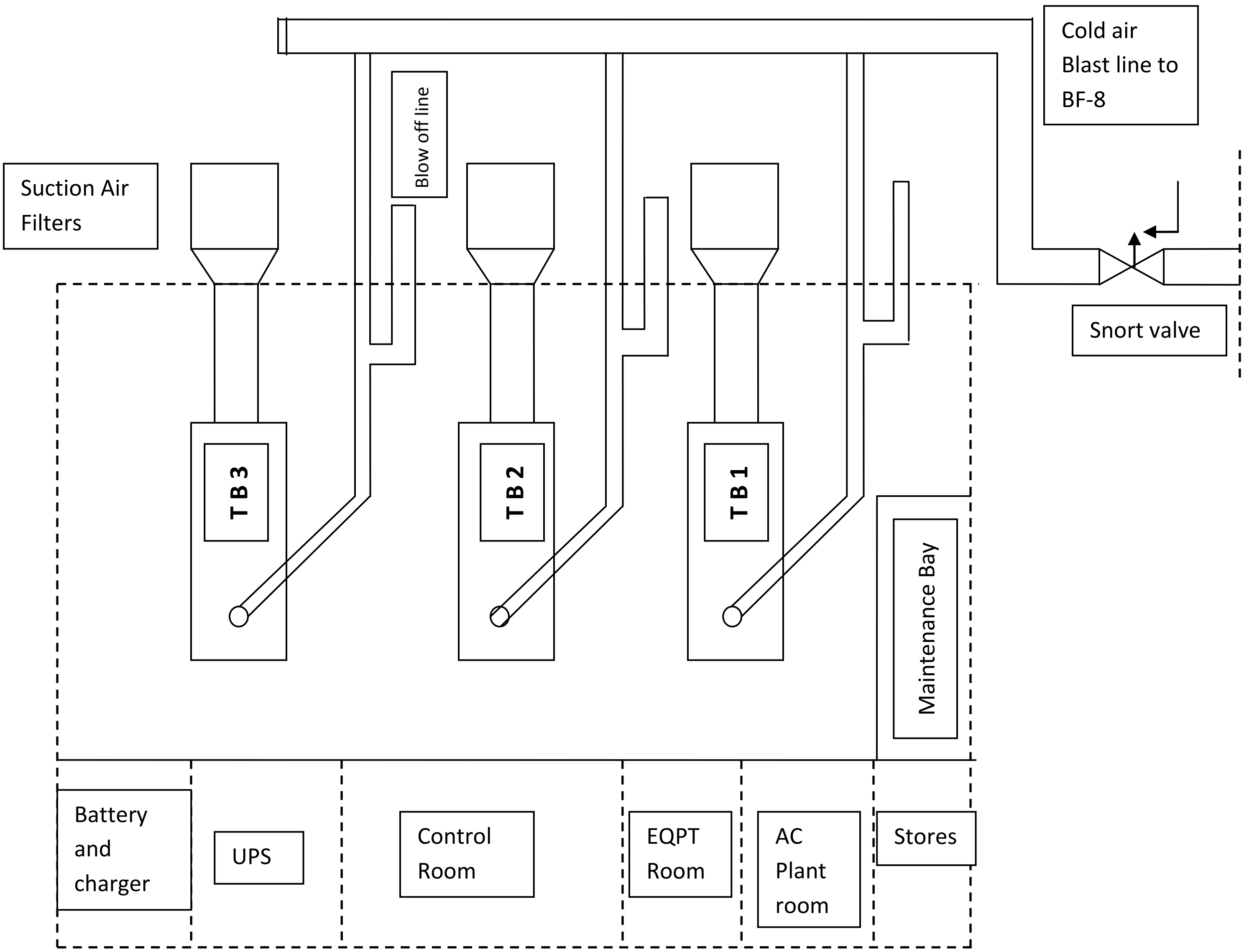
The steam used to drive the blowers is produced in 3 **Boilers** at 40 ata, 450 degree Celsius. Waste gases from blast furnace and coke oven mainly BF gas and CO gas are used to fire the burners in boiler to produce steam. The steam so produced is sent to main steam header from where tapings are taken for different stations mainly **Turbo blowers, Turbo generators** and **Pressure Reducing and De superheating Station**.

Steam enters the **Turbine** at around 36 ata, 440 degree Celsius. The steam in turbine passes through different stages where its enthalpy is converted into rotational energy to drive the turbine shaft which in turn drives the **Blower** attached. The blower thus sucks the air passing through air filtration system and delivers the high pressure air to the blower outlet. The steam from turbine outlet goes through **Condenser** where it is condensed by cooling water to liquid condensate which is collected in hotwell.

