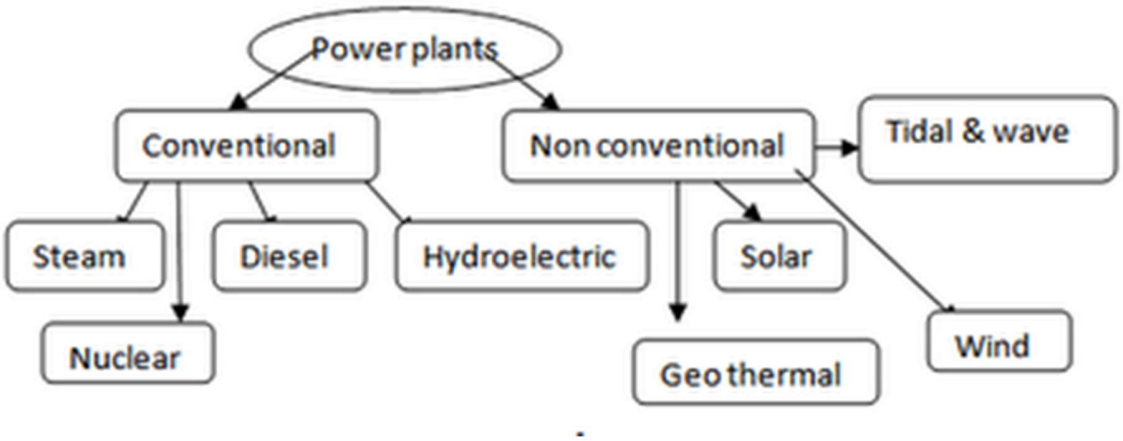
POWER PLANTS

Introduction

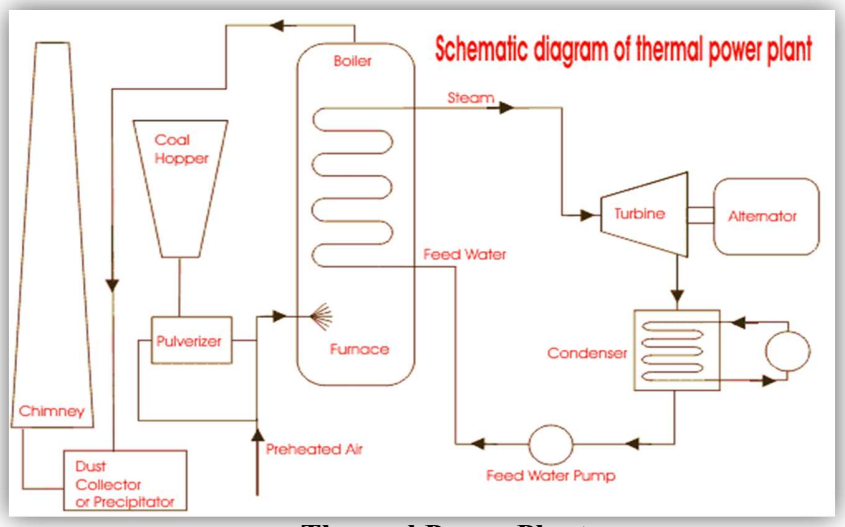
A power plant is a facility where electrical power is generated. A power plant is also referred as power station or power house or generating station. The source of energy to generate electrical power output can be water, coal, natural gas, diesel, solar energy, wind energy, ocean wave energy and nuclear energy. The classification of power plants is as shown in figure below



Classification of Power Plants

Thermal Power Plant

In thermal power stations, mechanical power is produced by a heat engine that transforms thermal energy from combustion of a fuel into rotational energy. Most thermal power stations produce steam and these are sometimes called steam power stations. The schematic diagram of a typical thermal power plant is shown below:



