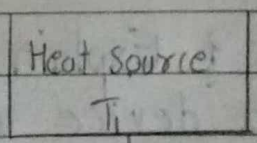
Q.1] Explain a) 1st law of Thermodynamics
b) Kelvin plank statement of thermodynamics
c) Clausis statement of 2nd law of thermodynamics.

→ a) 1st law of thermodynamics :

Energy can neither be created nor be destroyed but can only we be converted from one to another form. Thus, the total energy in the universe remains constant This is also known as law of conservation of energy.
Example: In steam power plant, chemical energy of coal is converted into heat energy of steam which is converted into the mechanical energy in the turbine that is again converted into electrical energy by alternate.
No machine can produce energy without corresponding expeltitute of energy i.e. It is impassible to the construct a perpetual motion machine of a first kind.

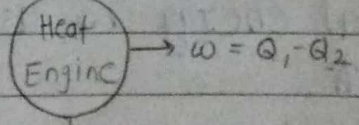
b) Kelvin - plank statement of Thermodynamics.

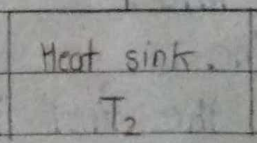


$Q_1 > w$

$\eta = \frac{w}{Q_1}$

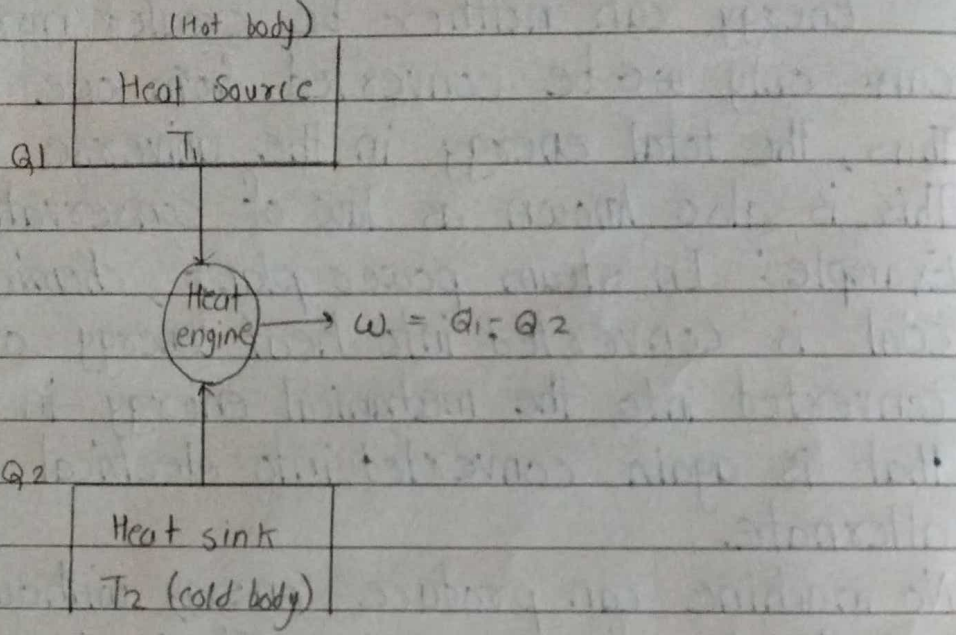
$\eta < 100\%$





It is impossible to construct a heat engine which occurs in a cycle and converts all amount of heat into equivalent amount of work.

c) Clausius Statement of second law of thermodynamics



It is impossible to construct a device which operating in a cycle transfer the heat from a colder body to hotter body without consuming any work.

Q.2] What is heat engine ? Explain its classification.

→ Heat engine is a device which transforms chemical energy of a fuel into thermal energy and this thermal energy is used for producing mechanical work.

Heat Engine is classified into:

1. External Combustion engine:

In some heat engine, the fuel is burnt and heat is produced outside the engine combustion is carried

out external called External Combustion engine.

2. Internal Combustion Engine:
It is some heat engine, in which the fuel is burnt inside the engine combustion is carried out internal called Internal Combustion Engine.