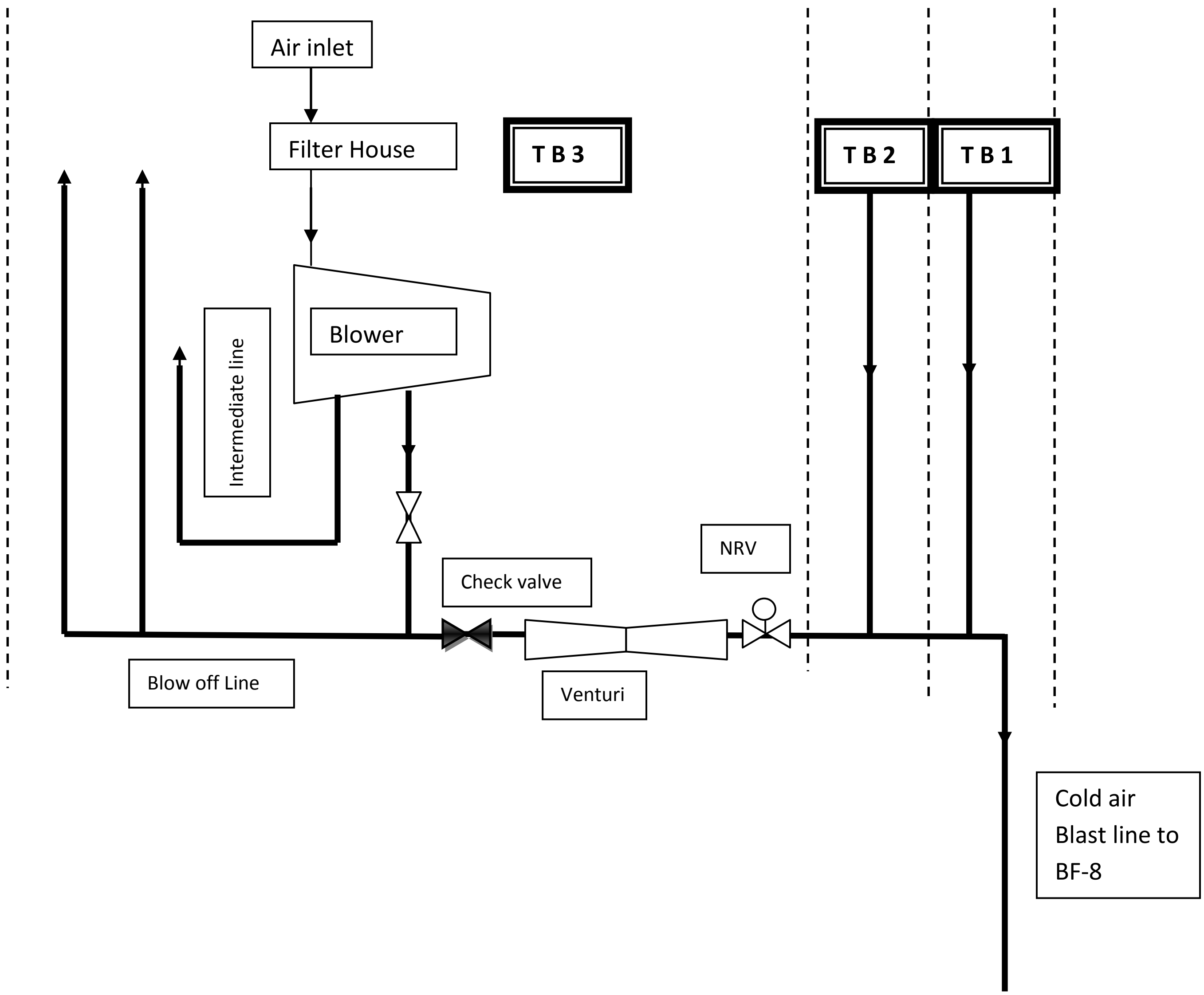
The liquid condensate from the hotwell is then pumped using **Condensate Extraction Pump**. The condensate is then passed through the **Steam Jet Air Ejector** where the condensate is heated and the air in the condenser is simultaneously ejected using the steam from **PRDS**. The condensate is then passed through the **Gland Steam Condenser** where it is heated using the PRDS steam.

The condensate is then stored in the **Condensate Storage Tank**. The condensate is then transferred to the **Dearator** using the **Condensate Transfer Pump**. The condensate is sprayed form the top in the dearator and PRDS steam is used to heat the condensate and remove the impurities. The feed water so formed is collected and then pumped to the Boiler using the **Boiler Feed Pump**. The feedwater in the boiler is first converted to saturated liquid by economizer and then it goes to the boiler drum where it is evaporated and then passes through superheater before reaching its final state and transferred to main steam header.

LAYOUT OF STB PBS-2



AIR DISTRIBUTION SYSTEM STB PBS 2



TURBO-BLOWERS

Turbo-blower is a combination of two turbo machines - Turbine and Blower. A turbo machine is a device that exchanges energy with a fluid using continuously flowing fluid and rotating blades The turbine is a work producing device which is run using the steam from the boilers. This turbine thus rotates the shaft attached to the blower. Blower is a work consuming device and is used to transfer energy to the fluids. Thus the turbine takes the energy from one fluid (steam) and the blower then transfers this energy to other fluid (air, in our case).