Thermal Power Plant

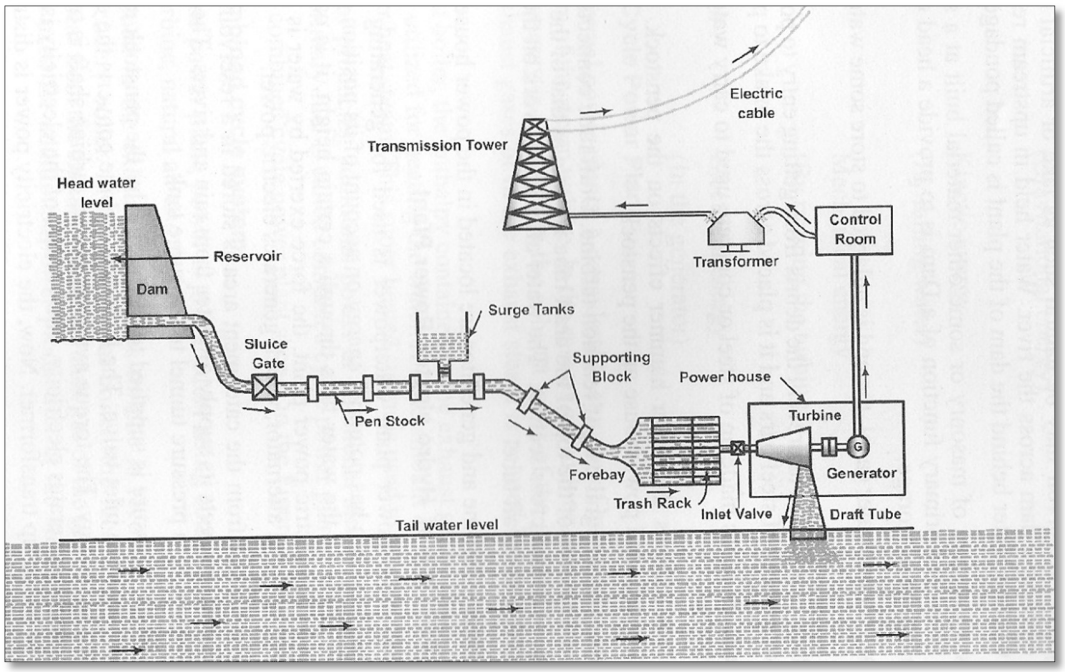
Working Principle:

In steam boiler the water is heated up by burning the fuel such as coal in the furnace and a high pressure steam is generated. Pulverizes are used to crush the large chunks of coal into powder that is mixed with air and burnt inside the furnace of the boiler. The steam so produced is used in driving the steam turbines. This turbine is coupled to synchronous generator (usually three phase synchronous alternator) which generates electrical energy. The exhaust steam from the turbine is allowed to condense into water in a steam condenser. Inside a condenser the steam is condensed by cooling water which is supplied by the cooling tower or a nearby water reservoir such as a lake, river or ocean. The condensate along with some fresh feed water is again fed into the boiler by a boiler feed pump. The flue gases coming out of the boiler are exhausted into atmosphere through stacks after passing through the dust collection device.

Hydel power plant

Hydro-electric power plant utilizes the potential energy of water stored in a dam built across the river. The potential energy of the water is used to run water turbine to which the electric generator is coupled. The mechanical energy available at the shaft of the turbine is converted into electrical energy by means of the generator. The schematic diagram of a typical hydel plant is shown in the figure below and consists of the following components:

- **Water reservoir:** Continuous availability of water is the basic necessity for a hydro-electric plant. Water collected from catchment areas during rainy season is stored in the reservoir. Water surface in the storage reservoir is known as head race.



Hydel Power Plant

- **Dam**: The function of a dam is to increase the height of water level behind it, which ultimately increases the reservoir capacity. The dam also helps to increase the working head of the power plant.

- **Spillway:** Water in the dam after a certain level in the reservoir overflows through spillway without allowing the increase in water level in the reservoir during rainy season.

- **Penstock:** Water from reservoir is taken to the turbine by means of pen stocks, made up of reinforced concrete pipe or steel.

- **Surge tank:** There is sudden increase of pressure in the penstock due to sudden backflow of water, as load on the turbine is reduced. The sudden rise of pressure in the penstock is known as water hammer. The surge tank is introduced between the dam and the power house to reduce the sudden rise of pressure in the penstock, otherwise penstock will be damaged by the water hammering effect.

