INDUS INSTITUTE OF TECHNOLOGY

THERMAL POWER PLANT

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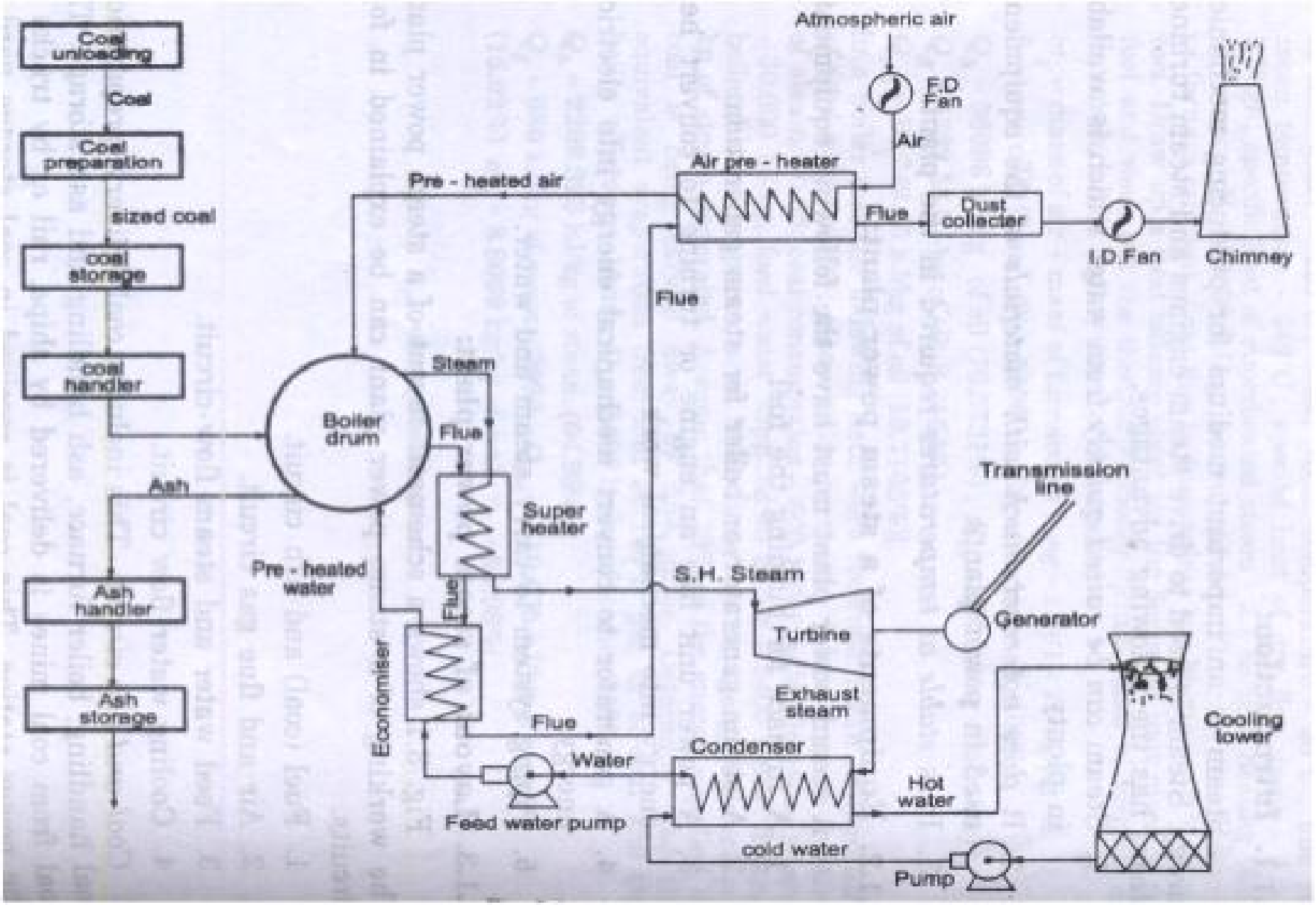
INTRODUCTION

A Thermal Power Plant converts the heat energy of coal into electrical energy. Coal is burnt in a boiler which converts water into steam. The expansion of steam in turbine produces mechanical power which drives the alternator coupled to the turbine.Thermal Power Plants contribute maximum to the generation of Power for any country . Thermal Power Plants constitute 75.43% of the total installed captive and non-captive power generation in India . In thermal generating stations coal, oil, natural gas etc. are employed as primary sources of energy.

