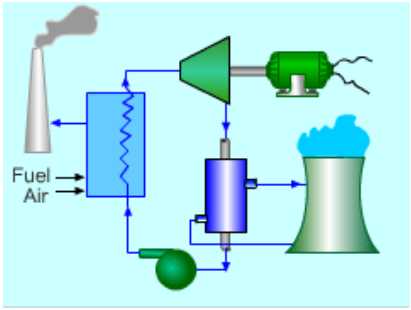

بسم الله الرحمن الرحيم

Thermal Power Stations



Lecture (6)

on

Schematic of a Thermal Power Plant

By

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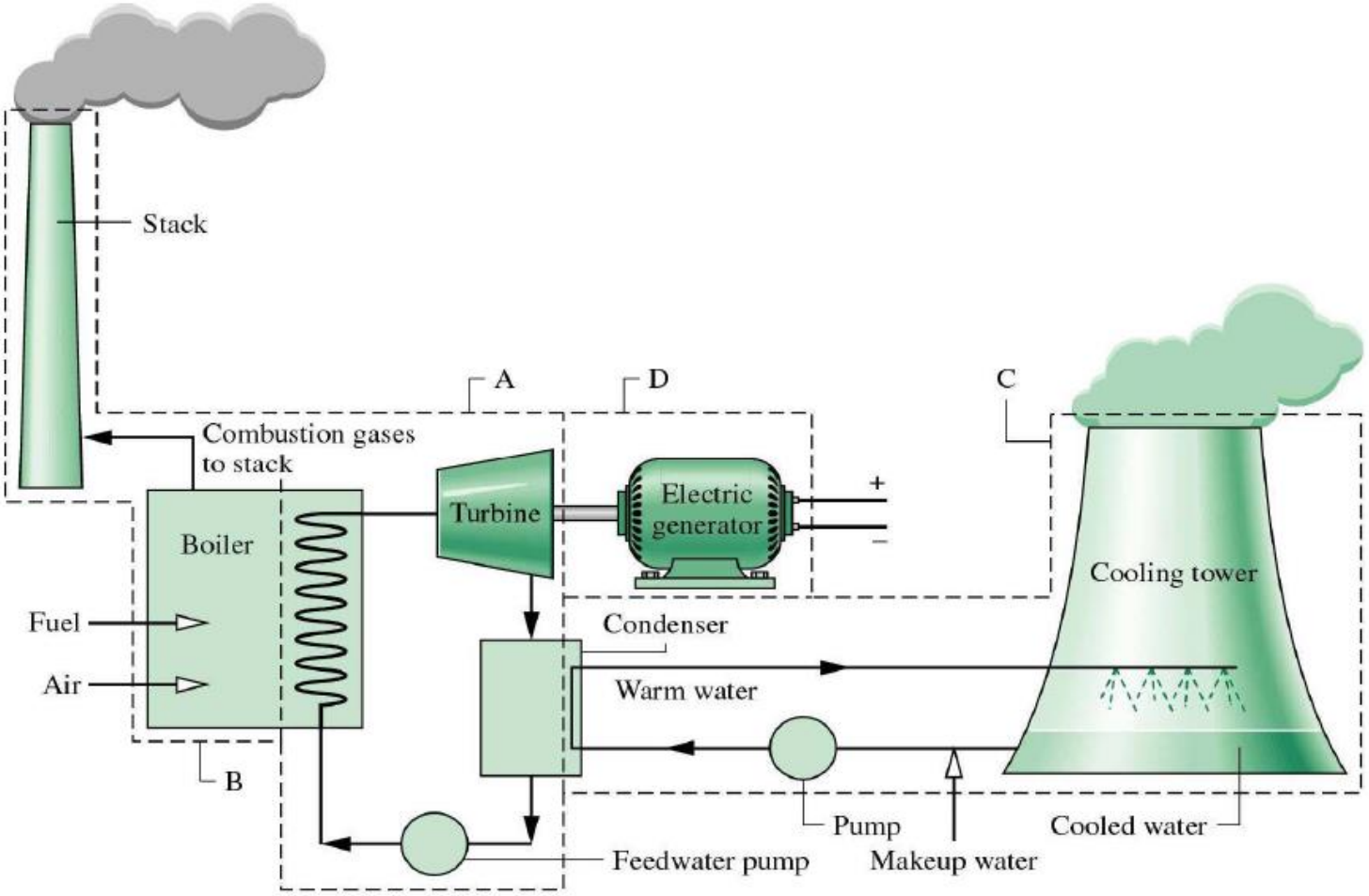
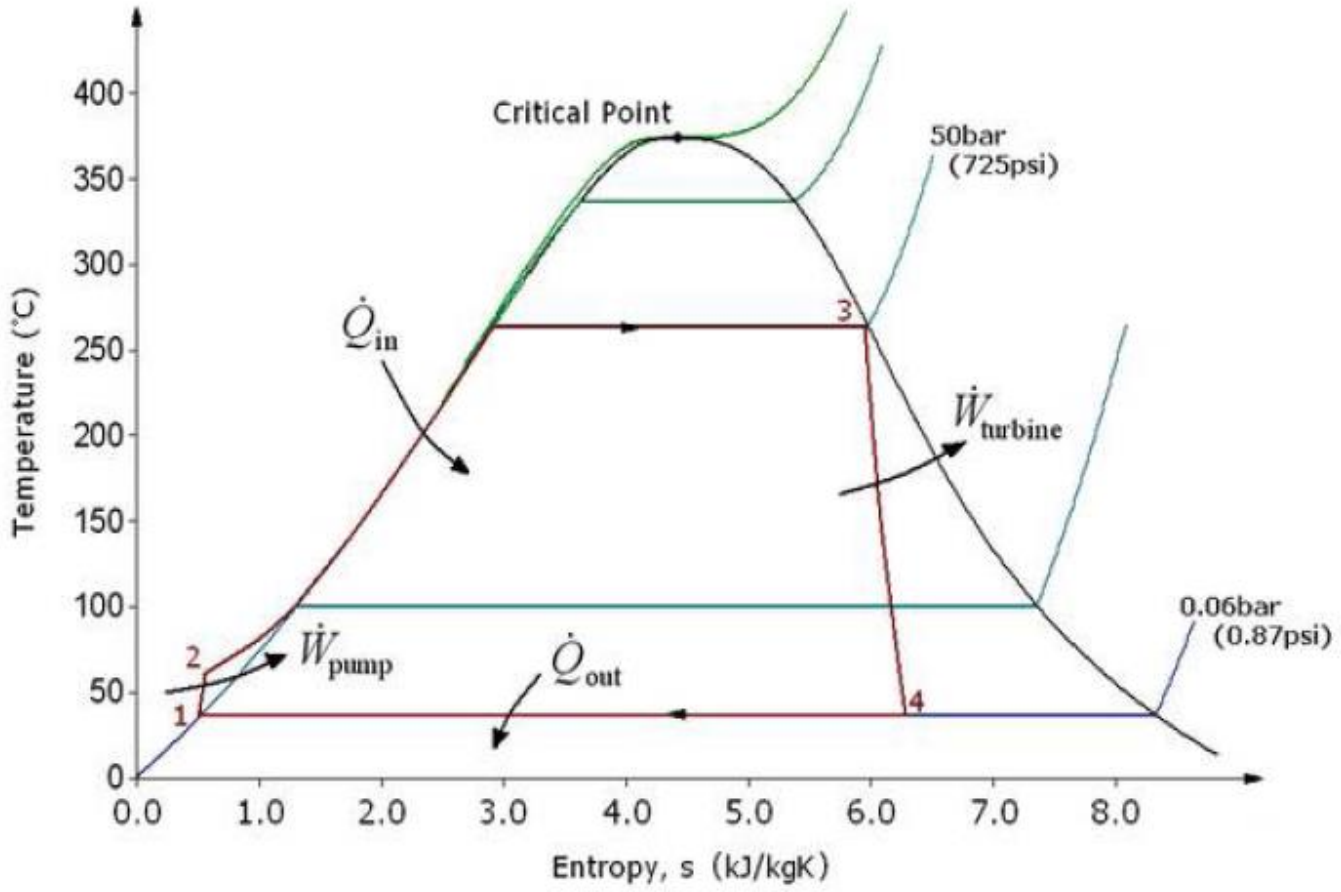
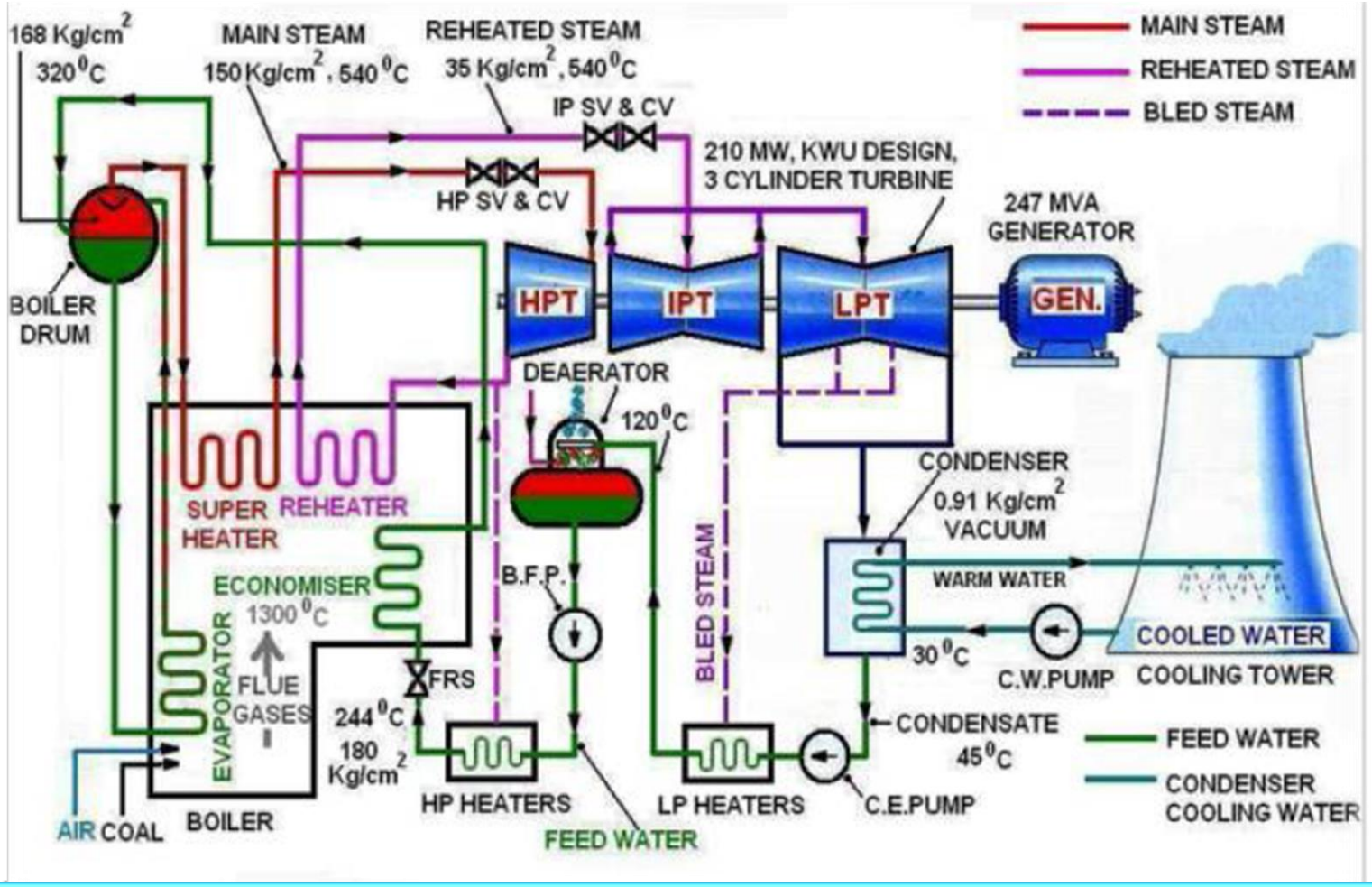
Rankine Cycle and Thermal Power Plants



