

Electrical Engineering



Power System



Lecture No 1

Generation of Electric Power



By- Ajay Gupta Sir



Recap of Previous class

1. Droop Characteristic ✓

2. Action of Governor. ✓

3. Problems. ✓



Topic To be covered

1. Types of load ✓

2. Terminology related to generation ✓

3. Base and peak load plant. ✓



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Generation

Types of Load:

(i) Domestic load.

Domestic load consists of lights, fans, refrigerators, heaters, television, small motors for pumping water etc. Most of the residential load occurs only for some hours during the day (i.e., 24 hours) e.g., lighting load occurs during nighttime and domestic appliance load occurs for only a few hours. For this reason, the load factor is low (10% to 12%)

(ii) Commercial load.

Commercial load consists of lighting for shops, fans and electric appliances used in restaurants etc. This class of load occurs for more hours during the day as compared to during night



day as compared to the domestic load. The commercial load has seasonal variations due to the extensive use of air conditioners and space heaters.

(iii) Industrial load.

Industrial load consists of load demand by industries. The magnitude of industrial load depends upon the type of industry. Thus, small scale industry requires load upto 25 kW, medium scale industry between 25kW and 100 kW and large-scale industry requires load above 500 kW.

Industrial loads are generally not weather dependent.

(iv) Irrigation load.

This type of load is the electric power needed for pumps driven by motors to supply water to fields. Generally this type of load is supplied for 12 hours

(v) Municipal load.

Municipal load consists of street lighting, power required for water supply and drainage purposes. Street lighting load is practically constant throughout the hours of the night. For water supply, water is pumped to overhead tanks by pumps driven by electric motors. Pumping is carried out during the off-peak period, usually occurring during the night. This helps to improve the load factor of the power system

(vi) Traction load.

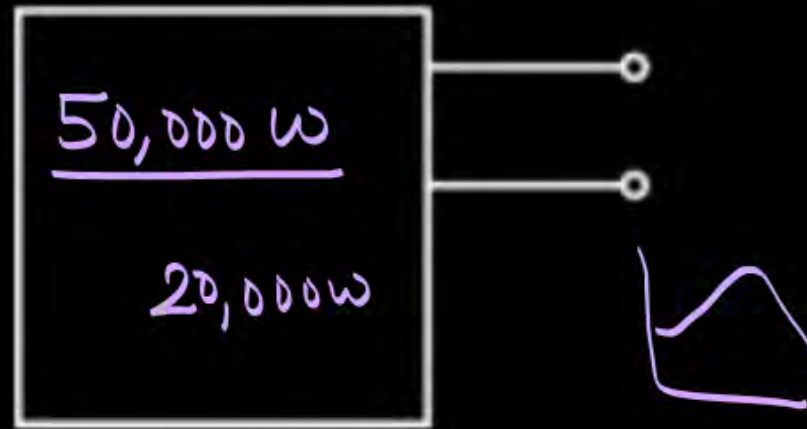
This type of load includes tram cars, trolley buses, railways etc. This class of load has wide variation.



During the morning hour, it reaches peak value because people must go to their work place. After morning hours, the load starts decreasing and again rises during evening since the people start coming to their homes.

Terminology related to generation:

- **Connected load:** It is the sum of the rating of all the equipment connected with power plant or system.



$$\begin{aligned}
 6 \text{ Bulb} \times 60 \text{ W} &= 360 \text{ W} \\
 5 \text{ fan} \times 100 \text{ W} &= 500 \text{ W} \\
 2 \text{ AC} \times 1500 \text{ W} &= 3000 \text{ W} \\
 1 \text{ Motor} \times 1000 \text{ W} &= 1000 \text{ W} \\
 \hline
 &4860 \text{ W}
 \end{aligned}$$

- **Maximum demand:** It is maximum load of at any time used by consumers.
- Maximum demand $\leq$ connected load

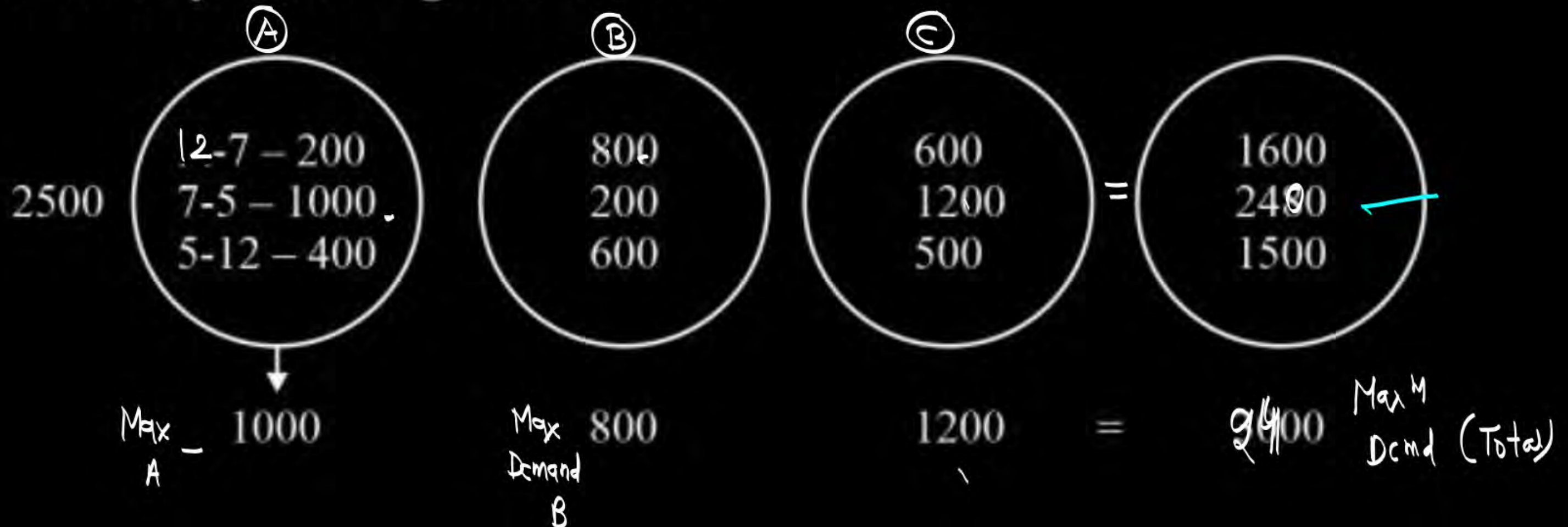
➤ Demand factor = Maximum demand/connected load

$$\frac{20,000}{50,000}$$

➤ Demand factor ≤ 1 ✓

➤ Diversity factor = $\frac{\text{Sum of individual consumer maximum demand}}{\text{Overall maximum demand of power station}} = \frac{3000}{2400}$ ✓

➤ Diversity factor is greater than 1.



- Installed capacity is dependent on maximum demand.
- So, to decrease the installed capacity of plant.
 - (i) Demand factor should be low. ✓
 - (ii) Diversity factor should be high. ✓

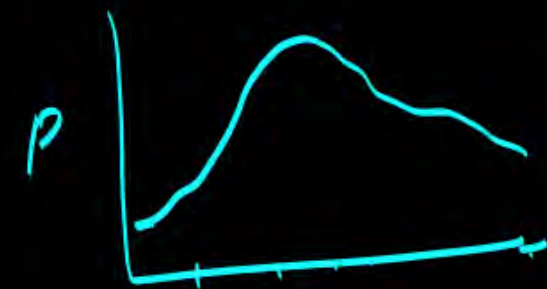
$$\text{Demand factor } \downarrow = \frac{\text{Maximum demand } \downarrow}{\text{Connected load}}$$

- ~~So, to reduce capital cost of power plant~~

Demand factor ↓

Diversity factor ↑

➤ Coincidence factor = $\frac{1}{\text{Diversity factor}}$



➤ Average load: The average value of load a plant in a given period.

➤ Load factor = $\frac{\text{Average load}}{\text{Maximum load}}$



$1 \text{ kWh} = 1 \text{ unit}$

➤ Daily average load = $\frac{\text{Total unit generated by plant in a day}}{24 \text{ hours}}$

➤ Monthly average load = $\frac{\text{Total unit generated in month}}{\underline{30} \times \underline{24}}$

➤ Load factor = $\frac{\text{Average load} \times t}{\text{Maximum load} \times t}$

$$\text{Load factor} = \frac{\text{Total unit generated in hours}}{\text{Maximum load} \times t}$$

- Load factor should be high so that more unit generated for same installed capacity.

$$\text{Capacity factor} = \frac{\text{Average load}}{\text{Rated plant capacity}}$$

$$= \frac{\text{Average load}}{\text{Maximum load}} \times \frac{\text{Maximum load}}{\text{Plant capacity}}$$

$$\text{Capacity factor} = \text{Load factor} \times \text{Utilization factor}$$

$$\text{utilization factor} = \frac{\text{Max}^m \text{ load}}{\text{Plant capacity}}$$

$$\begin{aligned} \text{Capacity factor} &= \frac{\text{Average load} \times (365 \times 24)}{\text{Plant capacity} \times (365 \times 24)} \\ &= \frac{\text{Unit generated in a year}}{\text{Unit a plant can produced in a year}} \end{aligned}$$

350
MW

350 MW



- It is also defined as the ratio of energy is actually produced in a year to maximum energy that a plant could produced.
- If plant run always at its rated capacity the capacity factor will be 100% .
- **Reserve capacity:** Every plant has some reserve capacity to meet future demand.
- Reserve capacity = Plant capacity – Maximum demand
- The difference between demand factor and diversity factor is a indication of reserve capacity.

➤ Utilization factor = Maximum demand / Plant capacity

$$= \frac{\text{Capacity factor}}{\text{Load factor}}$$

➤ Operation factor = Service hour / Total duration

➤ Installed capacity: Station capacity for which plant is designed.

200 MW x 2

300 x 1

400 x 1

1200 MW

Plant use factor : It is the ratio of energy generated to the maximum possible energy that could have been produced



$$\text{Plant use factor} = \frac{\text{Station output in } (W - H)}{\text{Plant capacity} \times \text{Hours in use}}$$

- **Firm power:** This is the power which is always available even in the emergency condition. 300 MW
- **Cold reserve:** It is reserve generating capacity which is available for service but not ready for immediate loading.
 $\bigcirc$ $\frac{200 \text{ MW} \times 2}{300 \text{ MW}}$
- **Hot reserve:** It is boiler excess capacity which is kept hot and ready to use.
- **Spinning reserve:** It is reserve generating capacity which is connected to bus bar and ready to take load. Alternator is connected to bus bar but it is in floating stage.





The Maximum demand of a power plant is 40 MW, The capacity factor is 0.5, The utilization factor is 0.8, Find out:



- a) Load Factor
- b) Plant Capacity
- c) Reserve Capacity
- d) Annual energy production

Max^m demand = 40 MW

Capacity factor = 0.5

utilisation factor = 0.8

$$\begin{aligned}\text{Capacity factor} &= \frac{\text{Avg load.}}{\text{Capacity of plant}} \\ &= \frac{\text{Avg load}}{\text{Max load}} \times \frac{\text{Max load}}{\text{Plant Capacity}}\end{aligned}$$

$$\text{Capacity factor} = \text{load factor} \times \text{utilization factor}$$

$$0.5 = \text{load factor} \times 0.8$$

$$\text{load factor} = \frac{0.5}{0.8} = 0.625.$$

(ii) utilization factor = $\frac{\text{Max}^m \text{ load}}{\text{Plant capacity.}}$

$$0.8 = \frac{40}{\text{Plant Capacity}}$$

$$\text{Plant Capacity} = \frac{40}{0.8} = 50$$

(iii) Reserve capacity = Plant capacity - Max^m demand.

$$= 50 - 40$$
$$= 10 \text{ MW}$$

IV $\text{Average energy} = \text{Average load} \times (365 \times 24)$

$$\text{load factor} = \frac{\text{Avg load}}{\text{Max load}}$$

$$0.625 = \frac{\text{Avg load}}{40}$$

$$\text{Avg load} = 25 \text{ MW}$$

$$= 25 \times 365 \times 24$$

$$= 219000 \text{ MWH}$$

$$= 219 \times 10^6 \text{ kWh}$$

Q. A 100 MW power station delivers 100 MW for 2 hours, 50 MW for 6 hours and is shut down for the rest of each day. It is also shut down for maintenance for 45 days each year. Calculate its annual load factor ? 

$$\text{load factor (Annual)} = \frac{\text{Avg load} \times \text{Working time}}{\text{Max}^m \text{ load} \times \text{Working time}}$$

$$\text{In a Day Total Energy} = 100 \times 2 + 50 \times 6 = 500 \text{ MWh}$$

$$\text{Total working day} = 365 - 45 = 320$$

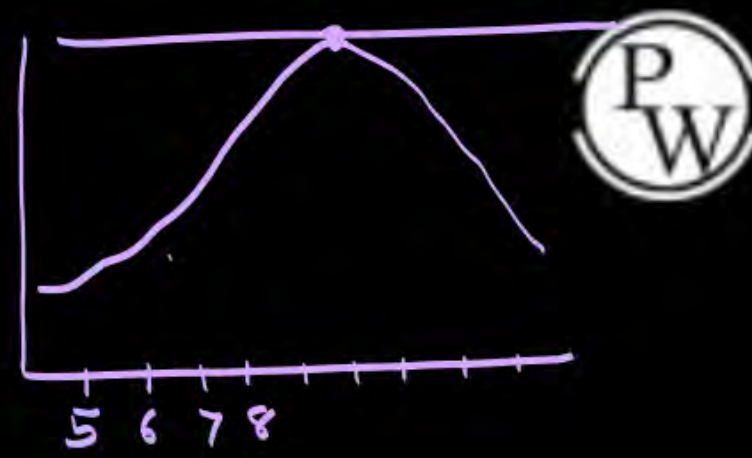
$$\text{Total energy generated} = 500 \times 320$$

Energy in a day As per Max demand = 150×24

In a year = $(150 \times 24 \times 320)$

$$\text{load factor} = \frac{500 \times 320}{150 \times 24 \times 320} = 0.208$$
$$= \underline{20.8\%}$$

Load curve:



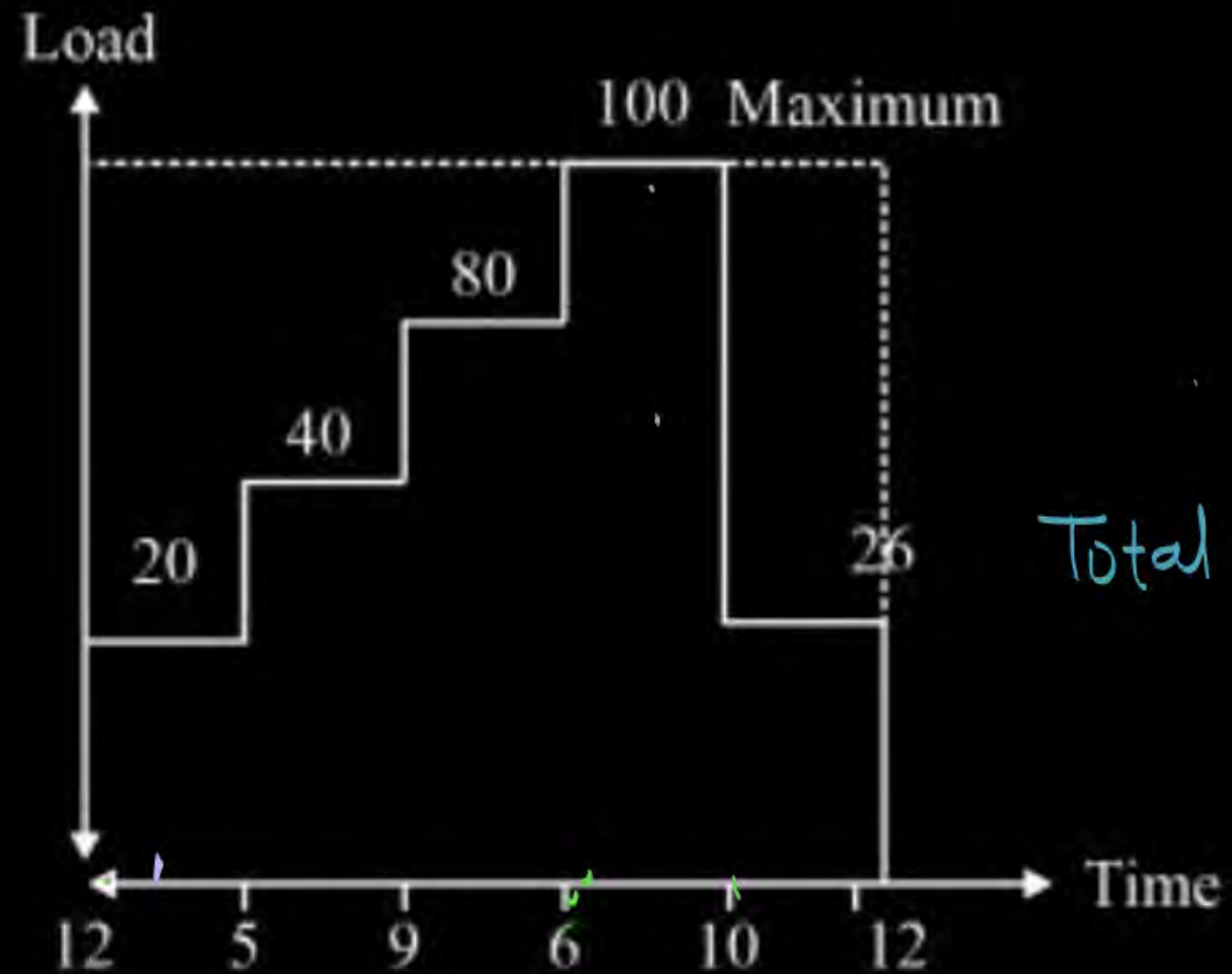
- it is a between load demand and time.
- Area under the curve is the is total no of unit is generated.
- Average load = Area under load curve / 24 hours
- Highest point on the curve give maximum demand.
- Load curve help in preparing the operating schedule of plant.
- It is also select total no and size of units.
- Monthly curve can be obtained from daily load curve and yearly load curve can be drawn from monthly load curve.
- Yearly load curve can be used to fined out yearly load factor.
Load factor = Area load curve / Area of Rectangle (100×24)

Q.



Draw load curve and find out Load Factor

	5	4	9	4	2
Time	12-5am	<u>5-9</u>	<u>9-6am</u>	<u>6-10</u>	10-12
Load	20	<u>40</u>	80	100	20



$$\text{load factor} = \frac{\text{Average load} \times 24}{\text{Max load} \times 24}$$

$$\begin{aligned}\text{Total energy} &= 20 \times 5 + 40 \times 4 + 80 \times 9 + 100 \times 4 + 20 \times 2 \\ &= 100 + 160 + 720 + 400 + 40 \\ &= 1420\end{aligned}$$

➤ Load factor =
$$\frac{(20 \times 5) + (40 \times 4) + (80 \times 9) + (100 \times 4) + (20 \times 2)}{100 \times 24}$$

= 0.5916

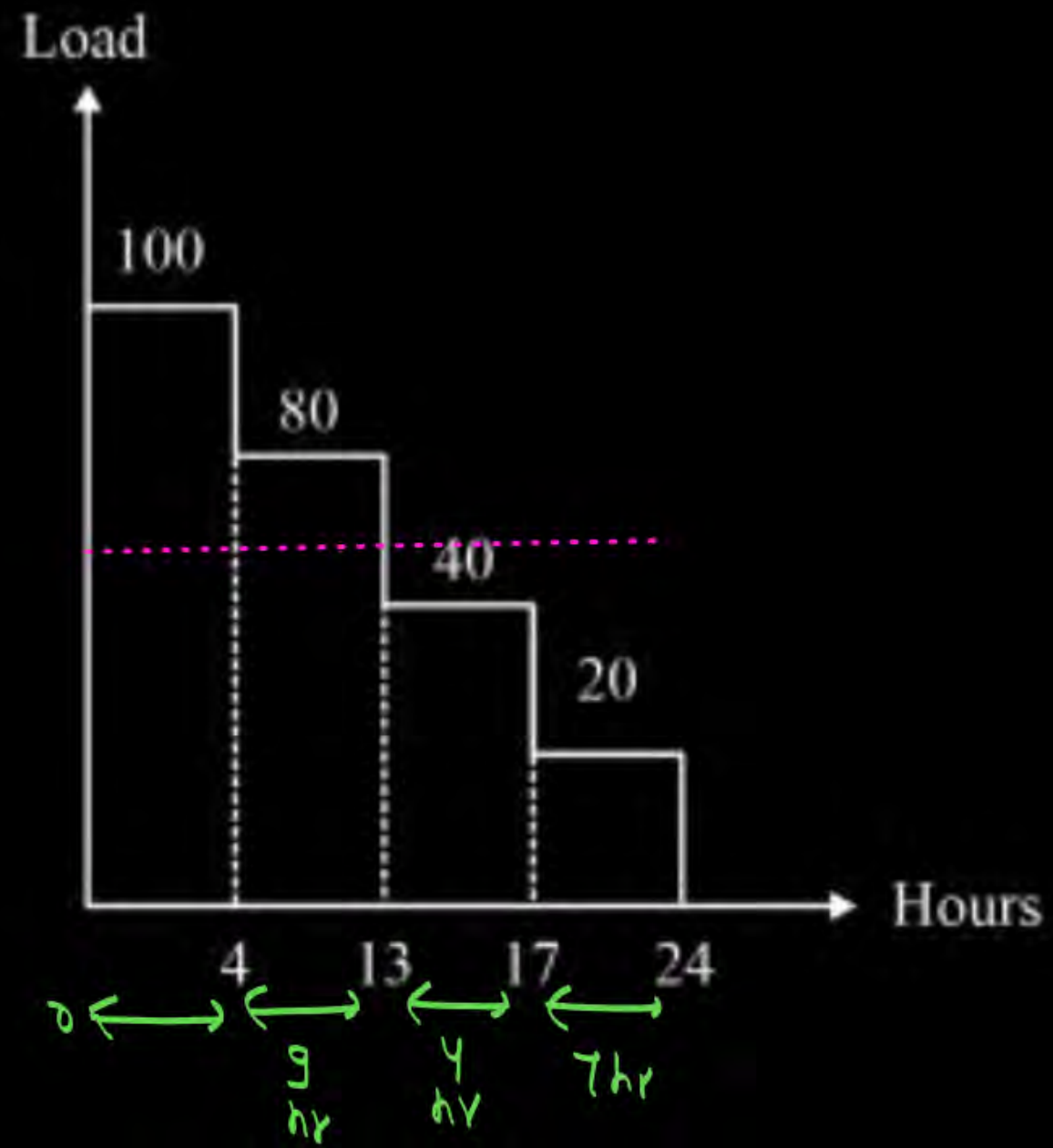
= 59.16% ✓

II Method

$$\text{Ave load} = \frac{1420}{24} = 59.166$$

$$\text{load factor} = \frac{\text{Avg load}}{\text{Max load}} = \frac{59.166}{100} = 0.59166$$

- **Load duration curve:** It is made from load curve. It is all the load element rearrange in descending order.
- It will give the idea that how many hours the load is grater than or less than some particular amount.
- It help us for selecting base and peak load.
- Area under load duration curve = Area of load curve



∴
∴



A generating station of maximum demand of 50 MW, load factor of 60% and plant capacity factor of 50%. The reserve capacity of plant is?



$$\text{Reserve Capacity} = \text{Plant Capacity} - \text{Max Demand}$$

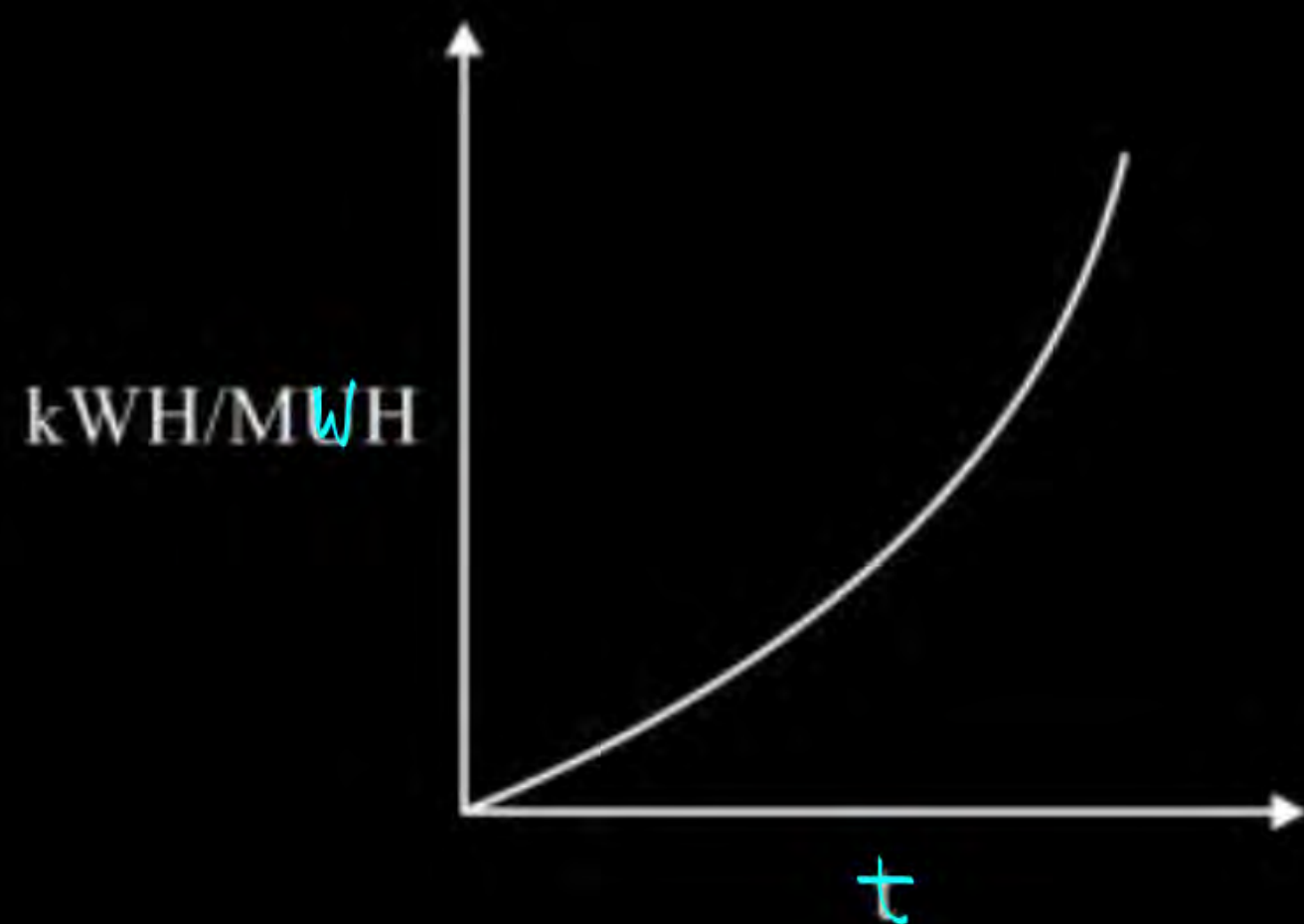
$$\text{Capacity factor} = \text{load factor} \times \text{utilisation factor}$$

$$0.5 = 0.6 \times \frac{50}{\text{Plant Capacity}}$$

$$\text{Plant Capacity} = 60$$

$$60 - 50 = 10$$

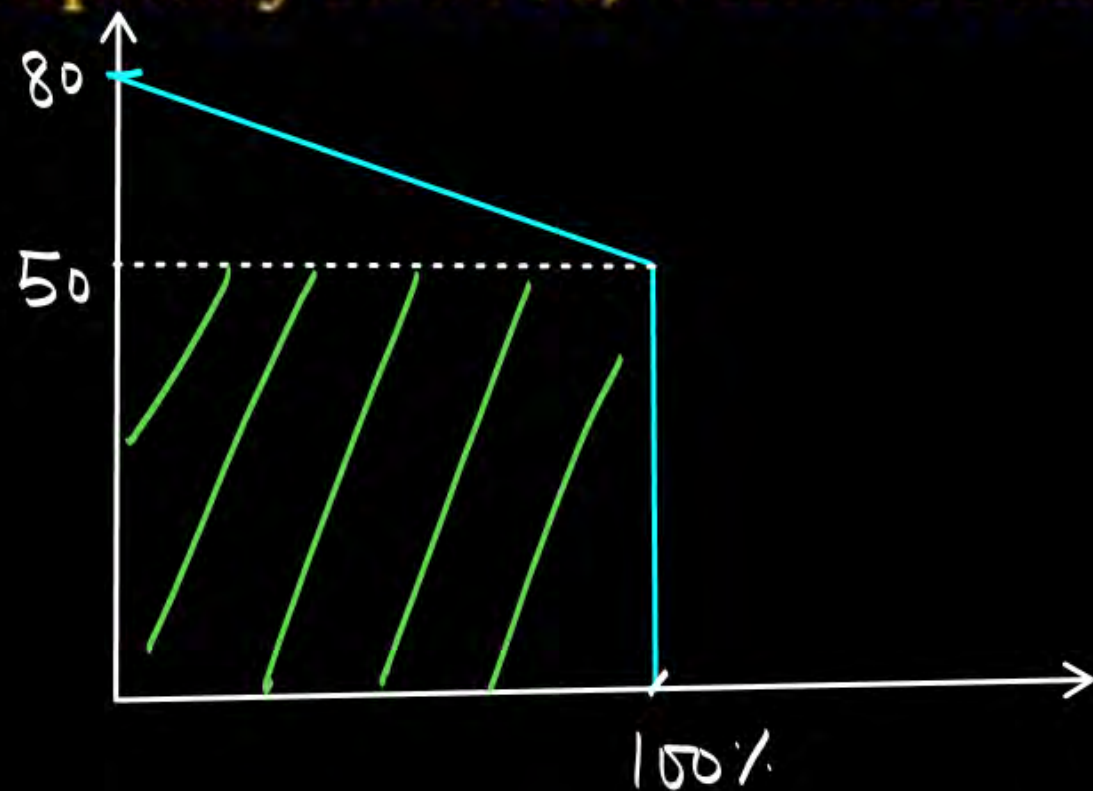
- **Mass curve:** It is the curve plotted between energy vs time.