Layout of Steam Power plant



General Layout of Thermal Power Station

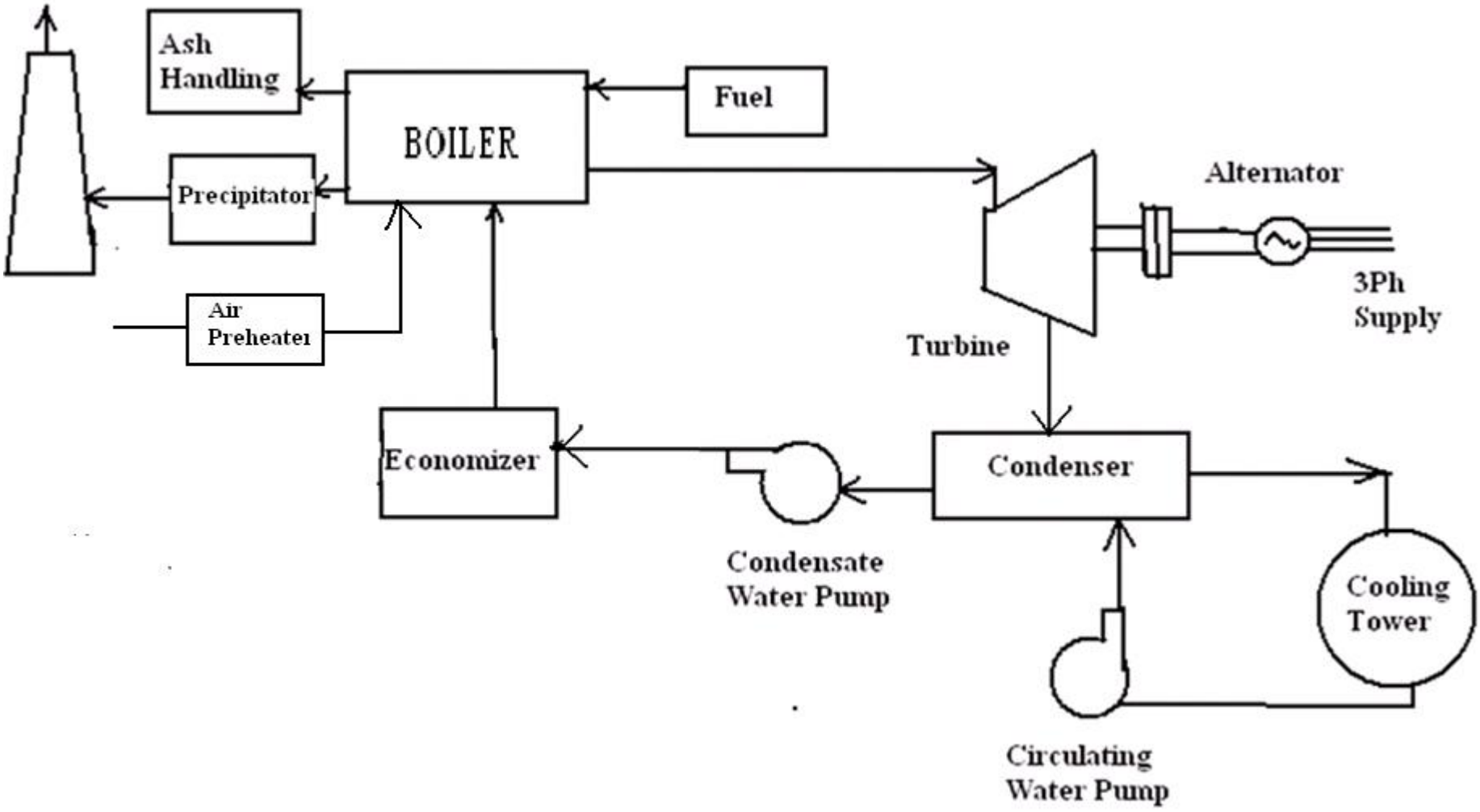
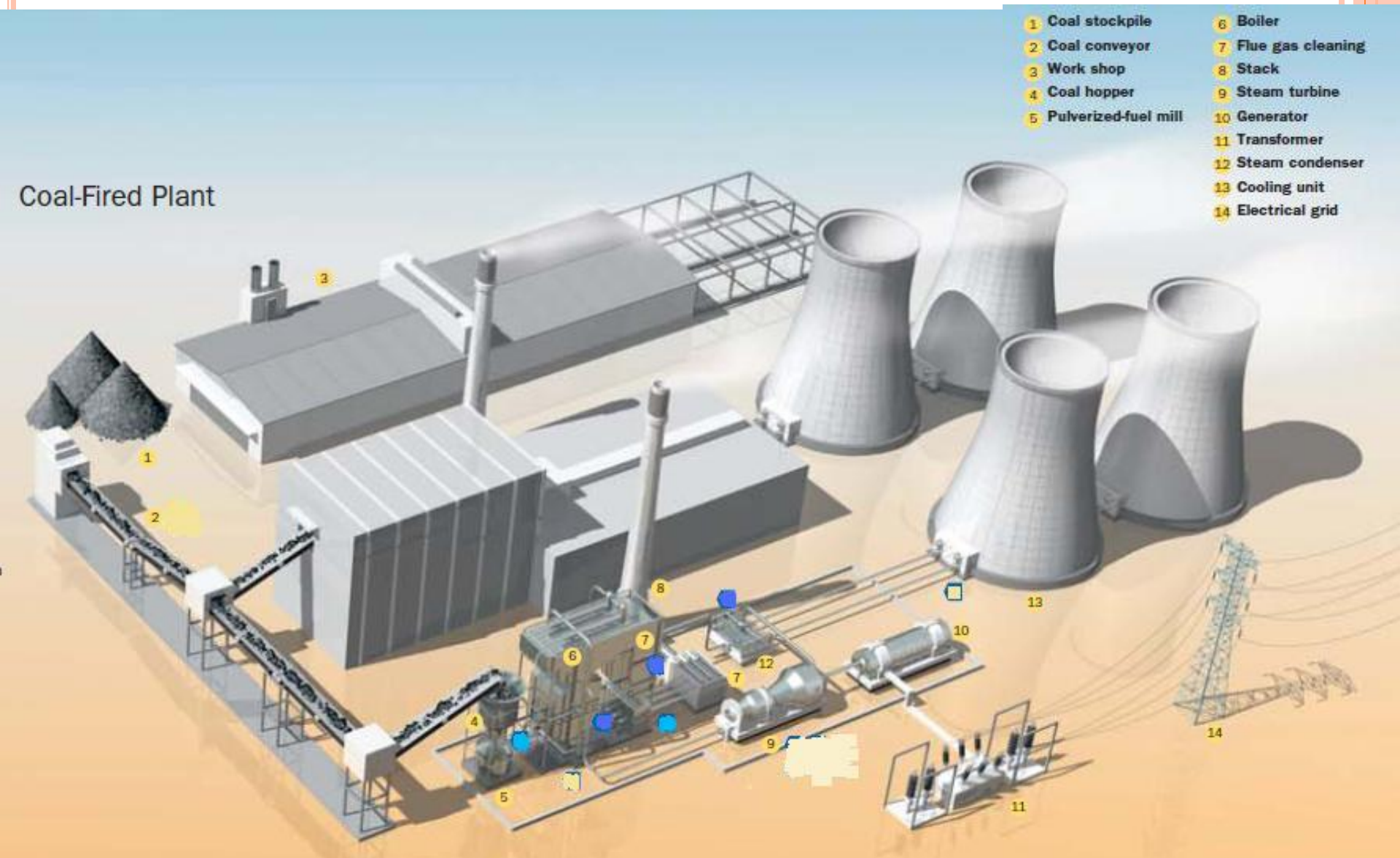


