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Coal Thermal Power Plant

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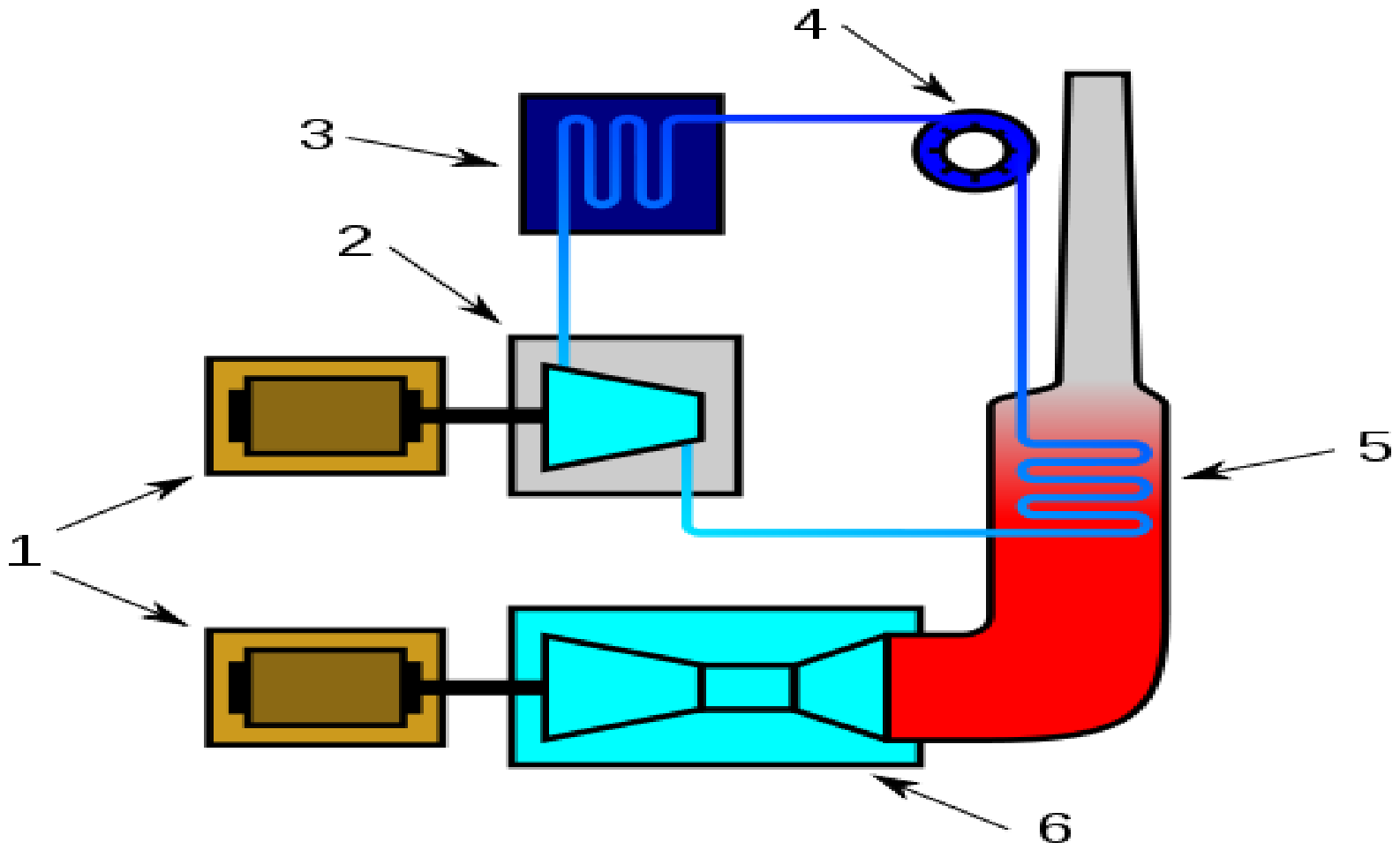
Thermal Power Generation

- **Thermal energy**
  - Matter is made up of particles or molecules. These molecules move (or vibrate) constantly. A rise in the temperature of matter makes the particles vibrate faster. Thermal energy is what we call energy that comes from the temperature of matter. The hotter the substance, the more its molecules vibrate, and the therefore the higher its thermal energy.

