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Internal Assesment Test – 3

Sub: ENERGY ENGINEERING				Code: 18ME81
Date: 17/06/2022	Duration: 90 mins	Max Marks: 50	Sem: 8	Branch (sections): ME (A,B)

Answer all five questions.

		Marks	OBE	
			CO	RBT
1	Estimate the height of chimney required to produce a static draft of 16 mm of water if the mean temperature of the flue gases in the chimney is 255 deg C and the temp of outside air is 25 deg C. The densities of atmospheric air and flue gases at NTP are 1.293 and 1.34 kg/m^3 respectively.	[10]	CO3	L2
2	Enumerate and explain the steps involved in handling of the coal.	[10]	CO3	L2

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3	What are the different types of cooling ponds and cooling towers?	[10]	CO3	L2
4	Explain with sketch overfeed and underfeed principle of firing coal.	[10]	CO3	L2
5	Explain a typical hydraulic ash handling system, with neat sketch.	[10]	CO3	L2

CI CCI HOD

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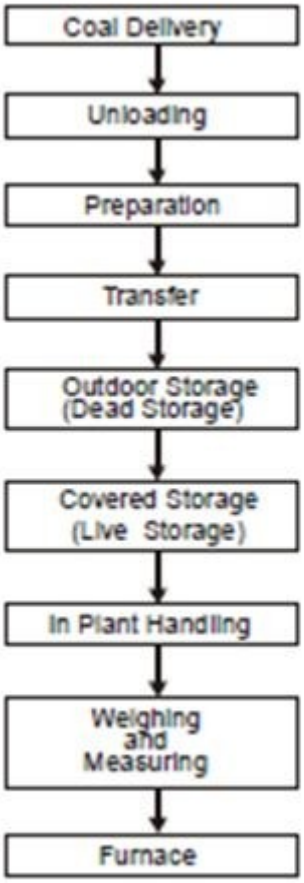
CI CCI HOD

Enumerate and explain the steps involved in handling of the coal.

The coal handling plant needs extra attention, while designing a thermal power station, as almost 50% to 60% of the total operating costs consists of fuel purchasing and handling. Fuel system is designed in accordance with the type and nature off fuel. Plants may use coal oil or gas as the fuel. The different stages in coal handling are shown below.



Steps in Coal Handling.

Coal delivery:The method of transporting coal to a power station depends on the location of the plant, but may be one or more of the following: rail, road, river or sea. Plants situated near river or sea may make use of the navigation facilities.

Unloading:The kind of equipment for unloading depends on how the coal is received. If the coal is delivered in dump trucks and if the plant site is favourable, then there is no need additional unloading equipment. When coal transported by using by sea or rivers unloading bridge or tower and portable conveyors are used.

Preparation:The coal preparation plant may be located either near the coal receiving point or at the point of actual use. The coal preparation plant may include the following equipments a) Crushers b) Sizers c) Dryers and d)Magnetic separators.

Transfer:Transfer means the handling of the coal between the unloading point and the final storage point from where it is discharged to the firing equipment. The equipments used for the transfer of

coal may be any one of the following or a suitable combination there of:a) Belt conveyors b) Screw conveyors c) Bucket Elevators d)Grab bucket Elevators e) Skip hoists and f) Flight conveyors.

Out door storage: Whether the storage is large or small, it needs protection against losses by weathering and by spontaneous combustion. With proper methods adopted even larger outdoor storage can remain safe. In order to avoid the oxidation of coal the compact layers are formed. To avoid spontaneous combustion air is allowed move evenly through the layers.

Indoor storage or Live storage: This is usually a covered storage provided in plants, sufficient to meet day's requirement of the boiler. Storage is usually done in bunkers made of steel or reinforced concrete having enough capacity to store the requisite of coal. From the coal bunkers coal is transferred to the boiler grates.

What are the different types of cooling ponds and cooling towers?