Diagram of a typical coal–fired thermal power station



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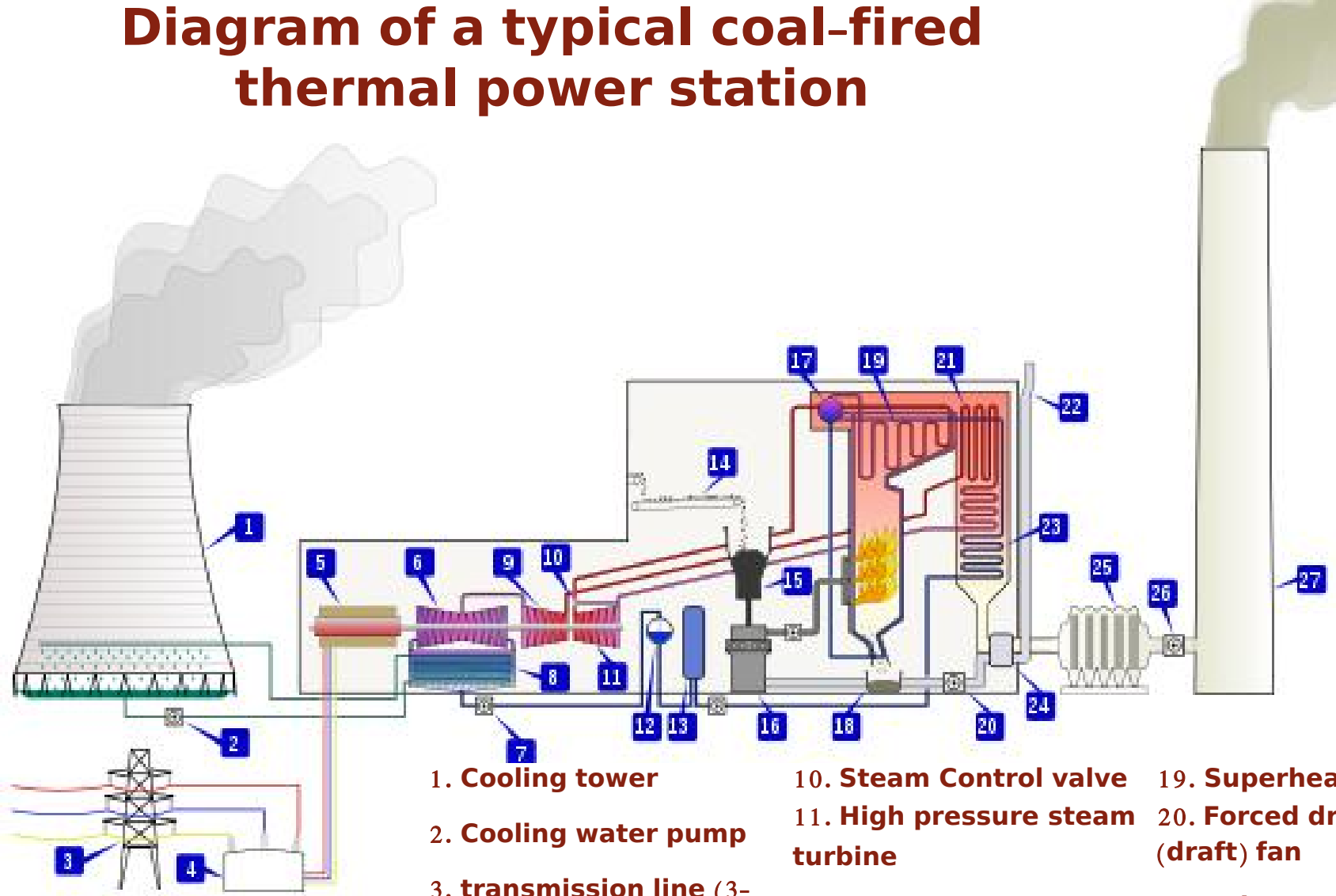
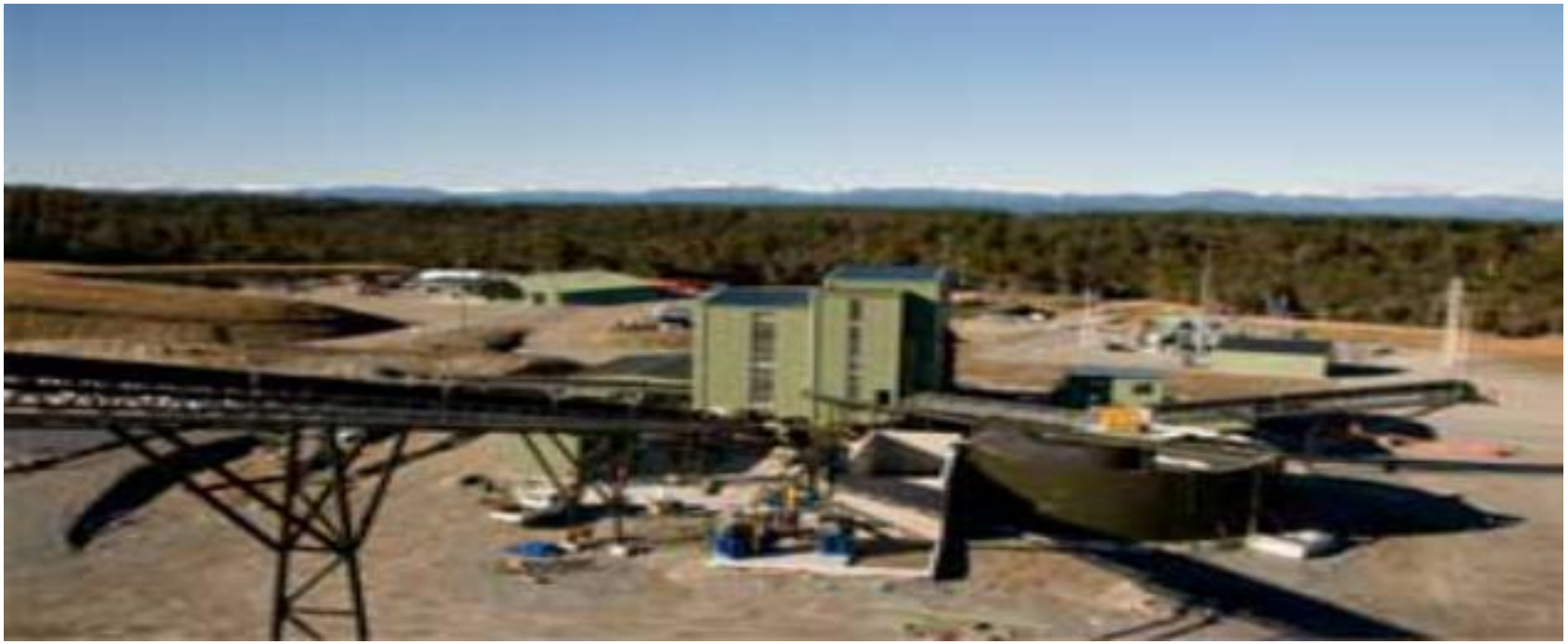