Thermal power station

- A **thermal power station** is a power plant in which the prime mover is steam driven. Water is heated, turns into steam and spins a steam turbine which drives an electrical generator. After it passes through the turbine, the steam is condensed in a condenser and recycled to where it was heated; this is known as a Rankine cycle.
- The greatest variation in the design of thermal power stations is due to the different fossil fuel resources generally used to heat the water.

- Non Combined Cycle or Single Cycle
  - A single cycle is an assembly of heat engine that convert heat to mechanical energy and then to electrical.
- Combined Cycle
  - In electric power generation a **combined cycle** is an assembly of heat engines that work in tandem from the same source of heat, converting it into mechanical energy, which in turn usually drives electrical generator.
  - the overall net efficiency of the system may be increased by 50 – 60 percent.



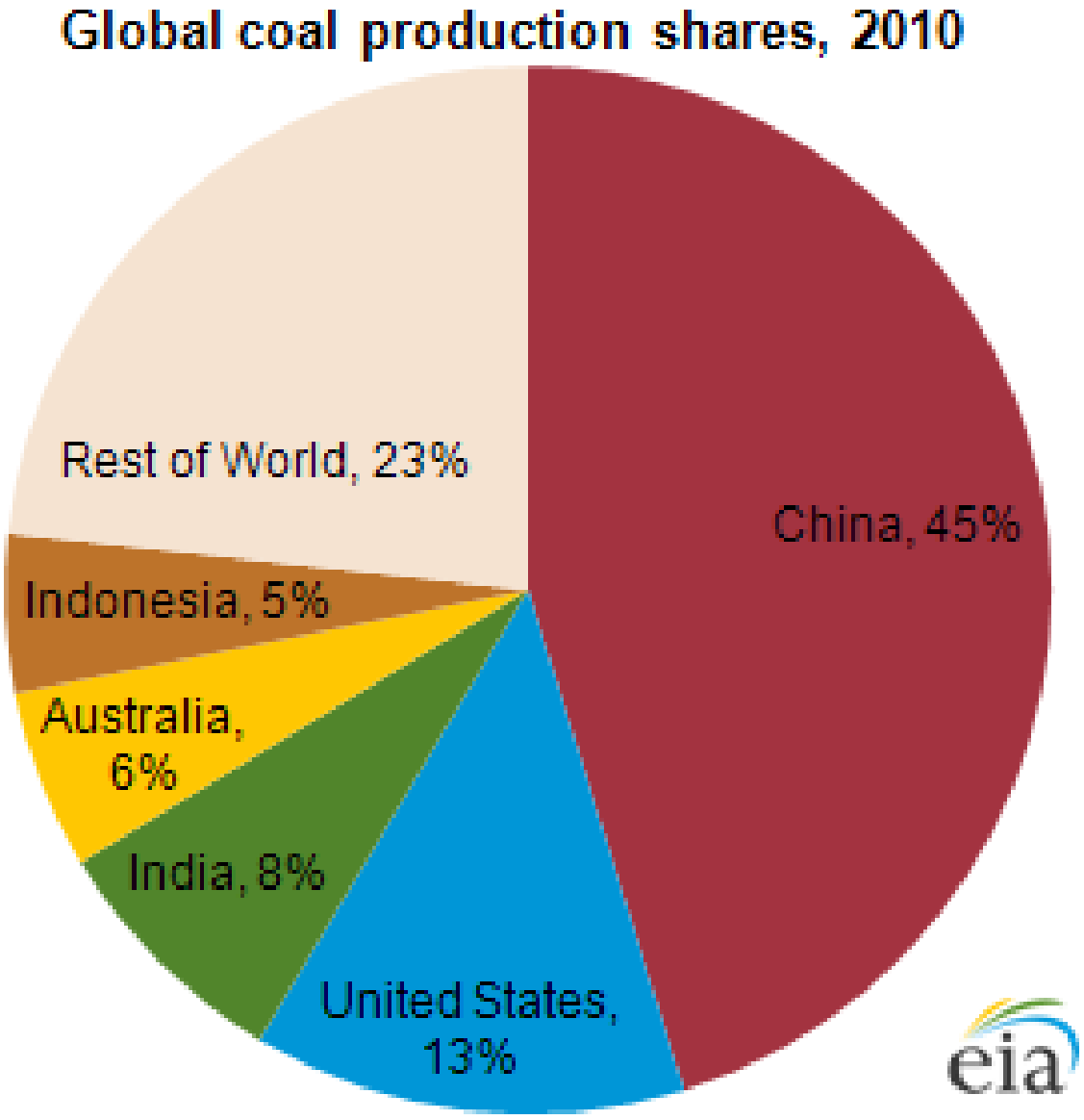
1. Electric generators. 2. Steam turbine. 3. Condenser. 4. Pump.
5.Boiler/heat exchanger. 6. Gas turbine