Rankine Cycle and Thermal Power Plants



Rankine Cycle and Thermal Power Plants

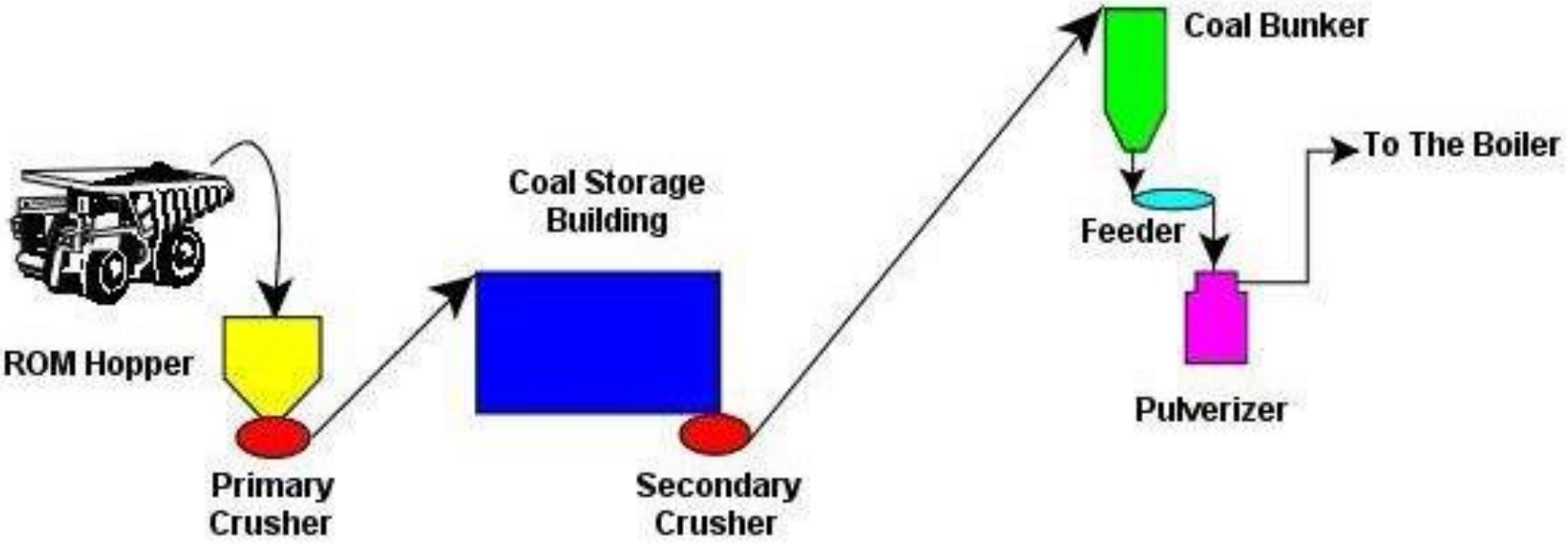


Major Components of a Thermal Power Plant

1. Fuel system
2. Draft or draught fan
3. Boiler
4. Exhaust handling system
5. Turbine and generator
6. Condenser
7. Cooling tower and ponds
8. Feed water heater
9. Economizer
10. Super heater and reheater
11. Air pre heater
12. Alternator with exciter
13. Protection and control equipment
14. Instrumentation