Q.3 Explain classification of IOC engine.
→

a) According to the type of fuel.
1) Gas engines
2) Petrol engines
3) Disel engines.

b) According to the type of mechanical cycle.
1) Two Stroke engine (2-s engine)
2) Four Stroke engine (4-s engine)

c) According to the type of ignition.
1) Spark ignition (S.I engine)
2) Compression ignition (C.I engine)

d) According to the type of Thermodynamics cycle.
1) Otto cycle engine (constant volume combustion)
2) Disel cycle engine (constant pressure combustion)
3) Dual cycle engine (mixed cycle)

e) According to the type of cooling.
1) Air cooled engines.
2) Water cooled engines.

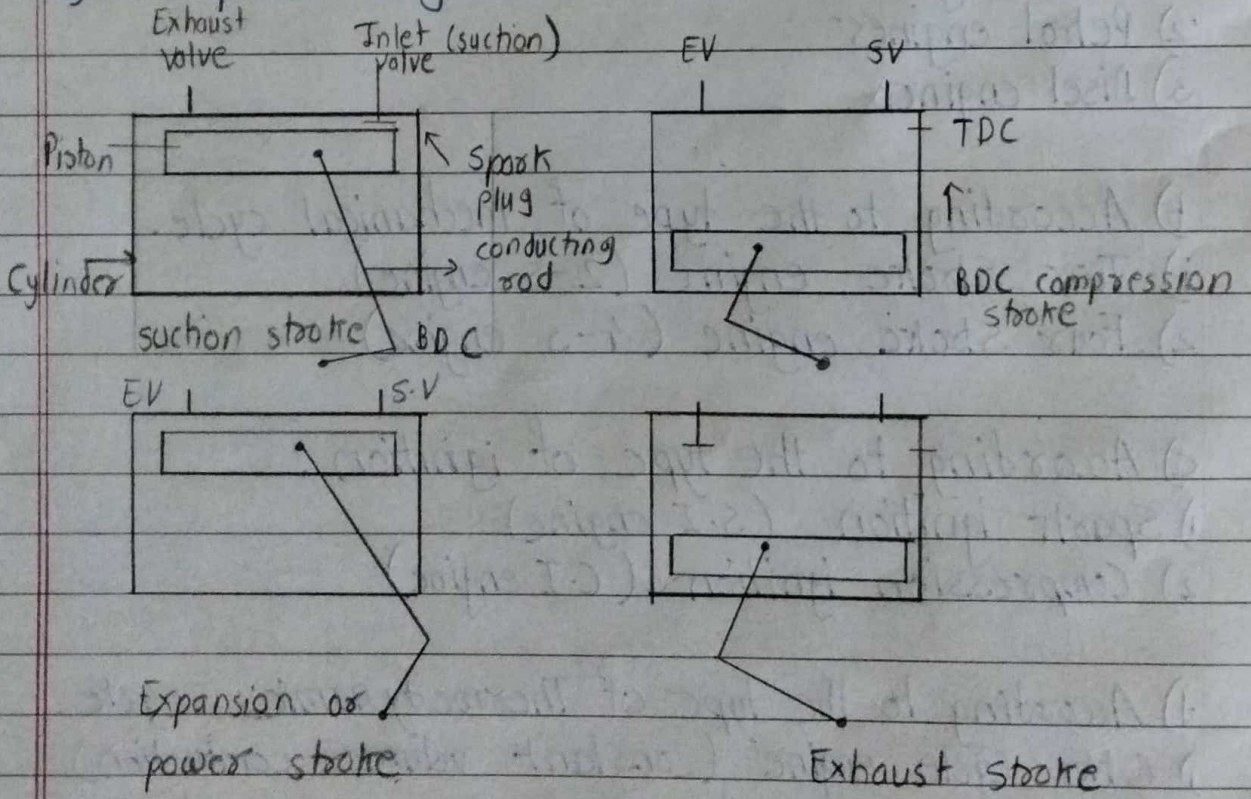
f) According to the type of piston
1) Reciprocating piston engine
2) Rotary piston engine.

g) According to the number of cylinders.
1) Single cylinder
2) Multi Cylinder

Q.4 Explain 4-S petrol and Disel engine.

→

a) 4-S petrol engine.