Types of thermal power station

- Coal
- Gas
- Oil
- Nuclear

Coal

- Coal is the largest source of energy for the generation of electricity worldwide, it is also known as black diamond.
- Coal is used as a solid fuel to produce electricity and heat through combustion.
- World coal consumption was about 7.25 billion tonnes in 2010.
- At least 40% of the world's electricity comes from coal.


Global coal production shares, 2010
Rest of World, 23%
China, 45%
Indonesia, 5%
Australia, 6%
India, 8%
United States, 13%
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Advantages

- Easily combustible, and burns at low temperatures, making coal-fired boilers cheaper and simpler than many others.
- Widely and easily distributed all over the world.
- Comparatively inexpensive to buy on the open market due to large reserves.
- Good availability for much of the world (i.e. coal is found many more places than other fossil fuels).

- Most coal is rather simple to mine, making it by far the least expensive fossil fuel to actually obtain.
- Coal-powered generation scales well, making it economically possible to build a wide variety of sizes of generation plants.
- A fossil-fuelled power station can be built almost anywhere, so long as you can get large quantities of fuel to it. Most coal fired power stations have dedicated rail links to supply the coal.
- Very large amounts of electricity can be generated in one place using coal, fairly cheaply.

Disadvantages

- It is Non-renewable and fast depleting.
- Coal has the lowest energy density of any fossil fuel - that is, it produces the least energy per ton of fuel.
- high coal transportation costs due to the bulk of coal (as a result of the preceding two low energy density problems), especially for countries with no coal resources and hence will require special port for coal import and storage.
- Coal dust is an extreme explosion hazard, so transportation and storage must take special precautions.
- Coal storage cost is high especially if required to have enough stock for few years to assure power production availability.

Thermal Power Plant:

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parts

1.Coal Conveyor

Coal conveyor is a belt type arrangement that are used to move coal efficiently.

2.Pulverizer

Pulverizer increases the coal combustion efficiency of coal.

3.Boiler

A boiler is a device used to create steam by applying heat energy to water.

4.Superheater

In a power plant, after the steam is conditioned by the drying equipment inside the steam drum, it is piped from the upper drum area into tubes inside an area of the furnace known as the super heater.

5.Economizer

Economizer are mechanical devices intended to reduce energy consumption, or to perform another useful function like preheating a fluid.

6. Reheator

Reheator added heat in the high-pressure steam.

7. Steam Turbine

A steam turbine is a mechanical device that extracts thermal energy from pressurized steam, and converts it into rotary motion.

8. Generator

A device which convert mechanical energy into electrical energy is called generator.