219000 Nm^3/hr BLOWER AT PBS-2 STB

There are 3 ways of classifying turbo machines

- Type of fluid they work on – Compressible or Incompressible.
- Direction of flow in the machines – Radial, Axial or Centrifugal
- Whether they deliver or extract power – Turbine or Blower

TURBINE

A steam turbine is a prime mover which continuously converts high pressure high temperature steam supplied by steam generator into shaft work with low temperature steam exhausted to the condenser. This energy conversion takes place in 2 steps

TURBINE AT PBS-2 STB

- High pressure high temperature steam expands in nozzle and comes out at a high velocity.
- The high velocity jet of steam coming out of nozzles impinge on the blades mounted on the wheel, get deflected by an angle and suffers a loss of momentum which produces torque.

CONSERVATION OF MASS

Conservation of mass in simple language states that the total mass flow into the turbine equals the total mass flow out of the turbine.

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$$

CONSERVATION OF MOMENTUM

Newton’s second law applied to the rotational motion states that “Rate of change of angular moment of a system equals the total external torque applied to the system”.

$$T = \frac{dL}{dt}$$

Also, the angular moment is given by moment of momentum

$$L = mv_\theta r$$

So the change in the angular momentum can be given as

$$mv_{2\theta}r_2 - mv_{1\theta}r_1$$

And

$$T = \dot{m}(v_{2\theta}r_2 - v_{1\theta}r_1)$$

And the power produced is given by

$$P = T\omega = \dot{m}\omega(v_{2\theta}r_2 - v_{1\theta}r_1)$$

This is known as Euler Turbomachinery equation. This is the basic equation and applies to all types of turbomachinery.

NOZZLE

A nozzle is a duct by flowing through which the velocity of a fluid increases at the expense of pressure drop. A duct which decreases the velocity of fluid and causes a corresponding increase in pressure is called a diffuser.

The shape of the nozzle depends on the mach number of a flowing fluid. If the fluid is subsonic, the nozzle will be convergent and if the flow is supersonic, the nozzle will be divergent in shape.

NOZZLE EFFICIENCY

Due to friction between the expansion process is irreversible, although still approximately adiabatic. In nozzle design, it is the usual practice to base all calculation on isentropic flow and then to make an allowance for friction using a coefficient or efficiency.

The nozzle efficiency is defined as the ratio of actual enthalpy drop to the ideal enthalpy drop

$$\eta_n = \frac{h_0 - h_1}{h_0 - h_{1s}}$$

BLADING

Depending on the types of blade used and the method of energy transfer from the fluid to the rotor wheel, the turbine may be of two types

- Impulse turbine
- Reaction turbine

In Impulse turbine, the pressure drop occurs in nozzle and no pressure drop occurs in rotors. The pressure energy is first converted to kinetic energy in nozzles and the kinetic energy is used to turn the rotor blades. These are called impulse turbines as the power is produced using the impulse of the high velocity fluid exiting the nozzles.

Generally, single stage turbines are not used as the enthalpy drop occurs only on one stage and the increase is velocity is very large and this results in higher blade velocity which is not desired. Hence compounding of steam turbines is necessary. The compounding is done in two ways

- Pressure compounding or Rateau staging
- Velocity compounding or Curtius staging

Pressure compounding corresponds to putting a number of simple impulse stages in series. The total enthalpy drop is divided equally among the stages.

Velocity compounding or curtis staging, all the pressure drop and hence enthalpy drop occurs on the single row of nozzles and the resultant kinetic energy of the steam is absorbed by the wheel in a number of rows of moving blades with stator in between the two such rows. The purpose of stator or guide blade is to guide the fluid without changing the velocity so that the fluid enters the next stage similar to the previous stage. In curtis satging as the number of rows of moving blades increases, the effectiveness of moving rows decreases.

REACTION TURBINES

In these turbines, the pressure drop occurs both in nozzles or fixed row of blades as well as the moving row of blades. Blades rotates both due to both the impulse effects of the jets and the reaction forces from the exiting jets on the blades and this is why they are called as reaction turbines.