Q.



The load duration curve of a power plant is shown below. If plant capacity is 60%, what is reserve capacity?



$$\text{Reserve capacity} = \text{Plant Capacity} - \text{Max demand}$$

$$\text{Capacity factor} = \frac{\text{Average load}}{\text{Plant Capacity}}$$

$$0.6 = \frac{(100 \times 50) + \frac{1}{2}(100 \times 30)}{100}$$

Plant capacity

$$0.6 = \frac{65}{\text{Capacity}}$$

$$\text{Plant Capacity} = \frac{65}{0.6} = 108.33$$

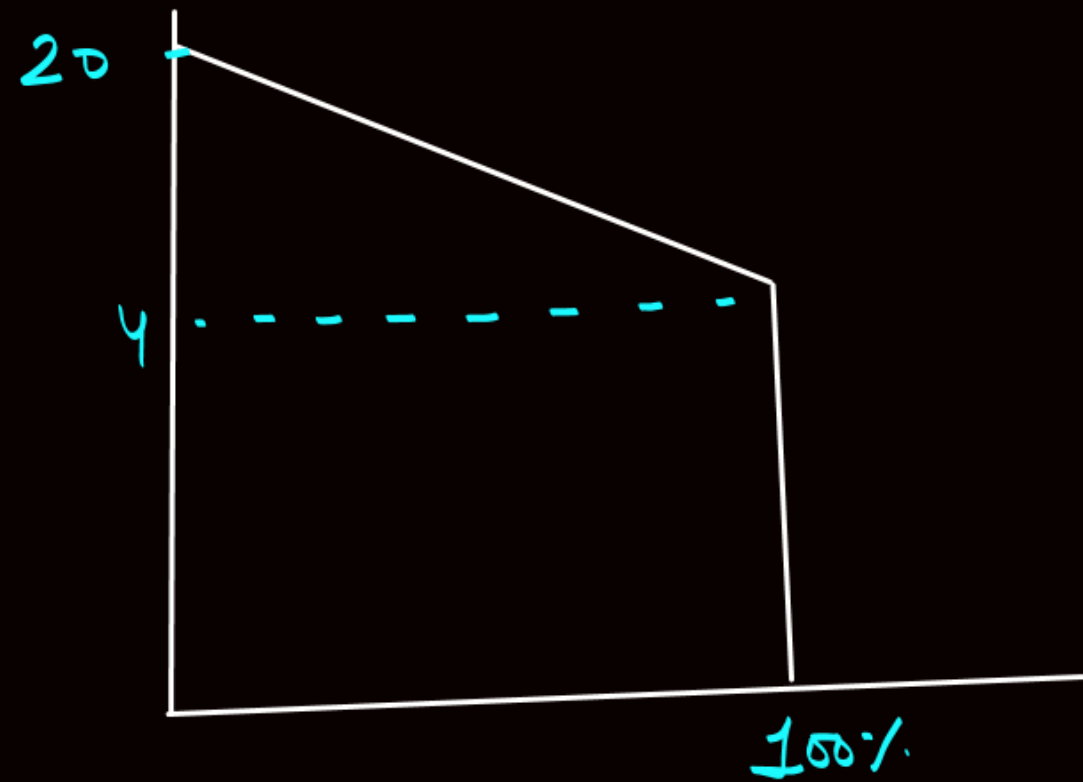
$$\begin{aligned}\text{Reserve} &= 108.33 - 80 \\ &= 28.33\end{aligned}$$



The annual load duration curve of a certain power station can be considered as a straight line from 20 MW to 4 MW. To meet this load, three turbine-generator units, two rated at 10 MW each and one rated at 5 MW are installed.

Determine (i) installed capacity (ii) plant factor (iii) units generated per annum (iv) load factor and (v) utilization factor

$$\begin{aligned} \text{(i) Installed Capacity} &= (2 \times 10) + (1 \times 5) \\ &= 25 \text{ MW} \end{aligned}$$



$$\begin{aligned}\text{Average load} &= \frac{(100 \times 4) + \left(\frac{1}{2} \times 100 \times 16\right)}{100} \\ &= 12\end{aligned}$$

$$\text{Max load} = 20$$

$$\text{Plant load factor} = \frac{\text{Avg load}}{\text{Max load}} = \frac{12}{20} = 0.6$$

$$\begin{aligned}\textcircled{iii} \text{ Average energy} &= 12 \text{ MWH} \times 365 \times 24 \\ &= 105120 \text{ MWH} \\ &= 105.12 \times 10^6 \text{ kWH}\end{aligned}$$

$$\textcircled{iv} \text{ Capacity factor} = \frac{\text{Average load}}{\text{Plant Capacity}} = \frac{12}{25} = 0.48$$

$$\textcircled{v} \text{ Utilization factor} = \frac{\text{Max}^m \text{ load}}{\text{Plant capacity}} = \frac{20}{25} = \underline{0.8}$$



A power station has a daily load cycle as under :

260 MW for 6 hours ; 200 MW for 8 hours : 160 MW for 4 hours, 100 MW for 6 hours.

If the power station is equipped with 4 sets of 75 MW each, calculate

(i) daily load factor

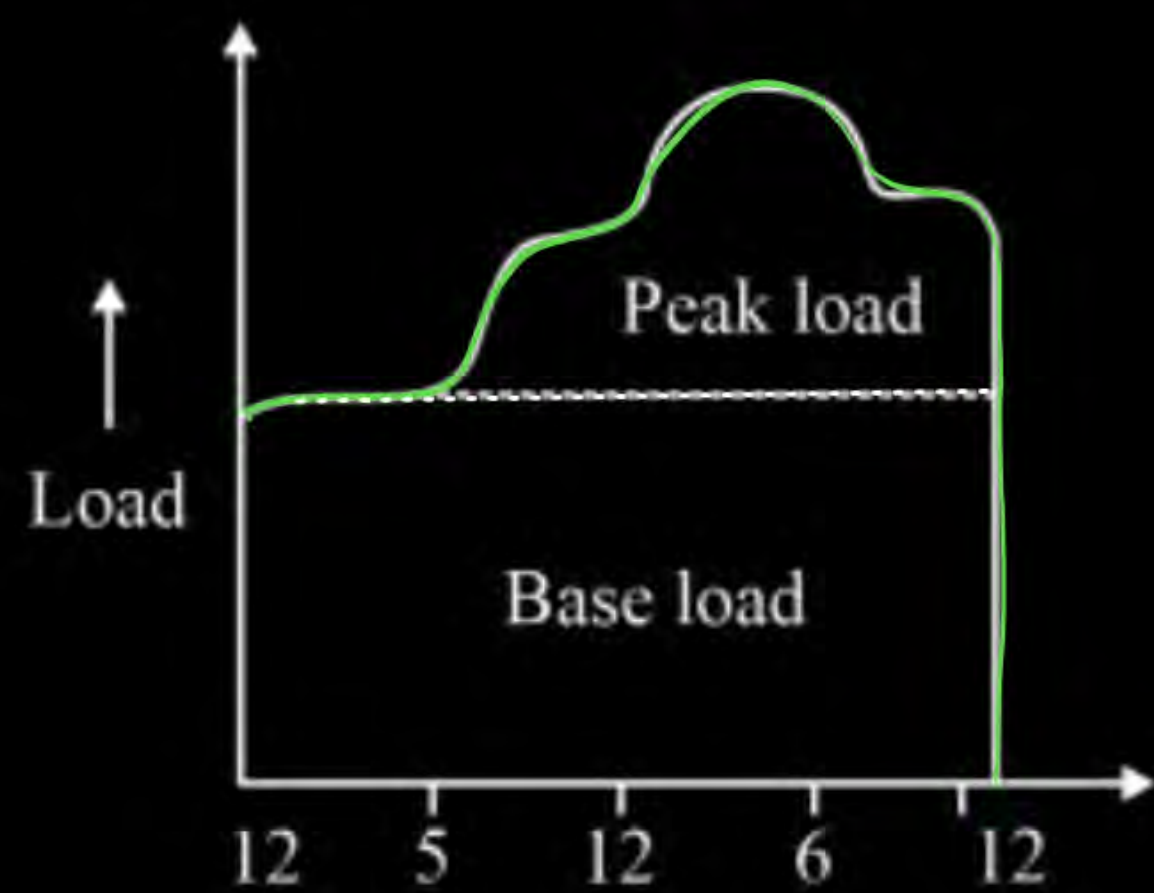
(ii) plant capacity factor and

(iii) daily requirement

if the calorific value of oil used were 10,000 kcal/kg and the average heat rate of station were 2860 kcal/kWh.

Base and peak load plant

- The load that occur in whole day is called base load.
- The peak demand of load above base load is called peak load.
- These two load should be supplied from two different plant
 1. Base load plant
 2. Peak load plant

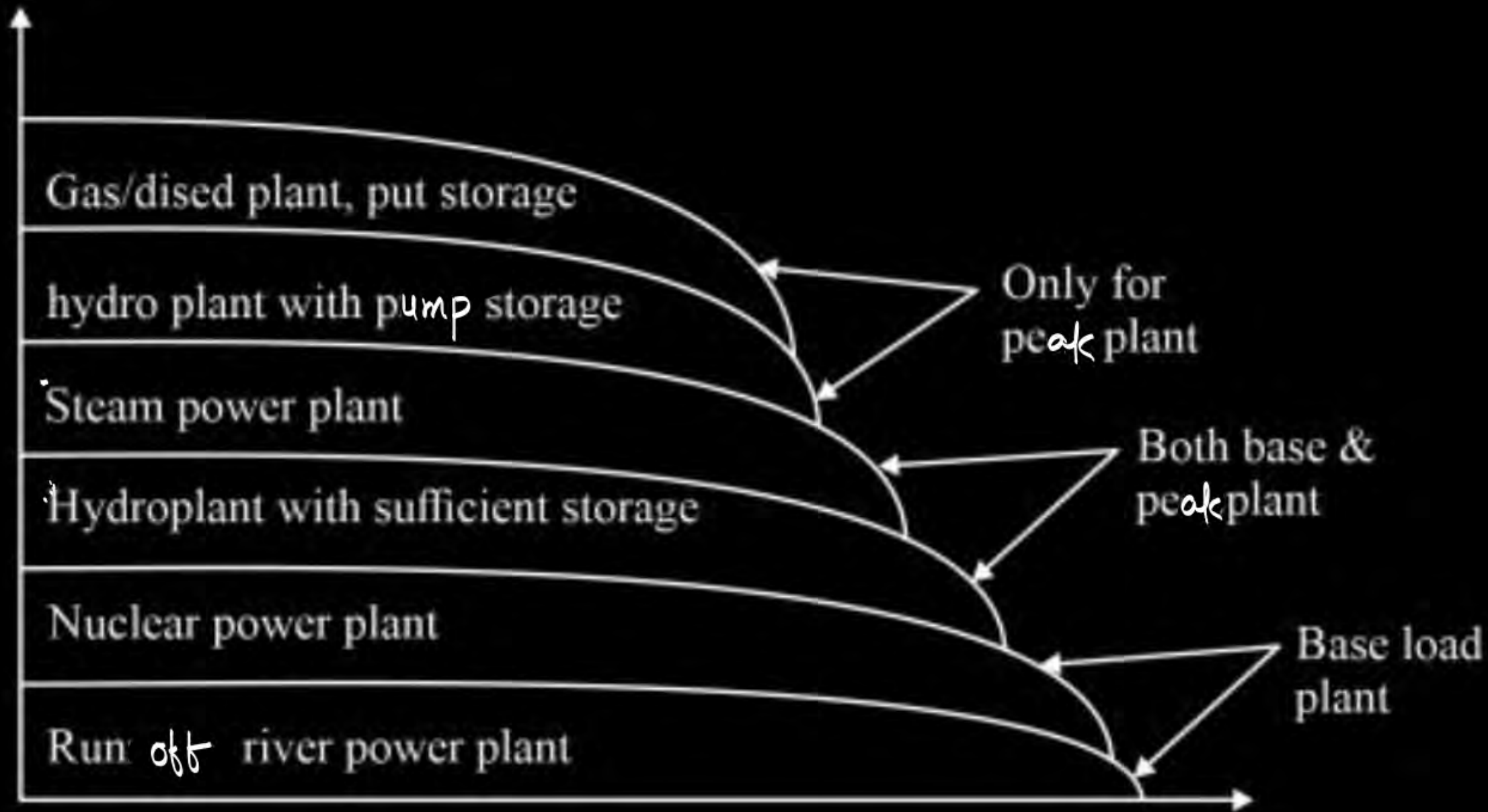


The base load plant should be:

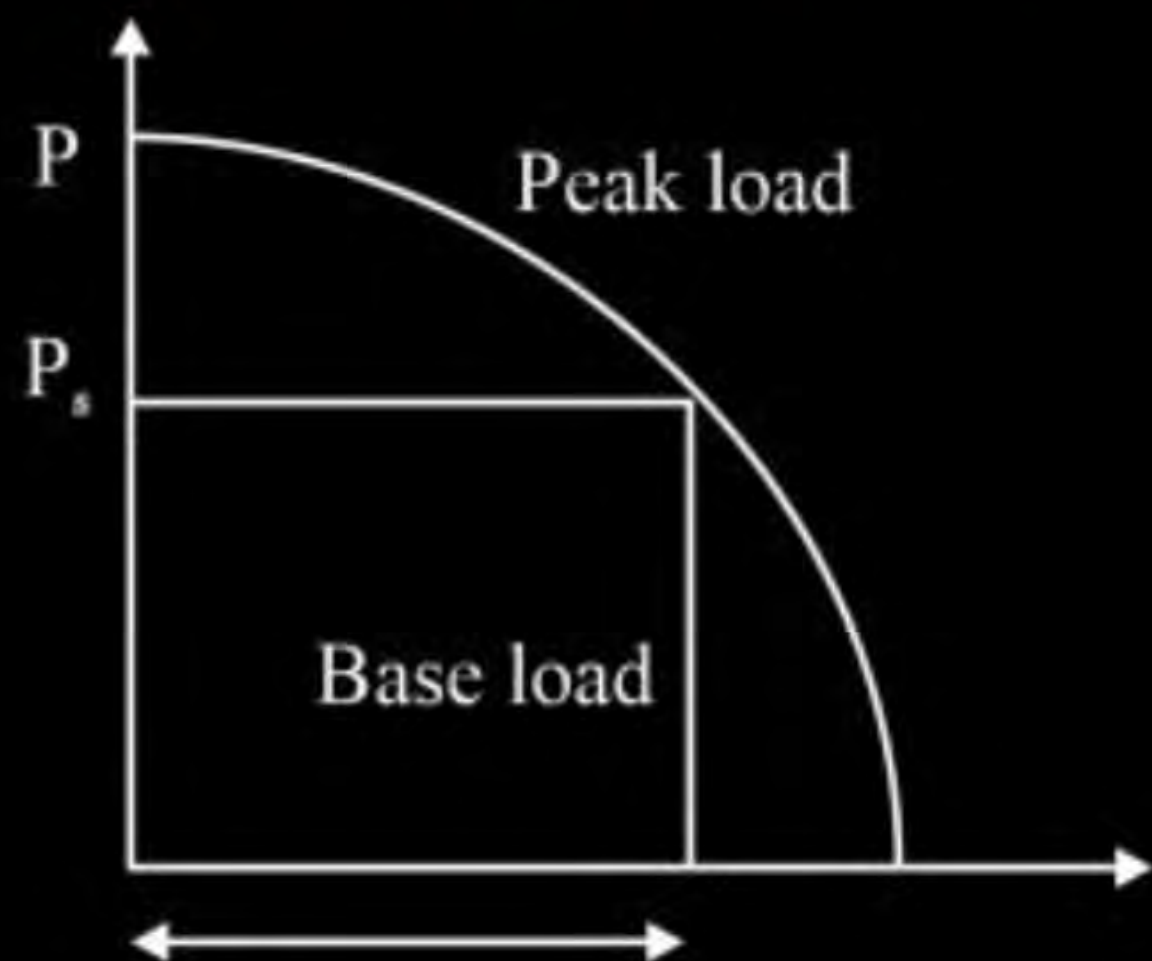
- Low operating cost
- Capacity to work continuously for long duration ✓
- Can be repaired easily. ✓
- Load factor should be high.
- High capital cost and low running cost

Peak load plant should be:

- Low load factor ~
- Quick start and synchronization ✓
- Quick response to load variation. ✓
- Low capital cost and high running cost.



Load sharing between Peak and Base load plant:



Suppose Total max. load = P

Total unit generated = x

Base plant $\left[\begin{array}{l} \rightarrow \text{Maximum load } P_1 \\ \rightarrow \text{Unit generated } x_1 \end{array} \right.$

Peak load plant $\left[\begin{array}{l} \rightarrow \text{Maximum load } P_2 \\ \rightarrow \text{Unit generated } x_2 \end{array} \right.$

$$P = P_1 + P_2 \quad \Rightarrow P_2 = P - P_1$$

$$X = X_1 + X_2 \quad \Rightarrow X_2 = X - X_1$$

Cost = Depend on capital cost and Running cost

$$C_1 = a_1 i_1 + b_1 x_1 \quad (\text{Note: } a_1 \text{ capital cost and } b_1 \text{ Running cost})$$

$$C_1 = a_1 i_1 + b_1 x_1$$

$$C_2 = a_2 p_2 + b_2 x_2$$

$$\text{Total cost} = (a_1 p_1 + b_1 x_1) + (a_2 p_2 + b_2 x_2)$$

$$= (a_1 p_1 + b_1 x_1) + [a_2 (p - p_1) + b_2 (x - x_2)]$$

$$C = p_1 (a_1 - a_2) \pm x_1 (b_1 - p_2) + a_2 p + b_2 x$$

For total cost to minimum

$$\frac{dc}{dp_1} = 0$$

$$(a_1 - a_2) + \frac{dx_1}{dp_1}(b_1 - b_2) = 0$$

$$\frac{dx_1}{dp_1} = \frac{(a_1 - a_2)}{(b_2 - b_1)}$$

$$\text{Time} = \frac{(a_1 - a_2)}{(b_2 - b_1)}$$

➤ So peak load plant to apart for time of $\frac{(a_1 - a_2)}{(b_1 - b_2)}$



2 Minutes Summary

- Classification of load.
- Terminology of generation
- Base load & peak load

Thank
you

Electrical Engineering



Power System



Lecture No 2

Generation of Electric Power



By- Ajay Gupta Sir



Recap of Previous class

- ✓ 1. Basic terminology of power plant
- ✓ 2. Load curve, ✓ load factor, ✓ demand F
- ✓ 3. Capacity ✓ and utilisation factor



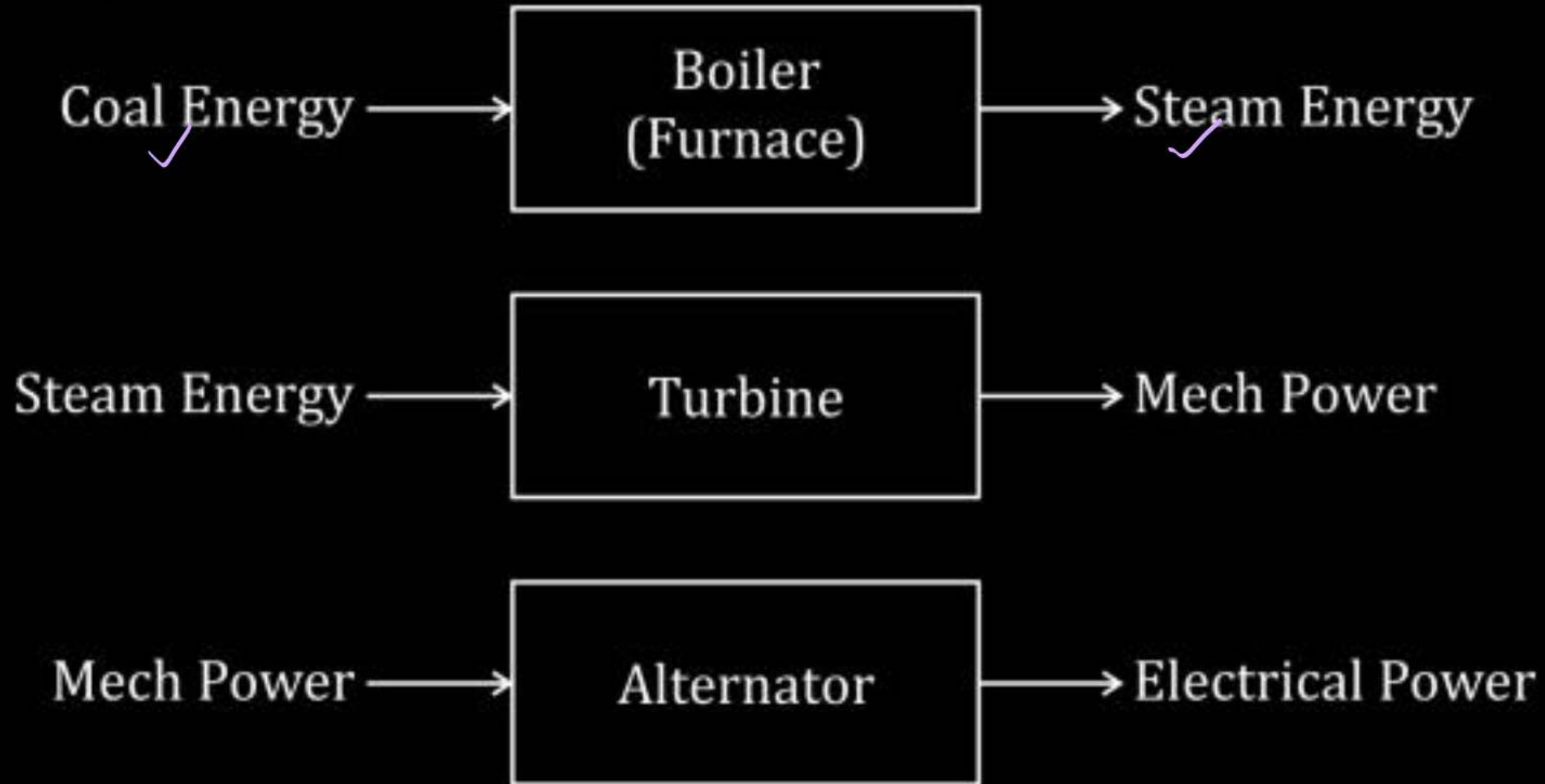
Topics to be Covered

1. Thermal power Plant ✓
2. Coal handling system ✓
3. Ash handling system ✓
4. economiser, superheater ✓
5. boiler, condensor, cooling tower ✓
6. Air precipitator, Draught system ✓



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Thermal Power Plant



Thermal Power Plant

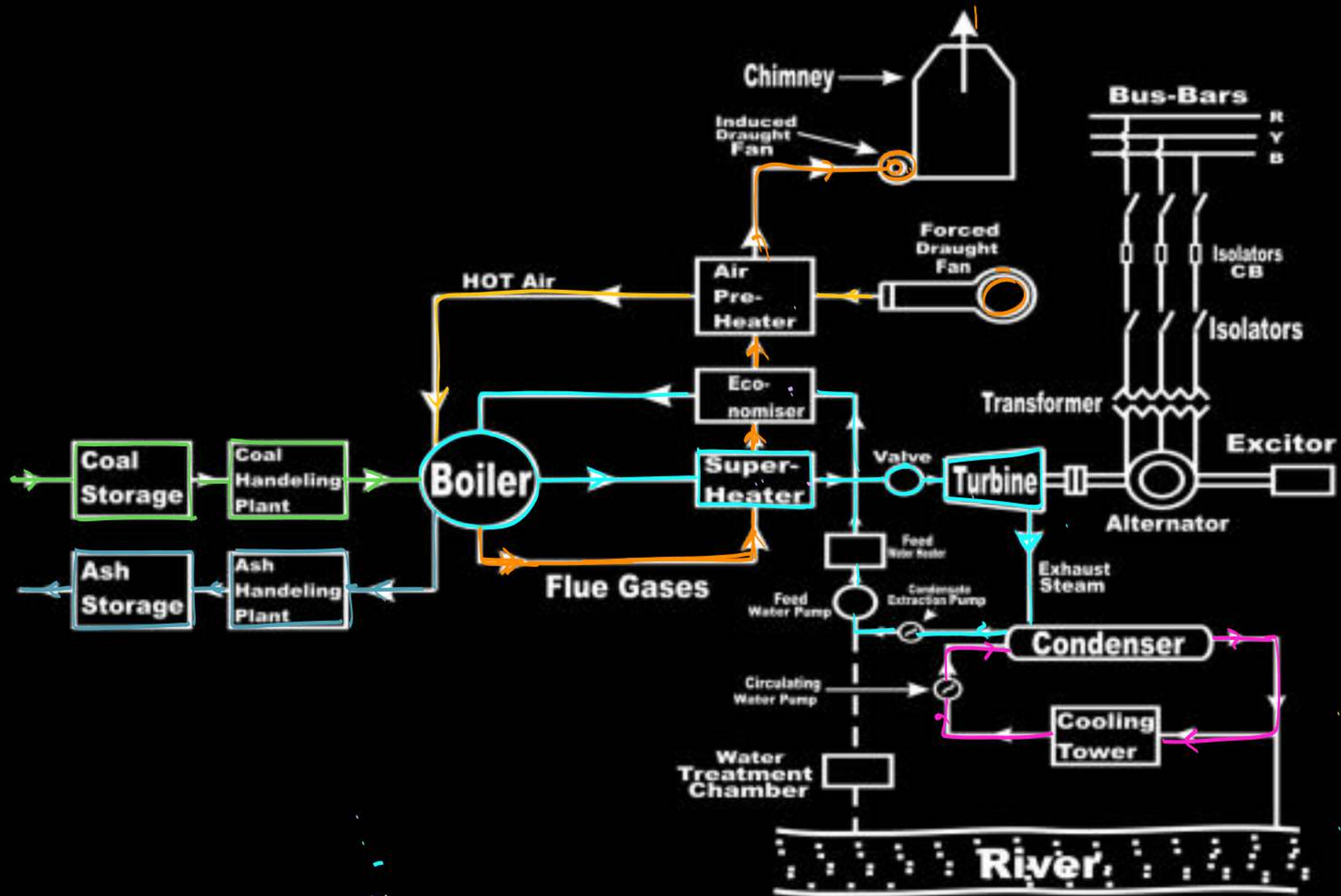
- Factor of selecting the sites:
- It should be near to coal mines it will reduce transportation cost
- The land cost should be low, and it should have high bearing capacity.
- Large quantity of water should be available
- It should be near to load center
- Facility for disposal of ash.