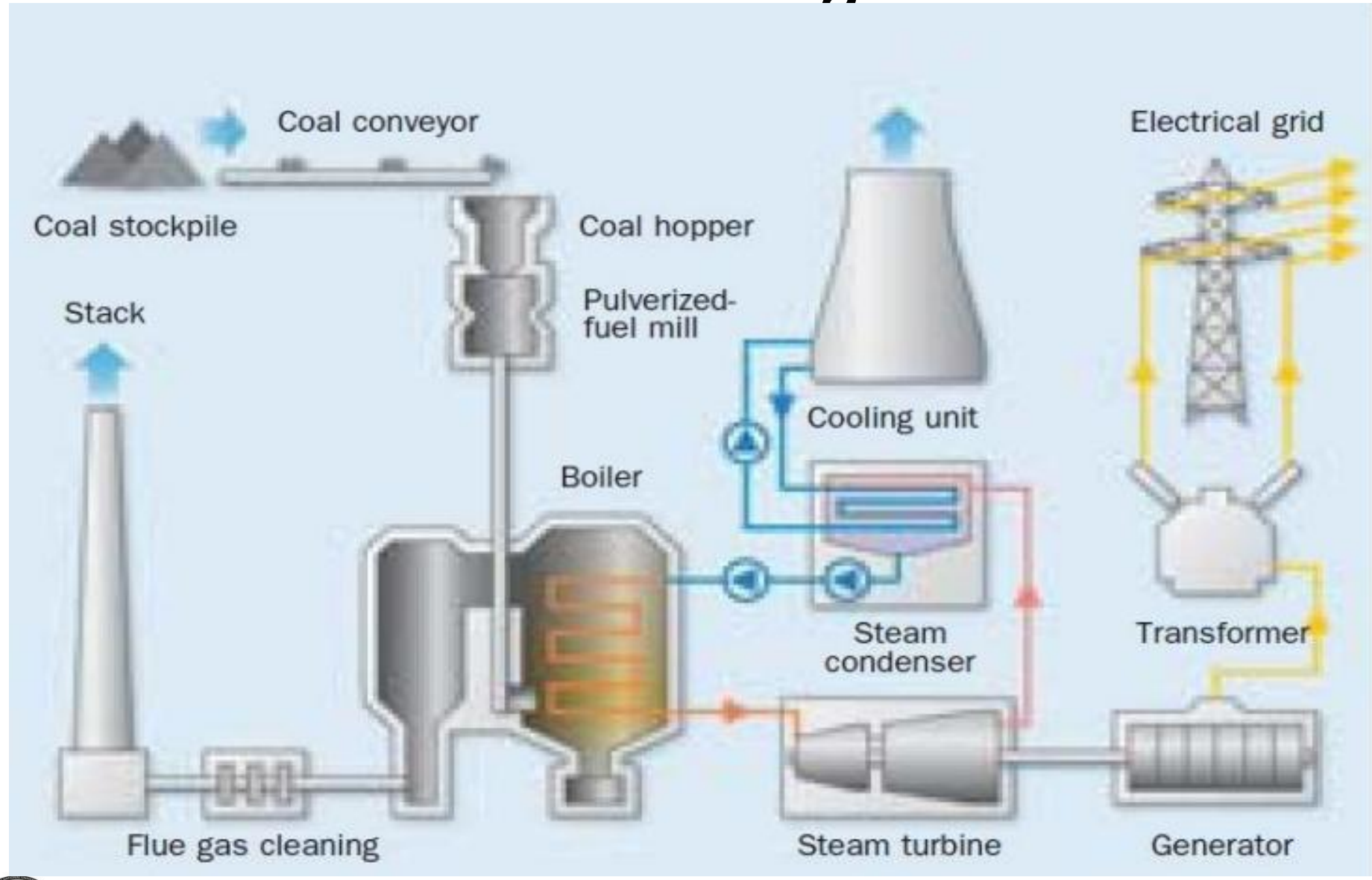
9. Condenser

Condenser is a device or unit used to condense a substance from its gaseous to its liquid state, typically by cooling it.

10. Deaerator

A deaerator is a device that is widely used for the removal of air and other dissolved gases from the feed water to steam-generating boiler.