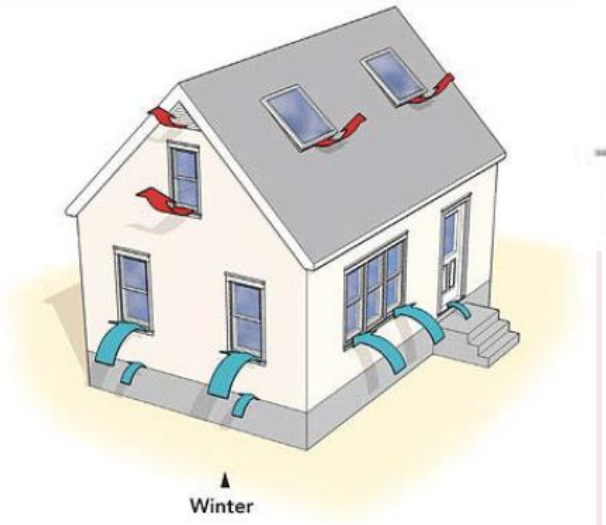
Major Components of a Thermal Power Plant

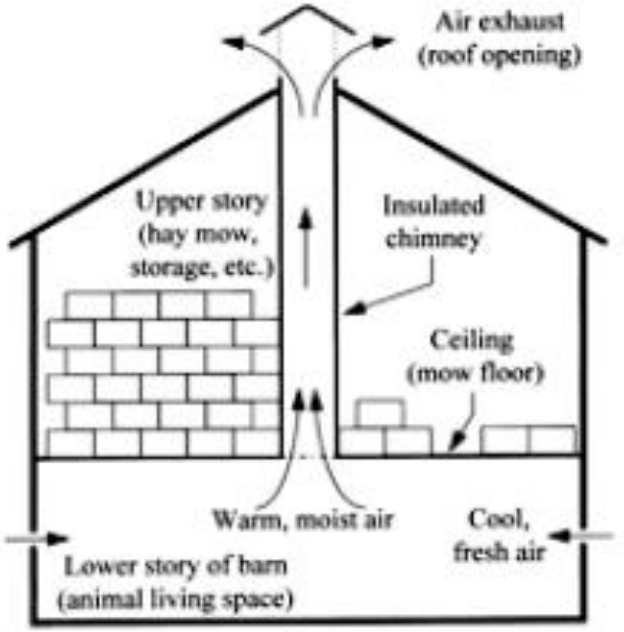
1. Processes in coal handling plant (Ex. of fuel system)



Major Components of a Thermal Power Plant

2. Draught System





Major Components of a Thermal Power Plant

2. Draught System

- The draught is one of the most essential systems of thermal power plant which supplies required quantity of air for combustion and removes the burnt products from the system.

- To move the air through the fuel bed and to produce a flow of hot gases through the boiler, economizer, preheater and chimney require a difference of pressure.

Major Components of a Thermal Power Plant

2. Draught System

- This difference of pressure for to maintaining the constant flow of air and discharging the gases through the chimney to atmosphere is known as draught.
- Draught can be obtained by use of chimney, fan, steam or air jet or combination of these. When the draught is produced with the help of chimney or stack only, it is known as Natural Draught and when the draught is produced by any other means except chimney it is known as artificial draught.
- Natural draught has its limitation. Modern plants has high rate of heat transfer and Draught losses are very high. in view of this Natural draught is used only for small boilers.