Thermal Power Plant

- Types of Coal:
- Peat: poor quality, low calorific value, ✗
- Lignite: mostly this is used (Brown coal) ✓
- Bituminous: soft bituminous is also used ✓
- Anthracite: top quality, but very costly ✗

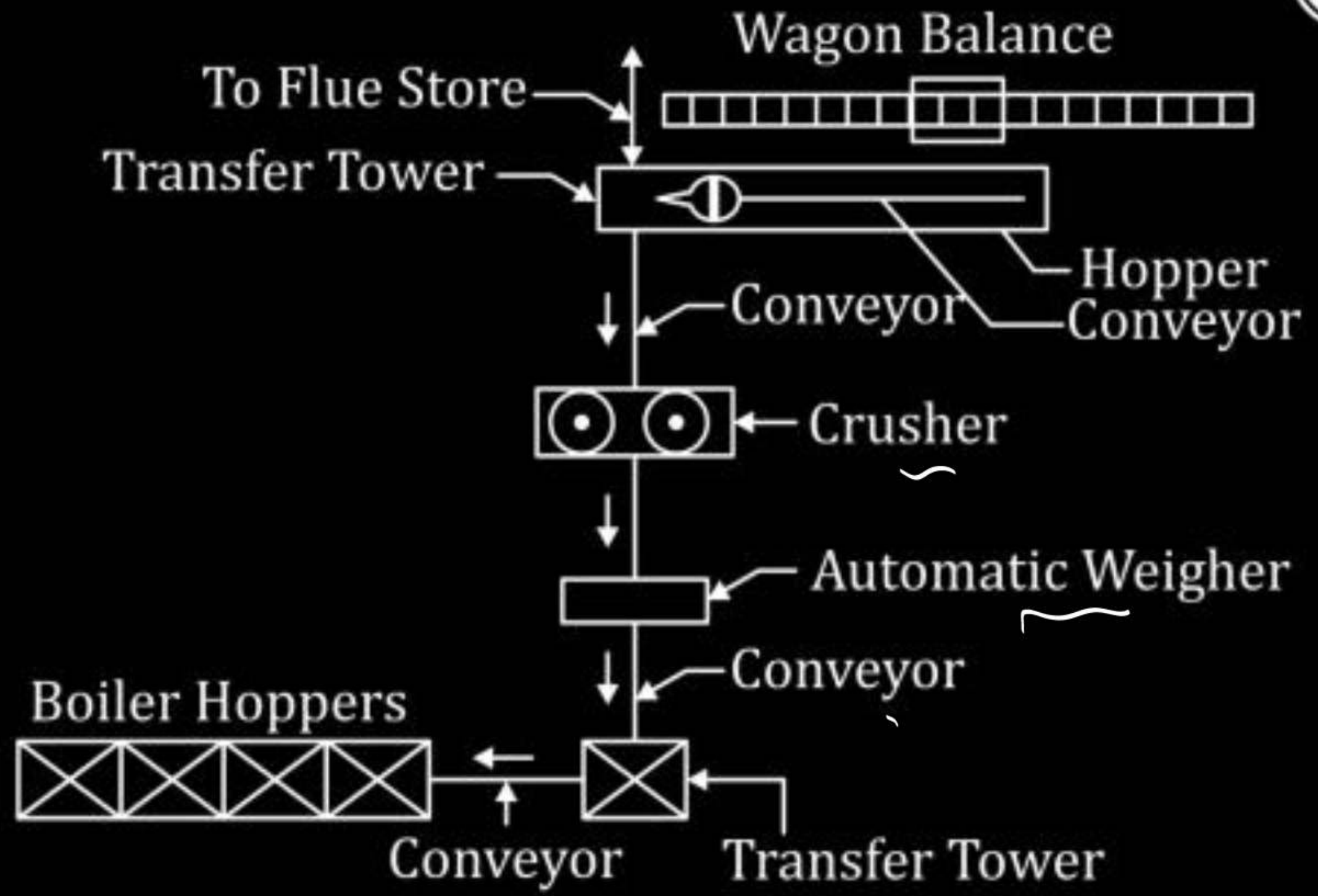
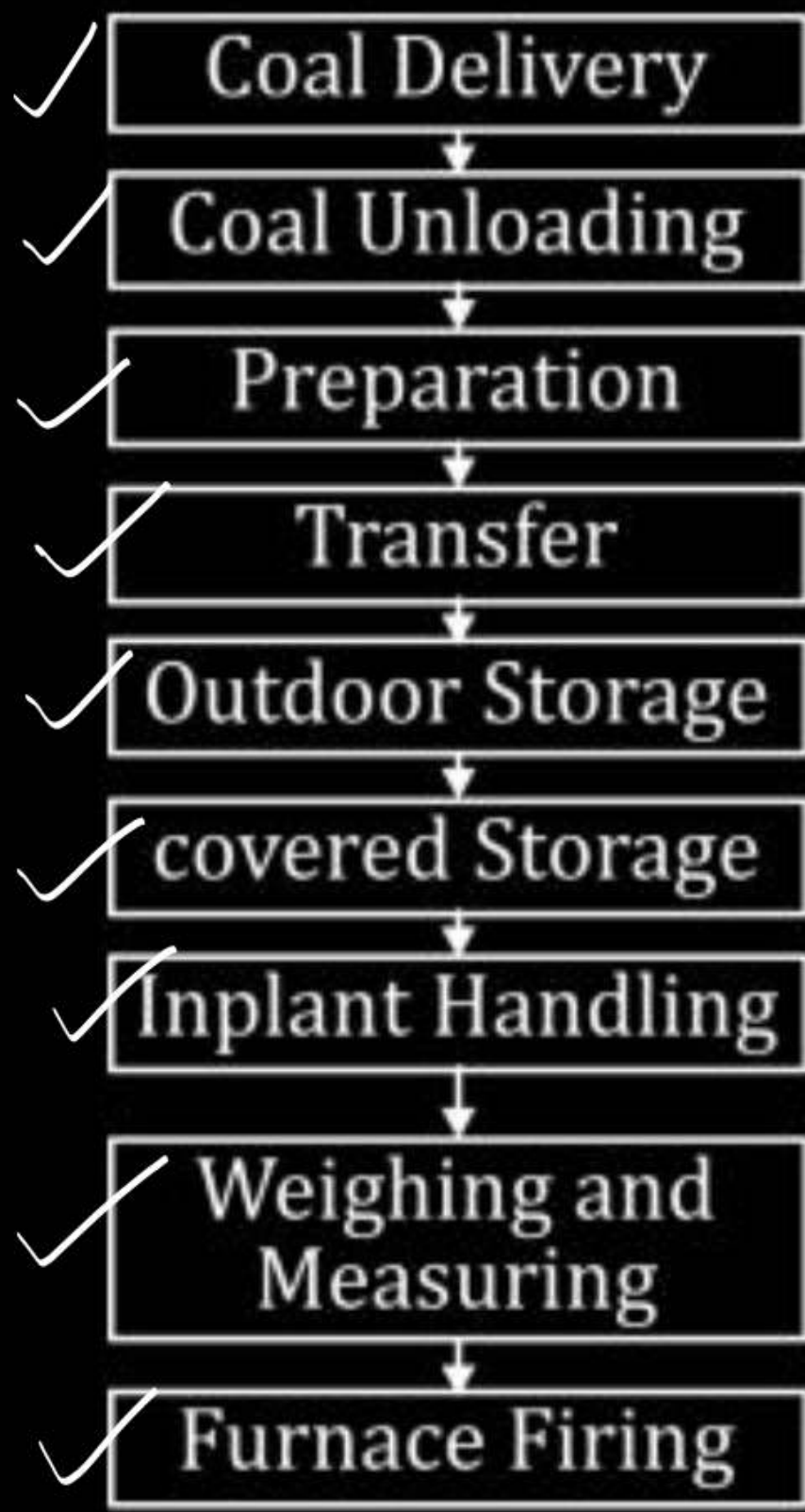
Why pulverized coal is used:

- Fast combustion occur due to more area is exposed to heat and oxygen
- It increase the combustion rate without using excess air, so boiler start easily. ✓
- So, it has fast response to change in load
- 100MW (Load factor-50%)—20000-ton coal per month



Coal Handling Plant

- Mostly huge amount of coal is supplied by railways the coal is delivered to stock yard
- Coal is unloaded by wagon tippler
- These coal is transported to coal bunker by conveyor belt which used 3 phase SRIM
- After hand picking foreign material, coal is transported to crush house by conveyor belt where it is crush to small pieces(20mm)
- Then coal is transported to bowl mill by coal feeders
- The coal is pulverized in bowl mill where it is grinded to powder form it has 3 roller spaced 120 apart.
- The pulverized coal is taken away through coal pipe with help of hot and cold air mixture.



Coal Handling Layout







Separator Top

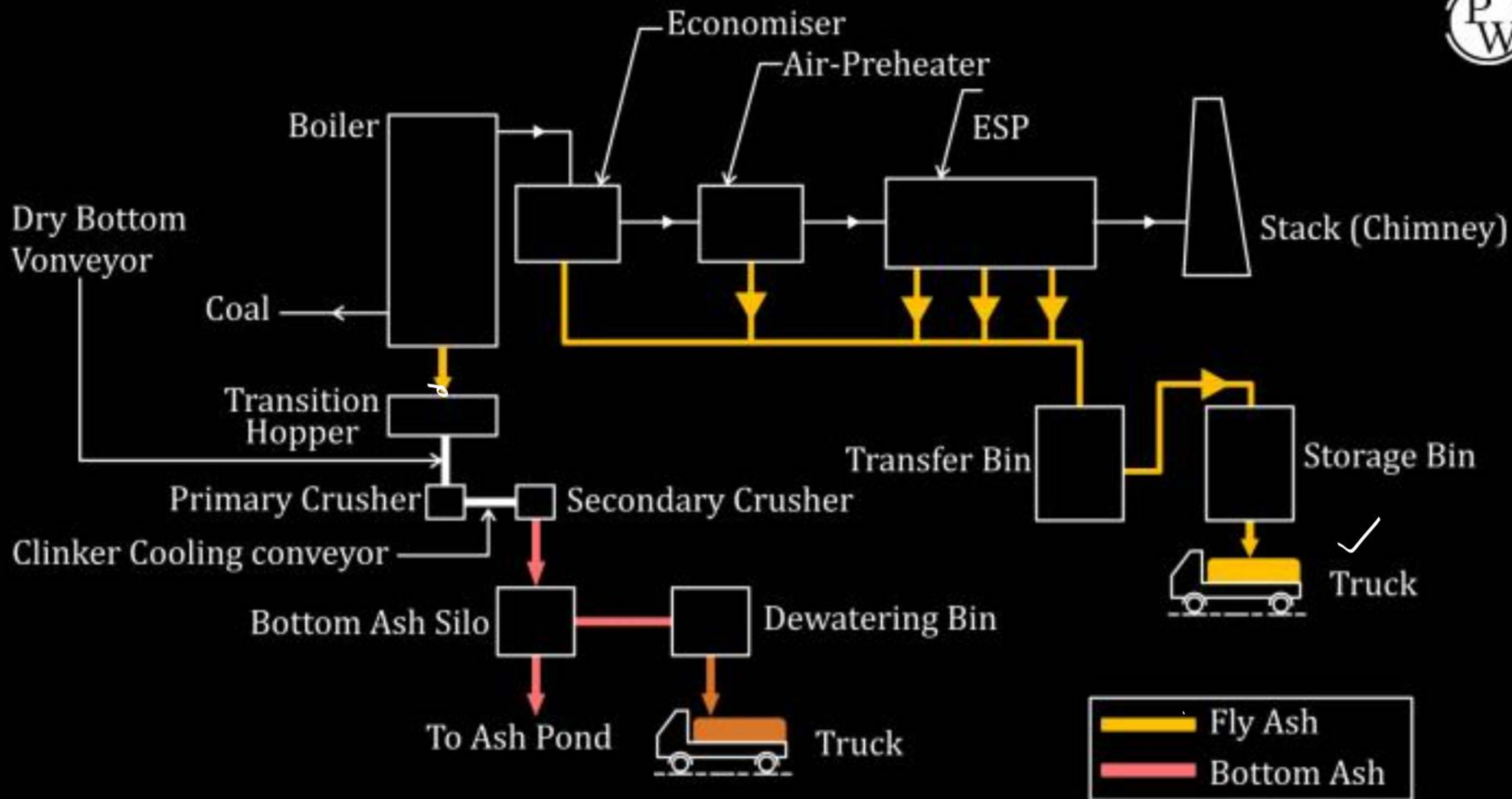


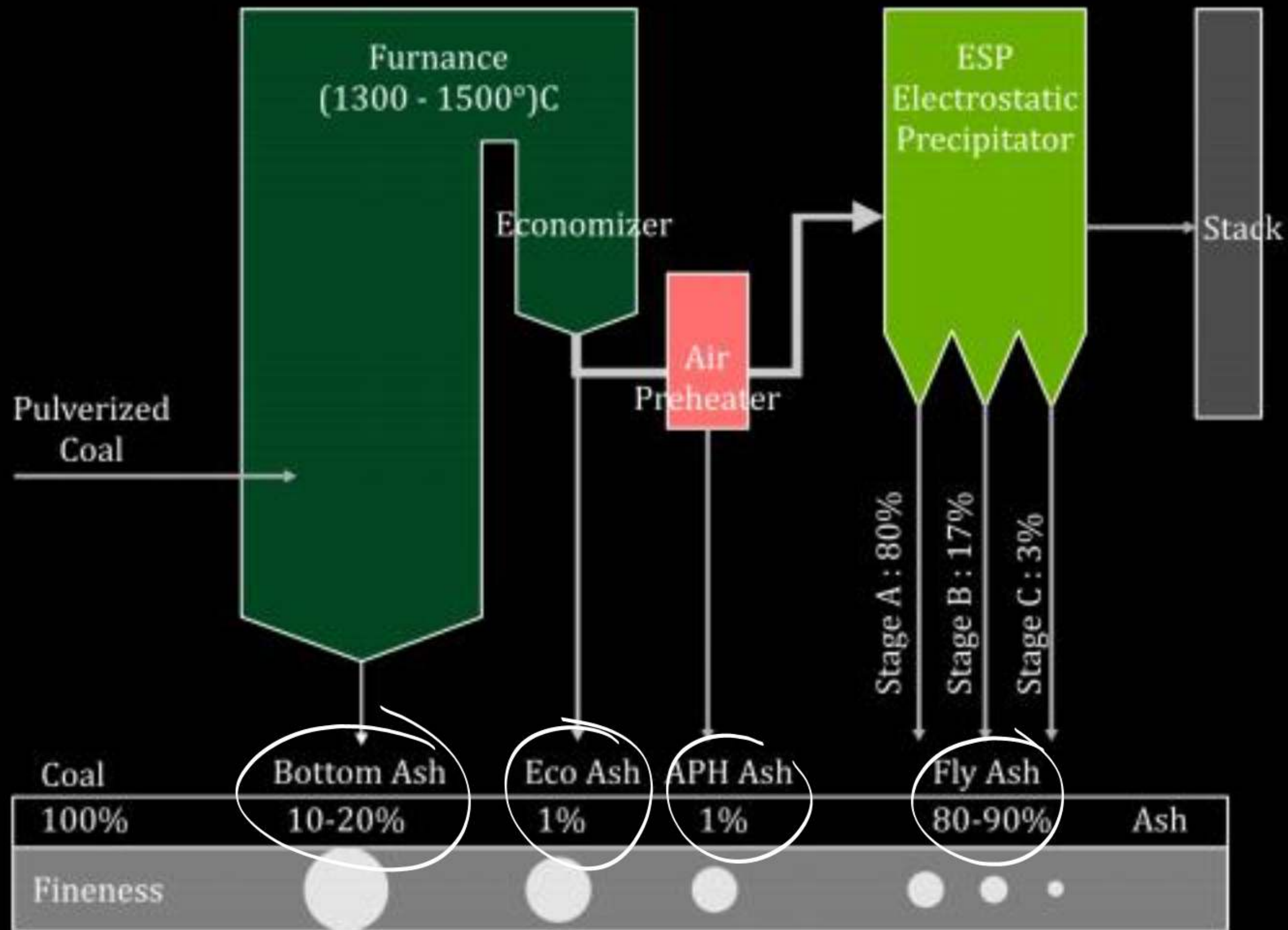
Ash handling plant:

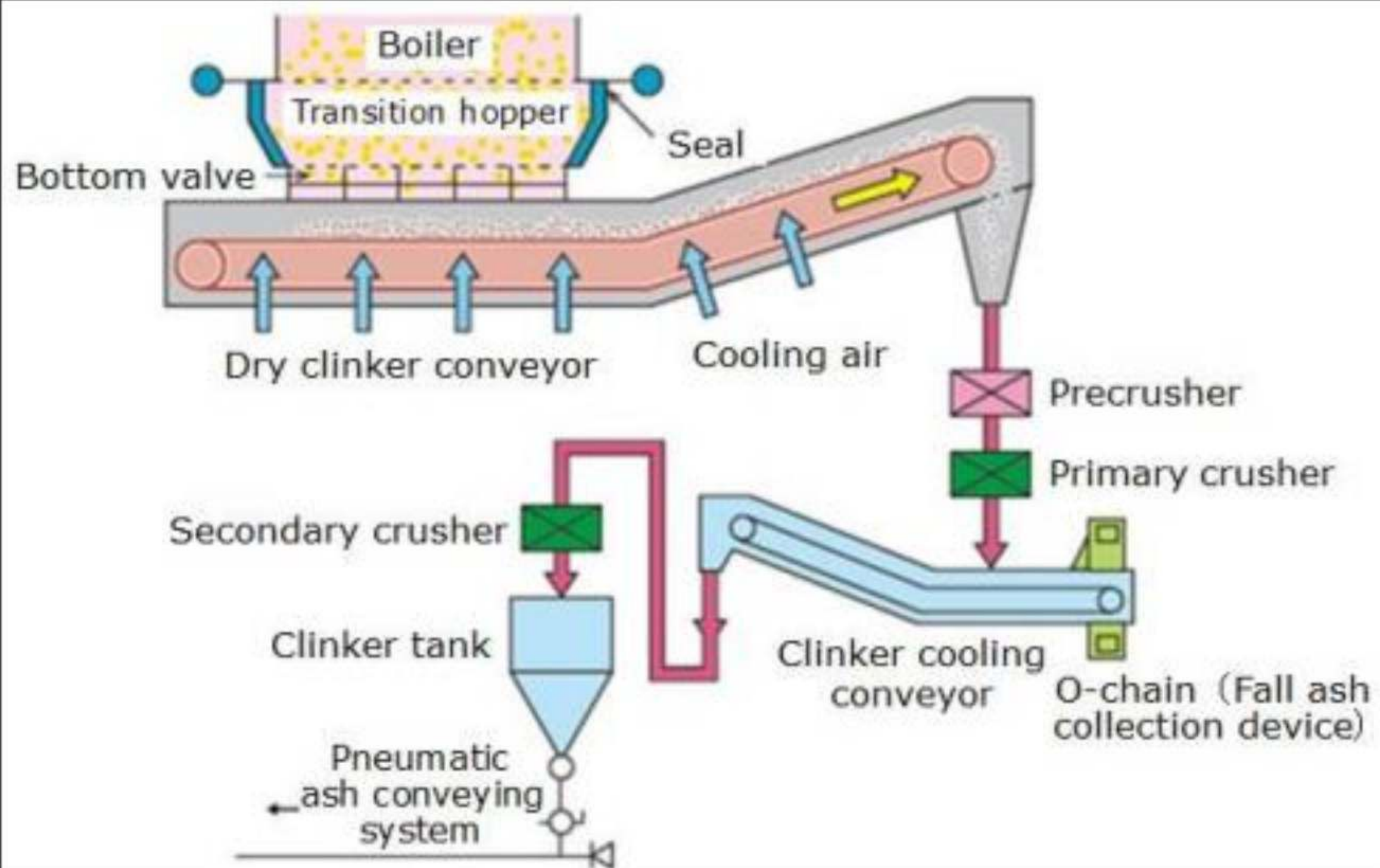
- In a thermal power plant ash is produced as a byproduct of combustion.
- Ash generation in power plant is about 30 to 40 percentage of total coal consumption so a system is required to handle the ash.
- Bottom ash(10-20%) ✓
- Coarse ash(1%) ✓
- Air preheater (1%) ✓
- Fly-ash(80-90%) ✓
- Bottom ash is fall into a W shaped ash hopper the slurry formed is transported to slurry pump through pipes.
- Fly ash is collected by ESP hopper(fabric bag) located at the outlet of furnace(boiler)

Ash handling plant:

- The bottom ash is generally inert but fly ash is quite acidic due to SO_2 .
- The sluicing system is generally used for removal of bottom ash. This ash after dried can be used as a "land fill".
- The pneumatic system is used for disposal of fly ash. In this system a high velocity air stream cause ash to flow into separator where ash is collected in hopper..
- Fly ash is mainly used to produce brick and building material.