Cooling Ponds

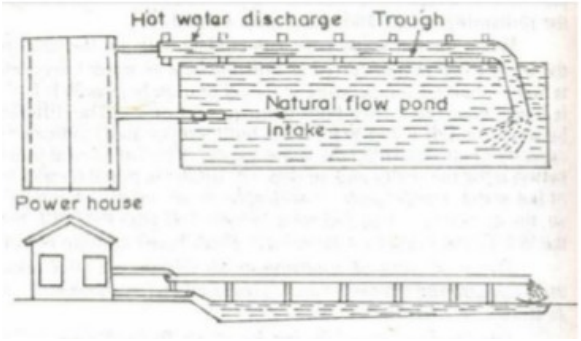
It is sometimes advisable not to locate a power plant where condensing water facilities in the usual form of river are not available. In such cases, the choice goes to spray pond or cooling towers. The spray cooling pond is one of the simplest methods of cooling the condenser water although it is not efficient. The following principles must be adopted for the design of cooling ponds:

- The long dimension should be placed broad side to the prevailing wind.
- Spray nozzles should be placed 1 to 2 meters above the water surface to obtain maximum cooling.
- The nozzle arrangement should be such that there is no interference between the different sprays produced.
- The distributing pipes may be spaced 6 to 7 m apart.
- A sufficient space (15 to 20 meters) should be allowed between the last nozzle and the edge of the pond to prevent excessive spray loss.
- The pressure of 1.5 bar should be used at nozzles for better atomization of water.
- A surface area of 2.5 to 3 m^2 per litre flow of water per second should be provided.

Types of Cooling Ponds

- Natural System
- Directed Flow System
- Single Deck System
- Double Deck System

Natural System: The figure shows a non-directed flow natural cooling pond. In natural flow system, water coming out from the condenser is just allowed to flow into the pond. This system is rarely used now-a-days.



Natural System

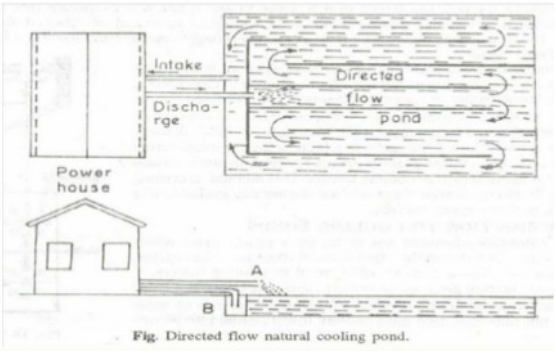
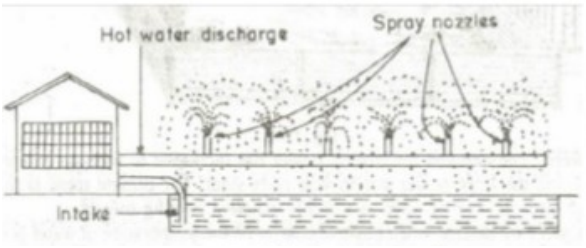


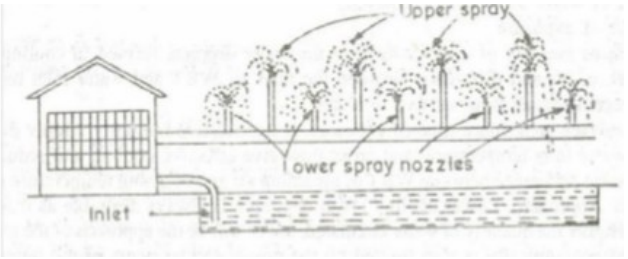
Fig. Directed flow natural cooling pond.

Directed Flow System

Directed Flow System: In a directed flow system, the hot water coming out of condenser enters the middle channel as shown in the figure. On reaching the far end divides into two currents, being directed by the baffle walls so as to traverse the pond several times before uniting at the intake point. The water gets more time and passes over a more surface, so the cooling achieved is very effective.

Single Deck System: In a single deck system, warm water received from the condenser is sprayed through the nozzles over a pond of large area. The spray nozzles are arranged at the same elevation as shown.





Single Deck System Double Deck System

Double deck system: In this system, spray nozzles are arranged at different elevations as shown in figure. Its cooling effect is more than single deck system as water comes in contact with air at lower temperature.

Disadvantages of cooling pond:

- The area required for cooling is considerably large.
- Spray losses due to evaporation and windage run high.
- There is no control over the temperature of cooled water. The cooling effect is reduced with the decrease in wind velocity and if the load on the plant increases, the pond does not respond to the requirement.
- The cooling effectiveness is low compared with cooling tower.