The degree of reaction is defined as

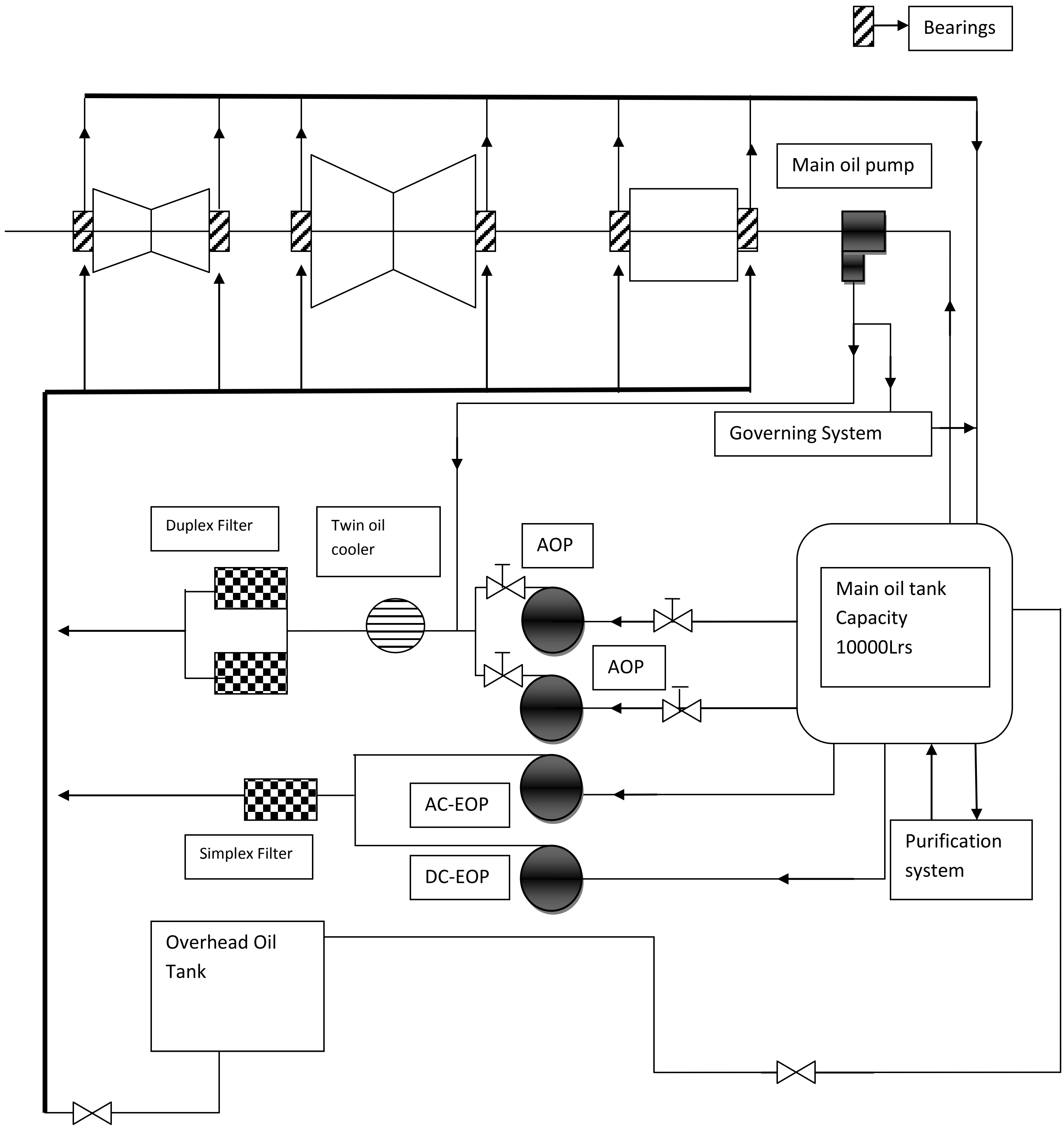
$$\boldsymbol{R} = \frac{\Delta \boldsymbol{h}_{rotor}}{\Delta \boldsymbol{h}_{stage}}$$

The general arrangement of consist of initial two-row Curtis stage initially which involves large enthalpy drop and then remaining stages can either be of impulse type or reaction type.

BLOWER SPECIFICATION IN STB PBS-2

Identification	AN AIR BLOWER
Serial Number	6612
Vendor's Name	MAN Diesel and Turbo SE
Gas Handled	AIR
Rated Capacity	219000 Nm^3/hr
Rated Power	22836 kW
Hydrostatic Test Pressure	10.7 Kg/cm^2g
Casing Design Pressure	7.1Kg/cm^2g
Casing Design Temp.	340°C
Purchaser Item Number	TBB 01
Year of Fabrication	2012
Type + Size	AG080/16RB
Min. Operating Speed	3964 rpm
Max. constant Speed	5814 rpm
Trip Speed	6104 rpm
First Critical Speed	2663 rpm
Max. allow work pressure	7.0 Kg/cm^2abs
Min/Max allow Temp	9/337°C

Turbine Lubrication System at STB PBS-2



TURBINE LUBRICATION SYSTEM

The modern steam turbine and generator are carefully designed pieces of equipment constructed of well selected materials. Its satisfactory performance and useful life in service depend, among other things, on the maintenance of proper lubrication. This is one of the best insurances against turbine outage. The Lubricating oil system performs three basic functions: It reduces friction between rotating and fixed elements, It removes heat from the bearings and In mechanical hydraulic governing systems, it is used as a hydraulic pressure fluid.

Figure shows a typical turbine lubrication system. Majority of oil is stored in a Lube oil tank. Different pumps as described below take suction from pump and discharge oil for bearings.

