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Overview of Thermal Power Plant

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ABSTRACT

A significant source of coal-based electricity production is thermal power plants. We shall comprehend a general review of a thermal power plant, including all of its components, including a boiler, turbine, etc. An overview of the thermal power plant is crucial for both maintenance and better operation. A good design should include the following: site selection, cost estimation, boiler, turbine, electrical generator, and cooling system selection. Compared to the transportation of coal, the transportation of electrical energy is more cost-effective. Because thermal power plants are very cost-effective for us, we must thus exert more effort in this area.

1. INTRODUCTION

A power plant that converts heat energy into electric power is called a thermal power station. The Ranking Cycle will determine this. Steam is created when water is heated, and this steam rotates the steam turbine that powers the electrical generator. The steam is condensed in the condenser after it has gone through the turbine.

2. CONCEPT OF HEAT AND WORK

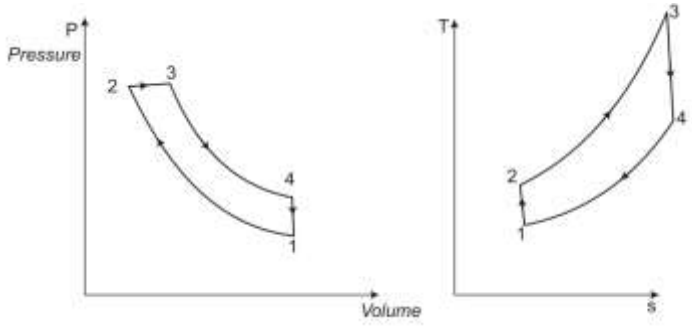
The fundamental forms of energy with which thermal power stations are mainly concerned are heat and work. Heat produces work and then work is further converted into electrical energy through some form or energy conversion cycle. The term heat and work designates two fundamental forms of energy flow. Heat flow involves a quantity aspect and the temperature available. A heat cycle receives a heat flow at a given temperature pattern, to convert part to work and discard the remainder to the receiver. A cycle which uses heat in an ideal or reversible manner to produce work from the available energy, is called an ideal cycle.

The First Law and the Closed System

The open system is one in which mass crosses the boundaries. A closed system is one in which only energy and not mass crosses the boundaries. A third system of some interest is the isolated system, a special instance of the closed system. It is one in which neither mass nor energy crosses the boundaries but energy transformations may take place within the boundaries. Because mass does not cross the boundaries in a closed system, the potential, kinetic, and flow energy terms drop out in the first law equation.

The Cycle

In order to convert forms of energy, particularly heat is to work on an extended or continuous basis, one needs to operate on a cycle. The process begins at one state of the working fluid and ends at another. A cycle, on the other hand, is a series of processes that begins and ends at the same state and thus can repeat indefinitely, or as long as needed. An example is the ideal diesel cycle, shown as the P-T and T-s in fig



It is composed of an ideal and adiabatic compression process 1-2, a constant-pressure heat addition process 2-3, an ideal and adiabatic expansion process 3-4 and a constant volume heat rejection process 4-1 which returns the cycle back to 1. Because the beginning and the end of the cycle is 1, thermodynamic cycle is a closed loop system where, $\Delta U = U1 - U1 = 0$ and first law for this and all other cycles becomes

$\Delta Qnet = QA - |QR| = \Delta Wnet$ (for a cycle).

The Second Law of Thermodynamics

The first law of thermodynamics was one of conservation of energy, declaring that all forms of energy are convertible to another, the second law puts a limitation on the conservation of same forms of energy to others. Second law does not negate the equivalence of conversion of these two, only the extent. Work is a more valuable commodity. It can be completely and continuously converted to heat. The opposite is not true. Heat cannot be completely and continuously converted to work. The portion of heat that cannot thus be converted to work, called unavailable energy, has to be rejected as low grade heat after the work has been done. Thus, while energy is conserved, availability is not.