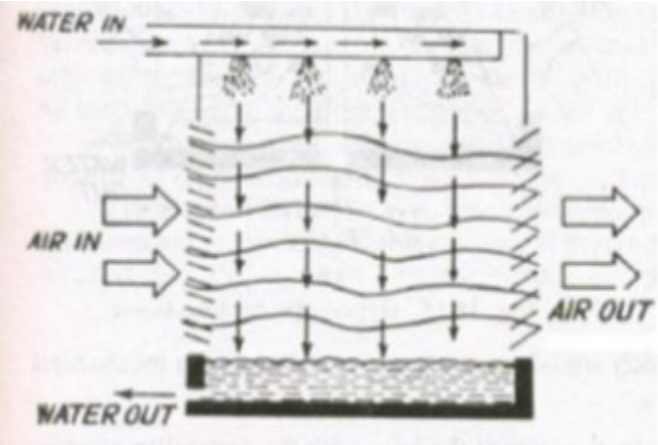
Cooling tower: The cooling towers are desired when positive control on the temperature of water is required, the space occupied by the cooling system is considerable factor and the plant is situated near load centre and far away from the adequate natural resources of cooling water.

Types of cooling tower:

- Natural draft or Atmospheric cooling towers
    a) Natural Draft Spray Filled Tower
    b) Natural Draft Packed Type Tower
    c) Hyperbolic Cooling Tower
- Mechanical draft towers
    a) Forced draft
    b) Induced draft.

Natural Draft Spray Filled Tower

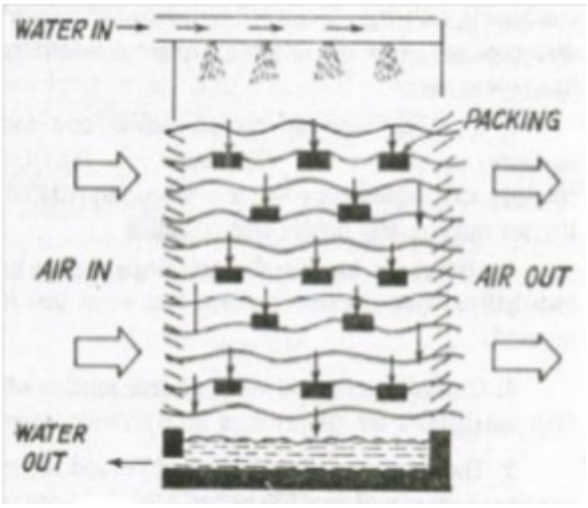
The arrangement of this type of tower is shown in figure below. The air enters through the louvered sides and flows across the unit in a transverse direction. The air circulation through the tower depends on wind velocity. The capacity of this tower varies from 50 to 100 litres per minute per m^2 of base area depending upon the air velocity. These towers are used only for diesel plants and where prevailing winds are not cut-off by obstructions. This is not used for high capacity thermal plants as cooling range is limited, wind losses are high and there is no control over the outlet temperature of water.



Natural Draft Spray Filled Tower

Natural Draft Packed Type Tower

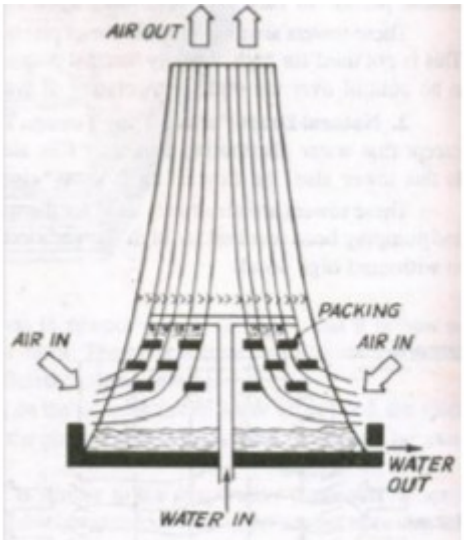
The construction of this tower is similar to spray filled tower except that water distributing toughs of fills are used which helps to break the water into small droplets. In this tower also, the flow of air is cross-wise to the flow of water. These towers are also rarely used for thermal power plants as original cost (due to height requirement) and pumping head required are high. Tower's extreme length and height and narrow width require anchoring to withstand high winds.



Natural Draft Packed Type Tower

Hyperbolic Cooling Tower

The arrangement of hyperbolic cooling tower is shown in figure below. It is steel reinforced concrete structure mostly slack (empty space) and the bottom 10 m above the air-intake contains packing over which warm water flows. The shape of the stack is circular in plan and hyperbolic in profile. The operation of this tower is much like that of other natural draft spray cooling towers with hot water cascading over timber splash type filling through which cooler air moves.