Function diagram



function

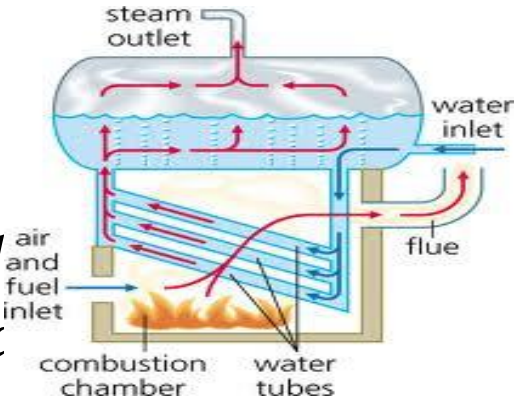
STAGE 1

- *Coal arriving by train can be stocked for later use or taken straight to the coal bunkers.*
- *Coal is prepared for use by crushing the rough coal to pieces less than 2 inch (5 cm in size). Crushing the coal into a fine powder makes easirer to burn it more completely.*
- *Coal mills grind the larger of 2 inch pieces to face powder and mixed them with primary combustion air which transports the coal to the furnace and preheats the coal to drive off excess moisture content.*
- *By pulverizing the coal combustion efficiency of coal increases.*

Conveyor ←

→mill

sTAGE 2



- *Pulverized coal is burnt to produce steam.*
- *Water from the feed pump, after pre-heating enters the boiler. This water may be obtained from a nearby river or lake. The condensed water from the cooling tower is re-used.*
- *The heated or vapourized fluid exits the boiler for use in various processes and heating applications.*

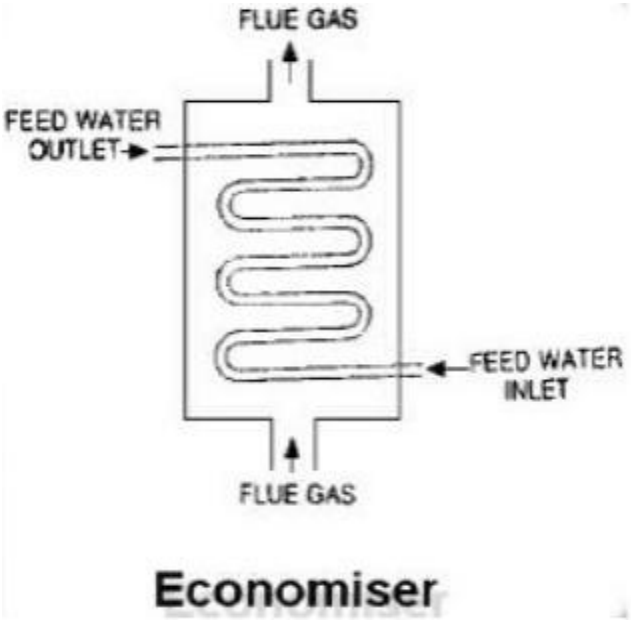
STAGE 3

- *The steam produced in the boiler, goes to the steam drum and is then piped to super-heaters where it is heated above saturation temperature.*
- *At this point steam is now turned into a very powerful source of energy.*
- *This rotates the turbine.*

STAGE 4

- *Flue gases coming out of the boiler carry a lot of heat. An economizer extracts a part of this heat from flue gases and use it for heating feed water.*

- *This use of economizer result in saving coal consumption and higher boiler efficiency.*