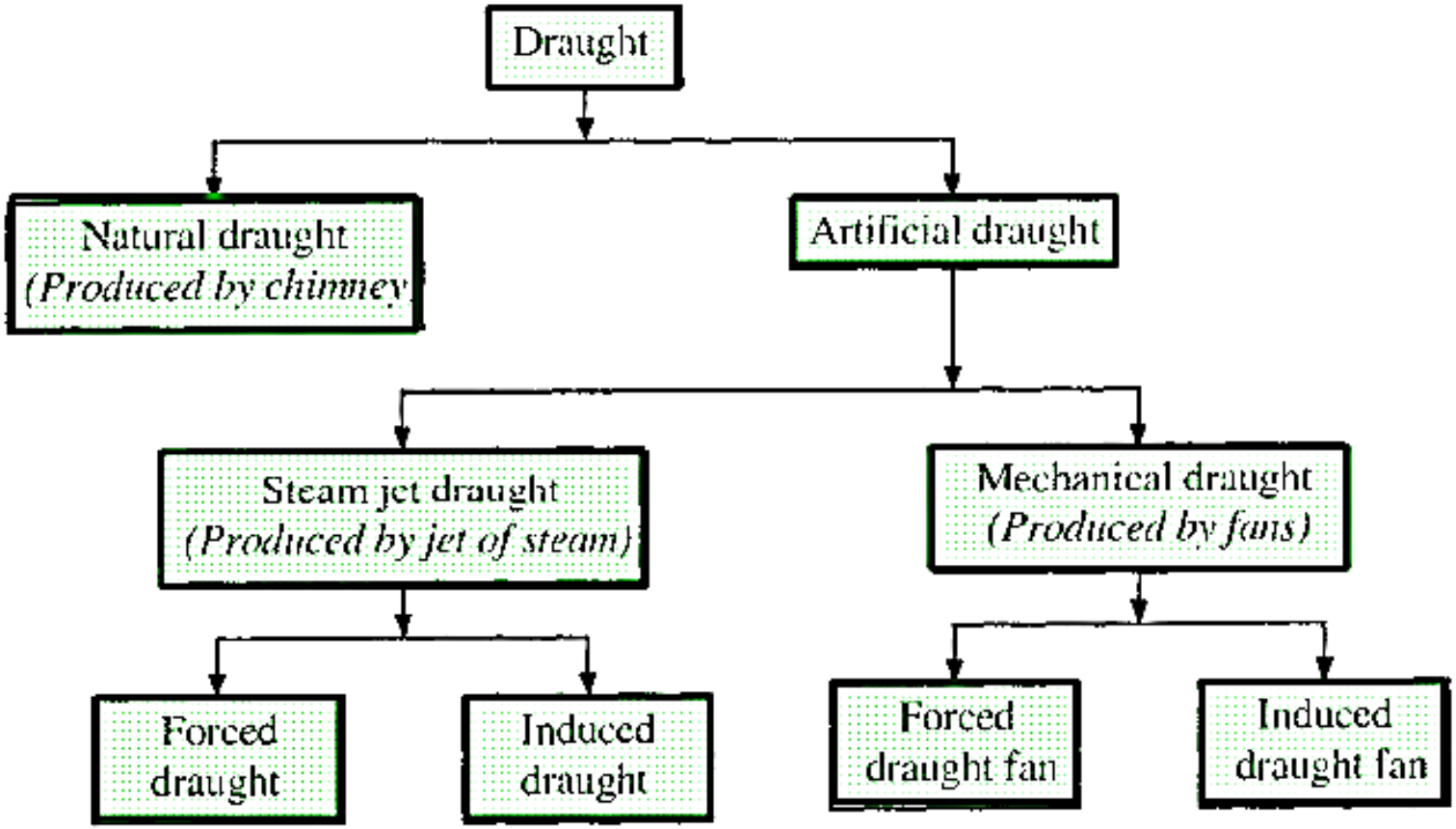
Major Components of a Thermal Power Plant

2. Draught System

- A chimney is a structure for venting hot flue gases or smoke from a boiler, stove, furnace or fireplace to the outside atmosphere.
- Chimneys are typically vertical, or as near as possible to vertical, to ensure that the gases flow smoothly,
- Drawing air into the combustion in what is known as the stack/chimney, effect.
- The space inside a chimney is called a flue.
- Chimneys may be found in buildings, steam locomotives and ships.
- A flue gas stack is a type of chimney, a vertical pipe, channel or similar structure through which combustion product gases called flue gases are exhausted to the outside air.

Major Components of a Thermal Power Plant

2. Draught System Classification



Major Components of a Thermal Power Plant

2. Draught System

Losses in the air-gas loop system

The total draught required to produce the current of air and to discharge the hot gases to the atmosphere is the arithmetic sum of all draught losses in the series circuit.

The total draught losses in the air and gas loop system are given by,

$$h_t = h_v + h_b + h_e + h_d$$

h_t = Total draught loss in cm of water

h_v = Velocity head in cm. of water head
(velocity of gas exits from chimney)