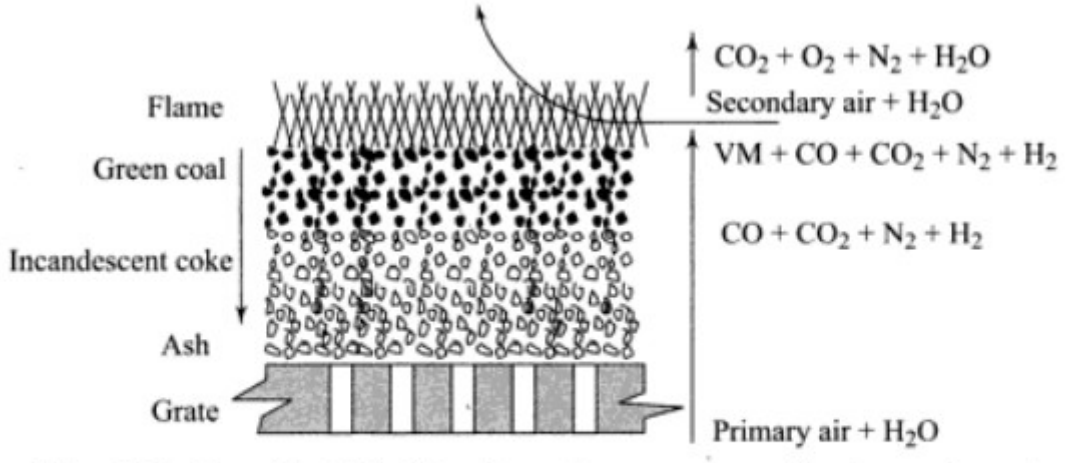
Hyperbolic Cooling Tower

Explain with sketch overfeed and underfeed principle of firing coal.

There are two ways of feeding coal on to the grate:

- Overfeeding
- Underfeeding

A overfeed fuel bed section receives fresh coal in its top surface. It is characterized by the following distinct zones from top to bottom.

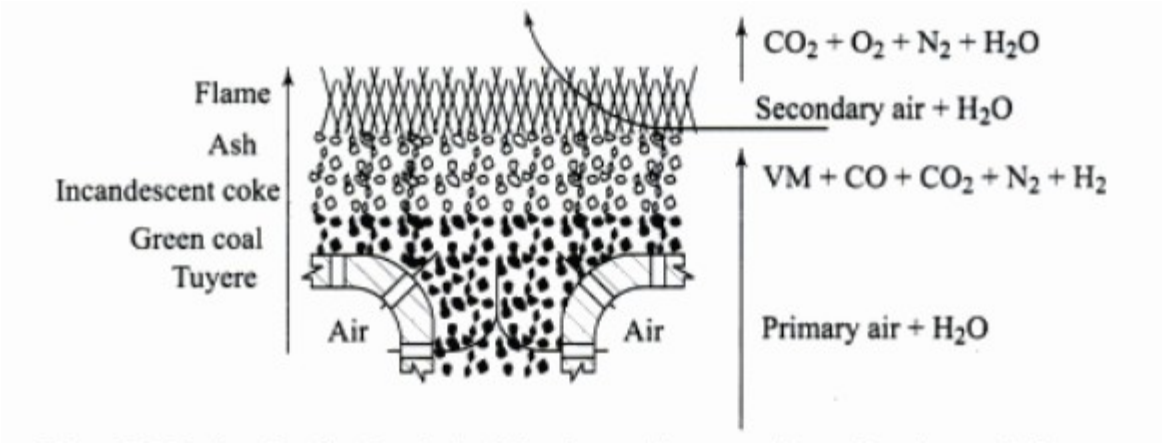


Overfeed fuel bed

1. A layer of fresh or green coal
2. A layer of coal losing moisture – drying zone
3. A coking layer of coal losing its volatile content-distillation zone
4. A layer of incandescent coke, where the fixed carbon is consumed- combustion zone
5. A layer of ash progressively getting cooler.

From zone 4 where heart is released by combustion, heat transfer occurs upward and downward by conduction, while the air flow from below will tend to carry away the heat upward by convention.

In underfeeding, the coal is fed from below the grate by a screw-conveyor or ram. Primary air passing through holes in the tuyeres diffuses through spaces in the raw or green coal picking up moisture and then through the distillation zone where volatile matter is added. When the gas stream passes next through the incandescent coke region, the volatile matter breaks up and readily burns with secondary air fed from the top. In overfeeding, burning the volatile matter will be somewhat cooler and so need longer time to ignite and burn.



Explain a typical hydraulic ash handling system, with neat sketch.