Main oil pump

The main oil pump is the one that delivers all the oil requirements for the turbine-generator at high pressure during normal operation. It is direct-driven from the turbine shaft and may be located at either the turbine or generator end of the shaft. Because the main oil pump is and attached pump, it runs at turbine shaft speed. During startup and shutdown, the main oil pump is not turning fast enough to deliver the required flow so auxiliary pumps are used.

Auxiliary oil pump

The auxiliary oil pump has two functions. The first is to operate during the startup and shutdown when the main oil pump is not running and second is to act as a standby during the main oil pump failure.

Emergency oil pump

The time required for a turbine to run down from operating speed to a stop is typically from 20 to 45 minutes. If the bearings did not receive lubrication during this period, they would rapidly overheat and be destroyed. The only method of protection is to provide a sufficient number of alternate power supply lube oil pumps to insure all lube oil flow is not lost. The auxiliary lube oil pump is normally backed up with ac and dc emergency lube oil pump. This pump is automatically started from a pressure switch in the lube oil supply header to the bearings.

Jacking oil pump

When the heavy turbine-generator shaft is at rest, It will squeeze the oil film from under the shaft at the bearings. If the shaft is then rotated, there will be metal-to-metal rubbing until the oil can work its way underneath. To avoid this situation, the jacking oil pump injects oil at high pressure into the bearing at the bottom of the shaft. This tends to lift or jack the shaft a few hundredths of a millimeter off the bearing so that there will be no metal-to-metal contact.

Equipments used in Turbine lubrication system

Type	AOP
Pump Sr. No.	110588
Pumping Head	102.30 m
Rate of flow	105 m^3/hr
Radial SKF	6311
Thrust SKF	2 X 7312
Casing Hyd.Tst	63 Kg/cm^2
Speed	2955 rpm

Auxiliary Oil Pump at P&BS 2 STB

Type	DC-EOP
Pump Sr. No.	110582
Pumping Head	45.45 m
Rate of flow	30 m^3/hr
Radial SKF	6309
Thrust SKF	2 X 7310
Casing Hyd. Tst	29 Kg/cm^2
Speed	3000 rpm

DC Emergency Oil Pump at P&BS 2 STB

Type	AC-EOP
Pump Sr. No.	110581
Pumping Head	45.45 m
Rate of flow	30 m^3/hr
Radial SKF	6309
Thrust SKF	2 X 7310
Casing Hyd. Tst	29 Kg/cm^2
Speed	2920 rpm

AC Emergency Oil Pump at P&BS 2 STB

CONDENSER

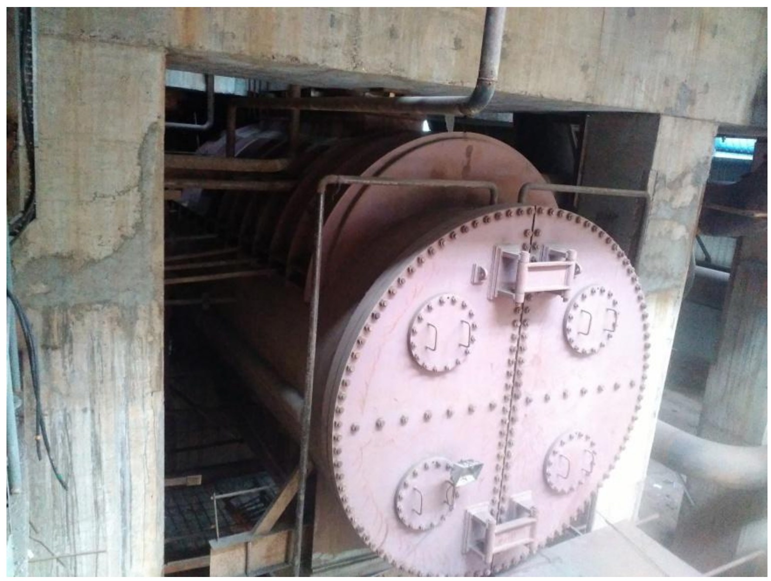
The condensers, as the name suggests are used for condensing the steam coming out of the turbine. The condenser is a heat exchanger where the saturated or wet steam loses its latent heat to form saturated liquid also known as condensate. The heat is provided by cooling water.

The condensers can be classified as

- **DIRECT CONTACT CONDENSERS.**
- **SURFACE CONDENSERS.**

Direct contact condensers are those where there is direct contact between the cooling medium and the steam. As shown, cooling water is sprayed over the turbine exhaust and the condensate is then pumped to the feedwater heaters. Some amount of this condensate is taken to the cooling tower where it is cooled and then again taken for spraying.

Most large scale power plant use surface condensers. They are essentially shell and tube heat exchangers. Cooling water flows through the tube side and steam is condensed in the shell side.



62.8 T/hr Surface Condenser at P&BS-2 STB

The condensate is collected in a hotwell and then taken through the Condensate Transfer pump.