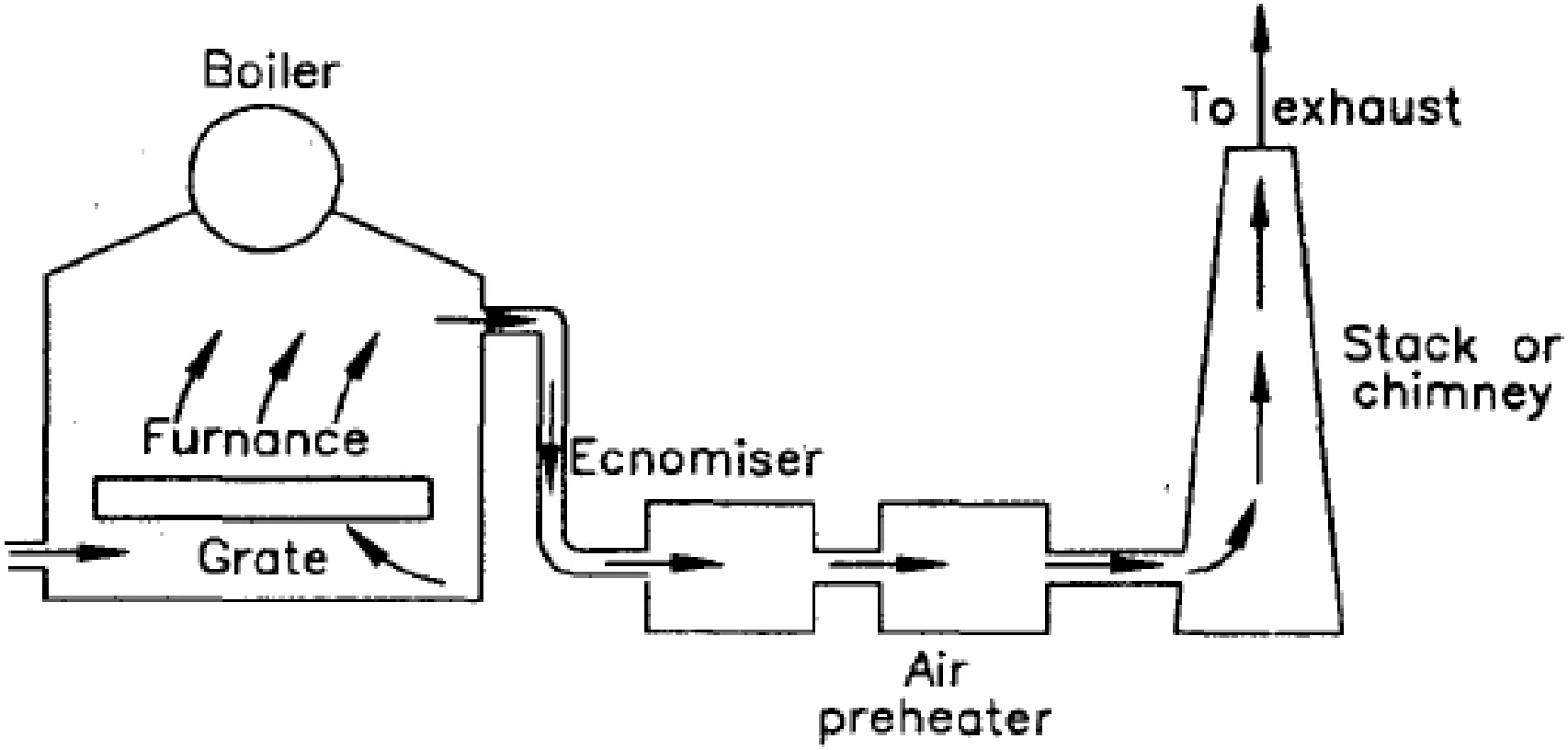
h_b = Fuel bed resistance equivalent to cm of water head.

h_e = Head loss in the equipments.

h_d = Head loss in ducts and chimney.

Major Components of a Thermal Power Plant

2. Draught System



Major Components of a Thermal Power Plant

2. Draught System

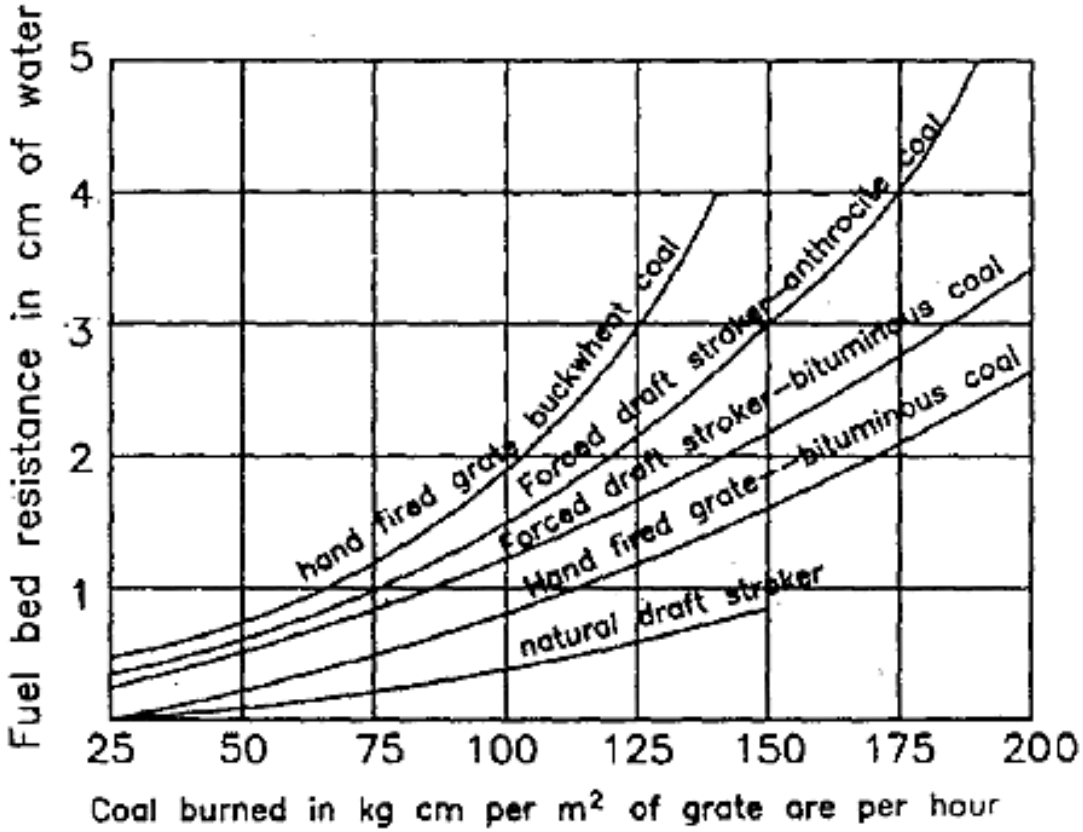
Fuel Bed Resistance (h_b):

The fuel bed resistance depends on fuel size, bed thickness and combustion rate. The effect of combustion rate on resistance for different types of stokers is shown in Fig. The resistance of the spreader stoker is not shown in figure because much of the coal is burned in suspension. The draught resistance of spreader stoker may be taken as 6 cm of water head.

