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Assignment - 1

Power Plant Engineering
EEN 14255

Q → 1 Explain in brief

(a) Open systems (b) close system (c) - thermodynamics cycle (d) - isothermal process (e) adiabatic process (f) heat engine (g) heat pump (h) entropy (i) enthalpy (j) Second law of thermodynamics (k) use of DM water for generator cooling (l) control of generated power in a coal-based system steam power station

Ans (a) Open system → A system that exchanges both matter and energy with its surroundings (e.g., a steam turbine)

(b) close system → A system that exchanges energy but not matter with its surroundings (e.g., a piston-cylinder with fixed mass of gas)

(c) thermodynamics cycle → A series of thermodynamics process that return a system to its initial state (e.g., the carnot cycle)

(d) isothermal process → A process occurring at a constant temperature, meaning heat transfer occurs to maintain equilibrium

(e) adiabatic process → A process where no heat is exchanged with the surroundings (e.g. rapid gas compression)

(f) Heat Engine → A device that converts heat energy into mechanical work by operating in a cyclic process
(e.g. an internal combustion engine)

(g) Heat Pump → → A device that transfer heat from a lower-temperature source to a higher-temperature sink using external work
(e.g. an air conditioner)

(h) Entropy → A measure of the disorder or randomness in a system indicating the unavailability in a system, indicating the unavailability of energy for useful work.

(i) Enthalpy → the total heat content of a system, defined as the sum of internal energy and product of pressure and volume.

(j) Second law of Thermodynamics → states that total energy/entropy of an isolated system always increases over time, and heat can not spontaneously flow over a colder body to a hotter body.

(k) use of DM water for generator → Deionized (DM) water is used in generators for cooling because it is non-conductive and prevents scaling or corrosion.

(l) control of generated power in a coal-based ~~sys~~ steam power station → the power output is controlled by regulating fuel supply, steam flow to the turbine, and boiler pressure, ensuring stability and efficiency.

(1)-(2) (A) Draw the schematic of a coal-based steam power plant and describe four cycles involved in a power plant

(B) describe three types of hydro power stations. what are the use of each types?

Answer → (2) (A) Below is a schematic diagram of a coal-based thermal power plant showing its major components:

(1) Coal Handling & Boiler: coal is burned to produce heat.
(2) steam turbine → High-pressure steam drives the turbine
(3) condenser → Exhaust steam is cooled and converted back into water
(4) Pump → Pumps water back into the boiler to repeat the cycle