1. **Cooling tower**
2. **Cooling water pump**
3. **transmission line** (3-phase)
4. **Step-up transformer** (3-phase)
5. **Electrical generator** (3-phase)
6. **Low pressure steam**
10. **Steam Control valve**
11. **High pressure steam turbine**
12. **Deaerator**
13. **Feed water heater**
14. **Coal conveyor**
15. **Coal hopper**
19. **Superheater**
20. **Forced draught** (draft) **fan**
21. **Reheater**
22. **Combustion air intake**
23. **Economiser**
24. **Air preheater**

Main and Auxiliary Equipments

1. Coal handling plant
2. Pulverizing plant
3. Draft fans
4. Boiler
5. Ash handling plant
6. Turbine
7. Condenser
8. Cooling towers and ponds
9. Feed water heater
10. Economiser
11. Superheater and Reheater
12. Air preheater

COAL HANDLING PLANT



•The function of coal handling plant is automatic feeding of coal to the boiler furnace.
• A thermal power plant burns enormous amounts of coal.
•A 200MW plant may require around 2000 tons of coal daily

PULVERISING PLANT

In modern thermal power plant , coal is pulverised i.e. ground to dust like size and carried to the furnace in a stream of hot air. Pulverising is a means of exposing a large surface area to the action of oxygen and consequently helping combustion.

Pulverising mills are further classified as:

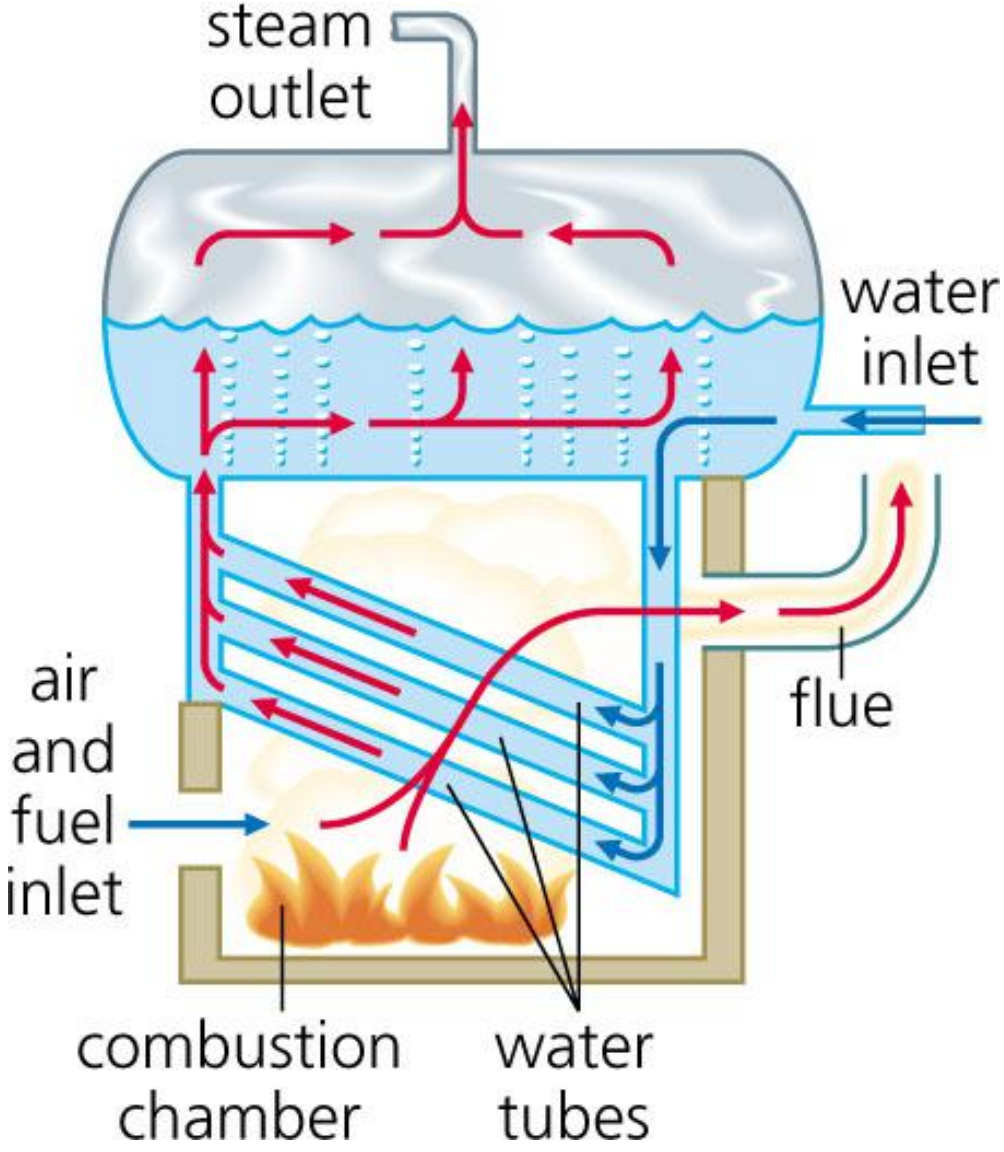
1. **Contact mill**
2. **Ball mill**
3. **Impact mill**