Specifications of Shell and Tube Condenser at STB – PBS 2

No. of Tubes	5450
Steam quantity (normal)	62.8 T/hr
Steam quantity (maximum)	104.45 T/hr
CW Temperature Inlet/outlet	34°C/43°C
CW quantity	6350 m^3/hr
CW area	2600 m^2
Hotwell Capacity	3 minutes
Cleanliness factor	0.85
Length of tubes	6990 mm
Total length of condenser	9500 mm

Specifications of Gland Steam Condenser at STB - PBS 2

Type	Two pass
Year of Production	2013
Serial No.	05910
Design pressure	20°C
Design Temperature	100°C
Test Pressure	26°C

STEAM JET AIR EJECTOR

The **Steam Jet Air Ejector** is used to remove non condensable gases and air from the condenser shell.

Condenser works under vacuum condition and so some leakage of air takes place. Air leaks through the condenser shells through flanges. Some air also comes with the steam which has leaked through the exhaust end of the turbine along the shaft. The air affects the condenser badly as it reduces the heat transfer and the condenser pressure which affects the overall performance of the powerplant.

The pressure in the condenser is approximately constant, and the steam and the air enters the condenser in fixed proportions when steady conditions prevail. As the steam is condensed, the partial pressure of the remaining steam decreases and hence the partial pressure of the air increases to maintain the same total pressure. At reduced pressure, the steam has the saturation temperature which is below that of the incoming steam. Hence condensation proceeds at progressively lower temperature.

Most of the condensation is carried out in the main banks of tubes and the air is drawn over another smaller bank which is shielded from the main bank by a baffle and is called the air cooler. Here, further condensation takes place at a lower temperature and thus there is saving in the feedwater as well as in the air ejection load. The air cooling tubes are at the centre of the condenser and air is removed from this section.

A steam ejector basically comprises of three (3) elements: a nozzle, a mixing chamber and a diffuser.

A high pressure motive fluid, typically steam, enters the steam ejector and passes through the nozzle. Through this nozzle, its velocity increases and consequently low pressure exists at that point on nozzle. This low pressure draws the suction fluid, typically air, into the mixing chamber where it mixes with the motive fluid. The mixture then passes through the diffuser. There, the mixed fluid expands, its velocity is reduced and its pressure is increased, resulting in recompressing the mixed fluids by converting velocity energy back into pressure energy.

Two stage SJAE at PBS-2 STB

There are basically two types of steam ejectors: **single-stage and multi-stage**. In PBS, multi-stage steam jet air ejector is used. The motive fluid being PRDS steam enters the nozzle and expands and sucks the air steam mixture. This mixture then passes through 2 condensers namely Intercondenser and aftercondenser. The condensate pumped from the condensate extraction pump is used to exchange heat. This has 2 advantages. The first one being that the steam jet air ejector works as a feedwater heater for heating the condensate and hence reducing the amount of heat to be supplied by the boiler. The second advantage is the removal of air from the condenser. After the heat exchange, the air is discharged to the atmosphere.

Specifications of Steam Jet Air Ejector in STB – PBS 2

Type	**SJAE C5/380**
Serial No.	**03959**
Year	**2012**
Steam Quantity	**650 kg/hr**
Rated Steam Pressure	**13 atm G**
Rated Steam Temp	**350° C**

DEAERATOR

An open feed water heater or deaerator is used to heat feedwater by direct mixing with steam source.. In STB unit, PRDS steam is used for heating the feedwater. A Dearetor is used to remove dissolved gases from the feedwater.

The presence of dissolved gases like oxygen and carbon dioxide in water makes water corrosive, as they react with metal to form iron oxide.

The solubility of these gases decreases with increase in temperature and becomes zero at the boiling point or saturation temperature. These gases are removed in the deaerator where feedwater is heated to the saturation temperature using the steam from PRDS. Due to the contact, the steam condenses and the feedwater is heated to the saturation temperature. Dissolved oxygen and nitrogen gases are released and are vented out.

Specification of Dearator Feed Water Storage Tank

Equipment Name	Feed Water Storage Tank
Contractor	Alied Energy Systems Pvt. Ltd.
Client	SAIL, Bhilai Steel Plant
Code	ASME Sec VIII, DIV.1/IBR 1950
Design Pr.	5.5Kg/cm^{2}g
Design Temp.	200°C
Operating Pr.	3.85Kg/cm^{2}g
Capacity	175.7m^3
Hydro Test Pr.	8.25Kg/cm^{2}g
Vessel Id	3900
Vessel Height	4391 mm
Year of MFGR.	2013

CIRCULATING WATER SYSTEM

The circulating water system supplies cooling water to the cooling tower and other heat exchangers for the purpose of extracting heat from the system. The cooling water can flow through condensers in two methods

- Once through system
- Closed loop system

Once through systems are used where there is large storage of cooling water example river. Water is taken from a natural body and is used for heat extraction and then again discharged back to the natural body.

In Closed loop system, warm water from condenser is passed through a cooling device like cooling tower or a spray pond and the cooled water is again pumped back to the concerned heat exchanger. Closed loop systems are universally preferred.