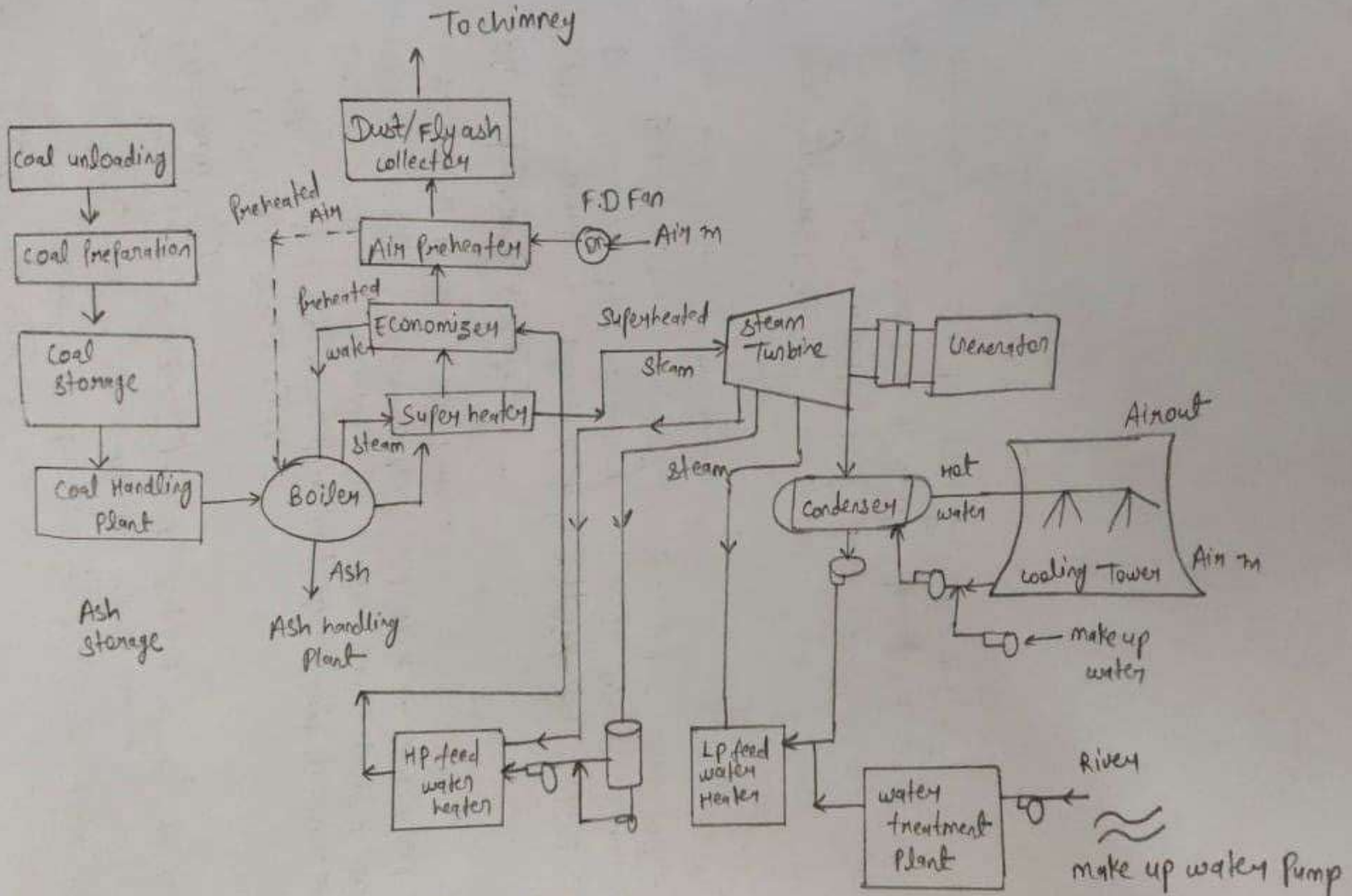


Fig-1 Schematic of a coal based steam power plant

Four cycles involved in a coal-based thermal power plant →

(I) Coal and ash cycle →

Coal is transported to the power plant and stored it is pulverised for efficient coal combustion in the boiler

After burning, ash is collected and disposed of using mechanical or hydraulic system.

(II) Feed water and steam cycle →

water is heated in the boiler to produce high-pressure steam. the steam. the steam drives the turbine, which powers the generator. exhaust steam is condensed in a condenser and recirculated back to the boiler.

(III) Air and flue gas cycle →

Air is drawn in, preheated, and supplied for combustion flue gases pass through heat recovery components like the economizer and air preheater. Gases are finally released through chimney after dust and Pollutant removal.

(IV) cooling water cycle →

Cooling water absorbs heat from steam in the condenser the heated water is cooled in a cooling tower and reused for further Processing in a coal-based thermal power plant.

Ans 2(B) ⇒ Hydropower Stations are categorized into three main types based on their water usage and storage methods.

1. Storage (Reservoir) Hydropower Stations →

Description → These power stations use a dam to store water in a large reservoir. when electricity is needed, water is released from the reservoir through turbines, generating power

Uses → Provides a steady state and controllable electricity supply.
Supports peak electricity demand by adjusting water flow.
Helps with flood control, irrigation and drinking water supply.

2. Run-of-River Hydropower stations →

Description → These plants generate electricity by using the natural flow of a river with minimal or no water storage.
They rely on consistent river flow rather than a large reservoir

Uses → Provides a continuous supply of electricity, depending on river conditions.
Has a lower environmental impact compared to storage hydropower
Suitable for areas with consistent water flow

3. Pumped Storage Hydropower Stations →

Description → These plants have two reservoirs at different elevations. during low electricity demand, excess power is used to pump water from the lower to the upper reservoir. During peak demand, water is released back to the lower reservoir generating electricity.

Uses → Acts as a large-scale battery, storing excess electricity for later use.
Helps balance supply and demand in the electrical grid.
Supports the integration of renewable energy source like wind and solar power.