Coal handling equipment is one of the major components of plant cost. The coal handling equipment should satisfy some of the requirement such as minimum maintenance, reliability, simplicity and should wear less due to abrasive action of coal particles. The various steps involved in coal handling are as follows:

1. Coal delivery
2. Unloading
3. Preparation
4. Transfer
5. Outdoor storage (dead storage)
6. Covered storage (live storage)
7. In-plant handling
8. Weighing and measuring
9. Feeding the coal into furnace.

Coal delivery:The coal may be delivered from the supply points by using ships or boats when the power station is situated near the sea or river. The rail or trucks may be used to deliver the coal when the power station is situated away from the sea or river. The trucks are used, when the railway facilities are not available near the power station.

Unloading: The type of equipment used to unload the coal in the plant depends up on how the coal is received at the power station. i.e., by road, rail or ship. If trucks are used to deliver the coal, there is no need of unloading device as the same trucks are used to dump the coal to the dead storage. Coal handling becomes easier,if lift trucks with scoop are used. If the coal is handled by railway wagons, ships or boats, unloading may be done by cranes, rotary car dumpers, grab buckets, coal accelerators, portable conveyors, self unloading boats etc.

Preparation: When the coal received at the site is in the form of big lumps (not of proper size), it is to be prepared before feeding to the combustion chamber by using the equipment i) Breakers ii)Crushers iii) Sizers iv) Dryers v) Magnetic separators. The coal crushers are used to prepare the coal of required size before supplying to the furnace. The coal which does not require sizing is to be by passed. The sizers seperates the unsized coal particles and returns to the crushers. The driers are used to remove the excess free moisture from the coal by passing hot flue gases through the coal storage. The magnetic seperators are used to remove the iron scrap and other foreign particles from the coal, before supplying to the storage hopper.

Transfer: Transfer of coal includes handling of coal between the unloading point and the storage site. The equipments used for transfer of coal are

a. Belt conveyors
b. Screw conveyors
c. Bucket elevators
d. Grab bucket elevators
e. Skip hoists
f. Flight conveyors

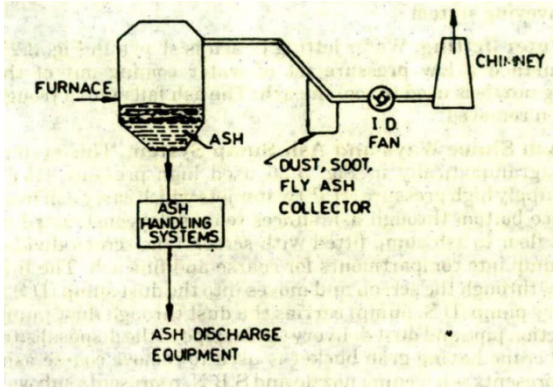
In-plant handling: The coal may be brought from dead storage to covered or live storage. It also refers to handling of the coal between final storage and the firing equipment. It includes the equipment such as belt conveyors, screw conveyors, bucket elevators etc.,

Weighing and measuring: The methods used to weigh the coal are 1) Mechanical 2) Pneumatic and 3) Electronic. The equipment used to weight the quantity of coal are i) Weight bridge ii) Belt scale iii) Weight lorry.

Ash Handling equipment

Mechanical means are required for the disposal of ash. The handling equipment should perform the following functions : (1) Capital investment, operating and maintenance charges of the equipment should be low. (2) It should be able to handle large quantities of ash. (3) Clinkers, soot, dust etc. create troubles; the equipment should be able to handle them smoothly. (4) The equipment used should remove the ash from the furnace, load it to the conveying system to deliver the ash to a dumping site or storage and finally it should have means to dispose of the stored ash. (5) The equipment should be corrosion and wear resistant. Fig. 3.23 shows a general layout of ash handling and dust collection system. The commonly used ash handling systems are as follows:

(i) Hydraulic system, (ii) Pneumatic system (iii) Mechanical system



Hydraulic System. In this system, ash from the furnace grate falls into a system of water possessing high velocity and is carried to the sumps. It is generally used in large power plants. Hydraulic system is of two types namely low pressure hydraulic system used for continuous removal of ash and high pressure system which is used for intermittent ash disposal.

In this method water at sufficient pressure is used to take away the ash to sump where water and ash are separated. The ash is then transferred to the dump site in wagons, rail cars or trucks. The loading of ash may be through a belt conveyor, grab buckets. If there is an ash basement with ash hopper the ash can fall, directly in ash car or conveying system.