- **Water turbine:** Water through the penstock enters into the turbine through an inlet valve. Prime motors which are in common use are Pelton turbine, Francis turbine and Kaplan turbine. The kinetic energy of water entering the turbine is converted into mechanical energy. The mechanical energy available at the turbine shaft is used to run the electric generator. The water is then discharged through the draft tube.

- **Draft tube:** It is connected to the outlet of the turbine. It allows the turbine to be placed over tail race level.

- **Tail race:** Tail race is a water way to lead the water discharged from the turbine to the river. The water held in the tail race is called tail race water level.

- **Step-up transformer:** Its function is to raise the voltage generated at the generator terminal before transmitting the power to consumers.

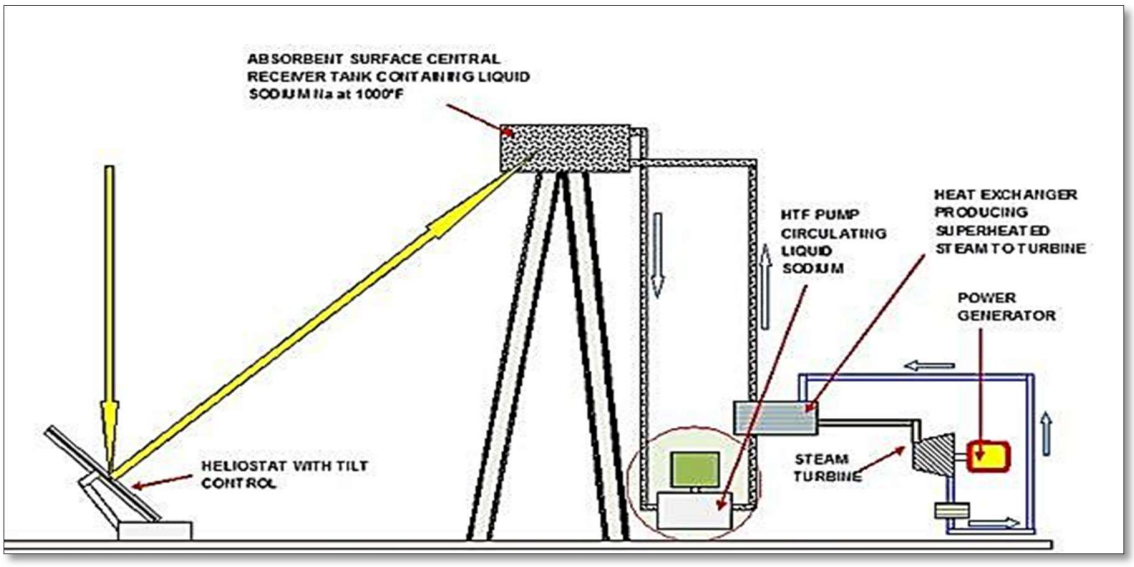
- **Power house:** The power house accommodates the turbine, generator, transformer and control room.

Solar Power Plant

Solar energy can be turned into electricity either directly in solar cells, or in a concentrating solar power plant by focusing the light to run a heat engine.

A solar photovoltaic power plant converts sunlight into direct current electricity using the photoelectric effect. Inverters change the direct current into alternating current for connection to the electrical grid. This type of plant does not use rotating machines for energy conversion.

Solar thermal power plants are another type of solar power plant. They use either parabolic troughs or heliostats to direct sunlight onto a pipe containing a heat transfer fluid such as liquid sodium.