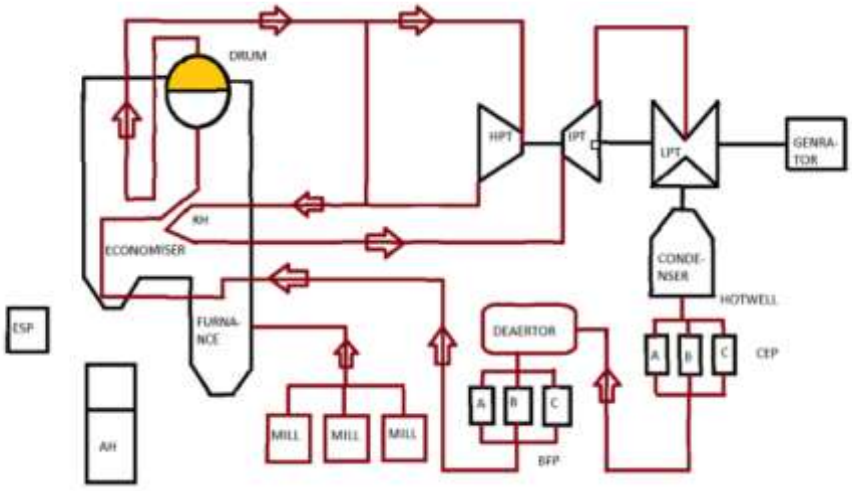
PRINCIPLE

A thermal power station works on the principle that heat is released by burning fuel which produces (working fluid) (steam) from water. The steam so produced runs the turbine coupled to generator which produces electrical energy. A working fluid goes through a repetitive cycle change and this cyclic change involving heat and work is known as thermodynamic cycle. Thus, a thermodynamic cycle is a series of operations, involving a heat source, a heat receiver, a machine and working substance.

WORKING:

FUEL USED

coal kind, stack calories per kilogram: 4450–5500 A boiler is a closed vessel where water is compressed and turned into steam. Type 1 Fire Tube Boiler: In this type, the combustion product travels via tubes that are submerged in water. 2. Water Tube Boiler - In this form of boiler, hot gases flow outside the tube while water circulates inside. Overhung type with natural circulation and tangential firing. There are water tube boilers. In addition to coal burners, oil burners are offered for initial start-up and flame stabilisation. First, initialization involves spraying light oil (diesel oil).



The flame is then stabilised using heavy oil (speed diesel oil). The fundamental component of a boiler is the furnace, where combustion transforms the chemical energy in the fuel into thermal energy. It is a pressure vessel called a boiler drum. Its job is to separate the mixture produced in the furnace walls into water and steam. It offers water storage to keep tubes from becoming saturated. The two sections of the drum are built of carbon steel plates with a thickness of approximately 133–135 m. Boiler drum is 53 metres above ground level. Feed Through feed nozzles, water is delivered to the drum from the economiser. Through downcomers, water from the drum is sent to the water walls.

FANS-

1. DRAUGHT FANS- A fan can be defined as volumetric machine which like pumps moves quantities of air or gas from one place to another. In doing this it overcomes resistance to flow by supplying the fluid with the energy necessary for contained motion.

2. PRIMARY AIR FAN (P.A FAN)- Pulverised coal is directly fed from coal mills to the burner at the four corners of the furnace through coal pipe with the help of heated air coming from P.A FAN. Usually sized for 1500 RPM due to high pressure.

3. FORCED DRAUGHT FAN (F.D FAN)- The combustion process in the furnace can take place only when it receive a steady flow of air. Thus FD FAN takes air from atmosphere at ambient temperature &provide additional draught. Its speed varies from 600-1500RPM.

4. INDUCED DRAFT FAN (I.D FAN)- The flue gases coming out of the boiler are passed to the ESP & then dust free gases are discharged up by the chimney to the atmosphere through the I.D fan.