Major Components of a Thermal Power Plant

2. Draught System

Fuel Bed Resistance (h_b):



Major Components of a Thermal Power Plant

2. Draught System

Loss in Equipments (h_e):

The manufacturers generally supply data for equipment resistance like air heater, economizer, boiler passes, super heaters, etc.

A survey of test data indicates that the draught losses follow a parabolic law. The loss at another rating can be calculated by using the following equation:

$$h_{e2} = h_{e1} \left(\frac{m_{s2}}{m_{s1}} \right)^{1.8 \text{ to } 2.0}$$

where h_e is the draught loss at the steam generating rate of m_s

Major Components of a Thermal Power Plant

2. Draught System

Velocity Head Loss(h_v):

The draught system is designed to give minimum velocity head loss $U^2/2g$. (where u is the velocity at the exit of the chimney) But it must be sufficient to diffuse and mix with the surrounding atmospheric air.

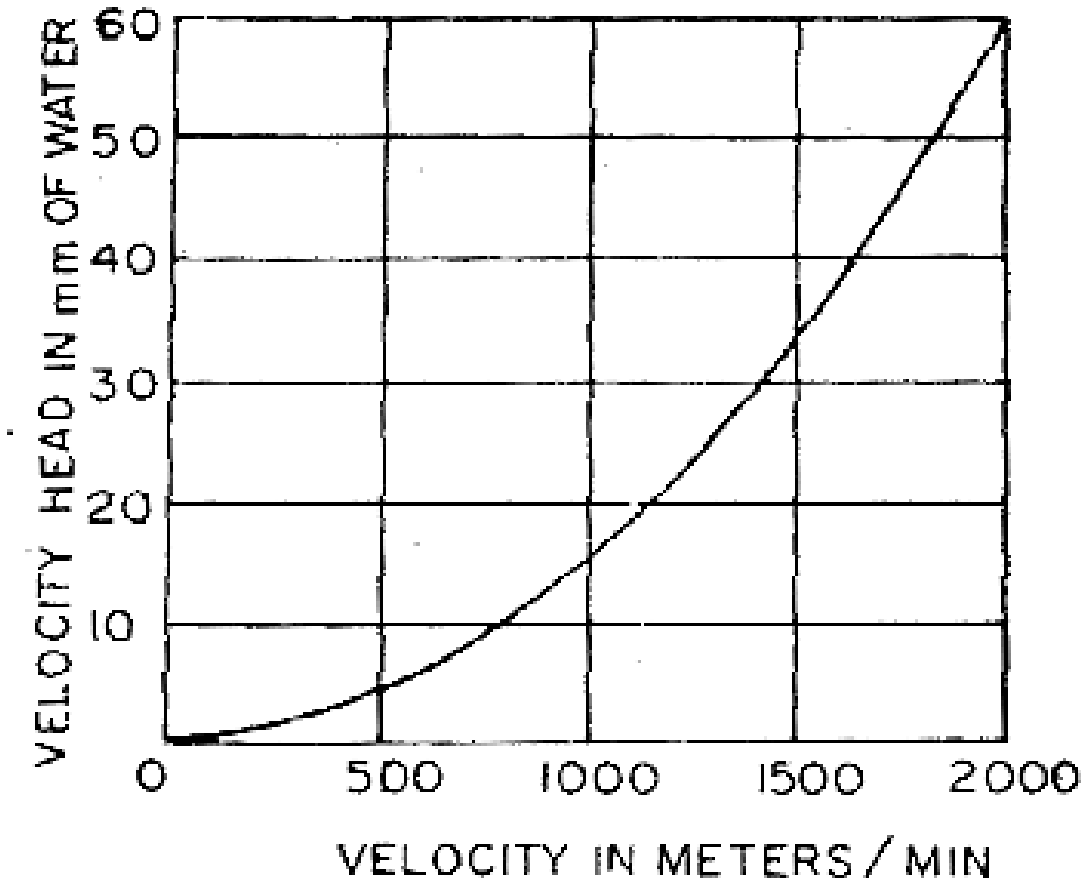
Its value also depends upon the natural air velocity at chimney height. Higher velocity head is required if the natural air velocity is higher.

No general data can be given for such loss. It is decided as per the site of the power plant, air temperature and natural air flow condition. To know the velocity head, a velocity versus, velocity head in cm of water is shown in Fig.