In a 4-S Petrol engine, the cycle operation is completed in 4-S of the piston or the two revolution of crank shaft.
Each stroke consist of 180° of crankshaft rotation.
A cycle consist of 720° rotation of crankshaft.

i) Suction Stroke : This stroke start when piston moves from TDC → BDC. Inlet valve is open and exhaust valve is closed due to suction, the charge (air & petrol) is coming into the cylinder.

ii) Compression Stroke : Charge is compressed. Both valves are closed, spark plug produces spark and ignites the air petrol mixture.

iii) Power or expansion stroke : Both valve closed because of combustion of fuel exerts pressure on piston. High pressure of hot gaseous are produced. Piston moves due to the expansion of hot gaseous.

iv) Exhaust Stroke : Exhaust valves are open and inlet valve is closed. Exhaust gaseous are drawn out from cylinder. One revolution of crank shaft occur during suction & compression.
Second revolution of crankshaft occur during power & exhaust

b) Four Stroke Disel Engine.
i) Suction Stroke : In case of disel engine, ~~the fuel~~ only air is drawn into the cylinder.

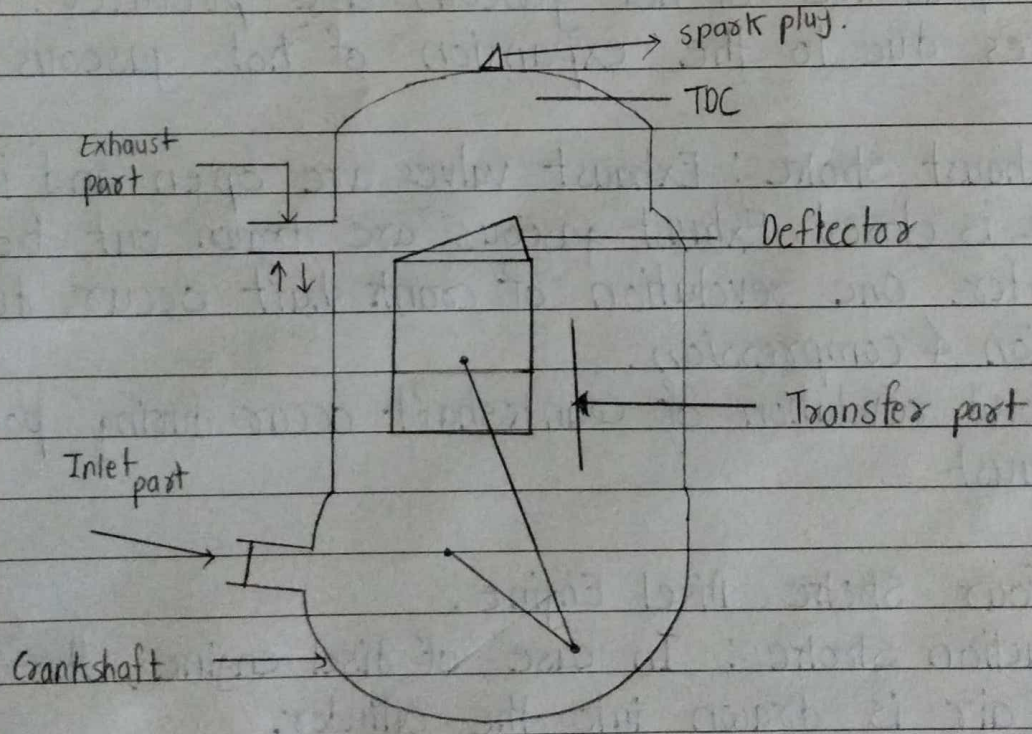
ii) Compression Stroke : In case of disel engine, the fuel injector injects the disel into the combustion space, the fuel get ignited due to, high temperature of the heavily compressed air.

iii) Power Stroke : Both valve closed because of combustion of fuel exerts pressure on piston. High pressure of hot gaseous, piston moves due to the expansion of hot gaseous.

iv) Exhaust Stroke : Exhaust valve open and inlet valve closed, exhaust gaseous drovven out from the cylinder.

5] Explain 2-S petrol & disel engine.

→



Exhaust blow down

Two stroke petrol engine.

1) Suction stroke & compression stroke

Piston moves from bottom dead centre to TDC, inlet ports open and transfer port and exhaust port are closed. Charge (air + petrol) is taken into

crankcase through inlet part and charge above the piston gets compressed simultaneously. Crankshaft revolves half revolution during these strokes i.e. crank revolution.

2) Expansion stroke and exhaust stroke

During these strokes, transfer port & exhaust port are open and inlet port is closed charge (air + petrol) is ignited by spark plug producing high pressure hot gaseous, when piston moves from TDC to BDC. First piston open exhaust port, charge (air + petrol) is taken into cylinder above piston and remaining gaseous are exhaust out by fresh charge. This process is called as scvanging The piston is given small slope near exhaust port and more slope near transfer port for the exhausting out exhaust gaseous.