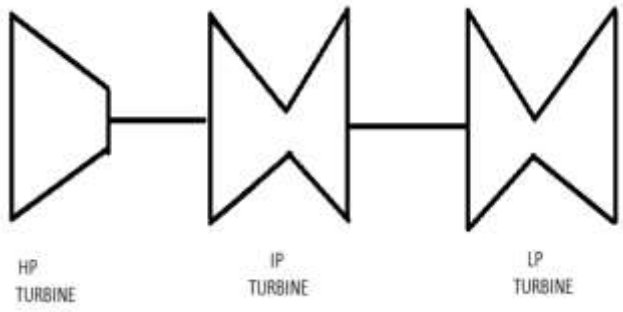
5. ECONOMISER- The flue gases coming out of the boiler carry a lot of heat. An economiser extract a part of this heat from the flue gases and uses it for heating the feed water before it enters into the steam drum. The use of economiser result in saving fuel consumption and higher boiler efficiency but need extra investment. A large no. of small diameter thin walled tube are placed b/w two header. Feed water enters the tube through the other. The flue gases flow outside the tube.

6. AIR PREHEATERS- Air Preheated are employed to recover the heat from the flue gases leaving the economiser and are used to heat the incoming air for combustion. Cooling of flue gases by 20% raises the plant efficiency by 1%. In some places regenerative type of preheated is used. They use a cylindrical rotor made of corrugated steel plate. The rotor is placed in a drum which is divided in two compartments, i.e. air compartment(primary air coming from primary air fan and secondary air for air coming from FD fan with +ve pressure) and flue gases (from economiser with –ve pressure) compartments. The rotor is fixed on an electrical shaft rotating at a speed of 2 to 4 rpm.

7. SUPERHEATER- Super heater steam is that steam, which contains more heat than the saturated steam at the same pressure. A Super heater is a device which removes the last trace of moisture from the saturated steam leaving the boiler tubes and also increase its temperature above the saturation temperature.

8. REHEATER- Reheated are provided to raise the temperature of the steam from which part of energy has already been extracted by HP turbine. This is done so that the steam remains dry as far as possible through the last stage of the turbine. A Reheated can also be convections, radiation or combination of both.

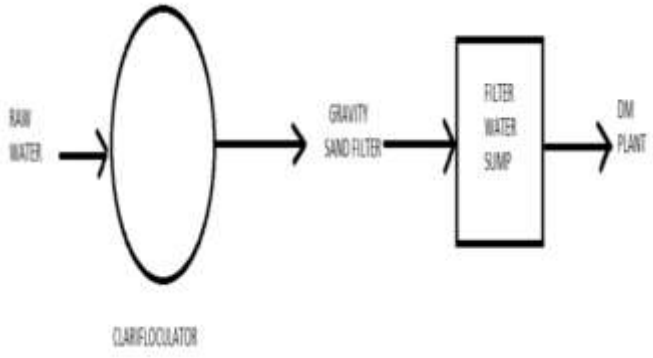
STEAM TURBINE- Turbine is a machine a shaft is rotated steadily by impact or reaction of current or stream of working substance(steam, air , water, gases etc.) upon blades of a wheel. It converts the potential or kinetic energy of the working substance into mechanical power by virtue of dynamics action of working substance.



COOLING SYSTEM

Generator cooling is accomplished using a hydrogen cooling system. Because of its great cooling abilities and low density, hydrogen is commonly utilised as a cooling medium.

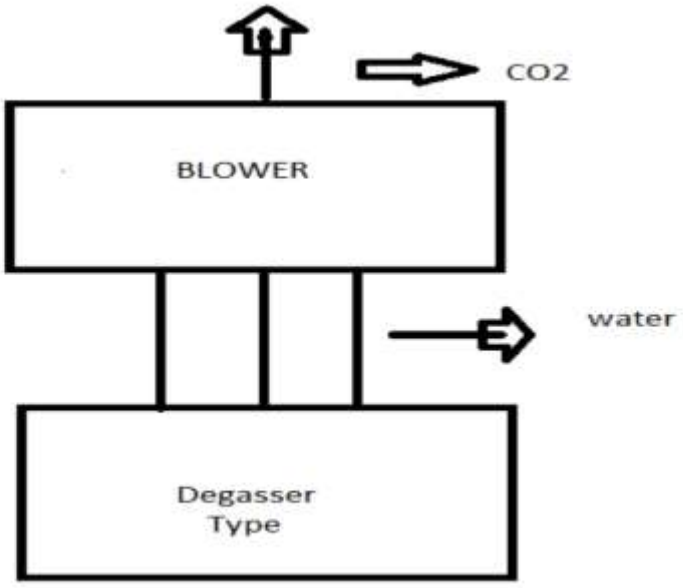
Hydrogen has a 7.3 times greater thermal conductivity than air. Additionally, the transfer coefficient is higher. It can transport heat via forced convection roughly 75% more effectively than air can.