Draft system

- The circulation of air is caused by a difference in pressure, known as Draft.
- Draft is a differential pressure b/w atmosphere and inside the boiler.
- It is necessary to cause the flow of gases through boiler setting
- It may be –

1. **Natural draft**
2. **Mechanical draft**

Boiler


steam outlet
water inlet
air and fuel inlet
flue
combustion chamber
water tubes

Boiler

- A boiler or steam generator is a closed vessel in which water under pressure, is converted into steam.
- It is one of the major components of a thermal power plant
- Always designed to absorb maximum amount of heat released in the process of combustion

Boilers are of two types-

1.Fire tube boiler

2.Water tube boiler

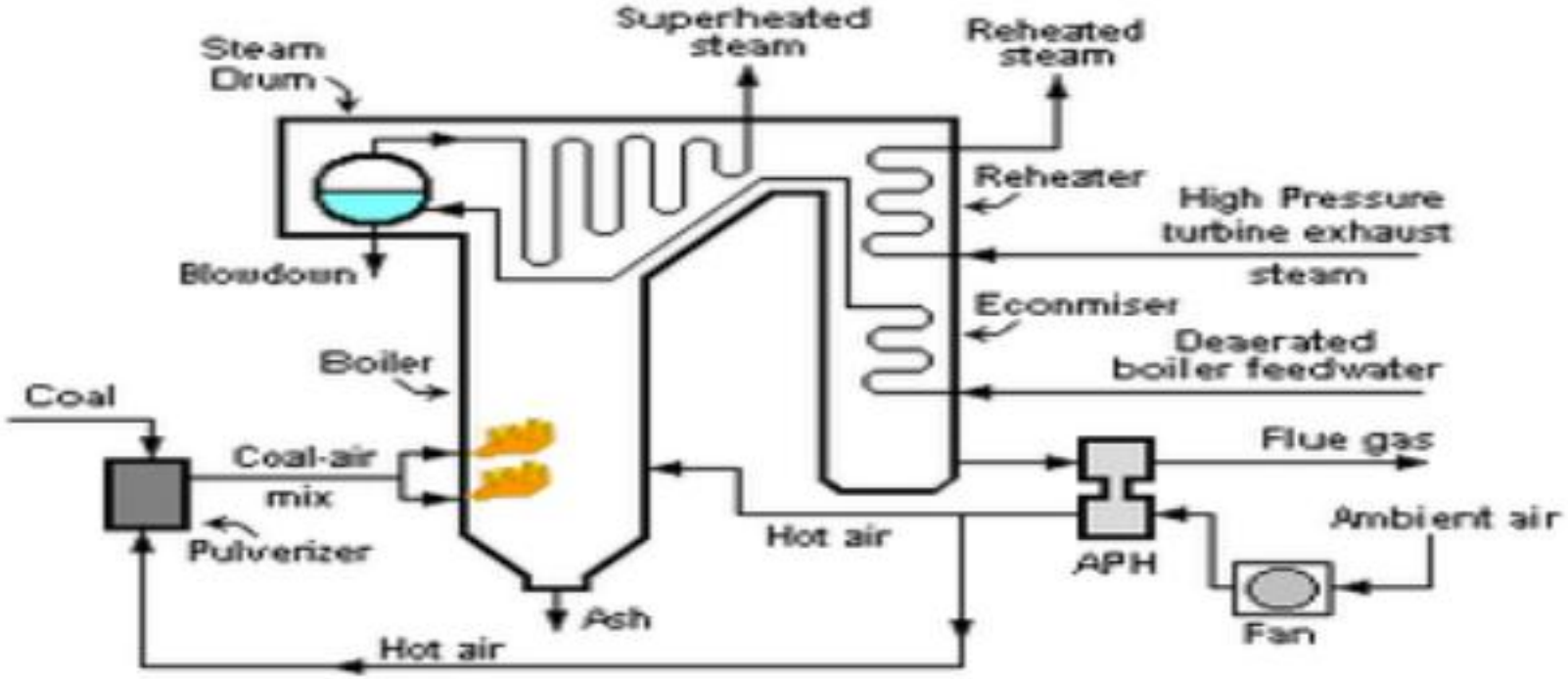
Superheater and reheater

Most of the modern boilers are having super heater and reheater arrangement.

Superheater :

Superheater is a component of a steam-generating unit in which steam, after it has left the boiler drum, is heated above its saturation temperature. The amount of superheat added to the steam is influenced by the location, arrangement, and amount of super heater surface installed, as well as the rating of the boiler. The super heater may consist of one or more stages of tube banks arranged to effectively transfer heat from the products of combustion. Super heaters are classified as convection , radiant or combination of these.

