

POWER GENERATION PLANT

An increasing number of Industrial consumers are considering the option of setting up their own Captive Power Plant.

In most of the cases co-generation of Power will not only reduces the environmental pollution but also reduce strain on the company's economy.

The present scenario therefore not only favors, but also warrants adoption of co-generation system in Plants to make them more economical and to ensure clear environment.

Sustainability of a Power scheme is decided by viability of technology, adaptability for integration into the existing infrastructure economic competence and environmental acceptance, co-generation of Power utilizing the Waste heat is an attractive proposition for Plants, thereby reducing green house emission.

In turn co-generation assumes greater significance in the Indian context in view of the Power shortages in many states, which results in production losses and high-energy consumption apart from increased dust losses due to unstable operations.

The industry can mitigate the problem of Power shortage and poor quality of Power to a considerable extent by adopting co-generation system based on Kiln Waster heat.

POWER GENERATION FROM WASTE HEAT LIBERATED FROM ROTARY KILN

It is to highlight that out of total heat generated from Coal and reduction, in Coal based D.R. Plant, only 35% heat is used in reduction, and the balance goes as Waste. This is a colossal Waste of energy. This scenario not only presented an opportunity to device ways and means to extract the heat energy from the Waste gases but have helped Plants to be self-sufficient as far as Power requirement is concerned.

However the heat source for co-generation depends on:-

1. Temperature
2. Mass flow rate and
3. Availability

To recover the sensible heat contained in Waste gases, a Waste heat Boiler is incorporated on Waste heat stream. The Boiler unit generates high pressure, high temperature Steam which will be fed to Turbine to generate electric

Power. The Power thus generated caters to the total electricity demand of Plant, the raw preparation Plant, all utilities, facilities, offices and residential areas. It is possible to exports surplus Power through grid. It is always advisable that the Turbine Generators runs

The Waste gases emanating from the Rotary Kiln at 1000 c and passes through a Waste heat recovery Boiler (WHRB) where these gases are cooled to 200 c and the heat thus recovered is used to generate Steam, which is further used to run Turbine and generate Power.

FLUIDISED BED COMBUSTION POWER PLANT

POWER GENERATION BY USING COAL/CHAR

The main aim of installing the fluidizing bed Boiler is to utilize the by-product of the Kiln i.e. Un-burnt Coal called as Char and fine Coal.

“d” grade Coal and the Coal fines is also being used along with Char.

Due to the burning of Coal/Char a known amount of heat is generated. The heat is then pass through the wall of Boiler tubes. Inside the Boiler tube water is circulating and Steam is generated due to the heat up of water, which runs the Turbine.

TECHNICAL FEATURES OF THE MAIN PLANT

STEAM GENERATING UNIT

1) WASTE HEAT RECOVERY BOLLER

The Waste heat recovery Boiler is used to generate the Steam by utilizing the temperature of flue gas liberated from Kiln.

The heat recovery Steam Generators is a vertical single drum Boiler consisting of Radiant Chamber, Superheater, Evaporator and Economiser.

Exhaust gas from PCC (post combustion chamber) of Kiln enters the Radiant chamber where it gets cooled sufficiently before entering into screen tube section. The gas then passes through the two stage Super heater section, Evaporator section and Economiser section and finally passed into the ESP. I.D. Fan draws the cooled exhaust gas and lets into atmosphere through the Chimney.

The Radiant chamber is to cool the dust laden gas below ash fusion temperature before it enters the screen and Super heater section. This will greatly aid in removal of dust particles in the gas.

Evaporator section has horizontal, inclined, inline tube arrangement with top and bottom headers for easy flow of Steam water mixture. It is connected to the Steam drum through adequately sized down comers and risers, to ensure adequate circulation under all circumstances. The primary purpose of evaporator tubes is to absorb latent heat.

Super heater is of two stage design, primary and secondary, with inter tage Attemperator. Secondary Super heater is preceded by a row of screen tubes to cool the flue gases. An interstate attemperator of spray type is provided between the super heater stages to control the final Steam temperature between the control range of HRSG load.

The spray water is tapped off from the feed line at a point, upstream of the feed control station.

Steam drum is of cylindrical fusion welded construction. It is liberally sized to have adequate Steam and water space. It is provided with two stage

screen separators for effective separation of water from Steam water mixture. The Steam drum is provided with nozzles for water level gauge, vent, pressure gauge etc.

The Economizer receives feed water from the feed pump through feed control station.

The Economizer heating surface blocks are arranged with required soot blowers, access doors and supports.