Two stroke disel engine

1) Suction and Compression stroke.

In case of disel engine, only air is droven into crankcase and only air is compressed inside the cylinder by piston during these stroke.

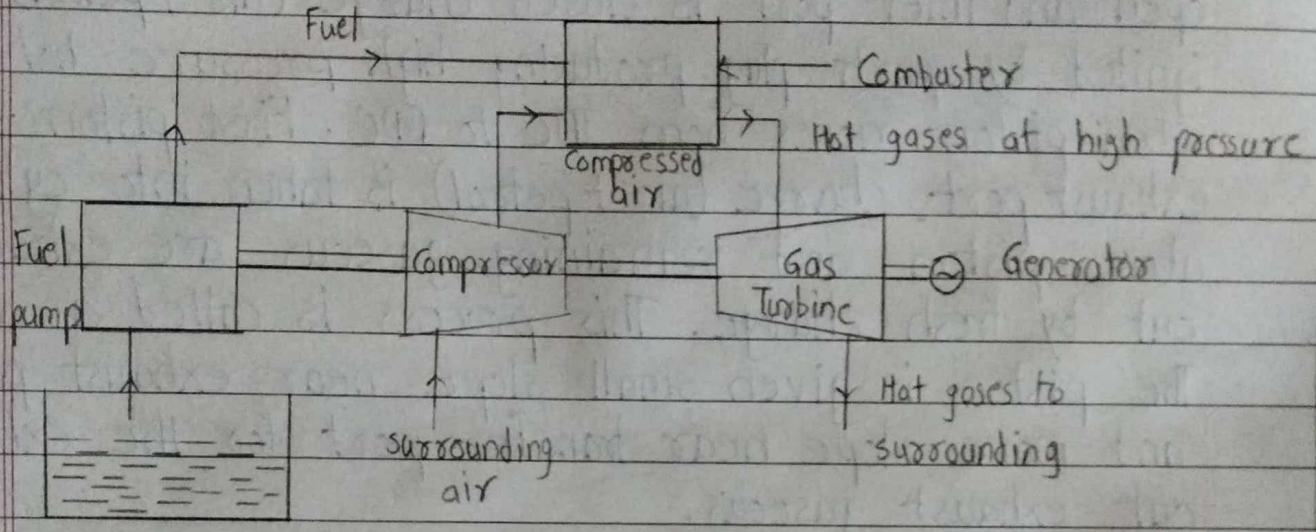
2) Expansion and exhaust stroke.

In case of disel engine, disel injected into high temperature compressed air and gets ignited producing high pressure and high temperature hot gaseous which act on piston.

Q.6 Explain the following with neat sketches:
a) Gas turbine power plant b) Thermal power plant
c) Nuclear power plant.

→

a) Gas Turbine Power Plant:



A simple gas power plant ~~it~~ is shown in fig and the main components of gas turbine are

① Compressor or coupled to turbine.
② Combustion chamber or combuster.
③ Gas turbine.
④ Oxilary such as fuel pump.

The surrounding air is taken from atmosphere is compressed in the compressor where its pressure is increased. It is then supplied to combuster simultaneously, the fuel from fuel tank with the help of fuel pump is given and spread into the combuster with high pressure. The fuel is ignited from the ignition system. The combustion of fuel with air increases the temperature of hot gaseous.

The air fuel ranges from 20:1 to 100:1 depending on the application requirement.
The high pressure & high temperature, hot gaseous from combuster given to the gas turbine.
The adiabatic expansion of hot gaseous takes place and mechanical power is produced.