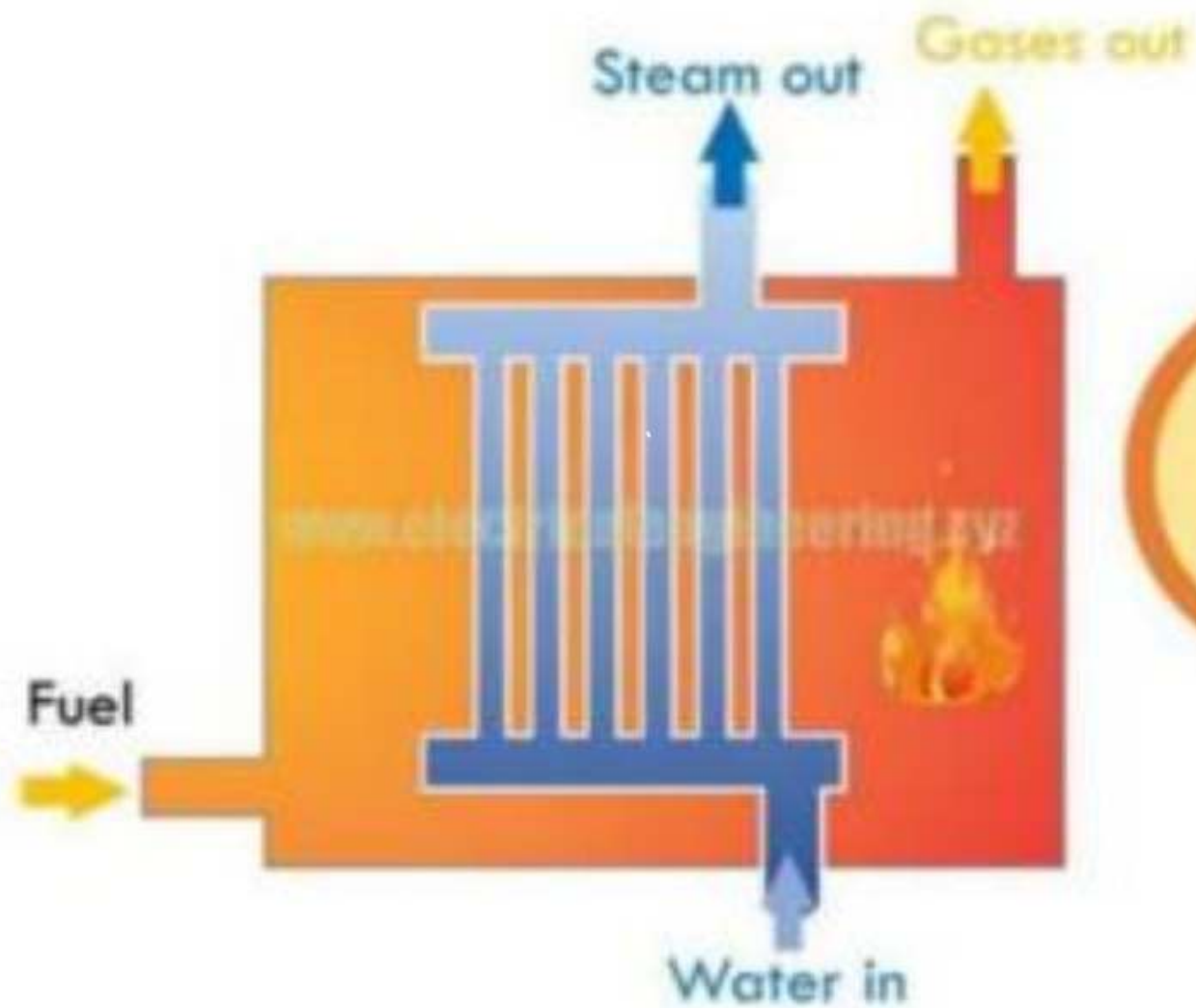


Boiler:

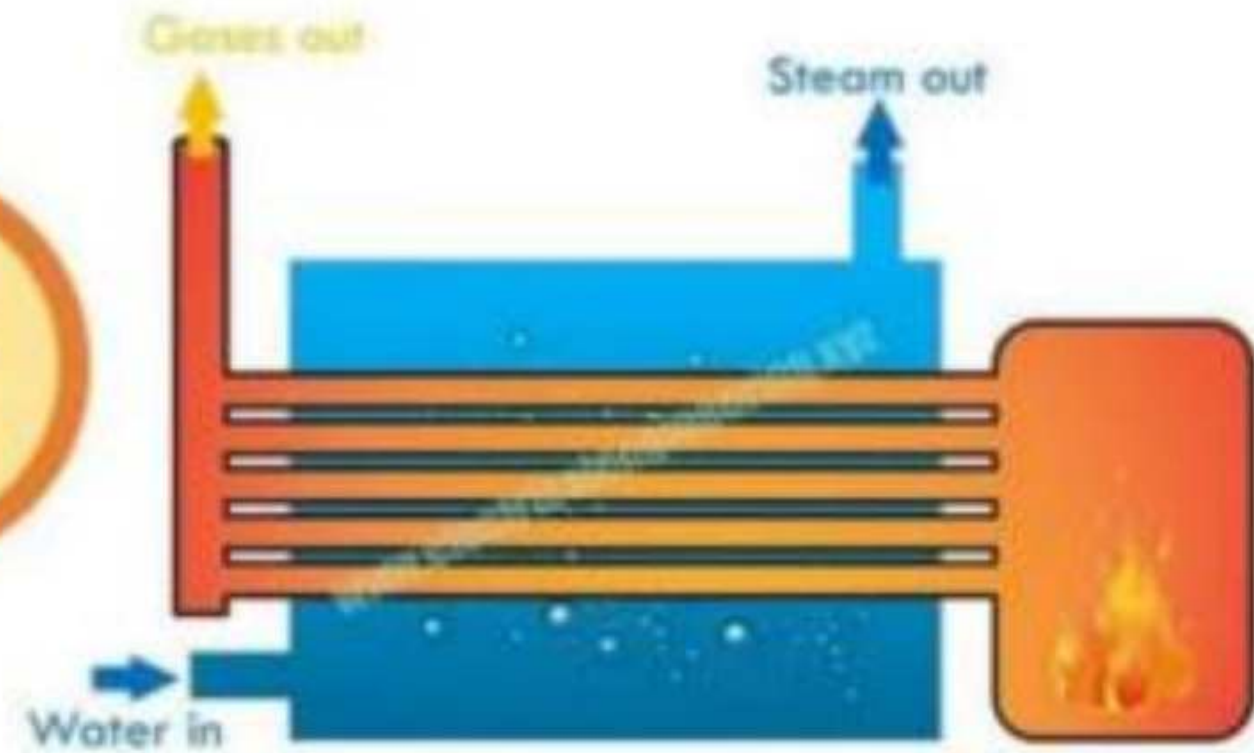
- A boiler is an enclosed pressure vessel in which water is converted into steam by gaining heat from source.
- Boiler may be two types
 1. Fire tube boiler
 2. Water tube boiler
- ✓ In thermal plant water tube boiler is used mostly
- The circulation of water through the tube in the boiler may be natural (due to difference in density between cold and hot water) or forced circulation through the action of pumps.
- Water tube boilers have a number of advantages over fire tube boilers viz., require less space, smaller size of tubes and drum, high working pressure due to small drum, less liable to explosion etc

- The modern high pressure boiler use forced circulation
- The pulverized coal (75-300 micron) is blown with part of combustion air through a series of burner nozzle. Combustion takes place at temperature 1300-1700.
- The feed water is entered in the boiler from economizer. The water is circulated in the tubes and converted into steams. The dry and saturated steam from boiler then pass through superheater and then finally available.
- Boiler is the most efficient part of thermal power plant ($\eta = 85\%$)
- Boiler give the steam at high pressure and temperature (110-170 Kg/m² pressure)





VS



Water tube boiler

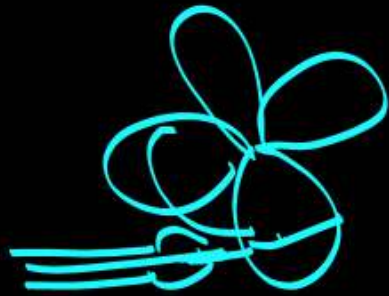
Fire tube boiler

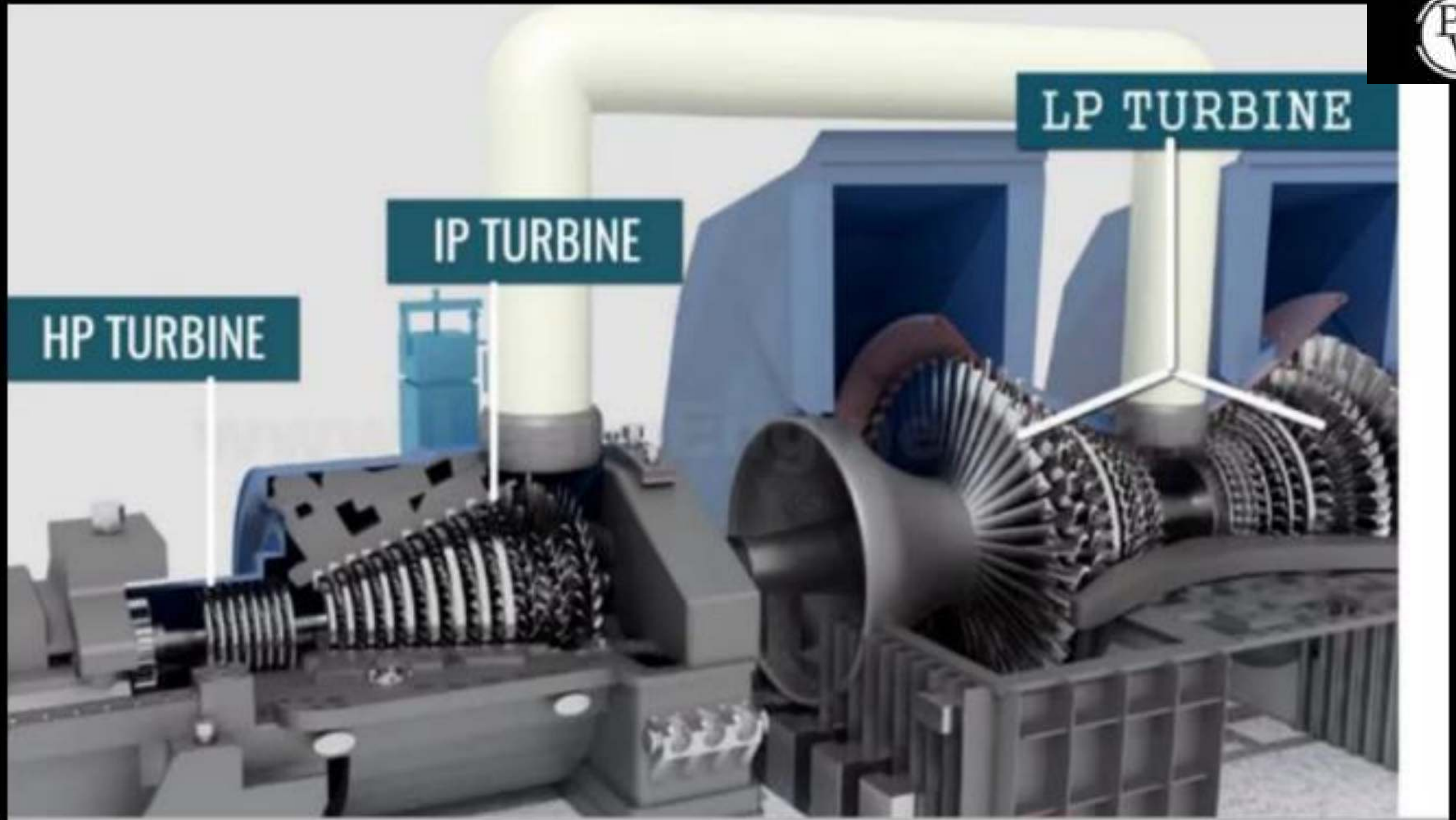
Superheater

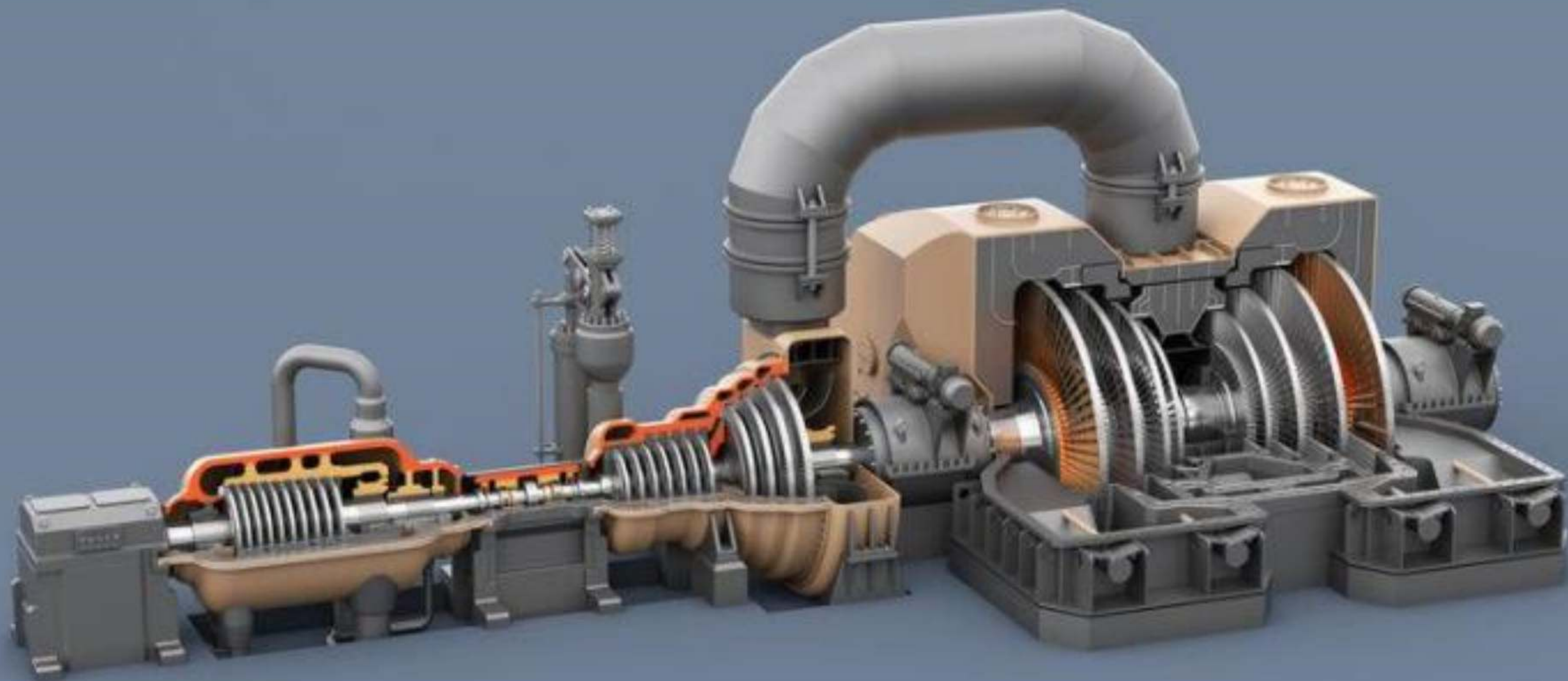
- Steam produced by boiler is saturated(wet steam). To improve the efficiency of turbine the temperature of steam coming from boiler is increased in superheater. ✓
- Superheater convert the wet steam into superheated (dry steam so it will reduce the corrosion of turbine).
- Superheater raise the temperature by using heat absorb from furnace radiation or from flue gases(convection).
- Superheater does not increase the pressure of steam.
- The temperature of steam is about 540 degree
- First benefit of superheater is that It improve Rankine cycle efficiency($n=30-40\%$)
- Secondly, too much condensation in the last stages of turbine (which would cause blade corrosion) is avoided

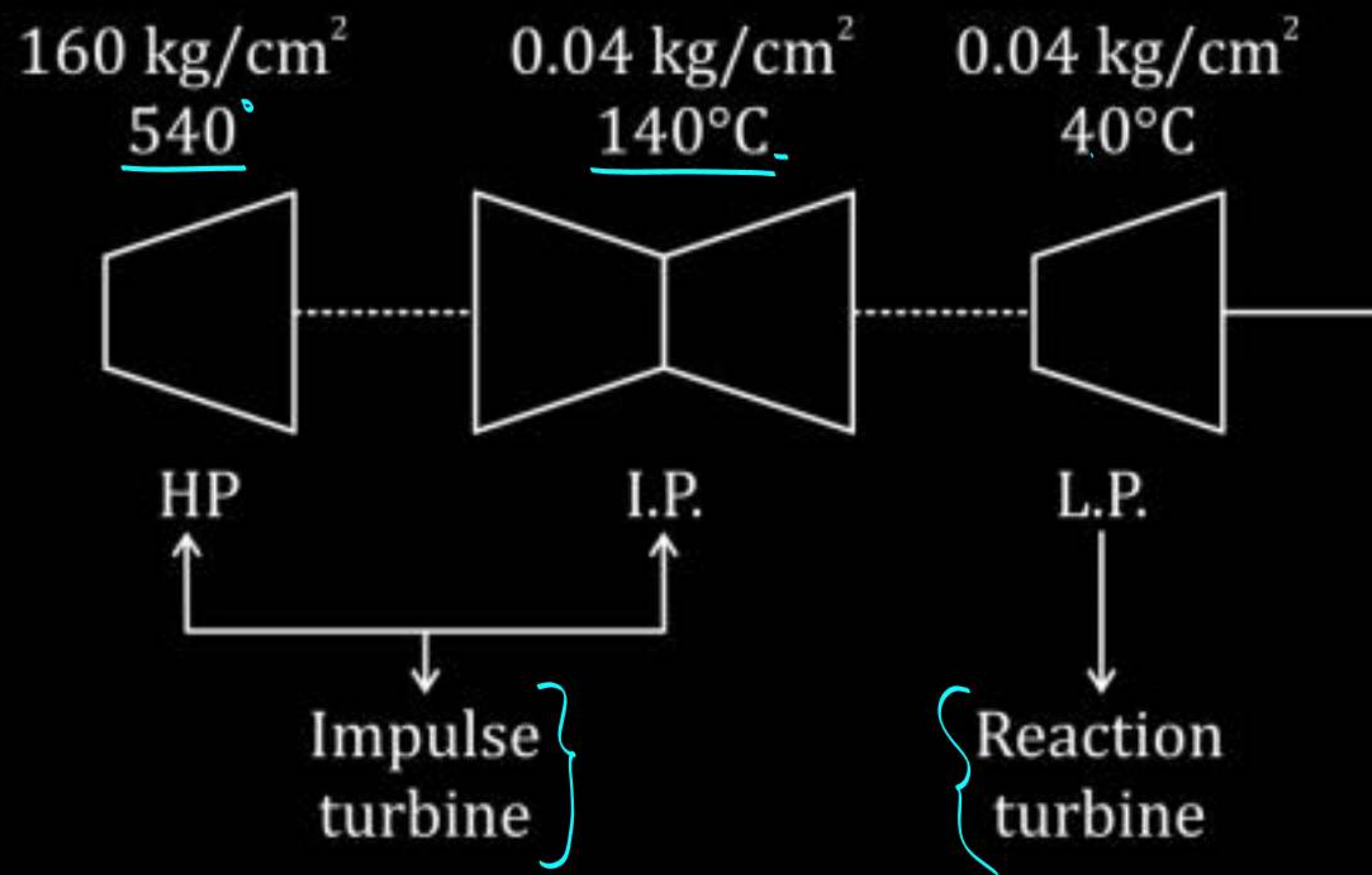


Turbine (Prime mover)

- It convert the thermal energy into mechanical energy. 
- For effective utilization of turbine, the steam at high pressure and high temperature is used and it is allowed the steam for expansion in more than one stage.
- For 2 pole alternator the speed of steam turbine is 3000RPM
- xxx In thermal power plant impulse-reaction turbine is used.
- In impulses turbine complete expansion occur in nozzle itself and steam pressure during flow of stream over turbine blade remain same..
- In reaction turbine partial expansion occur in nozzle and further expansion occur as steam flow over the blade.

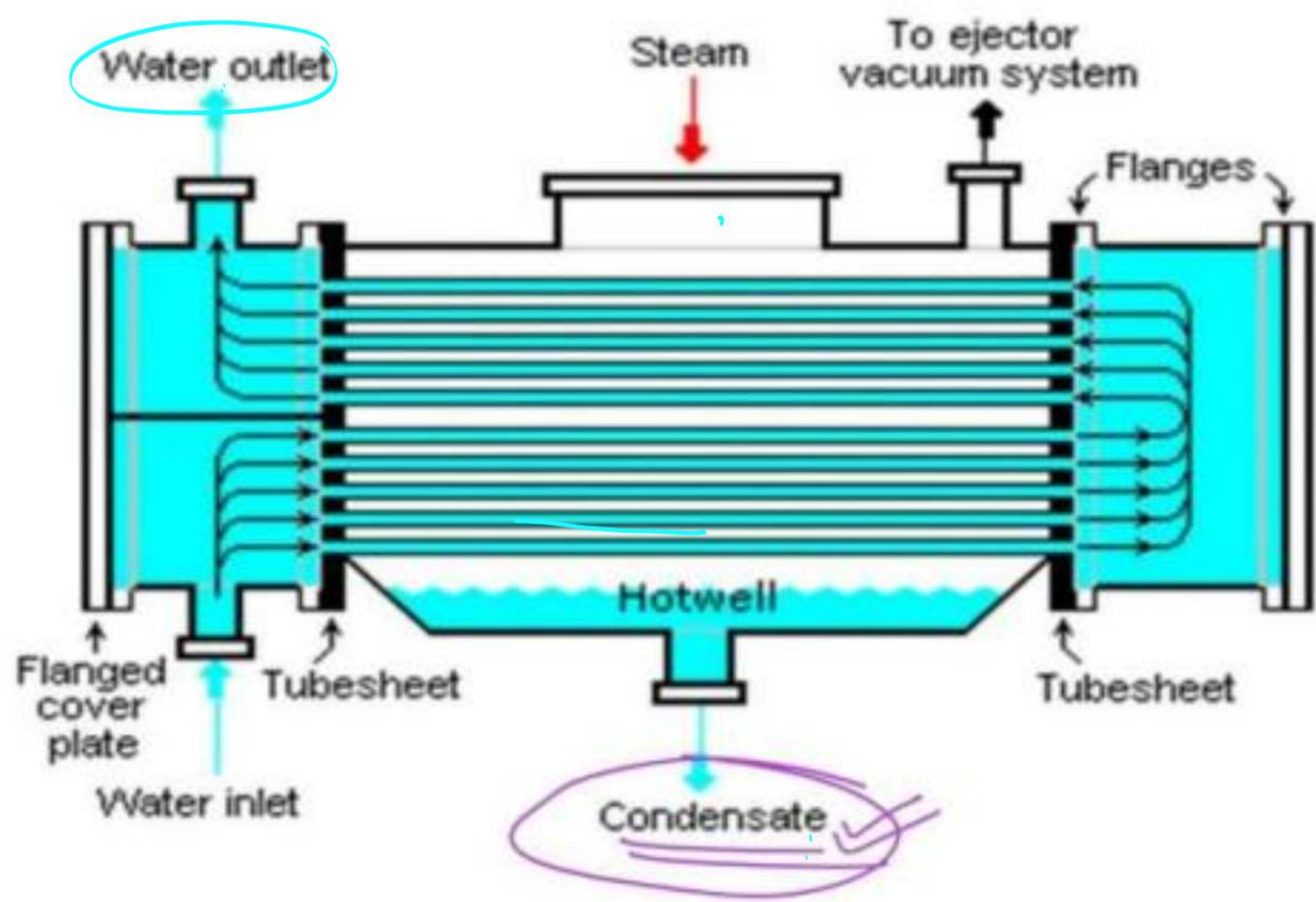






Condenser

- Condenser does the job of condensing the steam exhausted from turbine.
- It maintain low pressure(below atmospheric) at exhaust thereby permitting expansion of steam in the turbine to a very low pressure. So it improve the plant efficiency.
- It has two type
 1. Jet type
 2. Surface type
- Mostly surface condenser is used in which water is flow in the tube between chamber and steam is adjusted from top and get condensed due to contact with tube surface.
- Condensate leave from bottom it is mixed with(makeup) water from DM plant and feed to boiler again.

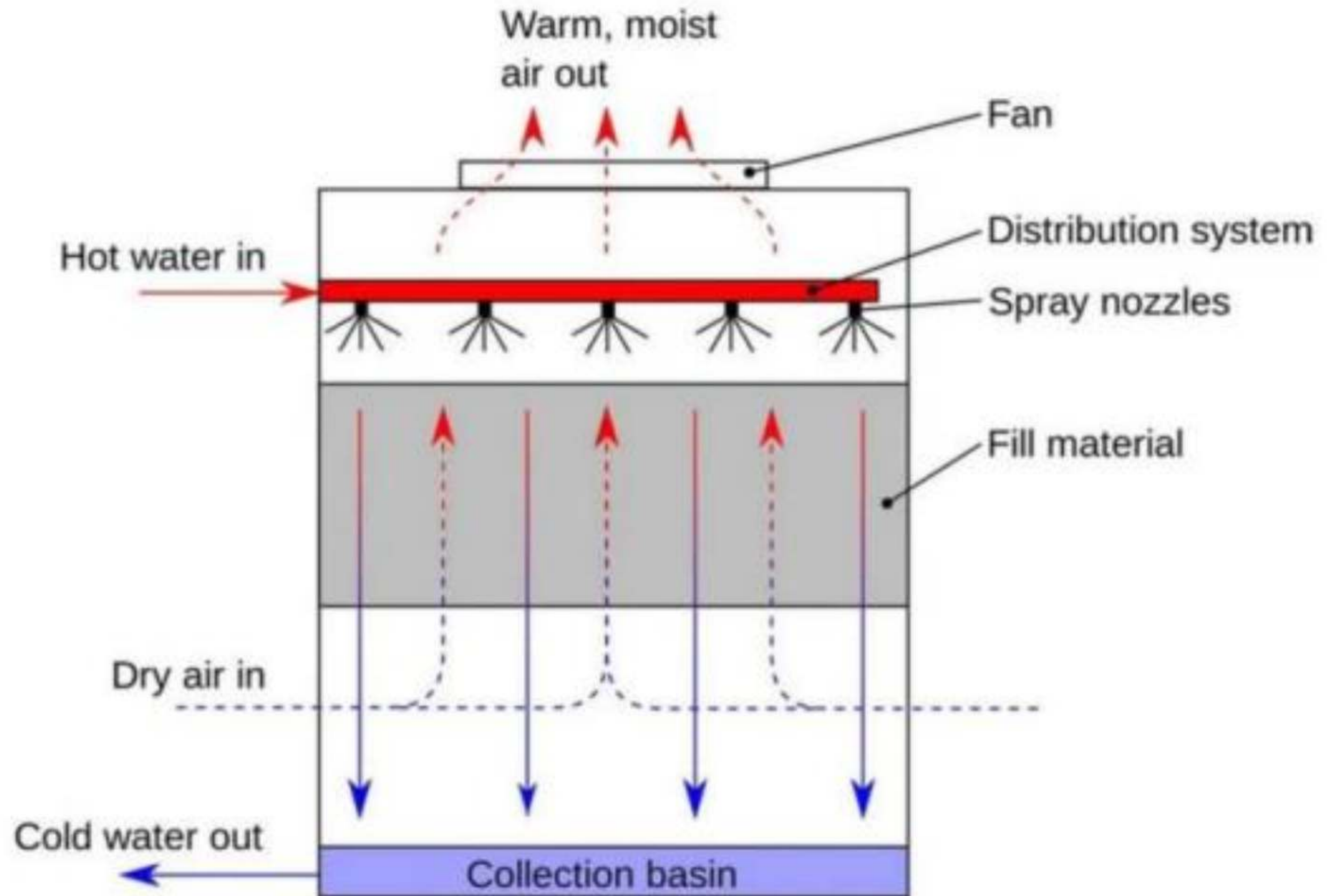


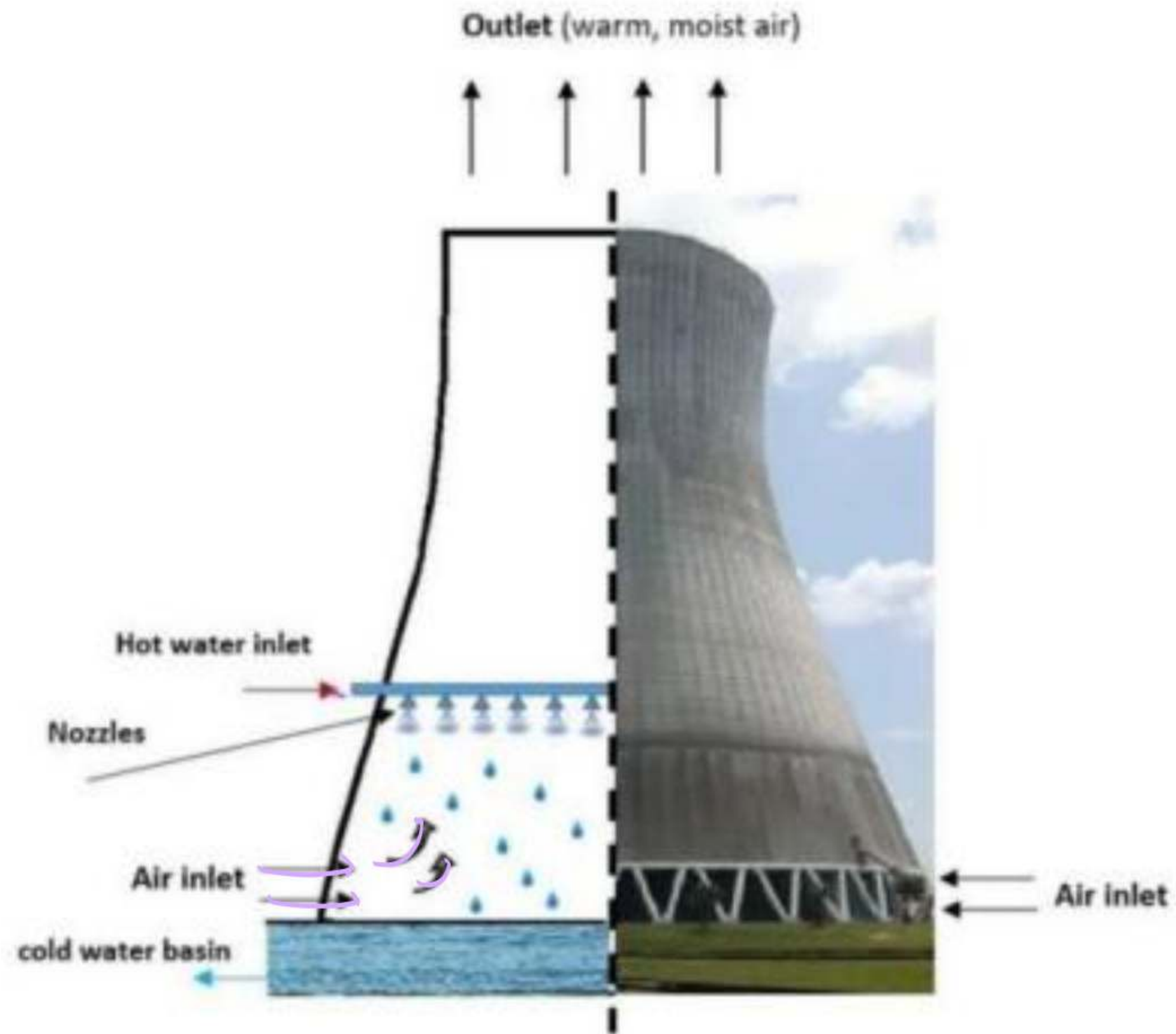
Cooling Tower:

- Modern steam station use large size of cooling tower. It is steel or concrete hyperbolic structure having a reservoir at the bottom for storage of cooled water.
- It cool the warm water coming from condenser so that it can be reused.
- The warm water is led to the top and air is flows from bottom to top. The water drop falling from top come in contact of air, it loose heat and get cooled.
- Air is circulated by natural draft, force draft or induced draft







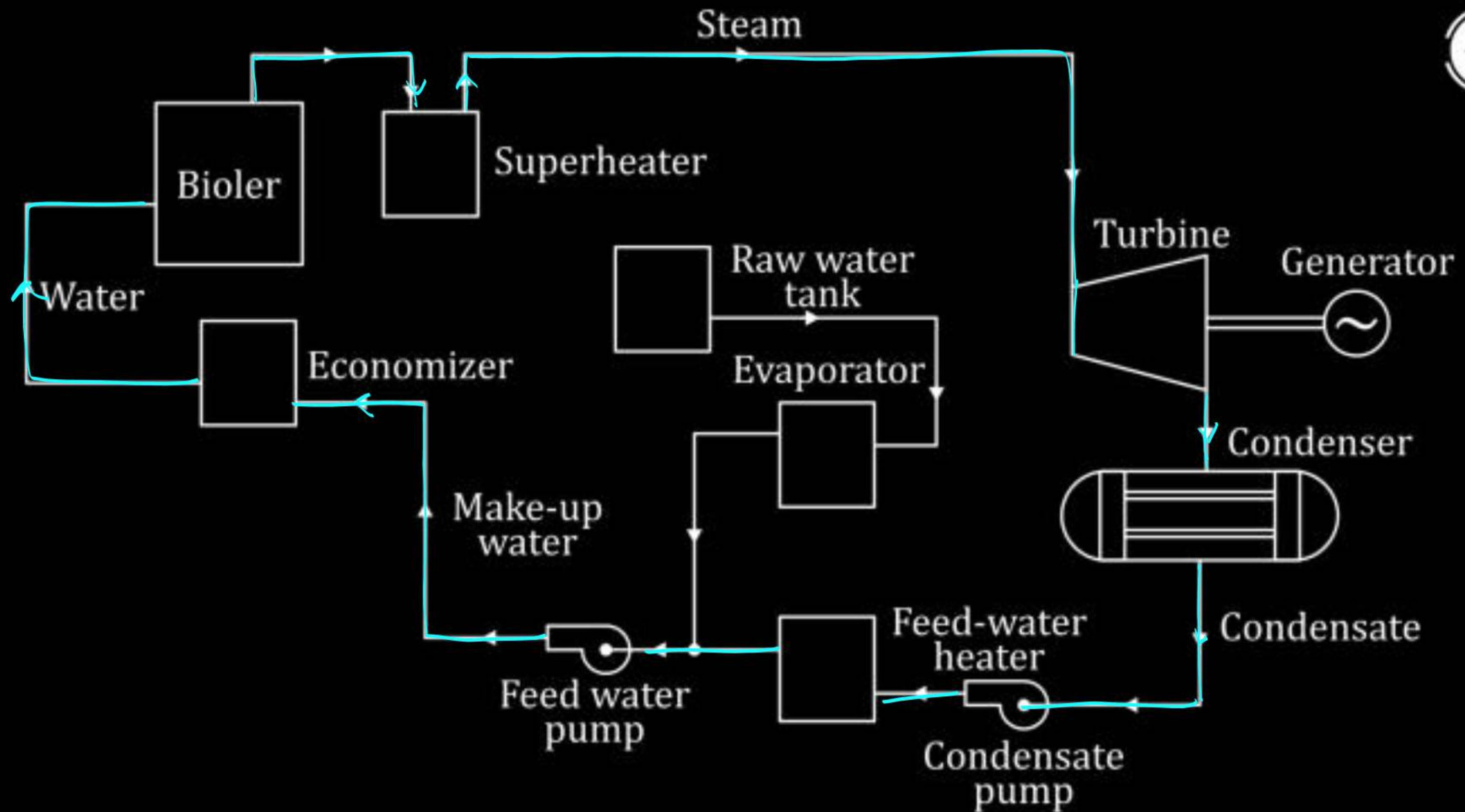


Water handling plant:

- The demineralized water is used in the boiler.
- Because if mineral water is used scaling (sodium and calcium) is formed in the tube of boiler.

Feed water pump

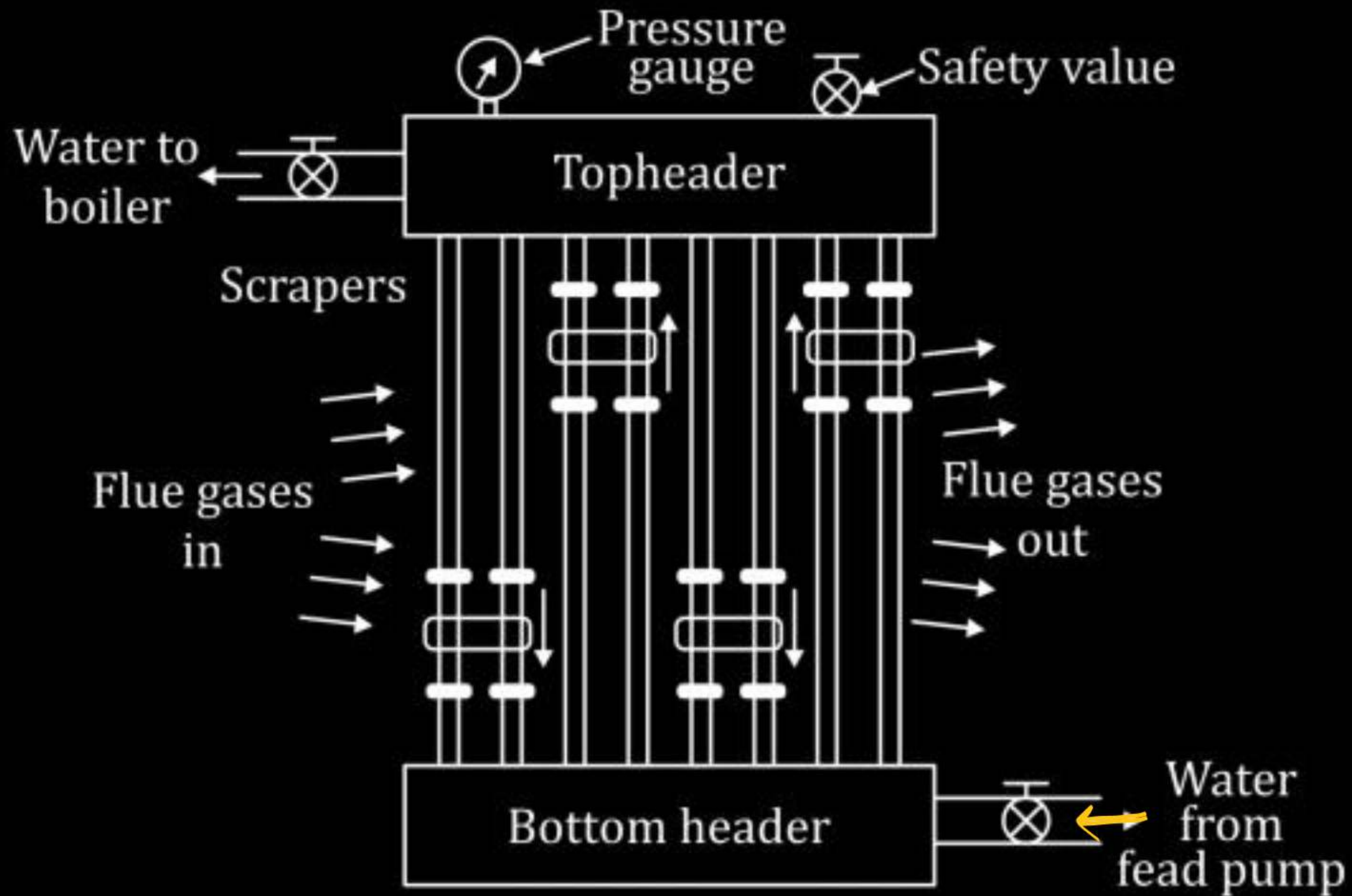
- The steam coming out of turbine is condensed and it is again feed back to boiler as a feed water. To make up the losses makeup water is also added. The makeup water is around 2 to 5 percentage.
- It is necessary to heat the feed water before feeding into boiler.
- It increase the overall plant efficiency. Quantity of steam produced is increased.
- It reduce the thermal stress due to cold water entering the boiler drum is avoided.
- The dissolve gases is like oxygen and CO₂ is also removed otherwise it create the corrosion of boiler.



Feed water and steam flow circuit for a Boiler turbine unit

Economiser

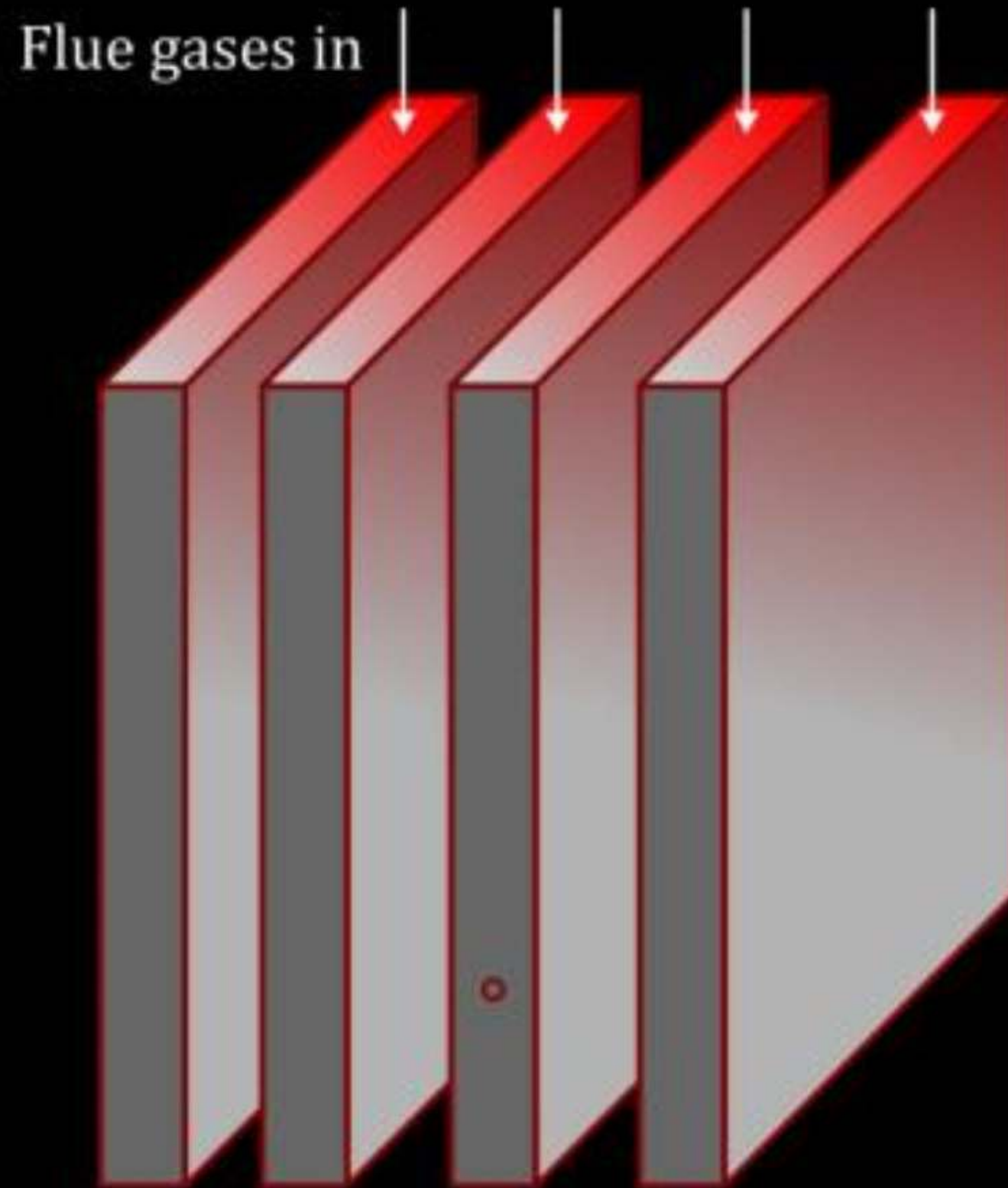
- Before feeding to boiler feed water is again heated in economizer.
- Flue gases are used to heat the feed water.
- It save the fuel (5-15%) and boiler efficiency is increased (10-12%)
- Economiser is used nowadays in all modern power plant.

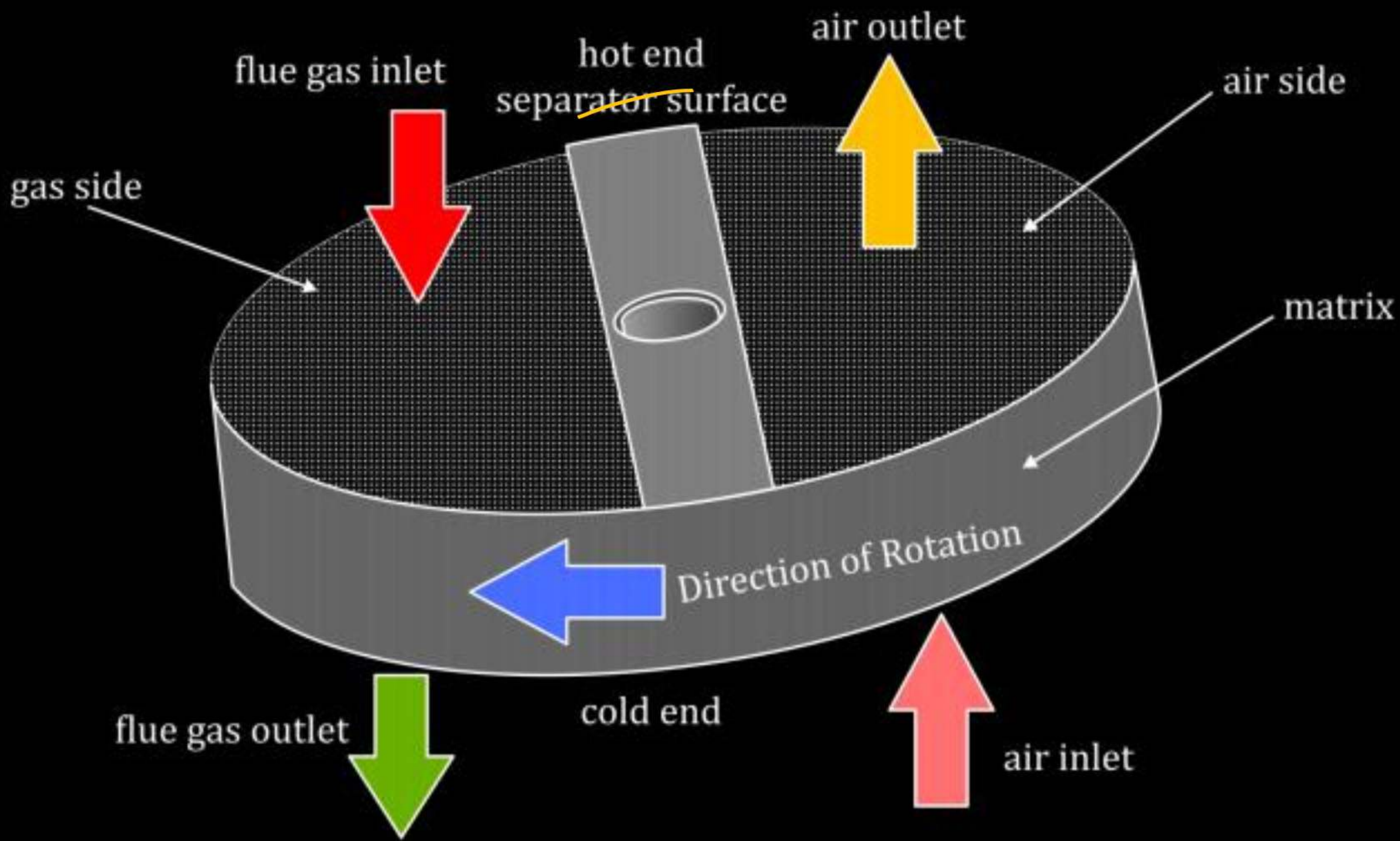


Air Preheater

- After flue gases leave the economizer some heat can be extracted from then to heat the air for combustion by use of force draught fan.
- It increase the plant efficiency by one percent.
- It may be plate type , tubular type and regenerative type.
- Nowadays regenerative air preheater is mainly used.

In this air preheater PLATES are used for flue gases



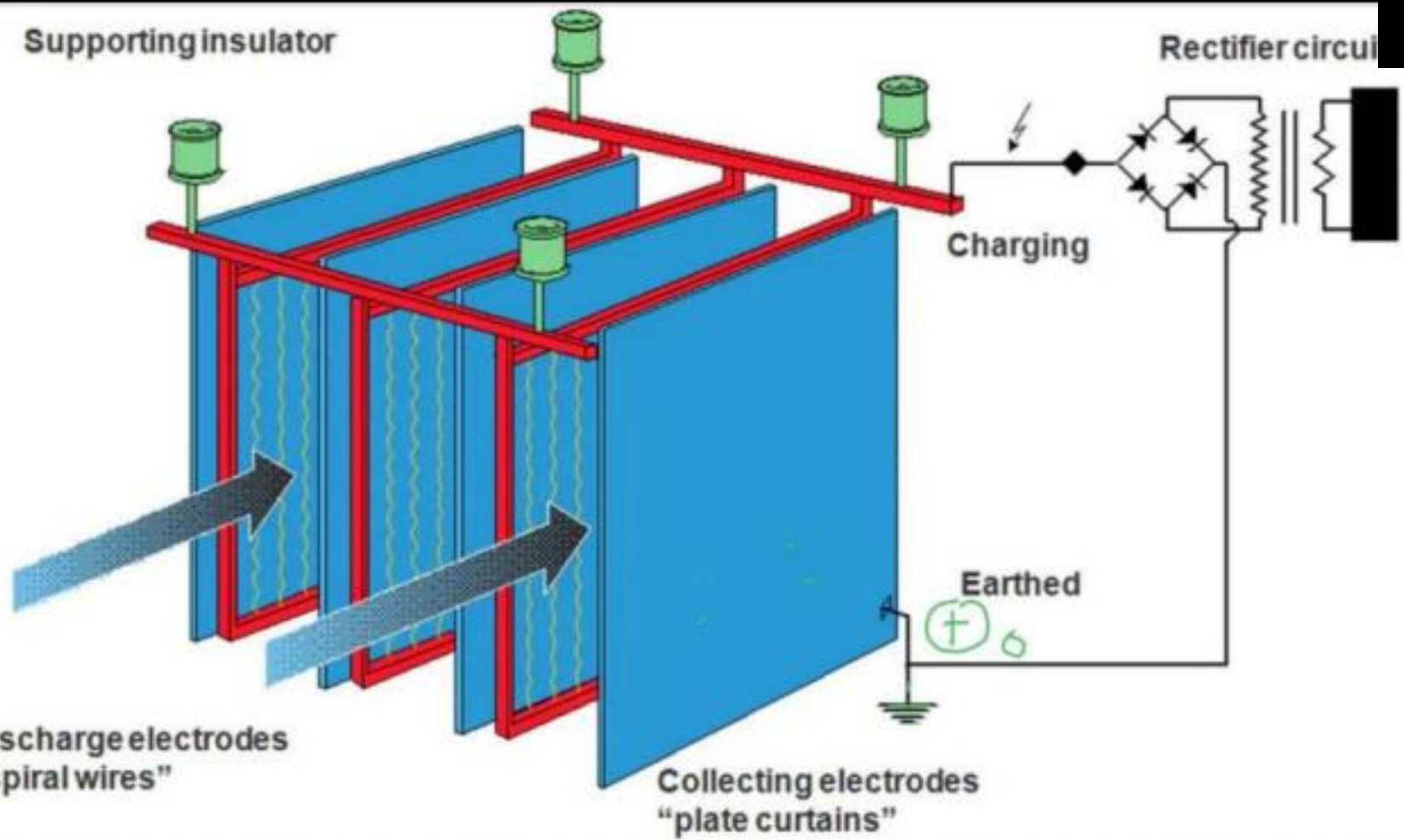


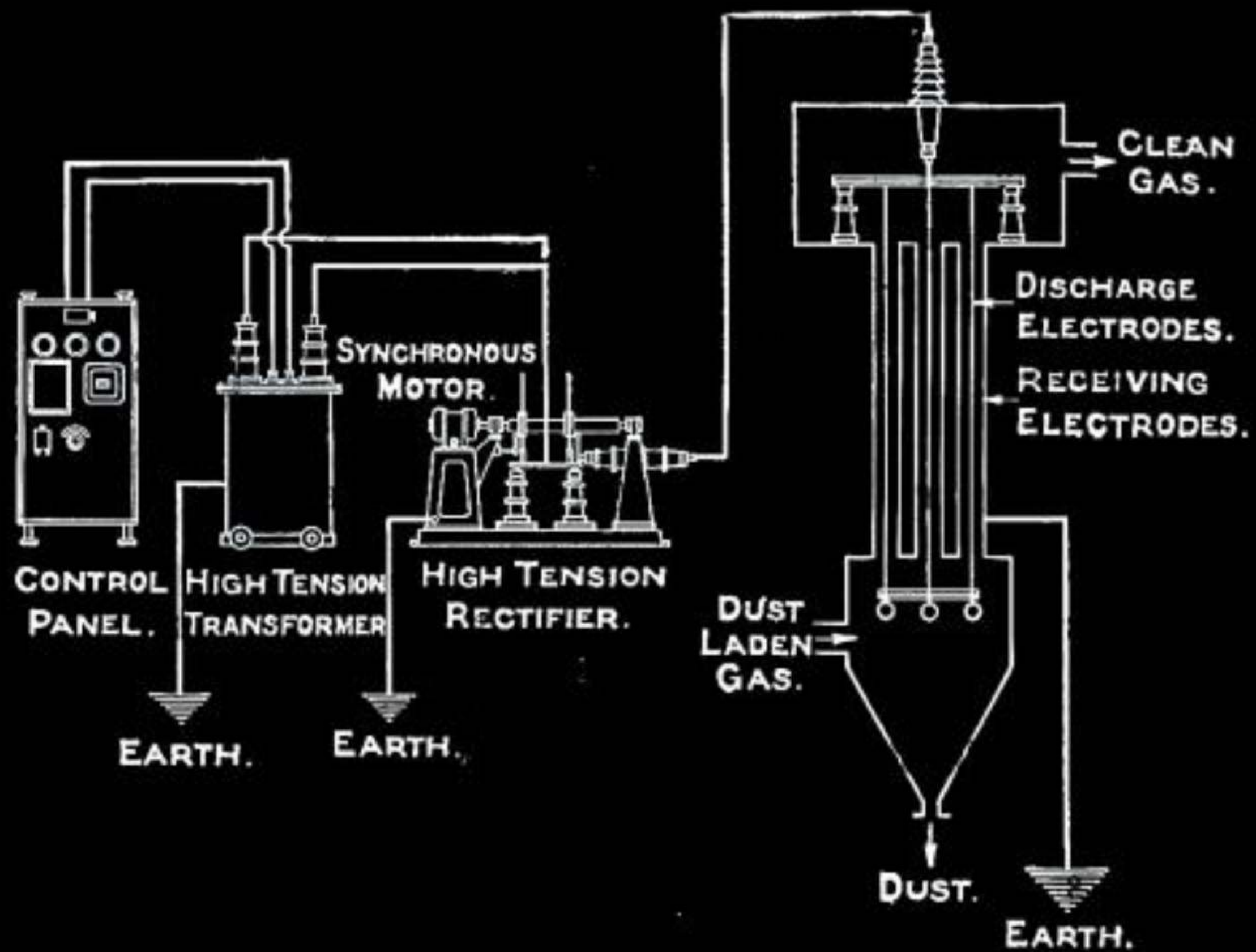
Electrostatic Precipitator (ESP)