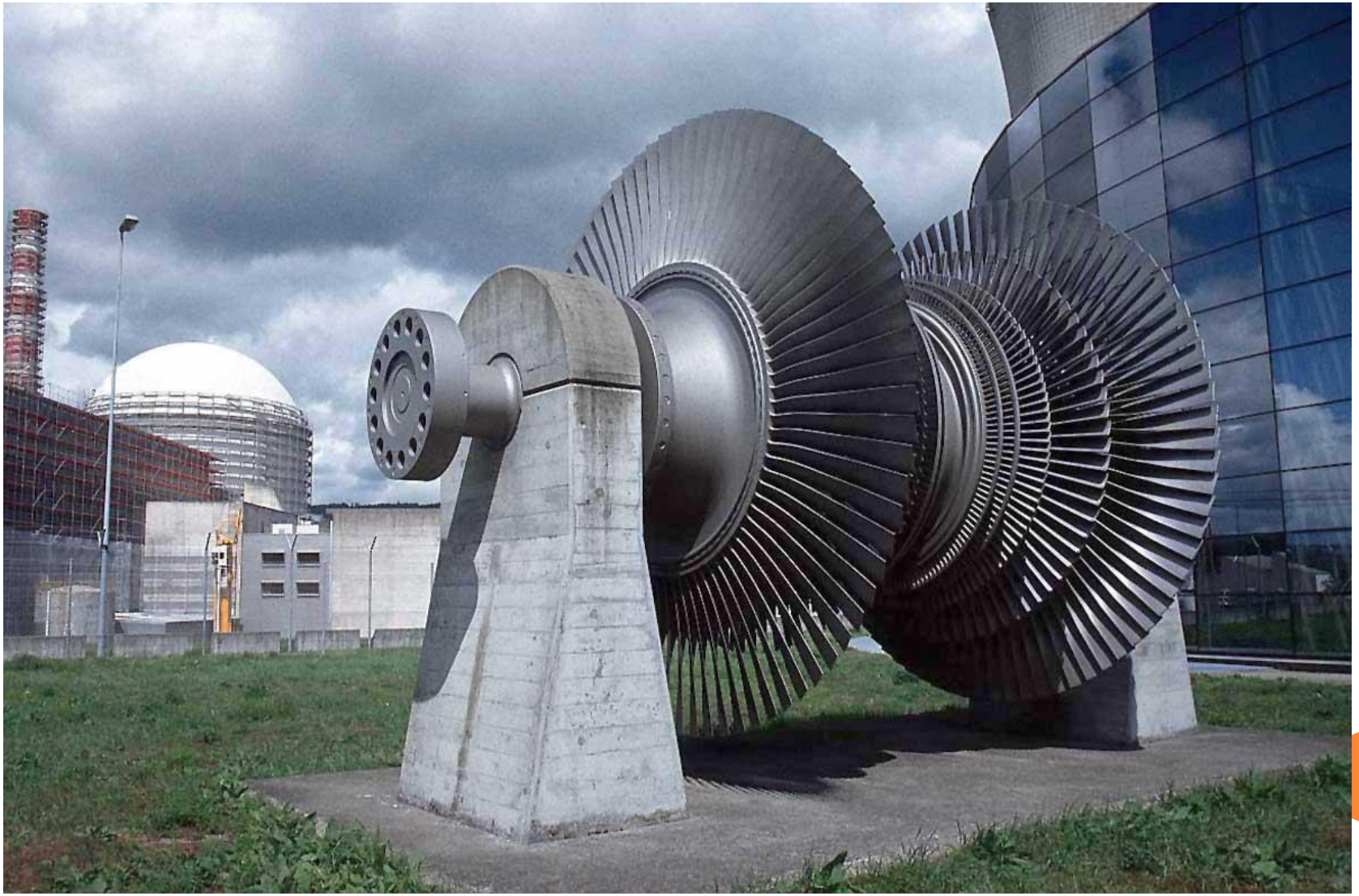
Reheater : Some of the heat of superheated steam is used to rotate the turbine where it loses some of its energy. Reheater is also steam boiler component in which heat is added to this intermediate-pressure steam, which has given up some of its energy in expansion through the high-pressure turbine. The steam after reheating is used to rotate the second steam turbine where the heat is converted to mechanical energy. This mechanical energy is used to run the alternator, which is coupled to turbine , there by generating electrical energy.



Note: APH is the air preheater

Turbine

Turbine – Full View



Steam turbine

A steam turbine converts heat energy of steam into mechanical energy and drives the generator. It uses the principle that steam when issuing from a small opening attains a high velocity. This velocity attained during expansion depends on the initial and final heat content of the steam. This difference b/w initial and final heat content repesents the heat energy converted into kinetic energy.

These are of two types :-

- **Impulse turbine**
- **Reaction turbine**

Ash handling plant

- The percentage of ash in coal varies from 5% in good quality coal to about 40% in poor quality coal
- Power plants generally use poor quality of coal , thus amount of ash produced by it is pretty large
- A modern 2000MW plant produces about 5000 tons of ash daily
- The stations use some conveyor arrangement to carry ash to dump sites directly or for carrying and loading it to trucks and wagons which transport it to the site of disposal