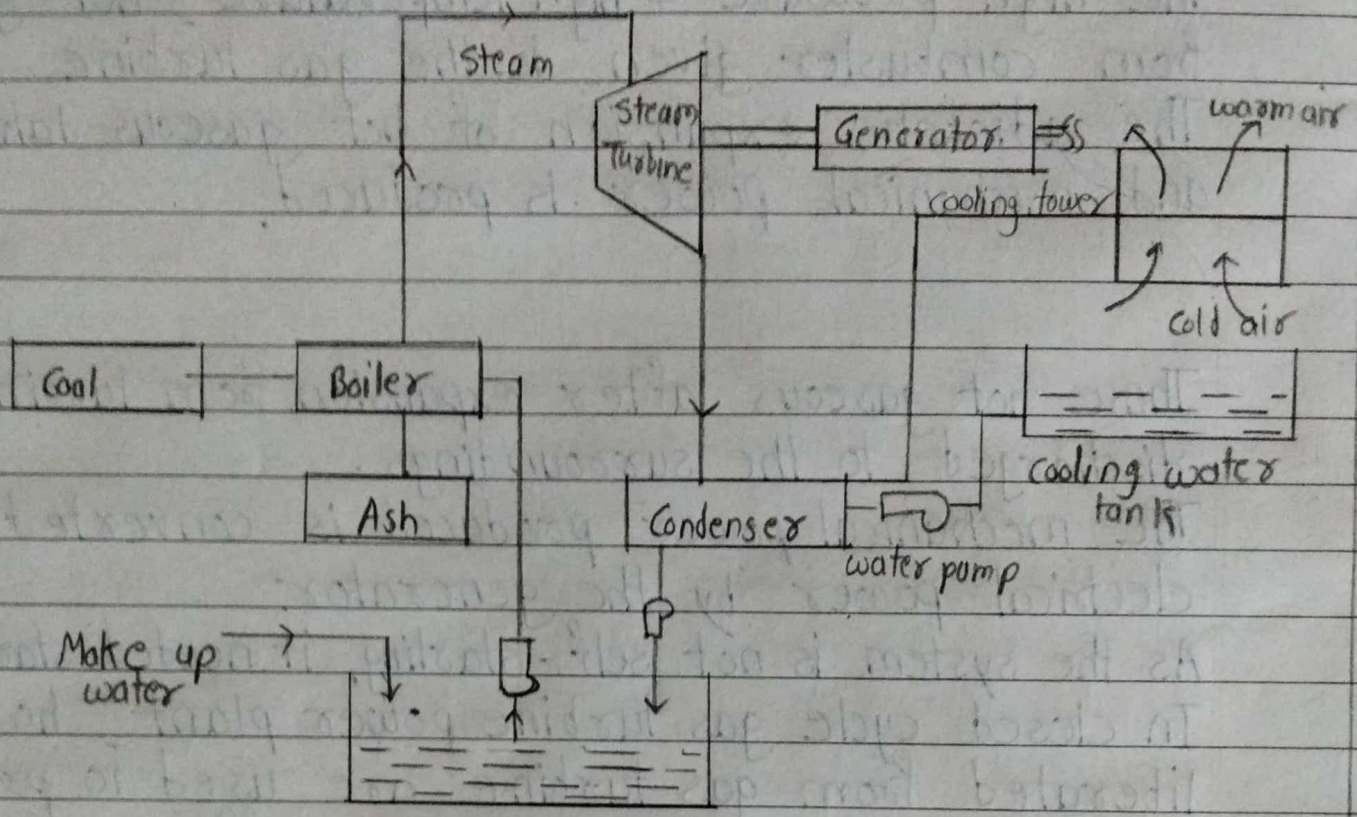
These hot gaseous after expansion from turbine are discharged to the surroundings.
The mechanical power produced is converted into electrical power by the generator.
As the system is not self-starting, it needed starting motor
In closed cycle gas turbine power plant, hot gaseous liberated from gas turbine are used to preheat the bottom which increases the efficiency of gas power plant by reducing wastage of heat.

Advantages
i) It can be started and stopped quickly with ease.
ii) It can use any type of fuel.

Disadvantages:
① It has low efficiency & has shorter life about 5-7 years
② It produces noise causing noise pollution.

Applications
① They can be used as stand-by & emergency power plant.
② They can be used to supply mechanical drive for auxiliary operation.
③ They can be used as pick load power plants.
④ They can run in 11^{el} with steam, hydro, wind, etc power plants

b) Thermal Power Plant



Elements or components of steam power plant:

1) Coal and ash circuit:
   i) Coal is burned and it is used for heating water.
   ii) After burning coal, ash is formed & collected separetly.

2) Steam Turbine & boiler.
   i) Boiler converts water into steam.
   ii) Steam passes over the blades of turbine and turbine starts rotating.
   iii) Turbines are connected to generators and ~~turbine~~ generator produce electricity.

3) Electrical Circuit:
i) Shaft of generator is connected to shaft of turbine and generator produce electricity.