- It is between the air preheater and chimney
- The flue gases coming out of air preheater has ash particle as well as some poisonous gas like CO, CO₂, SO₂. The purpose of ESP is to collect these particles.
- It has two electrode anode and cathode supplied by 25 kV to 30 kV
- Finally, flue gases is extracted from chimney

Supporting insulator

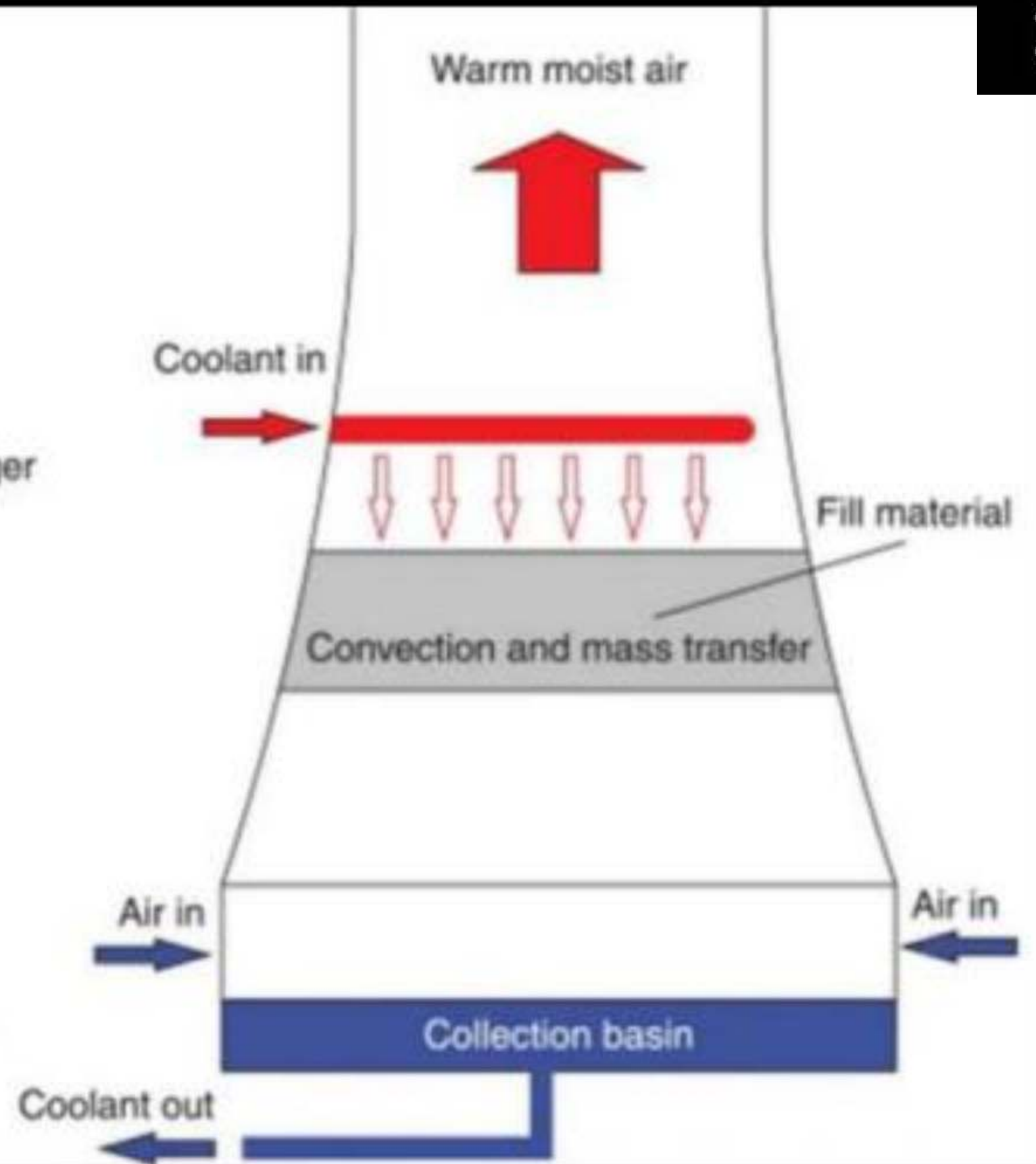
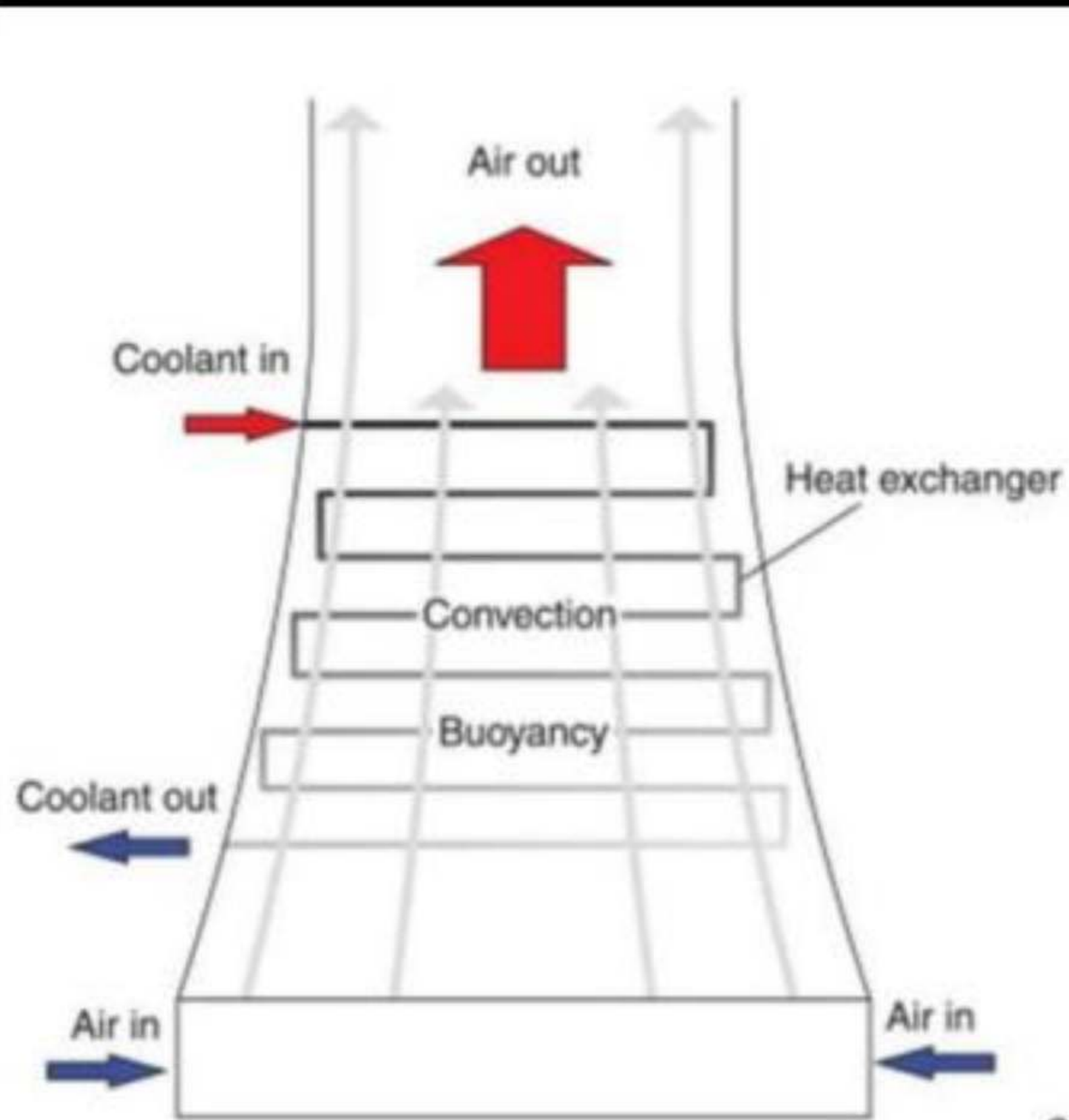
Rectifier circuit

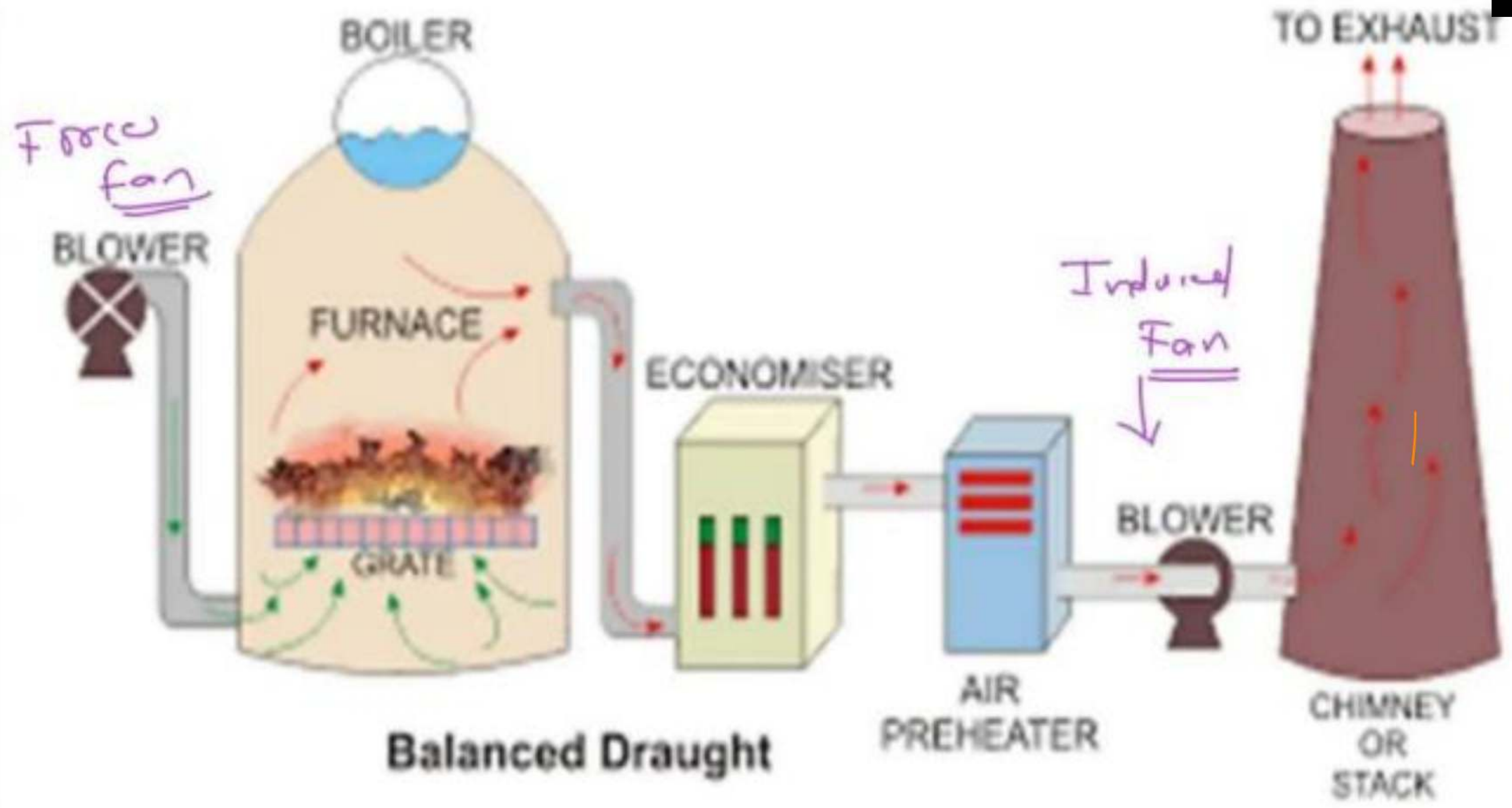




Draught System

- It is used for circulation of (flow) of air
- Two type of draught system is used.
- Natural draught—work on pressure difference (chimney)
- Artificial draught— By using fan
 1. Induced (negative pressure)
 2. Forced draught (positive pressure)
- ✓ The cooling tower is attached with forced draught so air is blowing on vapor particles to send them on atmosphere.
- ✓ The induced fan at chimney collect flue gas and send them to atmosphere.





Efficiency

- $n = \frac{\text{heat equivalent of electrical output}}{\text{heat of combustion of coal}}$
- $1\text{kwh} = 800 \text{ Kcal or } 36 * 10 \text{ Joule.}$
- The overall efficiency is 30 to 40%
- The main reason of low efficiency is due to poor efficiency of thermodynamic cycle (Rankine cycle)
- Huge amount of pressure and temp loss in condenser
- Auxiliary consumption of station is high. Because more auxiliary equipment





2 Minutes Summary

→ Thermal power plant

→ Auxillaries.

Thank
you

Electrical Engineering



Power System



Lecture No 3

Generation of Electric Power



By- Ajay Gupta Sir



Recap of Previous class

1. Thermal power Plant ✓
2. Coal handling system ✓
3. Ash handling system ✓
4. economiser, superheater ✓
5. boiler, condensor, cooling tower ✓
6. Air precipitator, Draught system ✓



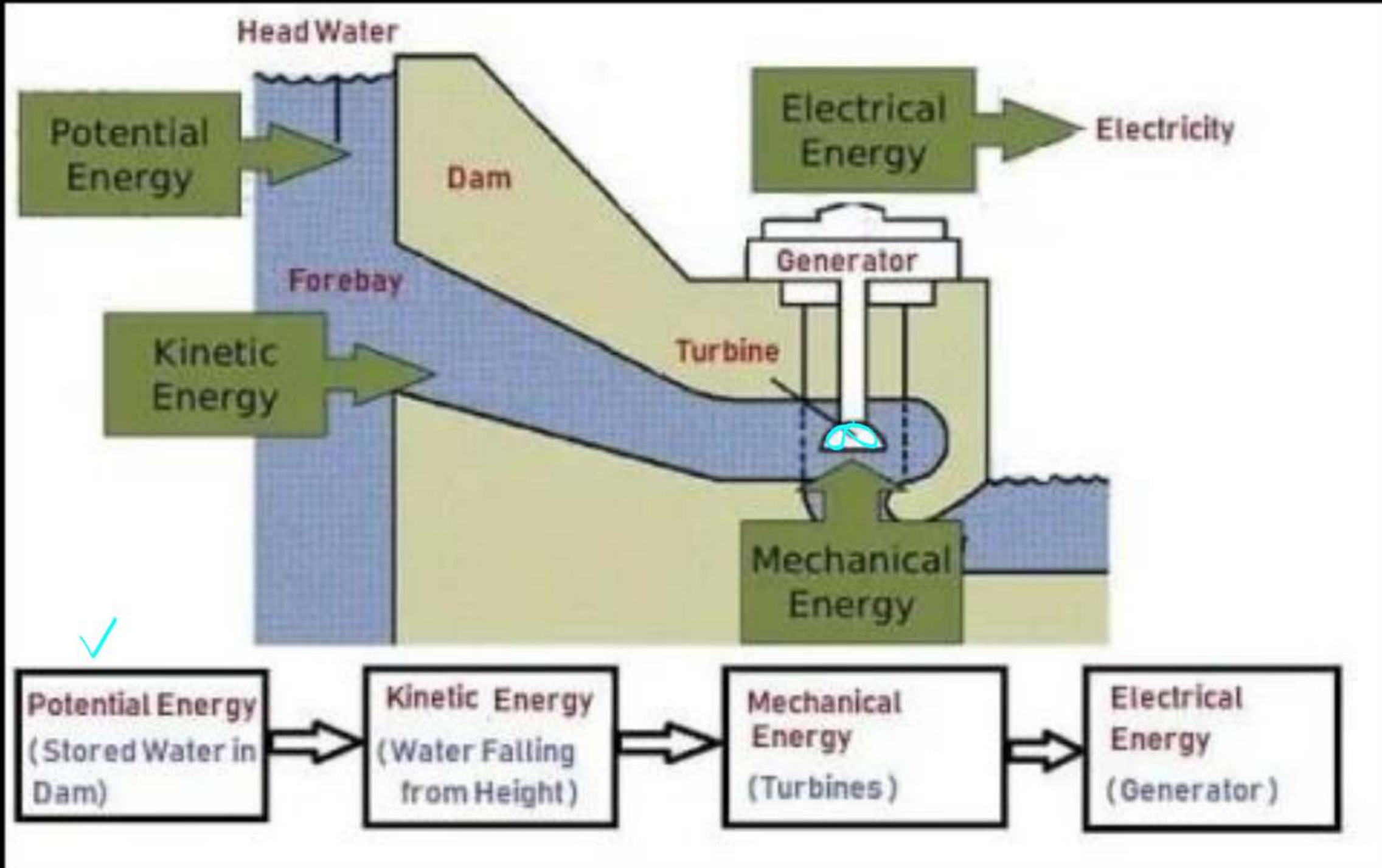
Topics to be Covered

1. Hydro power plant ✓
2. Hydrology ✓
3. Component of hydro power plant ✓
4. Types of turbine ✓
5. Classification of hydro power plant ✓
6. Pump storage power plant ✓



@AJAYGUPTASIRPW

Hydro Power Plant



Hydro Power plant

Selection of site:

- Sufficient amount of water should be available.
- It should be near to load center
- Area for storage of water
- Head of water should be available
- Land cost should be low.

Advantage:

- Useful life of hydro plant is about 50 year as compared to 25 year of thermal plant.
- It can be use as a peak load and base load plant.
- Operating cost is lowest (Running cost)

- Maintenance cost is very low. ✓
- Efficiency of plant do not reduce with age. ✓
- Free from -pollution. ✓
- Operating personnel required for hydro plant is less. ✓
- Efficiency of plant is high (80-85%). ✓
- Free from air pollution.

Disadvantage:

- It has very high initial cost due to large civil engineering works.
- Firm capacity is low. ✓
- It take long time for construction. ✓
- Hydro plant submerge huge area, uproot large population and create social and other problem.

Hydrology

Runoff : The part of water that flow on ground surface of catchment area to form stream is called RUN OFF

Hydrograph: it shows the variation of stream flow in m^3/sec (water discharge) as a function of time. It give

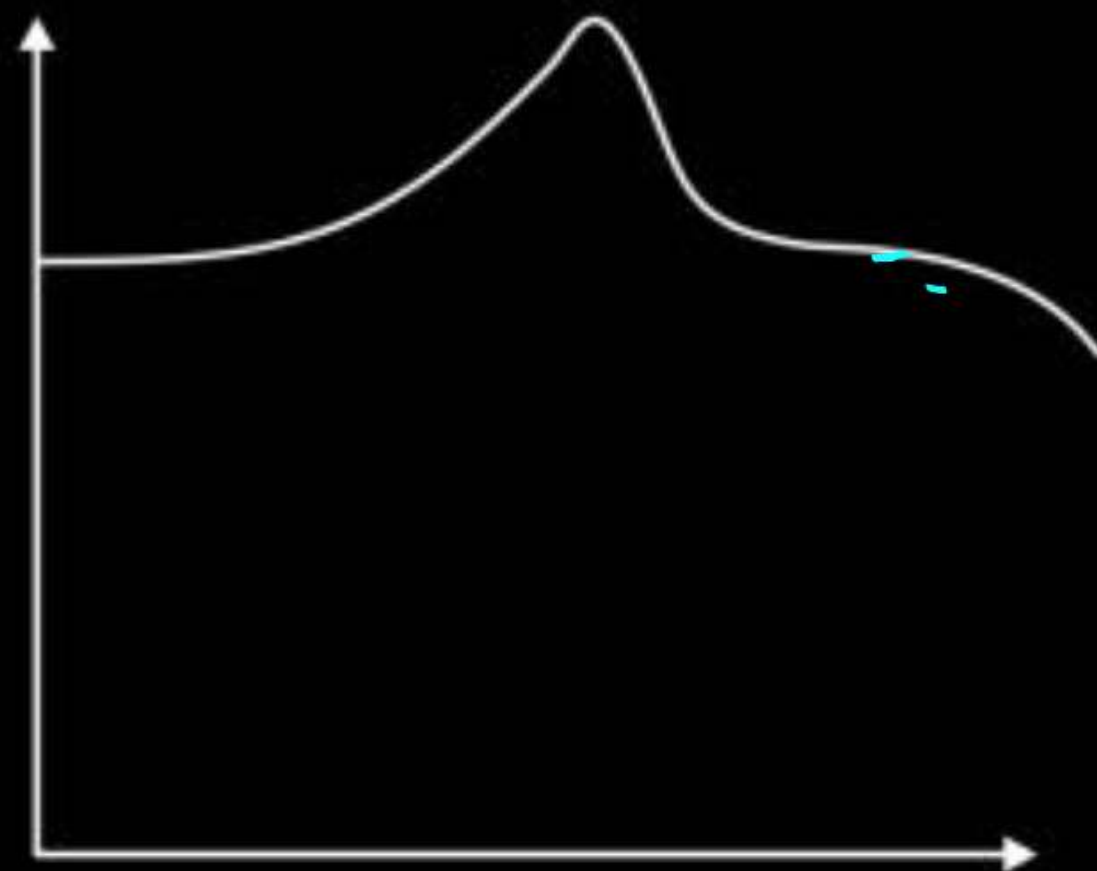
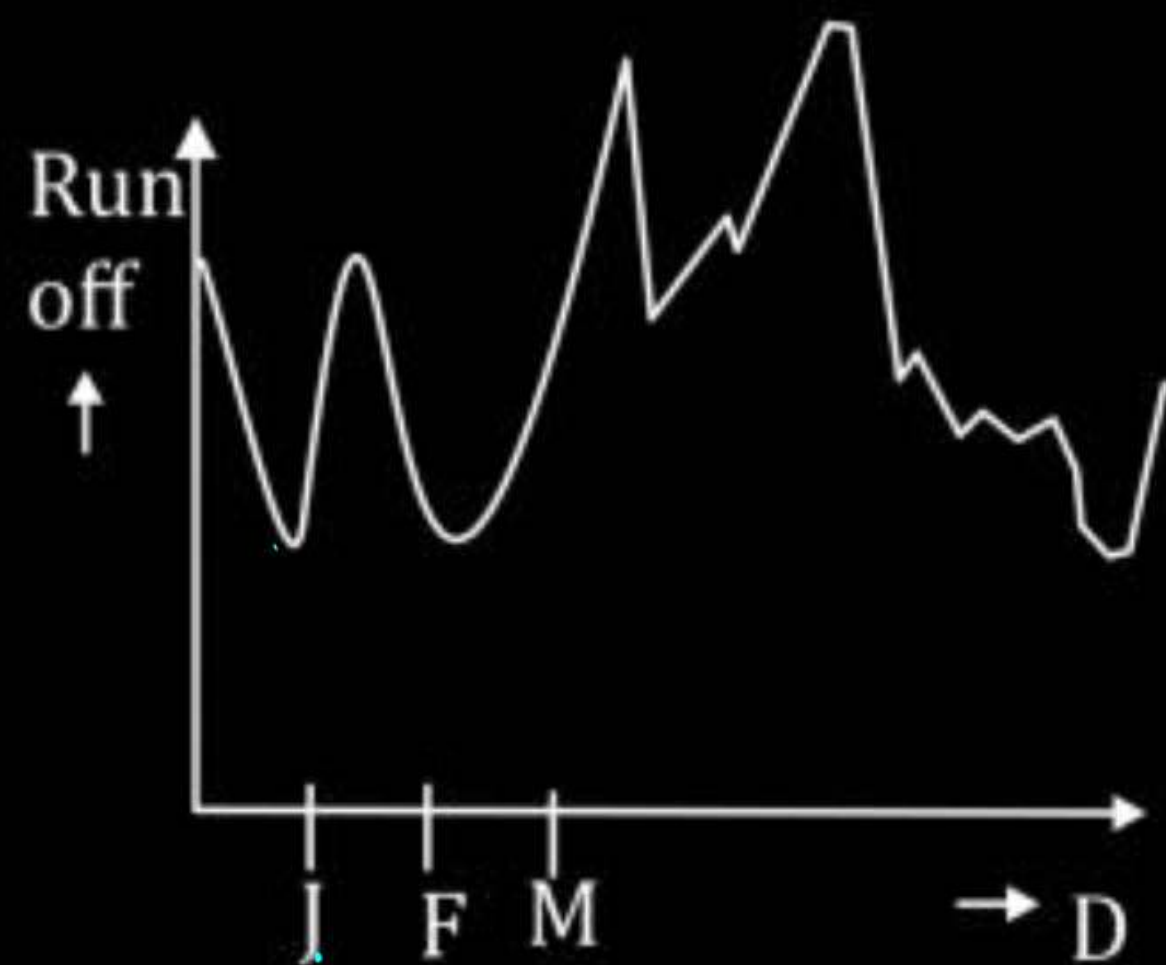
1. Max and min runoff during the period
2. Average value of runoff
3. Total volume of water up to that time

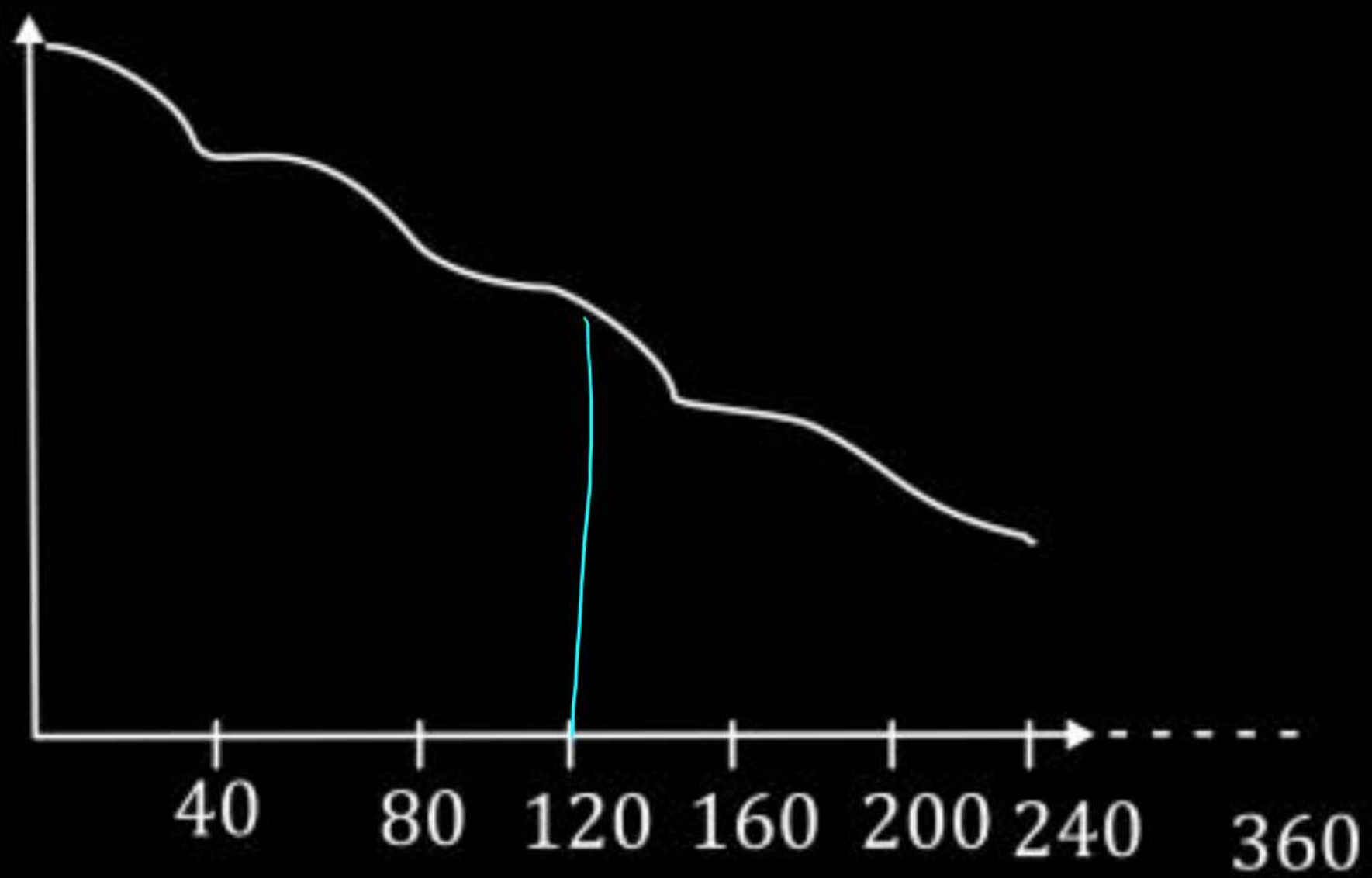
Storage requirement is determined by hydrograph.