Economiser

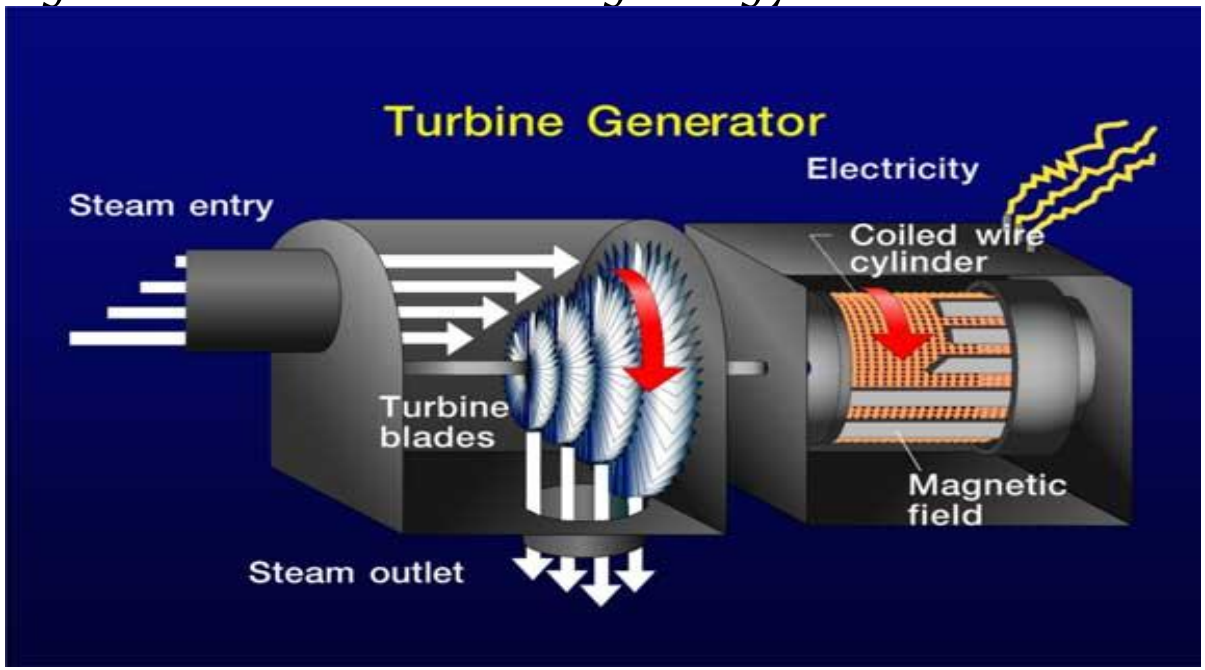
STAGE 5

- *Reheaters is also a steam boiler in which heat is added to this high-pressure steam. Which has given up some of its energy in expansion through the intermediate-pressure turbine.*
- *The steam after reheating is used to rotate the the second steam turbine where the heat is converted to mechanical energy.*
- *This mechanical energy is used to run the generator, which is coupled to the turbine, there by generating electrical energy.*

STAGE 6

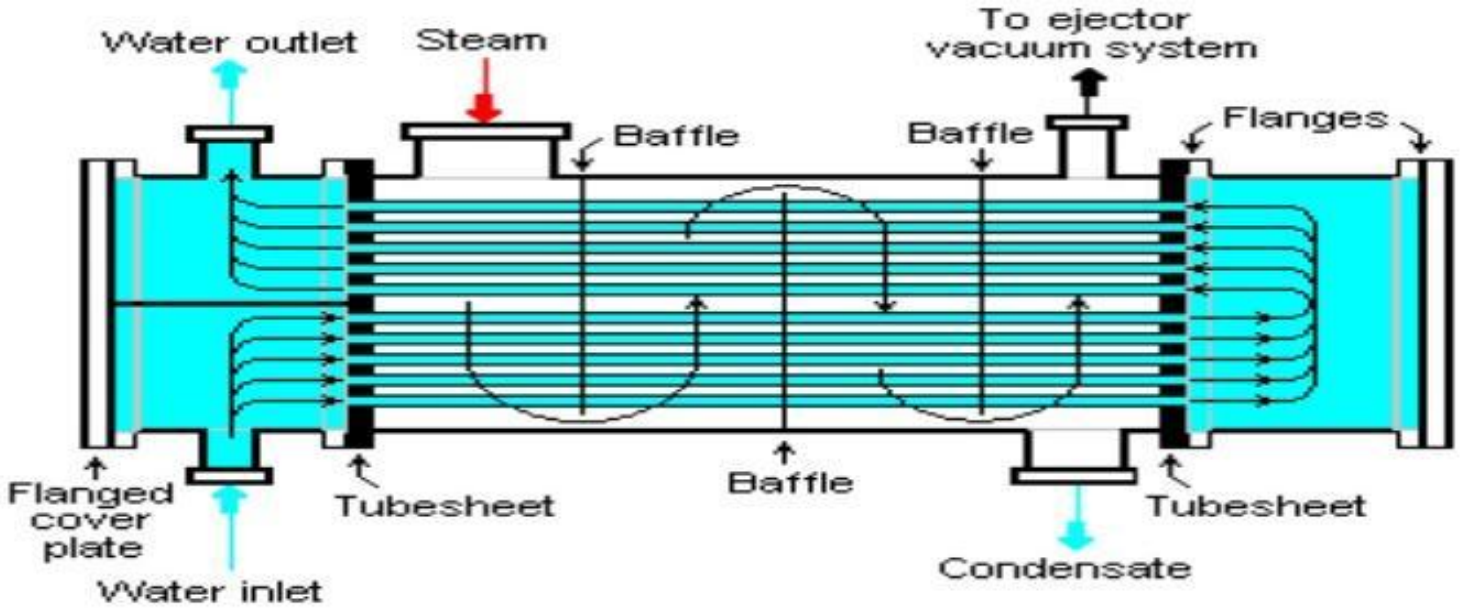
The turbine generator consists of a series of steam turbines interconnected to each other and a generator on a common shaft.