2) ATMOSPHERIC FLUIDIZED BED COMBUSTION BOLLER

The Steam Generators will be Atmospheric FLuidized Bed, out door, natural circulation and balanced draft type with direct crushed Coal firing. The Steam Generators unit will be sized for about flow at 65 ATA Steam pressure and 490 +/- 5 deg c Steam temperature at MCR with design Coal. This will ensure adequate margin over the requirement of Turbine at 100% MCR to cater for:

- a)Auxiliary Steam requirement
- b)De-aerating of the Steam generating unit

The Steam Generators will comprise Boiler pressure parts like Steam drum, water wall, bed tube sections, Superheating system, De superheating system, Economical system, together with all required Headers, Integral piping, Interconnecting piping, valves, fittings and supports. The complete system of pressure parts tubing, piping and headers will be of seamless construction.

The furnace proper is of natural circulation, balanced draft design suitable for firing the fuels specified.

The bed is provided with three Nos compartments with individual air isolation system for reliable and continuous operation of fluidized bed Steam Generators at continuous MCR load.

The Super heater system (SH) will be of two stage design, in convection and radiant zone to achieve the rated Steam temperature over 60% MCR to 100% MCR load range.

One Interstage De Super heater will be located between the Super heater stages to control the final Steam temperature of $495 \pm 5^\circ\text{C}$ between 60% MCR and 100% MCR load. The De-superheating system will be complete with all required isolating valves, piping insulation and supports, bypass regulating valves, etc.

The spray water will be tapped off from the feed line, at a point, upstream of the feed control station.

Economizer is of plain tubular, in-line counter flow and drainable type construction. Air heater of multi tubular recuperative type will be located at the downstream of economizer with gas flow inside the tubes and air flow over the tubes.

Boiler will be equipped with fluid bed combustor consisting of complete

system of fuel transportation from the bunker to the fluidized bed considering combination firing, twin bunker design is envisaged. One bunker is utilized to store Coal and the other for Char. Each bunker is provided with three outlets.

The outlet of bunker is connected with pocket feeders with variable frequency drive. The fuel flow rate will be controlled by varying the speed of the pocket feeder.

The outlet of pocket feeder is connected with drag chain feeders to interconnect the bunkers. Fuel from drag chain feeder will be taken to the air mixing venture and it will be sent to the furnace using high pressure air from primary air fan.

The fuel from the feeding points will be pneumatically transported through fuel feed pipes to the fluidized bed. A damper will be provided in the air ducting of each bed section. The feeding points will be located in the bed for uniform fuel distribution.

The Boiler will be equipped with each one no. Fo fan and i.d. Fan each designed for 100% mcr capacity and two nos. Pa fan each designed for 100% mcr capacity.

The Boiler unit consists of three (3) 100% capacity, horizontal, multistage, centrifugal type ac electric motor driven Boiler feed pumps. Deaerator feed storage tank outlet will be inter connected to provide a common suction

header to Boiler feed pumps to supply feed water to the economiser.

The air from the forced draught fan will pass through air heater & air box.

The combustion air will assist the combustion as well as the fluidization. In the proposed under bed system a small quantity of air which is tapped from the total combustion air will be boosted by a primary air fan and will be used to transport the fuel pneumatically to the furnace.

The Boiler will be provided with all required base frame steel work of sufficient height, with required foundation bolts, etc. The supporting structure for Boiler, Economizer & air heater will be from operating floor level onwards.

The required structural columns, frame work for ducting and piping, equipment, stair cases up to Boiler drum level, will be provided with liberally sized stairs and walkways.

The Steam drum ends will be provided with independent local platform of adequate size. In addition, pipe supports, hangers, duct supports, etc., will be provided for the complete systems covered in this specification.

3) DEAERATOR & DEAERATOR STORAGE TANK

Boiler unit will be provided with a constant pressure spray-cum tray type de-aerating heater with a de-aerator storage tank with minimum effective capacity and initial heating facility. Storage tank will be interconnected to provide a common suction header for Boiler feed pumps. De-aerator will be designed to deaerate all the incoming condensate and drain flow to keep the oxygen content of the condensate below the permissible limit. Deaerator will be located at suitable elevation to provide sufficient NPSH for the Boiler feed pumps.

4) ELECTROSTATIC PRECIPITATOR

In the proposed Captive Power Plant, the fbc Boiler unit has one (1) number of electrostatic precipitator. The ESP having three (3) working fields with collection efficiency of around 99.8%. The outlet dust concentration from the ESP will be limited to $100\text{mg}/\text{nm}^3$ with one field out as per. The latest requirement of pollution control board. Each ESP will be provided with ash

hoppers having capacity suitable for storing ash collected in at least one (1) shift operation of the Boiler at 100% mcr.