WATER TREATMENT PLANT

The principle problem in high pressure boiler is to control corrosion and steam quality. Internal corrosion costs power station cores of rupees in repair without strict control impurities in steam also form deposits over turbine blades and nozzles.

D.M PLANT (Demineralised Plant) - In this plant process water is fed from all these dissolved salts. Equipment for demineralisation cum softening plant is supplied .This plant consists of two stream with activated carbon filter, weak acid, cat ion exchange and mixed bed exchanger.



As we know, river is the raw water intake for Thermal Power Plant.

The coagulant used in Thermal Power Plant is

a) PAC (Poly ammonium chloride)
b) Chlorine Strong Acid Cat ion Unit- Cationic resin R-SO3H (Gel Sulphuric acid)

2.) C.W PLANT- Circulating water pump house has pumps for condensing the steam for condenser.

3.) B.C.W PUMP HOUSE-Filter water after demineralisation is used for bearing cooling from BCW pump house after passing through strainer and heat exchanger at 38 degree Celsius. The raw water used in ash handling plant and remaining quantity is stored in sumps of BCW Pump House.

SWITCHING GEAR

1.) 220 KV System
2.) Circuit Breaker
3.) Isolators
4.) Current Transformer
5.) Potential Transformer
6.) Lightening Arrestor

Main Control Room

In control room various control are provided simultaneously various measurement are made various relay are provided here. It has

a) Fan Control Desk
b) Fuel Control Desk
c) Steam & Water Desk
d) Turbine Desk
e) Generator Control Panel

EFFICIENCY

Potential energy or chemical energy of the fuel is converted into heat by the process of combustion. Plant efficiency consist of following parts

a) Cycle efficiency
b) Turbo-generator efficiency
c) Boiler efficiency
d) Auxiliary Power efficiency

Cycle Efficiency- Energy available for conversion in work/energy given in boiler as heat. Generator Efficiency-The alternator is very efficient m/c at about 98% efficiency. The losses can be categorised as –

a) Copper and iron losses
b) Wind age losses

Boiler Efficiency-It depends upon=

1) Dry Flue gas loss
2) Wet flue gas loss
3) Moisture in combustion loss
4) Radiator & Unaccounted loss

It means the efficiency of the steam turbine in converting the heat energy made available in the cycle into actual mechanical work.

Conclusion

Thermal power plants are the backbone of the electricity supply system in the United States, generating more than 50% of the electric power. Even if more natural gas-fueled combined cycle power plants and more renewable power-generation facilities will be built, a major portion of electric power will still be provided by coal-fired power plants. The fossil fuel reserves are limited; renewable sources; mainly hydro power plants, supply only about 10% of U.S. electric power. Hydro power plants generate 8% and all other renewable facilities generate 2% of this power.

At present, thermal power generation accounts for approximately 70% of the total amount of electricity produced around the world. However, thermal power generation, which uses fossil fuels, causes more CO2 emissions than other power generation methods. In order to reduce CO emissions per unit power produced, Toshiba Group is developing next-generation thermal power technologies aimed at improvin plant efficiency and commercializing the CO_2 capture and storage system.

To improve the efficiency of thermal power generation, it is of vital importance that the temperature of the steam or gas used to rotate the turbines is raised. Toshiba Group is working on the development of ultra-high-temperature materials and cooling technologies in order to commercialize an A-USC system (Advanced Ultra-Super Critical steam turbine system) more efficient than previous models, which is designed to increase steam temperature from 600°C to above the 700°C mark.

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