Flow duration curve:

- it is rearrangement of all the stream flow of hydrograph in descending order.
- It is similar to load duration curve
- Flow durations curve can be obtained from hydrograph
- The area under flow duration curve give total amount of run off water during that period



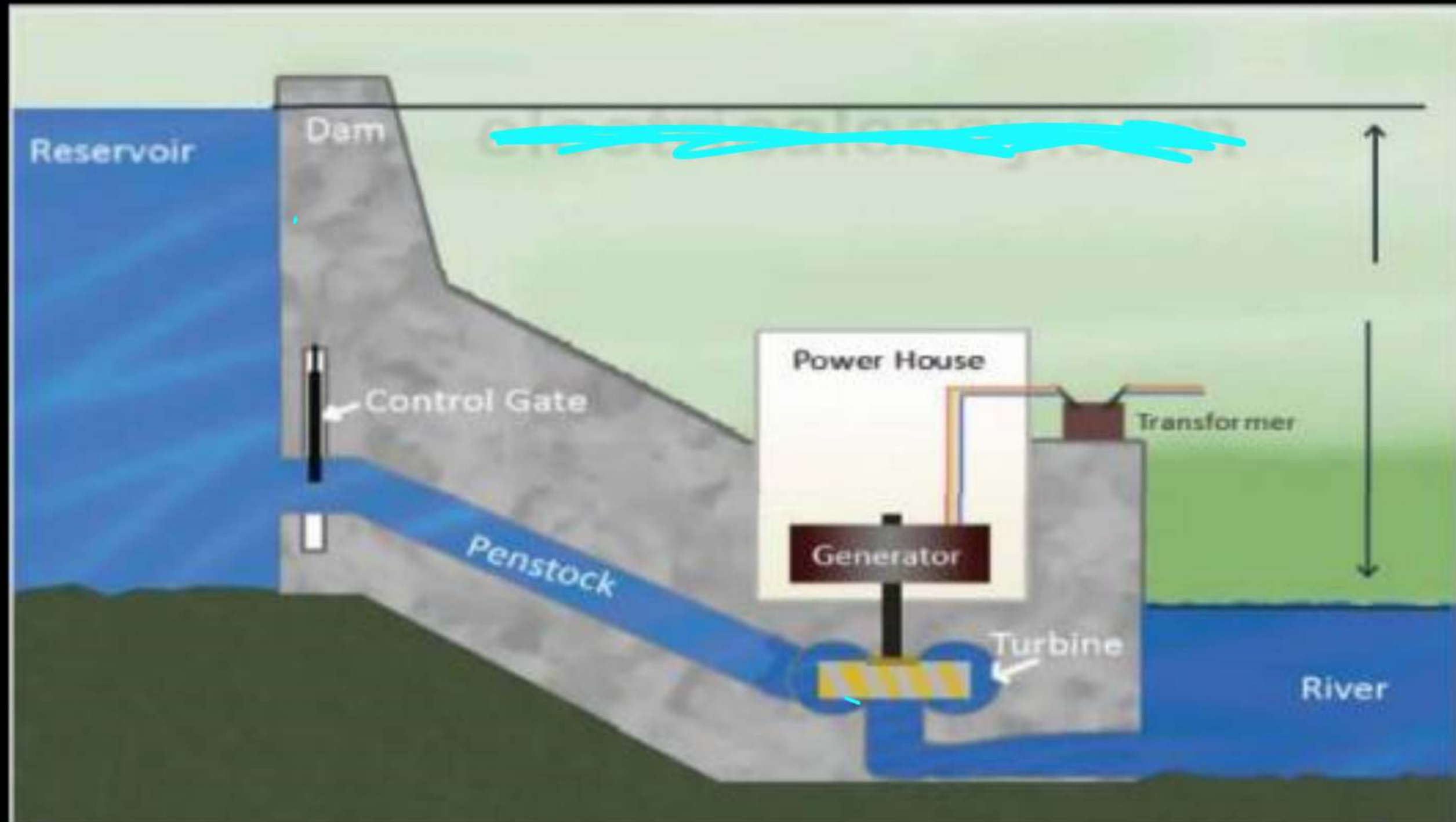


Component of hydro power plant



Storage reservoir:

- Most of the river have non uniform run offs. During rainy season runoff is high and power requirement are low.
- It is therefore necessary to store the water during excess flow period , so that it can be used in lean flow periods.
- It is area behind the dam where water is stored it help in supplying water to turbine as per load.
- Low head plant required big reservoir.
- Storage capacity depend on the difference between run off during high and low flows.



Dam(head)

- It is most expensive part of hydro plant.
- It create the artificial head and storage.
- Gross head is the difference between water intake and tailrace level
- Net head= gross head -head loss
- Head loss occur as a result of friction in pipe.

Type of head

Low---less than 30 m

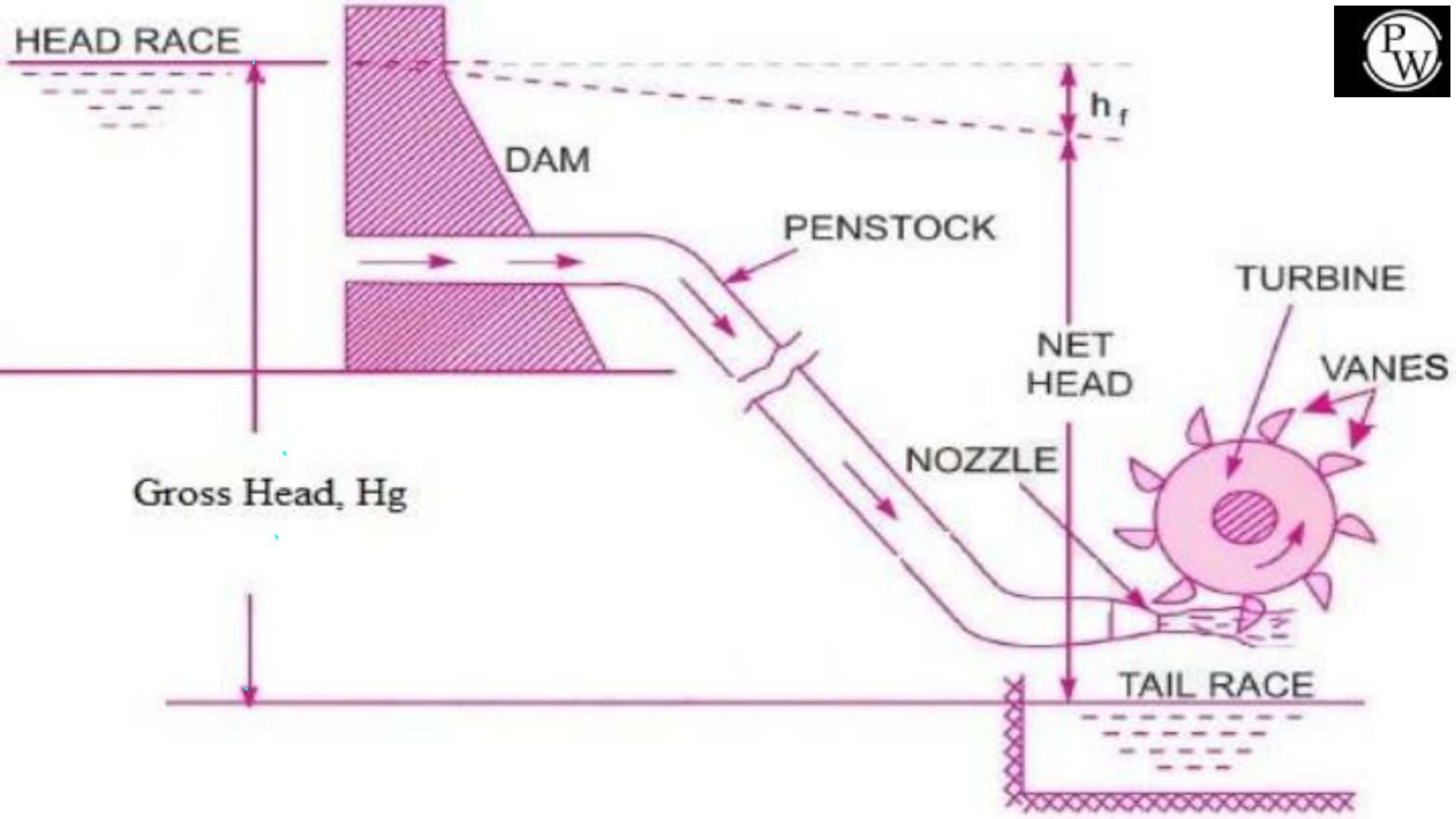
Medium---30 to 250

High head---grater than 250m

less than 15

between 15 to 70

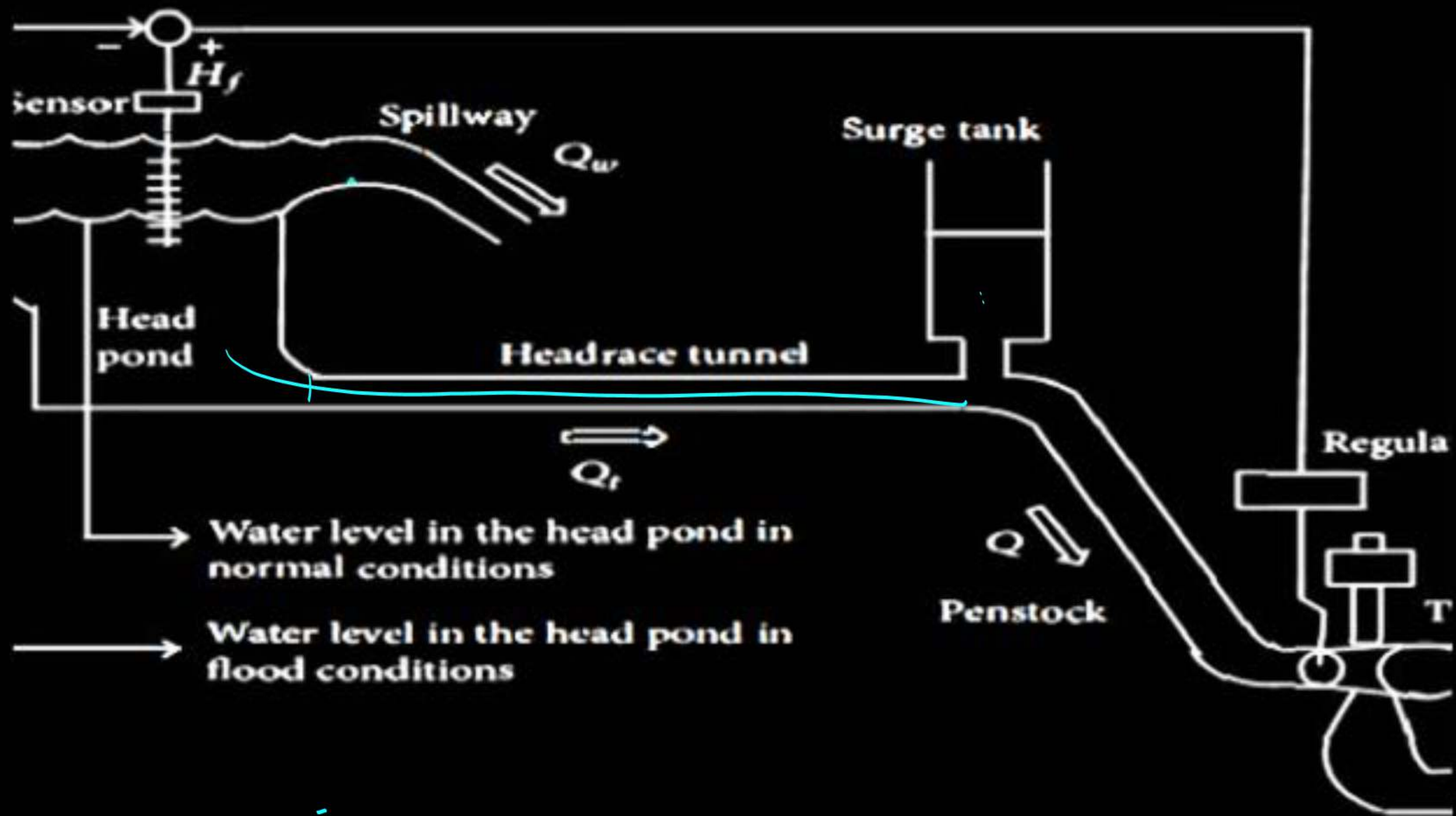
70 to 250 m





Spillway

- Spillway discharge excess water during flood without damage to dam but at the same time maintained predetermined head .
- It is like bypass tunnel or conduit.
- It act as a safety valve of plant

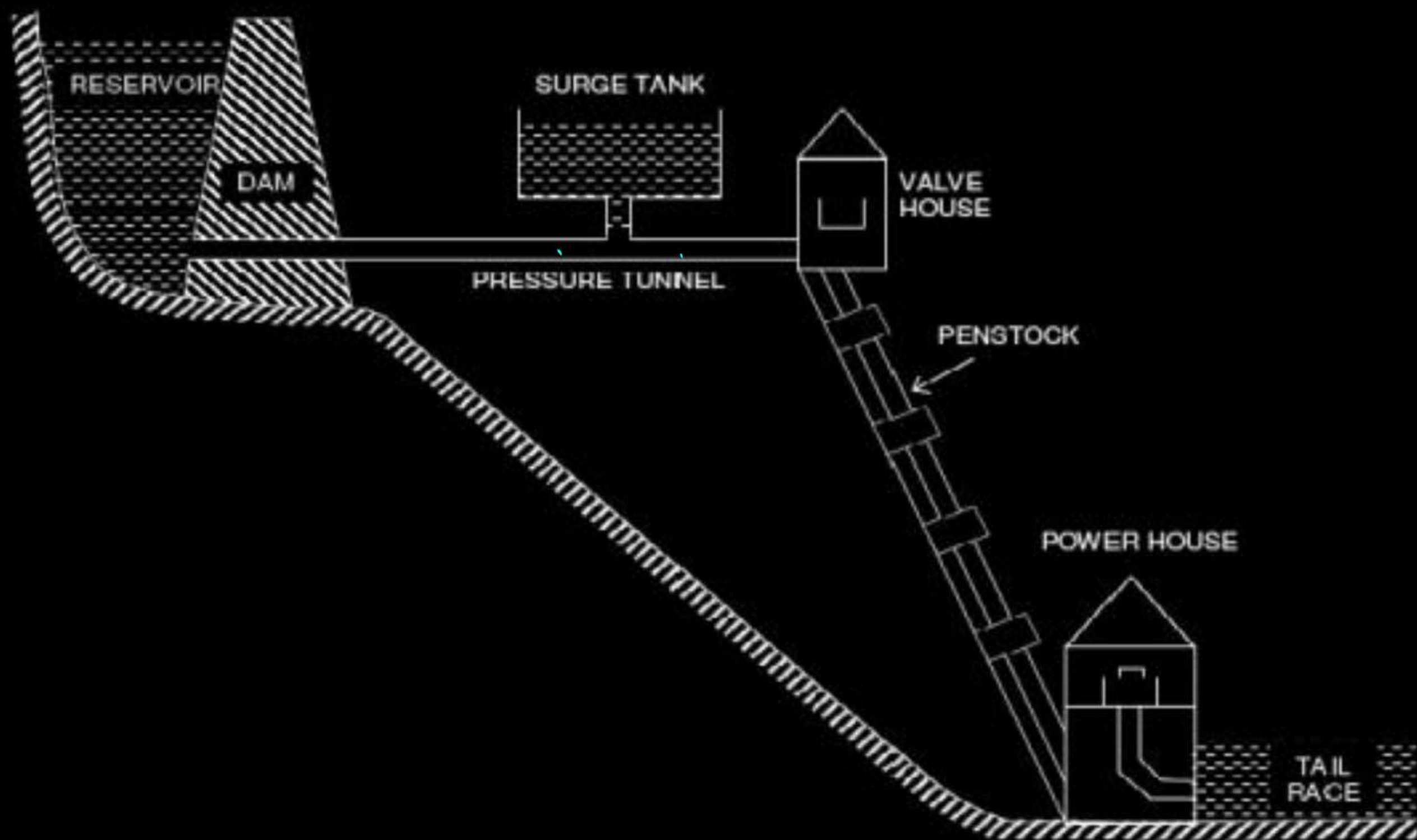




Pen stock

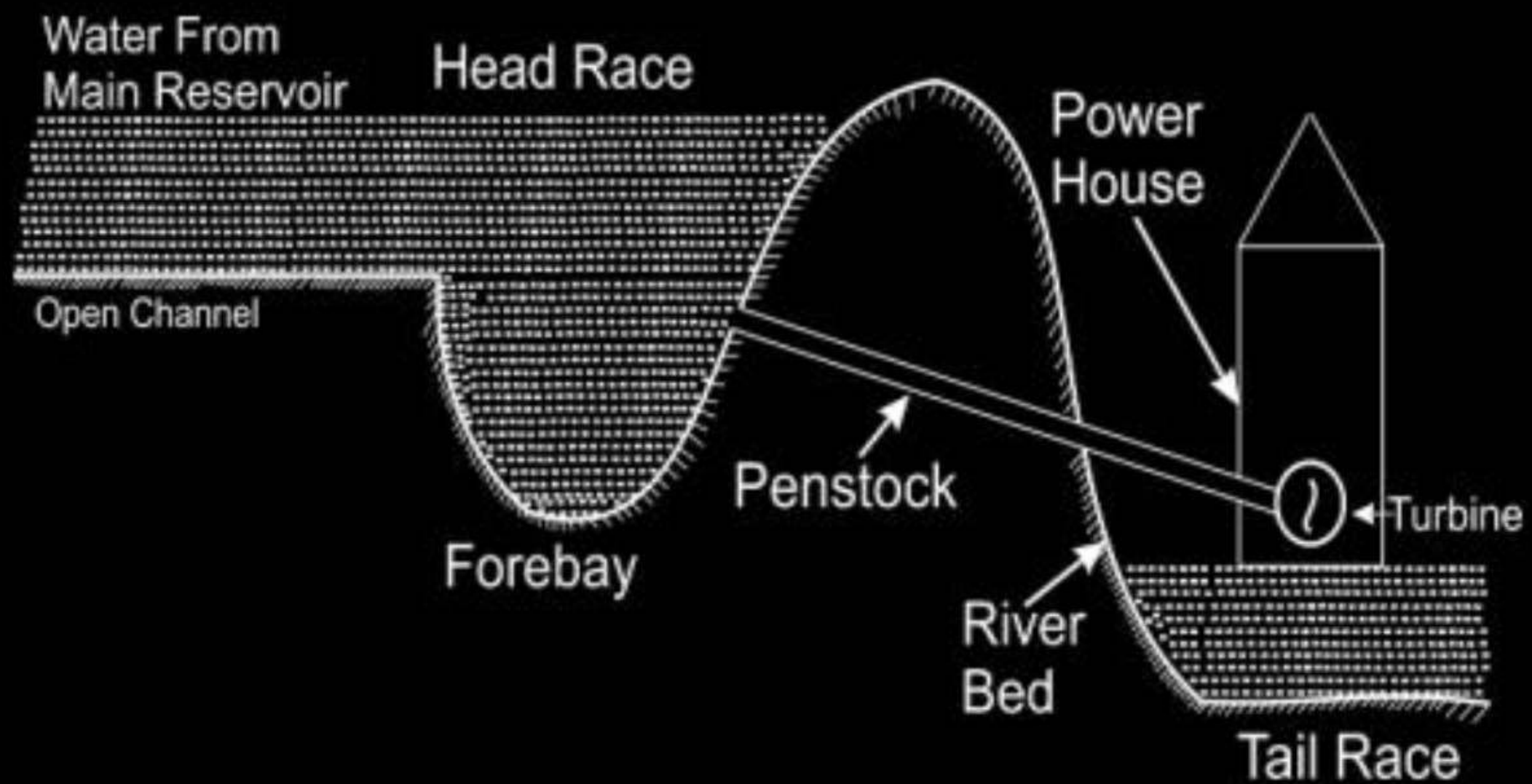
- It carries water from water storage to turbine.
- It may be low pressure or high pressure.
- Low pressure penstock may be canal or steel pipe.
- High pressure penstock consist of thick steel pipe.
- Each turbine has separate penstock.





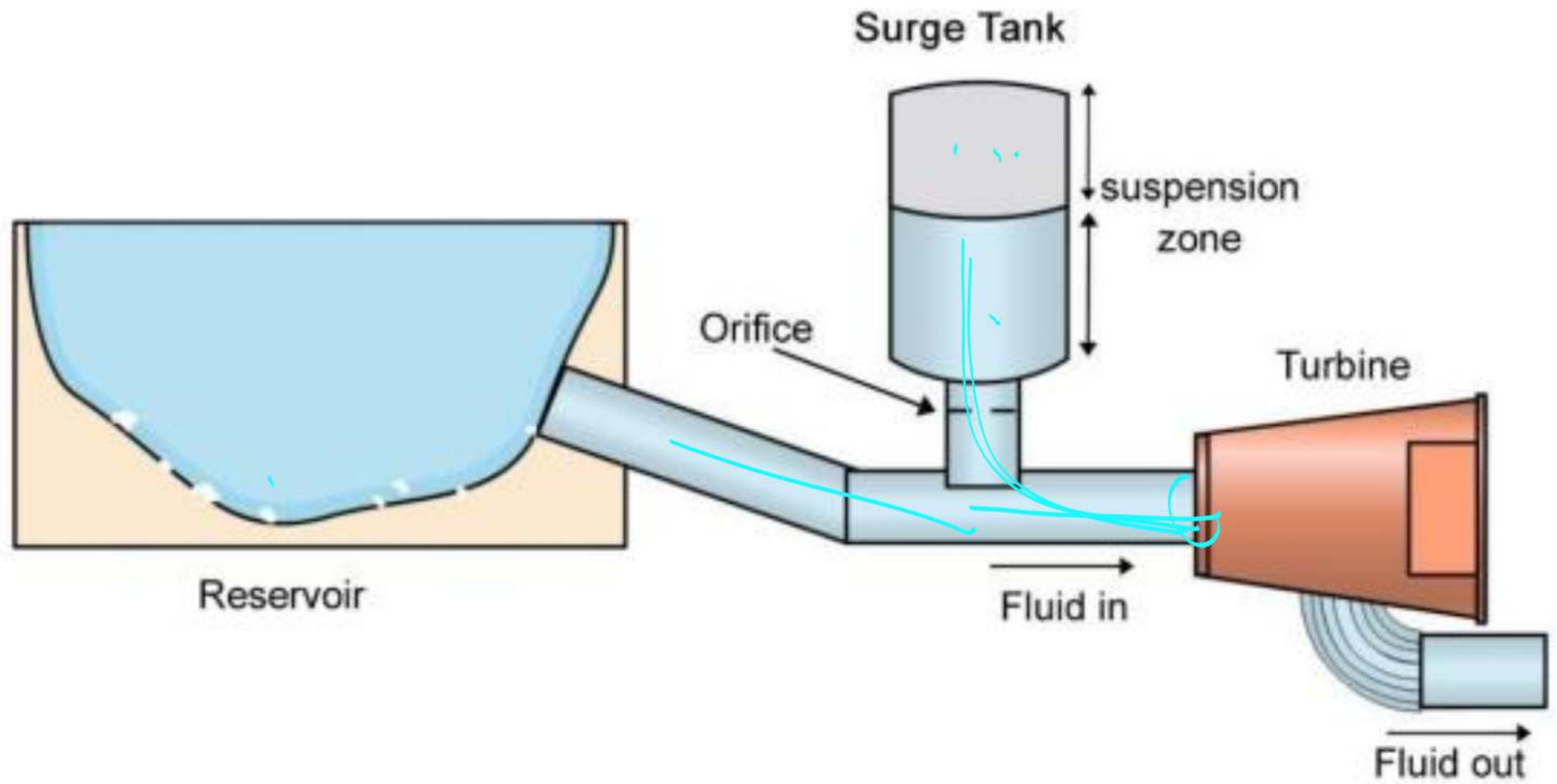
Forebay

- ~~It is the~~ enlarge body of water at the intake to store water temporarily to meet hourly load fluctuation.
- It may be enlarge section of canal or ponds.
- It is like regulating reservoir which store water under reduce load condition and provide water when load increase.
- The intake is also provided by trash rack, screen to prevent entry of debris.