5) STEAM TURBINE

The Steam Turbine is horizontally split, impulse cum reaction type, multistage, condensing type unit with uncontrolled extraction for regenerative feed heating. The Turbine will be designed for main Steam parameters of 65 ata pressure with temperature 490 +/- 5 deg c at emergency stop valves of Turbine and exhausting against condenser pressure of 0.095 ata.

The turbo - Generators set will be designed for a maximum throttle Steam flow at Turbine valve wide open (v.w.o) condition of 105 % of Turbine mcr condition.

The Steam Turbine will receive the Steam supply from main Steam header through emergency stop valve and governing valves all essential controls and safety interlocks will be provided.

The Turbine will be complete with condensate pumps, air ejectors or vacuum pumps with standby system, motor operated vacuum breaker valve, gland Steam condenser, deaerator, Steam and other miscellaneous piping and

valves associated with the Steam Turbine, including all control stations and all instrumentation.

The Turbine auxiliaries shall comprise the following –

- a) Seals
- b) Governor
- c) Turing gear
- d) Turning gear oil pump
- e) Turbine lube oil system with centrifuge and vap.extractor
- f) Jacking oil pump
- g) Oil coolers

Electro - hydraulic governing system backed up by hydro - mechanical system ensures stable operation under grid fluctuation.

Self contained lubricating oil system of ac and dc motor driven lube oil pumps for supplying oil to Turbine and Generators bearings and to the governing and control system.

PLANT FEATURES

MECHANICAL SYSTEMS

STEAM

Boilers will be operating in parallel and Steam at 67 ata and 495+/- 5 from super heater of each Boiler will be fed into the common header for supply to Steam Turbine.

The Steam will condense in water cooled condenser and returned to deaerator. Extraction Steam stages provided for regenerative feed water heating.

The auxiliary Steam will be fed from main Steam system through a pressure reducing valve and will supply Steam to ejectors, Turbine glands.

FUEL HANDLING SYSTEM

The Coal and Char required for fbc Boiler is fed by means of Coal handling system which contains ground hopper, crushing unit, screening unit.

The raw Coal/Char which is stored in yard are unloaded in the ground hopper by suitable movers. The ground hopper contains vibratory feeder and conveying belts. The Coal/Char is transferred to crushing unit through belt conveying system

The raw Coal/Char is crushed by crusher. The sized Coal/Char is transferred to screen house for screening. Coal/Char of size +6mm which is required by the afbc Boiler operation is screened and fed to the Boiler bunker. The Coal/Char which is of over size is separated by screen and it will be returned to crusher house by Coal return conveyor.

ASH HANDLING SYSTEM

The ash handling system envisaged in this project is to collect the ash from Boilers, ESP and conveying it to the ash silos. The ash is conveyed by means of compressed air. The ash handling system complete with collecting vessels, conveying pipe lines, ash silos.

In the WHR Boiler the ash will be collected from radiant zone, Evaporator /Economizer zone and Economizer zone. The ash is collected at below the hoppers of these zones by master and slave vessels and conveying the ash to the ash silos through ash conveying pipe lines.

In the AFBC Boiler the ash collecting areas are air pre heater,

Economizer zones. In the ESP the fly ash is collected at field hoppers and it will be transferred to ash silos. The ash silo shall be equipped with bag filter, ash conditioner. The ash will be disposed to yard outside by truck.

COMPRESSED AIR SYSTEM (INSTRUMENT/SERVICE)

To cater for the Plant compressed air requirements it is proposed to install air compressor for the instrumentation air system and Plant service air. It is Rotary, screw type non-lubricating type, complete with inter cooler, after cooler. The compressor will be oil free type. The air dryers and air receivers will be provided for the instrument air and another one air receiver for the

service air. The flow of instrument air will get priority over the service air and will be controlled through a control valve.

WATER SYSTEM

The water plays an important roll in the Power Plant. In the Plants the raw water is taken from the bore well/river which are located in various locations nereby the site. The raw water may contain unwanted foreign matters, suspended solids, dissolved solids and pathogenic contents so the raw water should be treated at ro/dm Plant and fed to Boiler and softener.

In RO/DM Plant the raw water is treated at various stages to remove the contaminants in the raw water. The RO/DM Plant consists of multi grade filter, softener, ultra filtration, chemical dosing systems, RO systems, mixed bed.