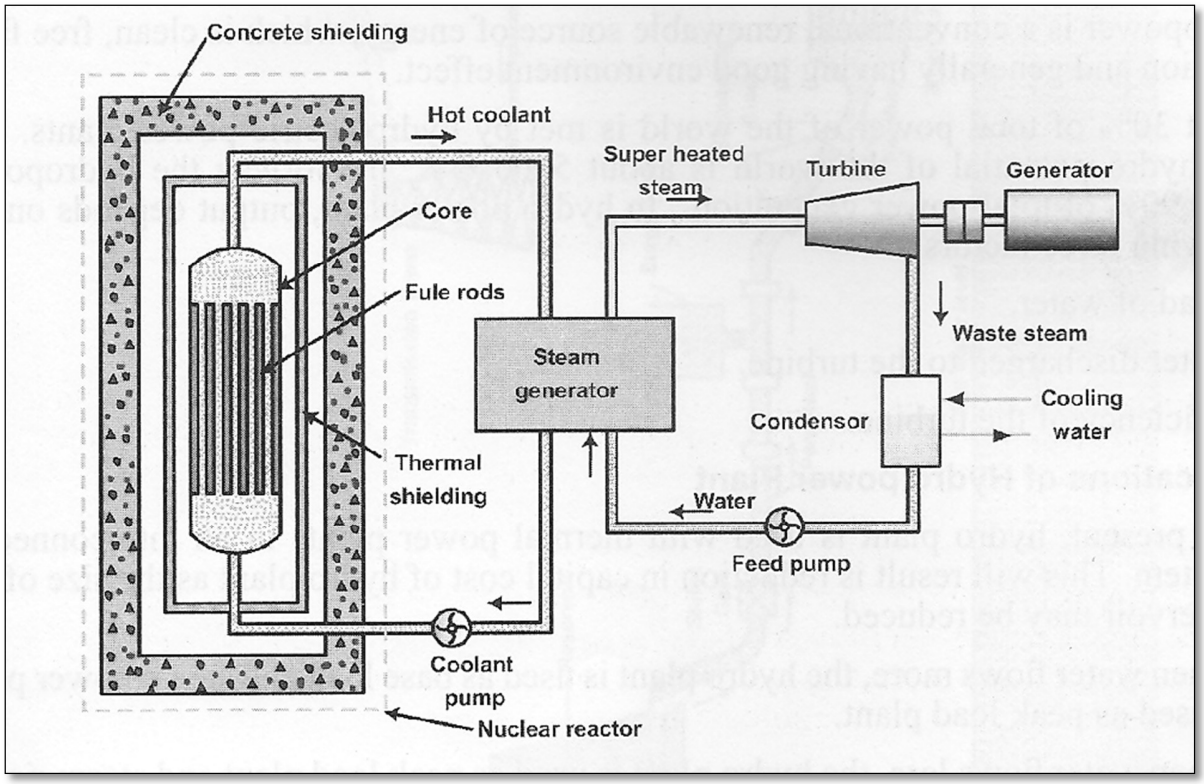
Solar Thermal Power Plant

Working Principle:

- The central tower type of solar thermal power plant uses hundreds or thousands of mirrors to direct sunlight onto a receiver on top of a tower.
- The central tower receiver absorbs the solar radiation reflected by the heliostats and transfers this heat energy to liquid sodium. Hot liquid sodium is then passed to the steam generator where the water flowing absorbs heat from liquid sodium and gets converted into superheated steam.
- This steam is passed through the steam turbine to generate electricity much like a steam power plant.
- The liquid sodium is pumped back to the central receiver to absorb more heat.

Nuclear Power Plant

A nuclear power plant is a thermal power station in which the heat source is a nuclear reactor. As is typical in all conventional thermal power stations the heat is used to generate steam which drives a steam turbine connected to a generator which produces electricity. The conversion to electrical energy takes place indirectly as in conventional thermal power plants. The heat is produced by fission reaction in the nuclear reactor. A typical nuclear reactor power plant is as shown below:



Nuclear Power plant

Working Principle:

- The core of the reactor contains the nuclear fuel and generates all the heat. It contains low-enriched uranium (<5% U-235), control systems, and structural materials. The core can contain hundreds or thousands of individual fuel pins.
- The heat generated in the reactor due to nuclear fission reaction is taken up by the coolant (Usually Heavy water, liquid sodium or helium).
- The hot coolant then leaves the reactor and flows through the steam generator.
- In the steam generator the hot coolant transfers its heat to the feed water which gets converted into steam.

- The steam produced is passed through the turbine which is coupled to the generator and thus power is produced.
- The exhaust steam from the turbine is condensed in the condenser.
- The condensate then flows to the steam generator through the feed pump.
- The containment is the structure that separates the reactor from the environment. These are usually dome-shaped made of high-density steel-reinforced concrete.

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