Major Components of a Thermal Power Plant

2. Draught System

Velocity Head Loss(h_v):



Major Components of a Thermal Power Plant

2. Draught System, Head Loss in Ducts and Chimney (h_d):

The draught loss due to friction in air and gas ducts and chimney is given by Fanning equation as

$$h_d = f.\frac{L}{4R_h}\left(\frac{V^2}{2g}\right)$$ **in meters of fluid flowing**

where R_h is hydraulic radius (cross-sectional area/wetted perimeter) and f is the friction factor of the duct through which air or gas flows. The value of depends upon the smoothness of the duct and Reynolds number of the fluid flowing.

(The values of f may be taken as 0.005 for steel and 0.007 for masonry and concrete when air is flowing and 0.014 when gas is flowing either through steel or masonry or concrete duct)

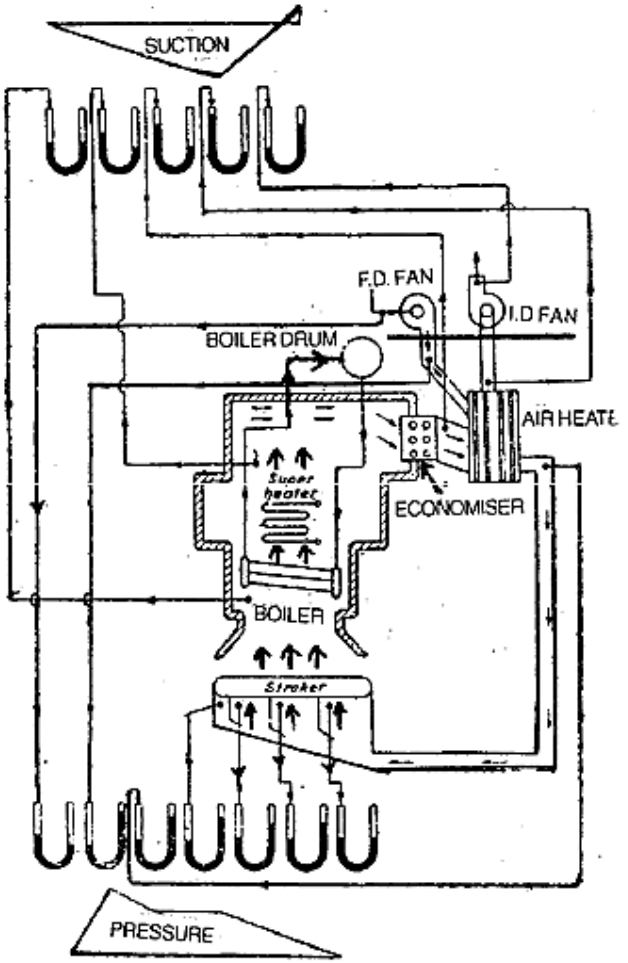
To find out the losses in bends, elbows and valves, the losses are generally given in terms of equivalent duct length and the same equation as given above can be used for finding the pressure losses.

Major Components of a Thermal Power Plant

2. Draught System

Measurement of Draught:

The draught losses in different parts of the boiler plant are measured in mm of water with the help of manometers. This pressure may be above atmospheric pressure or below atmospheric pressure. For very accurate measurement, the inclined type manometer is used. The typical draught at different points of the boiler plant measured by U-tube manometer is shown in figure. The measurement of draught serves not only to find out the resistance to the air and gas flow but it also indicates the rate of flow.



Major Components of a Thermal Power Plant

2. Draught System

Advantages and Limitations of Chimney / Natural Draught

Advantages

1. It does not require any external power for producing the draught.
2. The capital investment is less. The maintenance cost is nil as there is no mechanical part.
3. Chimney keeps the flue gases at a high place in the atmosphere which prevents the contamination of atmosphere.
4. It has long life.

Major Components of a Thermal Power Plant

2. Draught System

Advantages and Limitations of Chimney / Natural Draught

Limitations

1. The maximum pressure available for producing natural draught by chimney is hardly 10 to 20 mm of water under the normal atmospheric and flue gas temperatures.
2. The available draught decreases with increase in outside air temperature and for producing sufficient draught, the flue gases have to be discharged at comparatively high temperatures resulting in the loss of overall plant efficiency. And thus maximum utilization of Heat is not possible.

Major Components of a Thermal Power Plant

2. Draught System

Advantages and Limitations of Chimney / Natural Draught

Limitations

3. As there is no through mixing of air and fuel in the combustion chamber due to low velocity of air therefore combustion is very poor. This increases the specific fuel consumption.

4. The chimney has no flexibility to create more draught under peak load conditions because the draught available is constant for a particular height of chimney and the draught can be increased by allowing the flue gases to leave the combustion chamber at higher temperatures. This reduces the overall efficiency of the plant.

Major Components of a Thermal Power Plant

2. Draught System

Advantages and Limitations of Chimney / Natural Draught

Nearly 20% heat released by the fuel is lost to the flue gases. The chimney draught is only used for very small boilers. Nowadays the chimney is never used for creating draught in thermal power plants as it has no flexibility, the total draught produced is insufficient for high generating capacity. The chimney is used in all power plants only to discharge the flue gases high in the atmosphere to maintain the cleanliness of the surrounding atmospheric air.


Thank You