The raw water is fed to multi grade filter (MGF) to remove suspended particles in the raw water. The water from multi grade filter will be passed through the softener for removal of hardness. Minerals like calcium, magnesium, will be removed in softener with the exchange of sodium. The softener water is fed to cooling water make up requirement and ultra filtration unit for further treatment.

The filtered water is fed into the ultra filtration system to remove colloidal contents like silica, iron, aluminum and manganese in water causing fouling, scaling and poor performance of the Plant.

The treated water from ultra filtration unit is fed to reverse osmosis system in which a synthetic semi-permeable membrane is used to separate water

from dissolved solids by applying reverse osmosis principle.

The water from the ro unit is further passed through the mixed bed unit wherein the total dissolved is further removed with cat ion and anion resin in the mixed form to achieve the conductivity less the 1.0 ms/cm. This treated water will be used for Boiler feed. The chemicals like HCL, NAOCL and SMBS are dosed with the water at various stages to control ph of water, and de-chlorination.

The de mineralized water from RO/DM Plant is stored in DM water tank and the water is fed to De-aerator for Boiler make up and Boiler initial filling by dm water transfer pump. The water from softener unit is fed to cooling tower for cooling water make up.

COOLING WATER SYSTEM

The cooling water for the surface condenser will be transferred by cooling water pumps from cooling tower basin. The cooling water for the auxiliary equipments such as oil cooler, alternator, Boiler feed pumps, sample coolers & ash handling system, etc. will be transferred by cooling water pumps from cooling tower basin. The hot water return piping will be transferred to the cooling tower for dissipating the heat by the cooling tower.

PIPING

The piping system will complete with Steam piping, cooling water piping and compressed air piping. The Steam from Boiler is fed to the Turbine through common Steam header, the bleed line from main Steam line is taken and connected to the pressure reducer cum de-super heater. The Steam from PRDS station is fed to ejector; gland sealing and de-aerator initial heating purpose.

The water from auxiliary cooling tower will be circulated to cool the equipments like alternator, oil cooler, Boiler feed pump, sample cooler, and ash vessels through cooling water pipe lines. The cooling water in cooling tower basin is pumped by cooling water pump, and fed to the equipment, and then the hot water from equipments is returned to cooling tower by cooling water return line.

The atmospheric air is compressed by the compressor; the compressed air is used for instruments and other service purposes. The instrument air is further treated with dryer to remove moisture in compressed air and store it in a separate reservoir. The service air is stored separately in another reservoir. The instrument air is fed to instruments in various locations at site by instrument air piping. The service air is fed to ash conveying vessels and other purposes like cleaning through service air piping.

CRANES

To handle the main turbo - Generators set and its auxiliaries housed in the TG building EOT crane will be provided. The crane will move entire TG floor to handle the equipment during maintenance.

VENTILATION AND AIR CONDITIONING SYSTEM

For proper functioning of the equipment, controls and accessories as well as to provide the right environment for operation and maintenance of the Plant, adequate ventilation and air-conditioning system will be provided for the Plant as described below.

Main control room and a few offices in the Power house will be air-conditioned. ESP controls will be located in the main air-conditioned control room.

Battery room (dust proof construction fan & flame proof motor) will be ventilated by exhaust fans.

A/c Plant room, pump house and dm Plant will be provided with ventilation system.

CHEMICAL LABORATORY

A chemical laboratory is envisaged for the Plant. This will have necessary equipments and facilities to test and analyze Steam, water, fuel etc. Require to ensure satisfactory operation & maintenance of Steam Generators.

THERMAL INSULATION

Insulation will be provided wherever necessary to- contain heat loss from the. Equipment, piping duct and to ensure protection to personnel. Insulation will be held by adequate cleats, wire nets, jacket etc, to avoid loosening. Insulation thickness will be so selected that the covering jacket surface temperature does not exceed the surrounding ambient temperature by more than 15 deg c.

TURBINE OIL PURIFICATION SYSTEM

A Turbine oil purification system will be provided for the unit consisting of centrifuge type oil purifier, indirect oil heater. Dirty & clean oil pumps and polishing filters. This will be required to condition the Turbine oil continuously on by pass mode, in order to remove water and other impurities from the system to maintain the Turbine oil at the optimum condition.

CHIMNEY

RCC chimney envisaged with this Power Plant for AFBC Boiler. The flue gas from afbc Boiler contains sulphur content. If the sulphur is exhausted in the atmosphere it will cause severe environmental problems. So the flue gas should be exhausted at safe height as per pollution control norms. The RCC chimney is suitable for this purpose.