COOLING TOWERS

Cooling towers are the devices that take heat from the cooling water to cool them for condenser heat removal. The heat is rejected to the atmosphere. The cooling towers can be further divided as Wet type and Dry type

Wet cooling towers

Wet cooling tower have showers that sprays hot water over horizontal packing. The outside air enters the tower through louvers on the side of the tower. The water evaporated is directly proportional to cooling. Cold water is collected in a concrete basin and is pumped again to the condensers.

The minimum temperature to which water can be cooled is the adiabatic saturation or wet bulb temperature of the ambient air. At this temperature, the air is 100 % saturated and cannot absorb more moisture.

A cooling tower is specified by

Approach (A) = (Exit Temp of C.W.) - (WBT of ambient air)

Also the cooling efficiency is defined as

$$\eta_{cooling} = \frac{Actual\ cooling}{maximum\ possible\ cooling}$$

BOILER

Boilers or Steam generators are used to generate steam at desired rate and desired pressure and temperature by burning fuel in its furnace. They can be classified as fire tube or water tube boilers depending on whether the hot gas or water is present in the tubes inside the boiler.

Fire Tube Boilers

Earlier designs include fire tube boilers suitable for small steam requirements. They can be externally fired or internally fired. The externally fired is the one in which furnace is outside the boiler shell. The products of combustion flow through the tubes which are immersed in a shell containing water As the flue gases flow through the tubes, heat is transferred from gas to water and water is converted to steam. In internally fired fire tube boiler, the furnace is present inside the shell containing water. Combustion gases flow through the pipes and let out to the atmosphere. These gases exchange the heat with the water present in the shell. The major shortcoming of fire tube boiler is that the pressure limitations are inherent in its basic design. The steam present in the drum exerts hoop stress on the shell and larger the shell, larger is the stresses induced and to increase the pressure carrying capacity, the thickness has to be increased which increases the manufacturing cost.

Water Tube Boilers

Modern boilers are mostly water tube boilers. These were developed to permit increases in boiler capacity with reasonable metal stresses. Since water tube boilers have water flowing in small tubes, the pressure carrying capacity of the tubes being higher, they are used to generate high pressure steam. The water tube boilers can be further divided as straight tube or bent tube boilers.

Modern Boilers

Figure shows a typical configuration of a modern boiler. The main parts of a boiler are Economizer, Boiler Drum, Water Walls, Furnace, Convective Superheater, Radiant Superheater, Pendant Superheater, Desuperheater, Reheaters, FD Fan, ID Fan, Electrostatic Precipitator,Air Preheater.

Economizer is the first step in the steam generation process. The feed water from the boiler feed pump enters the economizer where it is heated by the hot flue gases. The hot flue gases leave burner and travel through the furnace to the chimney and exchanges its heat from different heat exchangers in its way to the exhaust chimneys.

After getting saturated, the feed water is taken to the **Boiler drum**. The purpose of boiler drum is to evaporate the feed water or provide latent heat. The saturated water from the boiler drum comes down via **Downcommers** and is then passed through **water walls (Risers)** which are number of evaporation tubes spaced all around the walls of the furnace and is used to take away the latent heat using the heat exchange from the hot flue gases. The flow of the feed water can be natural circulation by the density difference between the water in the riser and downcommers or when the pressure is higher, the circulation pump is used to provide the flow as the density difference is not enough to cause natural circulation. The mixture of saturated liquid and steam then enters again to boiler drum where the steam and the liquid are separated and the steam goes to the superheaters.

A **Superheater** is a heat exchanger in which heat is transferred in a saturated steam to increase its temperature to the desired value. In modern boilers, more than 40% of the heat absorption takes place in superheaters. Superheaters are commonly classified as either convective, radiant or pendant supreheaters. The **Convective superheaters** are often termed as primary superheaters where the saturated steam from the drum is admitted. After passing through the convective superheater, the steam proceeds to the **Radiant superheaters** where the heat exchange between the flue gases and the steam is mostly due to radiation. As the heat exchange is due to radiation, the amount of temperature increase is generally more than what is required so the steam is desuperheated in **Desuperheaters**. The desuperheater is a direct contact type and the tapping from the boiler feed water is taken and sprayed over the steam to desuperheat it. The steam is then passed to **Pendant superheater** where the steam is finally heated to the desired temperature. There heat is transferred partly by convection and partly by radiation.