- *There is a high pressure at one end , follower by an intermediate pressure turbine. A low pressure turbines, and the generator.*
- *As steam moves through the system, it losses pressure and thermal energy and expands in volume, requiring increasing diameter and longer blades at each succeeding to extract the remaining energy.*



Stage 7

- *Steam after rotating steam turbine comes to the condenser.*
- *The purpose of condenser is to condense the outlet steam from steam turbine to get the condensed steam in the form of pure water.*
- *This water is then pumped back to boiler.*



STAGe 8

- *A steam generating boiler requires that the boiler feed water should be devoid of air and other dissolved gases,particularly corrosive ones.*
- *In order to avoid corrosion of the metal power station uses a Deaerator, for the removal of air and other dissolved gases from the boiler feed water.*
- *A deaerator has a vertical. Domed deaeration section mounted on top of a horizontal cylindrical vessel.*

STAGE 9

- *The enormous pressure of the steam pushing against a series of giant turbine blades turns the turbine shaft. The turbine shaft is connected to the shaft of the generator, where magnets spin within wire coils to produce electricity.*

- *Electricity is send through power grid lines and then travelled to substations located in towns.*

Efficiency of Steam Power stations

The overall efficiency of a steam power station is quite low (about 29%) due mainly to two reasons. Firstly, a huge amount of heat is lost in the condenser and secondly heat losses occur at various stages of the plant. The heat lost in the condenser cannot be avoided. It is because heat energy cannot be converted into mechanical energy without temperature difference. The greater the temperature difference, the greater is the heat energy converted* into mechanical energy. This necessitates to keep the steam in the condenser at the lowest temperature. But we know that greater the temperature difference, greater is the amount of heat lost. This explains for the low efficiency of such plants.

Thermal efficiency, $$\eta_{thermal} = \frac{\text{Heat equivalent of mech. energy transmitted to turbine shaft}}{\text{Heat of coal combustion}}$$

Advantages of Liquids fuels over solid fuels

The following are the advantages of liquid fuels over the solid fuels :

(*i*) The handling of liquid fuels is easier and they require less storage space.

(*ii*) The combustion of liquid fuels is uniform.

(*iii*) The solid fuels have higher percentage of moisture and consequently they burn with great difficulty. However, liquid fuels can be burnt with a fair degree of ease and attain high temperature very quickly compared to solid fuels.

(*iv*) The waste product of solid fuels is a large quantity of ash and its disposal becomes a problem. However, liquid fuels leave no or very little ash after burning.

(*v*) The firing of liquid fuels can be easily controlled. This permits to meet the variation in load demand easily.

Advantages of Solid fuels over Liquid fuels

(*i*) In case of liquid fuels, there is a danger of explosion.

(*ii*) Liquids fuels are costlier as compared to solid fuels.

(*iii*) Sometimes liquid fuels give unpleasant odours during burning.

(*iv*) Liquid fuels require special types of burners for burning.

(*v*) Liquid fuels pose problems in cold climates since the oil stored in the tanks is to be heated in order to avoid the stoppage of oil flow.