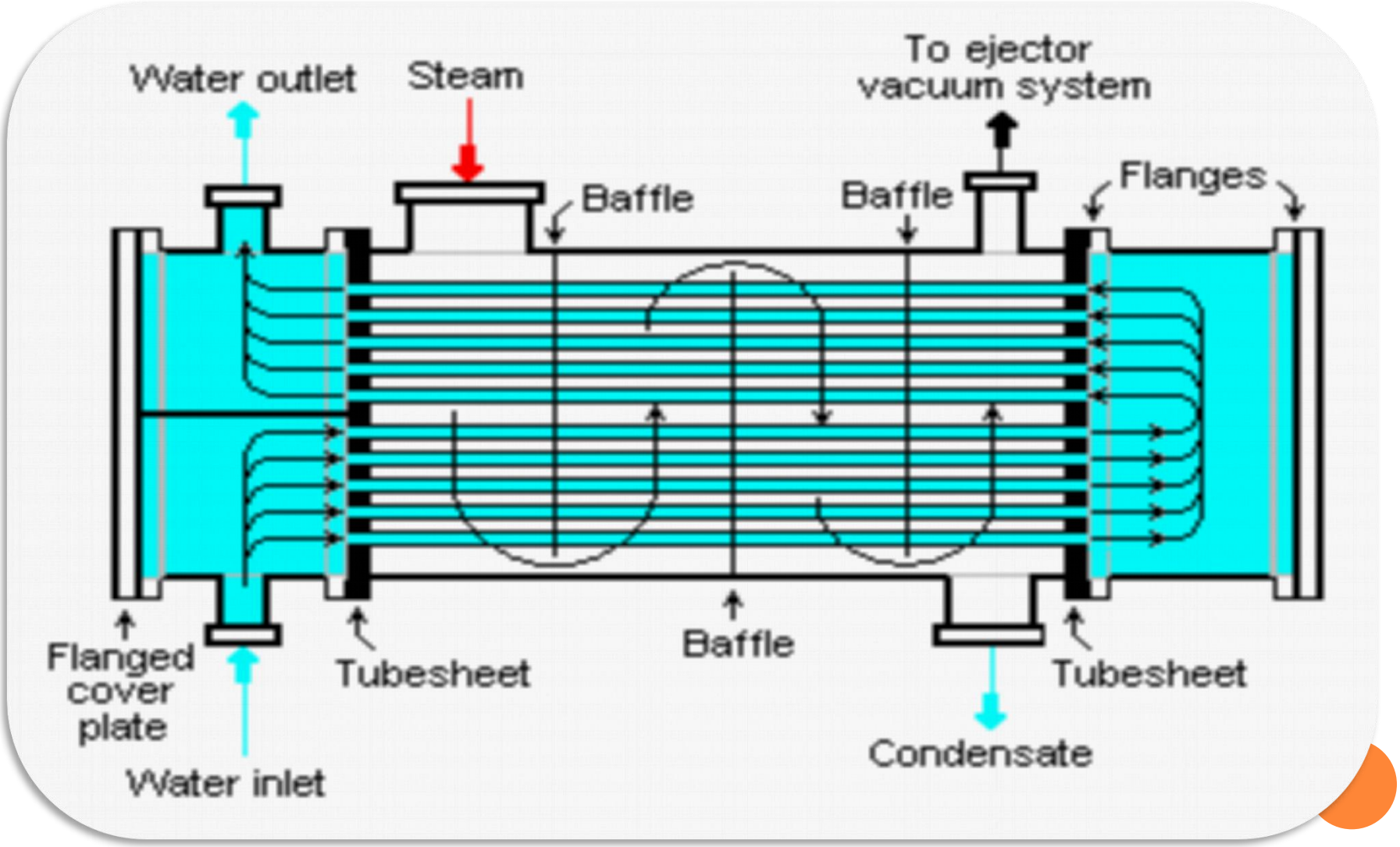
Condenser

Steam after rotating steam turbine comes to condenser. Condenser refers here to the shell and tube heat exchanger (or surface condenser) installed at the outlet of every steam turbine in Thermal power stations of utility companies generally.

- These condensers are heat exchangers which convert steam from its gaseous to its liquid state, also known as phase transition.
- In so doing, the latent heat of steam is given out inside the condenser. Where water is in short supply an air cooled condenser is often used.
- An air cooled condenser is however significantly more expensive and cannot achieve as low a steam turbine backpressure (and therefore less efficient) as a surface condenser.

The purpose is to condense the outlet (or exhaust) steam from steam turbine to obtain maximum efficiency and also to get the condensed steam in the form of pure water, otherwise known as condensate, back to steam generator or (boiler) as boiler feed

Condenser


Water outlet
Steam
To ejector vacuum system
Baffle
Baffle
Flanges
Flanged cover plate
Tubesheet
Baffle
Tubesheet
Water inlet
Condensate

Cooling towers and ponds

- A condenser needs huge quantity of water to condense the steam .
- Typically a 2000MW plant needs about 1500MGallon of water.
- Most plants use a closed cooling system where warm water coming from condenser is cooled and reused
- Small plants use spray ponds and medium and large plants use cooling towers.
- Cooling tower is a steel or concrete hyperbolic structure having a reservoir at the base for storage of cooled water
- Height of the cooling tower may be 150 m or so and diameter at the