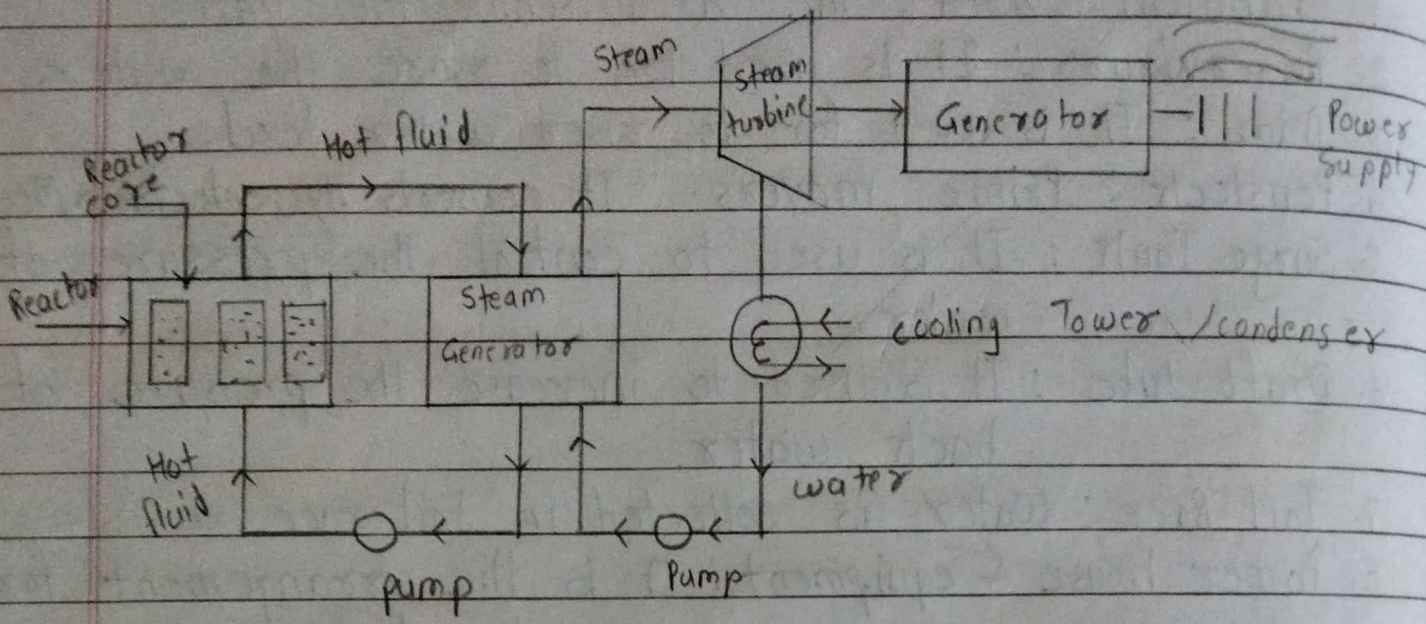
4) Cooling Water circuit:
i) It consist of condenser, cooling tower, cooling water tank and pump.
ii) Steam is converted into hot/warm water.
iii) By using cooling tower and cooling water tank, warm water converted into cold water.
iv) Make up water is supplied for filling the losses due to vapourisation.
v) Economiser, air preheater, super heater are used in steam power station to improve efficiency.

Advantages
i) Electricity is free of radiation
ii) Electricity is cheap
iii) Area required is less.
iv) Capacity of this plant is high.

Disadvantages:
i) Because of exhaust gases, it cause air pollution.
ii) Maintainance cost is high.
iii) Possibility of accident because of damage of steam pipeline.
iv) Ash handeling is problematic.

Applications:
i) Generates electricity.
ii) It is also used in sugar factory to produce electricity.

Nuclear Power Plant



Nuclear Power Plant

Elements / components of Nuclear Power Plant.

1) Nuclear Reactor
2) Steam Generator
3) Steam Turbine
4) Condenser / Cooling Tower
5) Generator

* Working

Reactor produce heat

ii) Heat enter into steam generator and heat the water and produce high pressure steam.

iii) Steam Enter in steam turbine, turbine starts rotating, turbine connected to generator, generator produce electricity

iv) Steam was condensed and water is recirculated back by using pump.

v) Hot fluid (heat) is also recirculated back by using pump.

Advantages

1. Electricity produced is in large quantity
2. More electricity is produced in short time.

Disadvantages

1. Radioactive elements emits radiations which are harmful to human
2. Construction and maintainance cost is very high.
3. More safety precaution is required.
4. It is very dangerous for handleing.
5. Site selection is major problem.