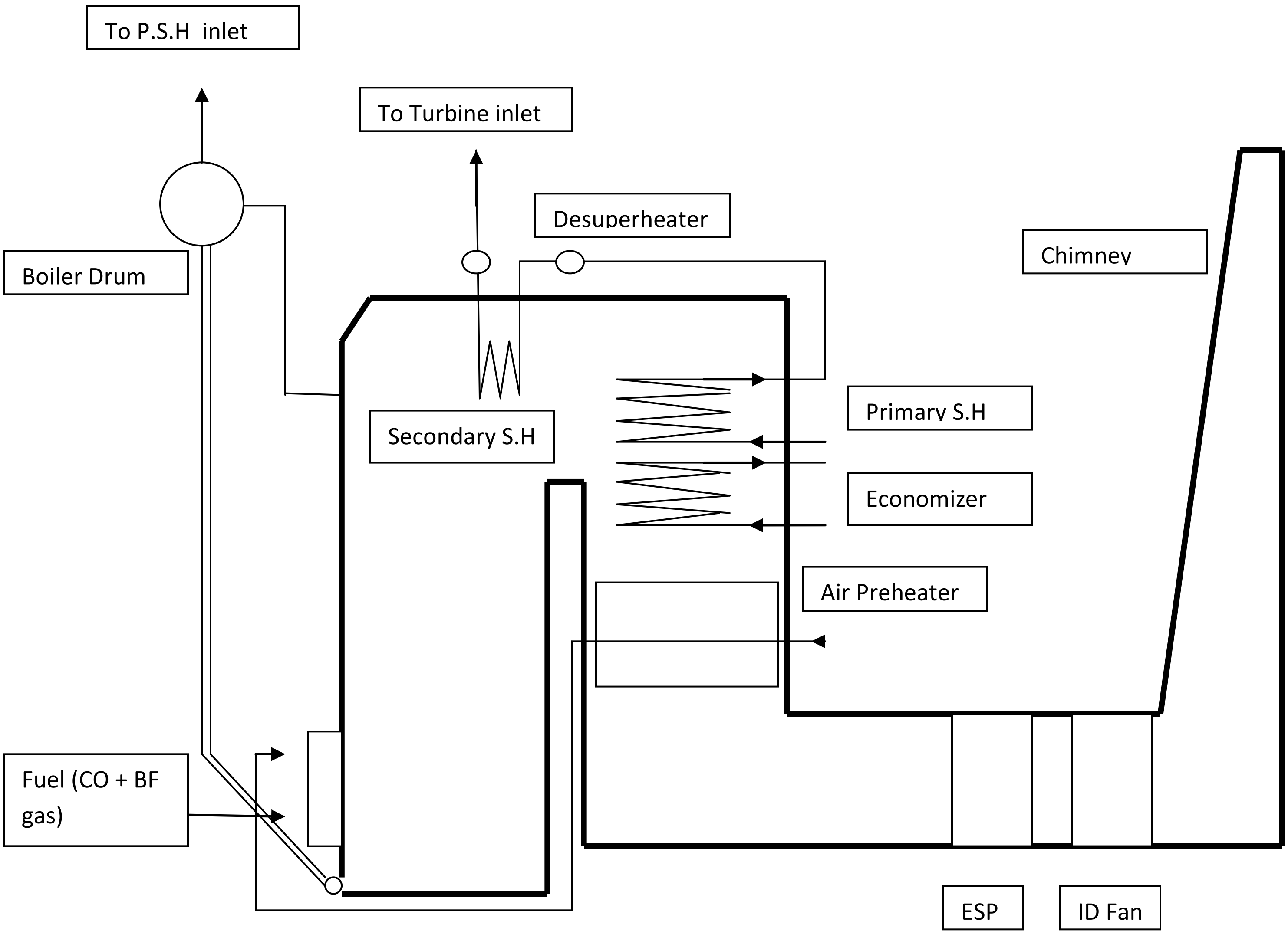
The flue gases are produced in the burners by burning the mixture of gases and preheated air. The gases contain mixture of BF (Blast Furnace gas), CO (Coke oven) gas, LDO (Light diesel oil) gas. The air is preheated using the **Air Preheater.** The air is sucked through the **Forced Draught** fan and then passed through the Air Preheater where the heat exchange takes place between the flue gases and the air.

The flue gases after passing through the air perheater then passes through the **Electrostatic Precipitator** where the dust particles are precipitated and the **Induced Draught** Fan then takes it to the atmosphere via **chimneys.**

Specifications of Boiler in PBS – 2

Heating area of Economizer	3100 m^2
Heating area of Superheater	967 m^2
Heating area of Water walls	1005 m^2
Heating area of Evaporators	1240 m^2
Total heating area	6312 m^2
Rated capacity	150 T/hr, 383 Mpa, 450° C
Design Fuel:	
BF gas	3245 kJ/Nm^3
BOF gas	7531 kJ/Nm^3
CO gas	16246 kJ/Nm^3

FLOW DIAGRAM OF BOILER



CONCLUSIONS

The Power and Blowing Station is one of the most important station of Bhilai Steel Plant. The production of cold air blast is carried out in STB unit and is taken to the various blast furnaces for further conversion to the hot air blast. The waste gases from the blast furnaces and other units mainly coke oven are used as fuel to produce the cold air blast thereby reducing the fuel requirement and hence the overall efficiency of the plant. The project tries to explain various processes and equipments used in the production of cold air blast for the blast furnace. The various equipments for example Boiler, Condenser, Turbo-Blowers, Deaerator, Steam jet air ejector, lubrication system etc. have been studied.

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