Feed water heater

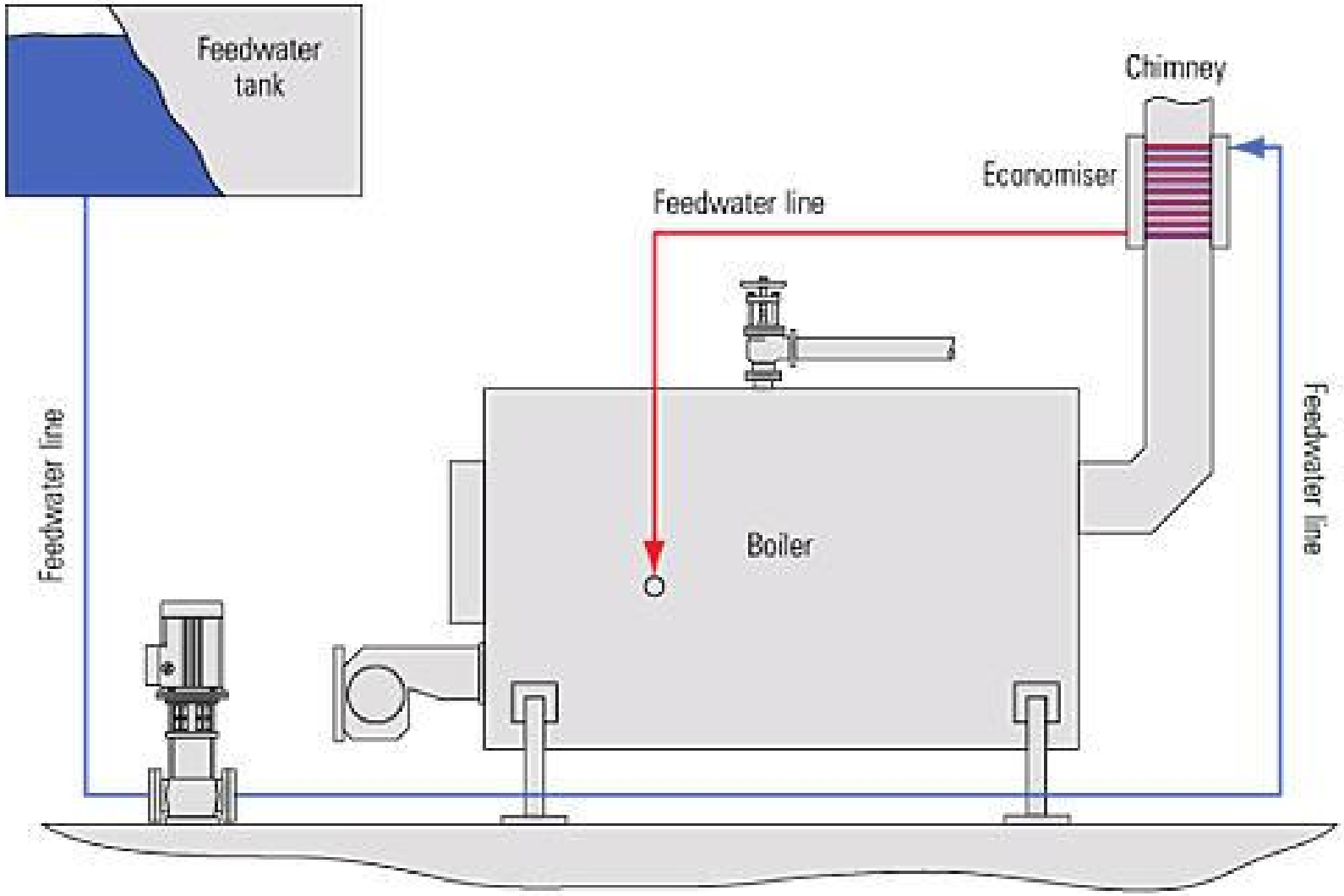
Advantages of heating water before feeding back to the boiler:-

a) Feed water heating improves overall plant efficiency.
b) The dissolved oxygen and carbon dioxide which would otherwise cause boiler corrosion are removed in feed water heater
c) Thermal stresses due to cold water entering the boiler drum are avoided.
d) Quantity of steam produced by the boiler is increased.
e) Some other impurities carried by the steam and condensate, due to corrosion of boiler and condenser are precipitated outside the boiler.

Economiser

Flue gases coming out of the boiler carry lot of heat. An economiser extracts a part of this heat from flue gases and uses it for heating feed water. This use of economiser results in saving coal consumption and higher boiler efficiency

Economizer


Feedwater tank
Chimney
Economiser
Feedwater line
Feedwater line
Boiler
Feedwater line

Air preheater

After flue gases leave economiser, some further heat can be extracted from them and used to heat incoming heat. Cooling of flue gases by 20 degree centigrade increases the plant efficiency by 1%.

Air preheaters may be of three types

- Plate type
- Tubular type
- Regenerative type

SITE SELECTION FOR THERMAL POWER PLANT

A few important factors to be considered for the selection of site for thermal plants are listed below:

- Availability of Coal
- Ash Disposal Facility
- Space Requirements
- Nature of Land
- Availability of Water
- Transport Facilities
- Availability of a Labour
- Public Problems
- Size of the Plant

– Advantages:


1
2
3
4
• Low fuel cost
• Small area
• High output power
• Another used

– Disadvantages:

1. • Pollution
2. • Low efficiency
3. • Position (near the river) need cooling water

Steam (Thermal) Power Plant…

- Advantages of thermal power plant :

  Low initial cost

  Since located near the load centre, the cost of transmission and the losses due to transmission are considerably reduced.

  The construction and commissioning of thermal power plant takes lesser period.

- Disadvantages of thermal power plant:

- Fuel is a non-renewable source of energy.
- Efficiency decreases with decreasing load.
- Cost of power generation is high.
- Smoke produced by burning the fuel causes air pollution.
- Life of thermal power plant is 25 years. The efficiency decreases to less than 10% after its life period.
- Turbines has a high running speed of 3000 to 4000 rpm.

Thermal power plants in INDIA

1. Chhabra thermal powerplant- 500MW
2. Kota super thermal powerplant- 1240MW
3. Giral lignite powerplant- 235MW
4. Suratgarh super thermal powerplant - 1500MW


INDIA
Thermal Power Plants
N
AFGHANISTAN
PAKISTAN
CHINA (Tibet)
NEPAL
BHUTAN
BANGLADESH
MYANMAR
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
SRI LANKA
LAKSHADWEEP (INDIA)
ANDAMAN AND NICOBAR ISLANDS (INDIA)
Rupnagar
Bathinda
Yamuna Nagar
Suratgarh
Panipat
Badarpur, Delhi
Dadri
Gurha
Faridabad
Harduaganj
Rosa
Dibiyapur
Panki
Bongaigaon
Kanti
Kahalgaon
Vidyutnagar
Barauni
Thumbli
Unchahar
Kota
Baran
Paricha
Obra
Anpara
Farakka
Sidhi
Rihand
Suri
Murshidabad
Durgapur
Birsinghpur
Jamani Palli
Puruliya
Hoogly
Gandhinagar
Chachai
Jamnagar
Kheda
Mecheda
Janor
Sarni
Sipat
Jharsuguda
Kutch
Nani Naroli
Tamnar
Kaniha
Kaparkheda
Adityanagar
Deepnagar
Vidyutnagar
Talcher
Nashik
Chandrapur
Parli-Vaijnath
Ramagundam
Jyothi Nagar
Chelpur
Ibrahimpatnam
Paloncha
Simhadri
Raichur
Dondapadu
Kudatini
Cuddapah
Athipattu
Ennore
Metturdam
Neyveli
Kayamkulam
Tuticorin
LEGEND
Thermal Power Plant
Map not to Scale
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Thank you