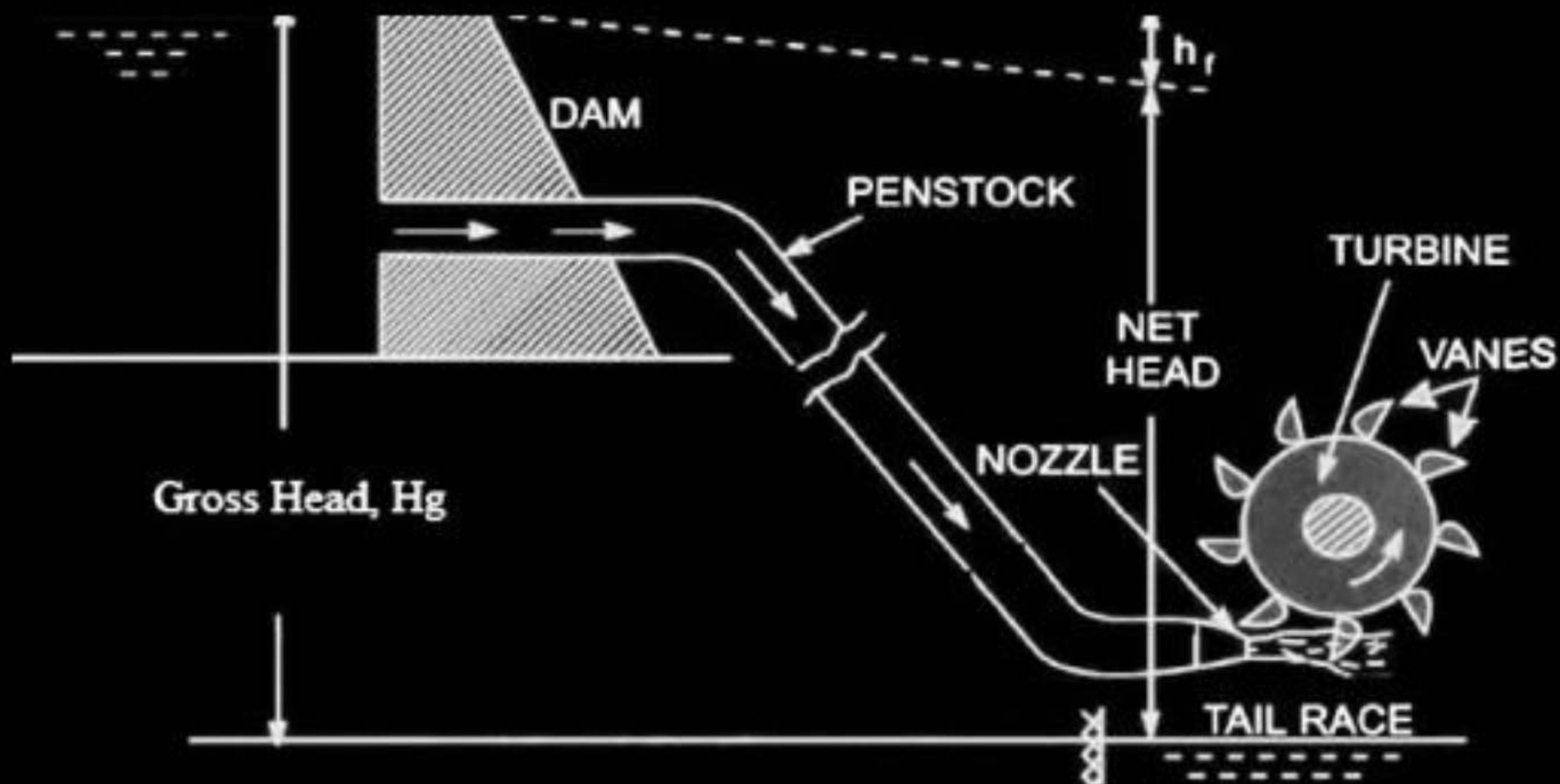
xxx Surge tank

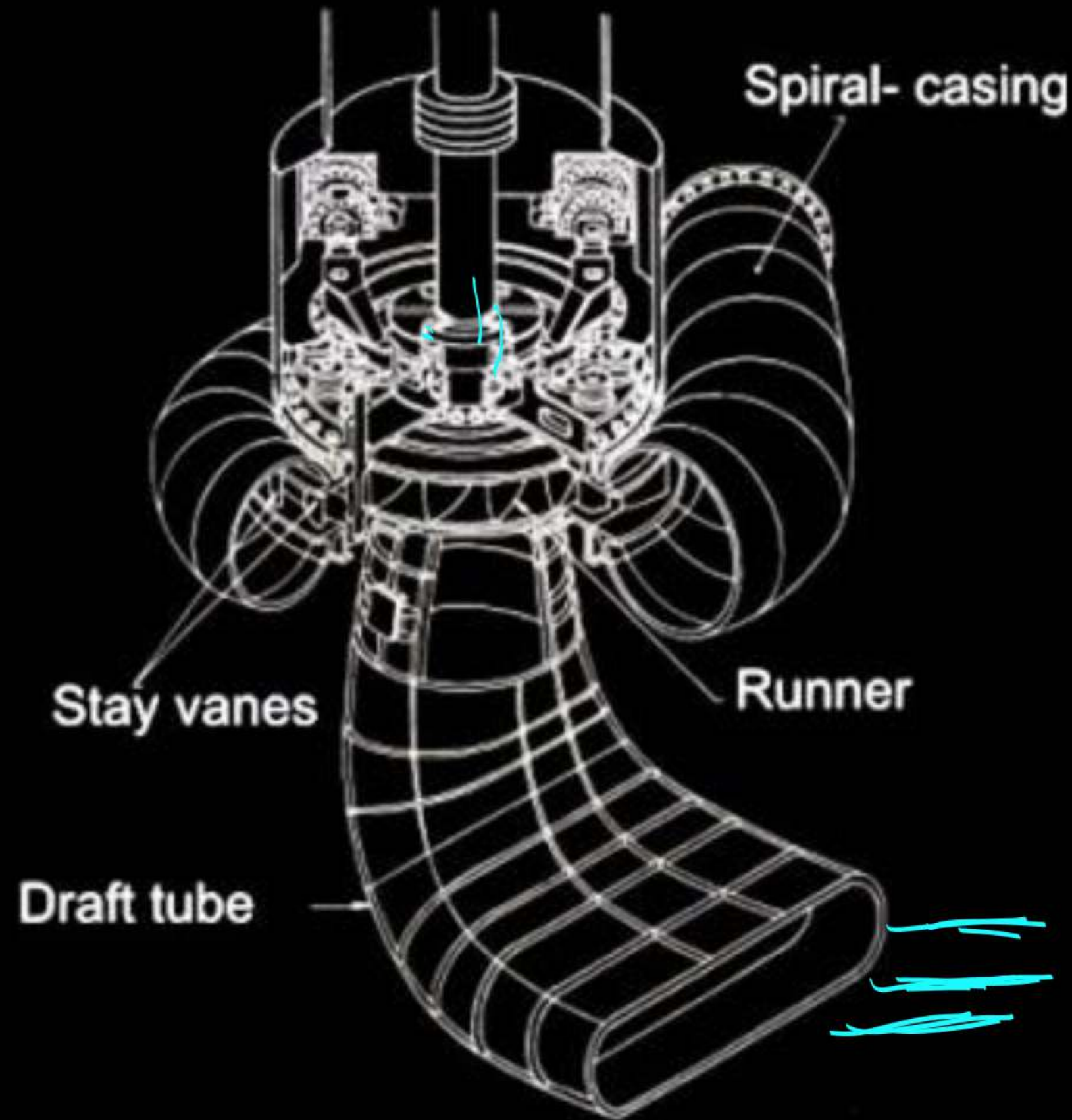
- If load decrease it cause governor to close the gate. Sudden closure of turbine gate may create the pressure in penstock. it is known as water hammering.
- Similarly the sudden opening of gate create the vacuum in penstock.
- So a surge tank is provided to absorb the sudden change the in water requirement.
- Decrease the requirement cause rise in water level in surge tank. So water velocity in penstock is reduced.
- An increase in requirement cause water to flow out of surge tank
- It is near to turbine mainly used in high head power plant.
- 22/2 A forebay can also function as a surge tank

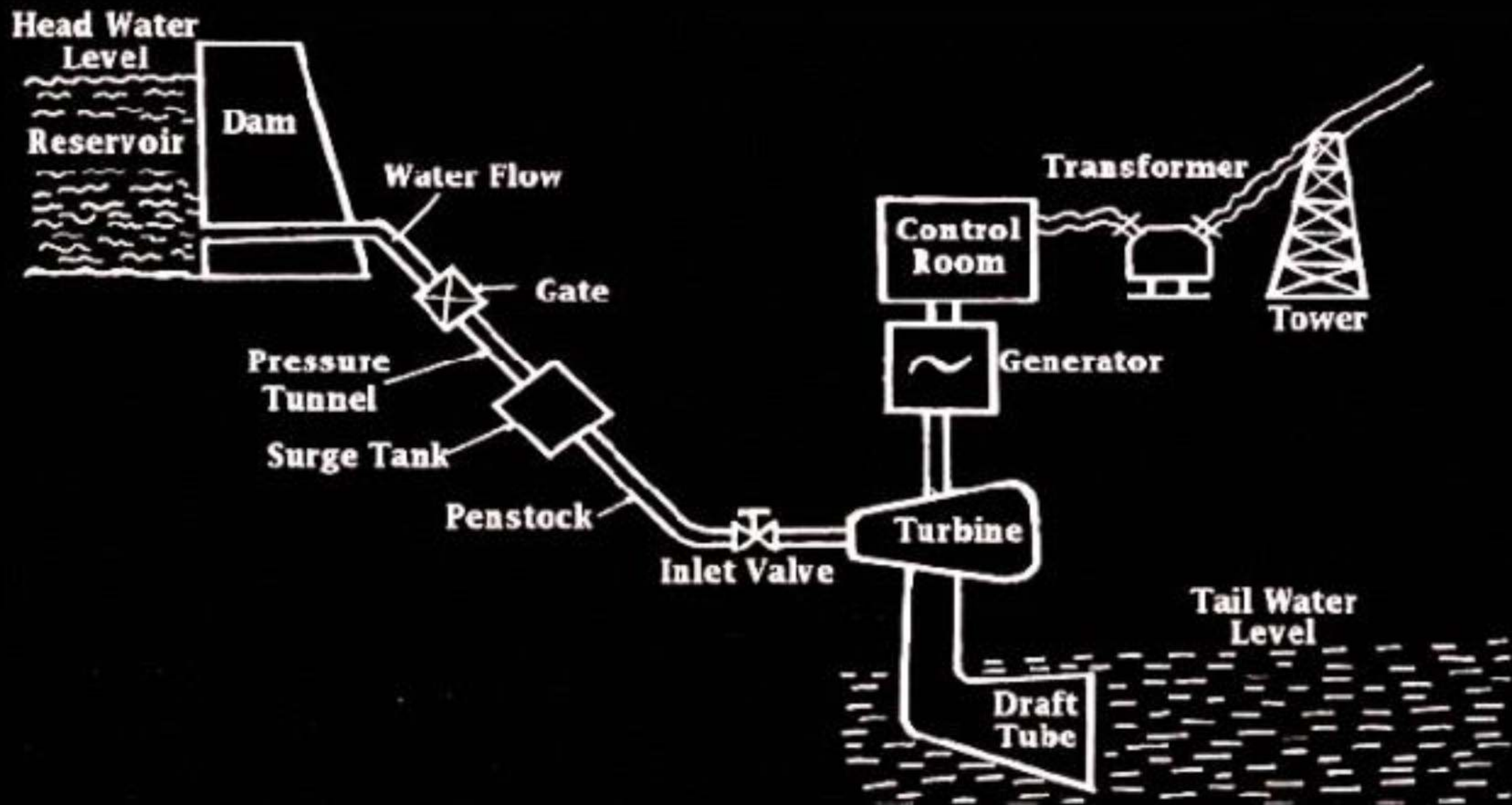


Tail Race

- A tail race is required to discharge the water, leaving turbine into river.
- Draft tube must be water sealed all the time.
- Impulse turbine do not need tail race it discharge water directly.

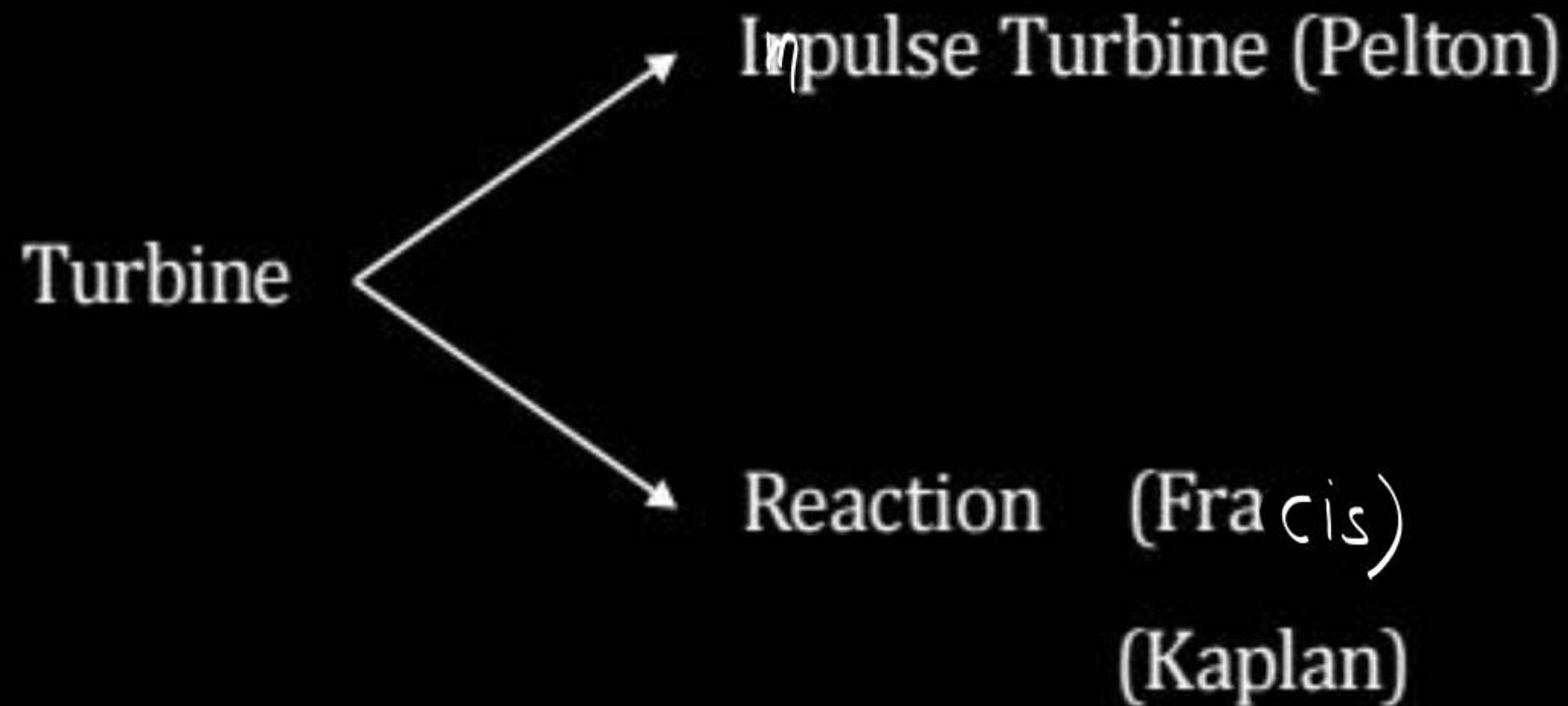






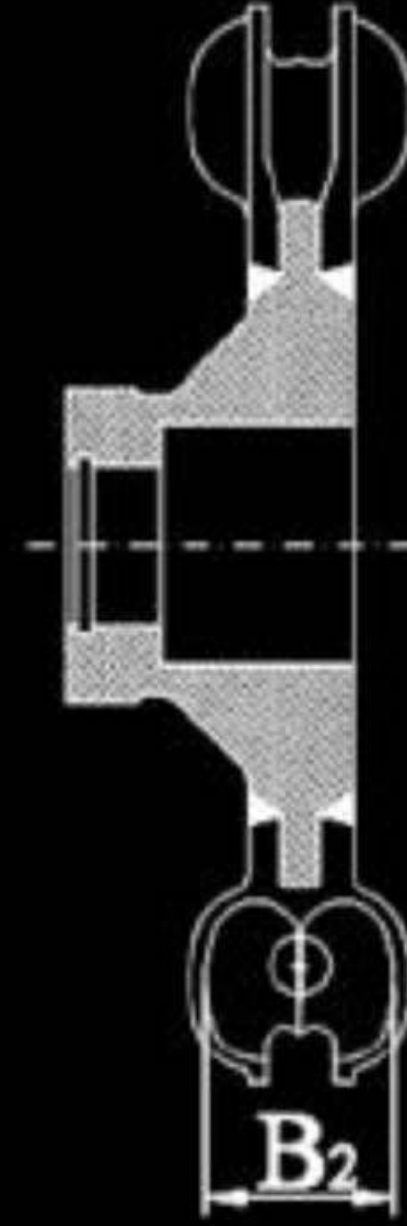
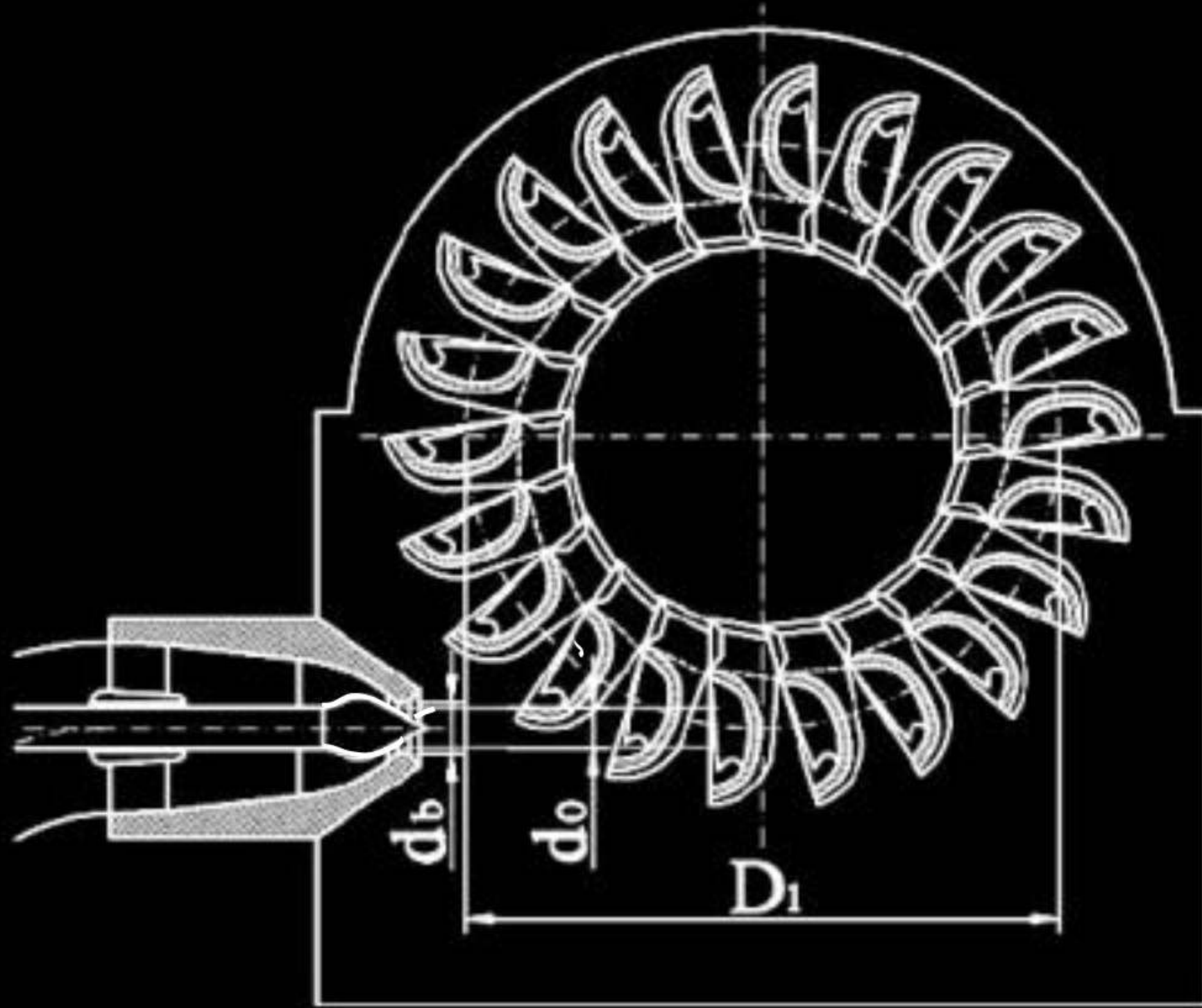
Turbine

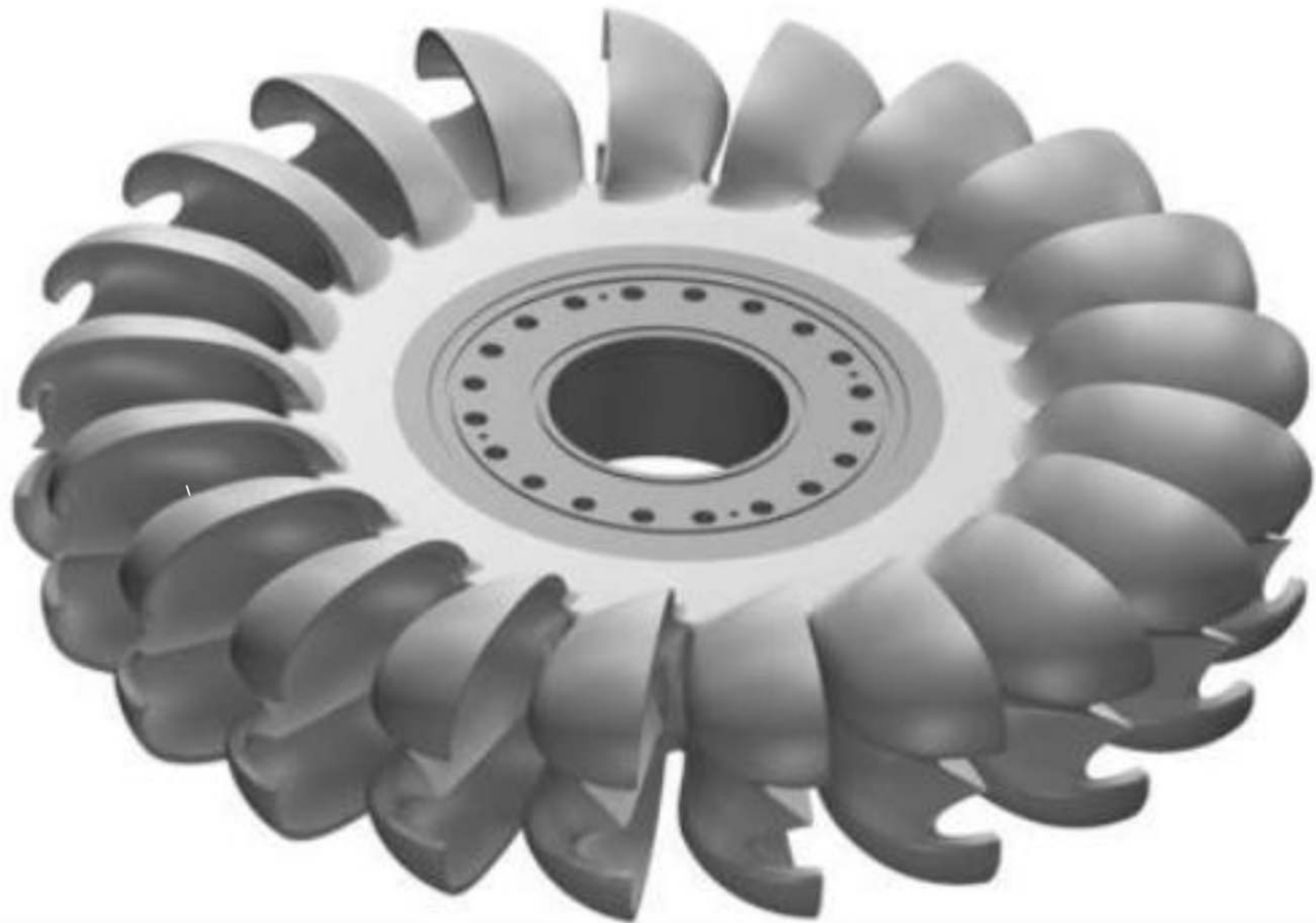
- Hydraulic turbine convert the water energy into mechanical energy
- They are very efficient (approx. 90% at F.L.)
- And pick up load at very short time .
- It rotate at low speed (300 RPM)



Pelton Turbine

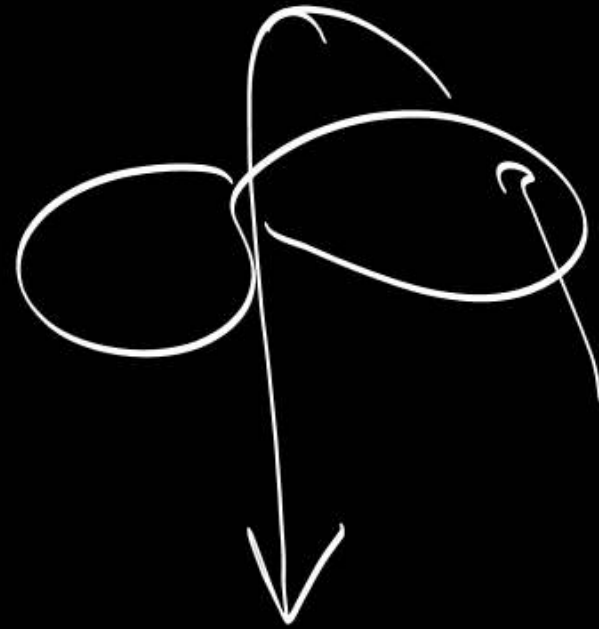
- It is mainly used in large head and low quantity of water.
- The potential energy of water is converted into kinetic energy in a jet of water from nozzle.
- Water jet impinge on bucket fixed on rotor and cause the motion.
- Each bucket is divided into two hemispherical cups with ridge in center
- The ridge divide the jet into two symmetrical part
- The spear control the rate of water flow.
- Mostly one jet is used sometime 2 -4 jet may be used.
- It is horizontal in configuration.
- Mainly used above 200 m head.
- Specific speed 10-50

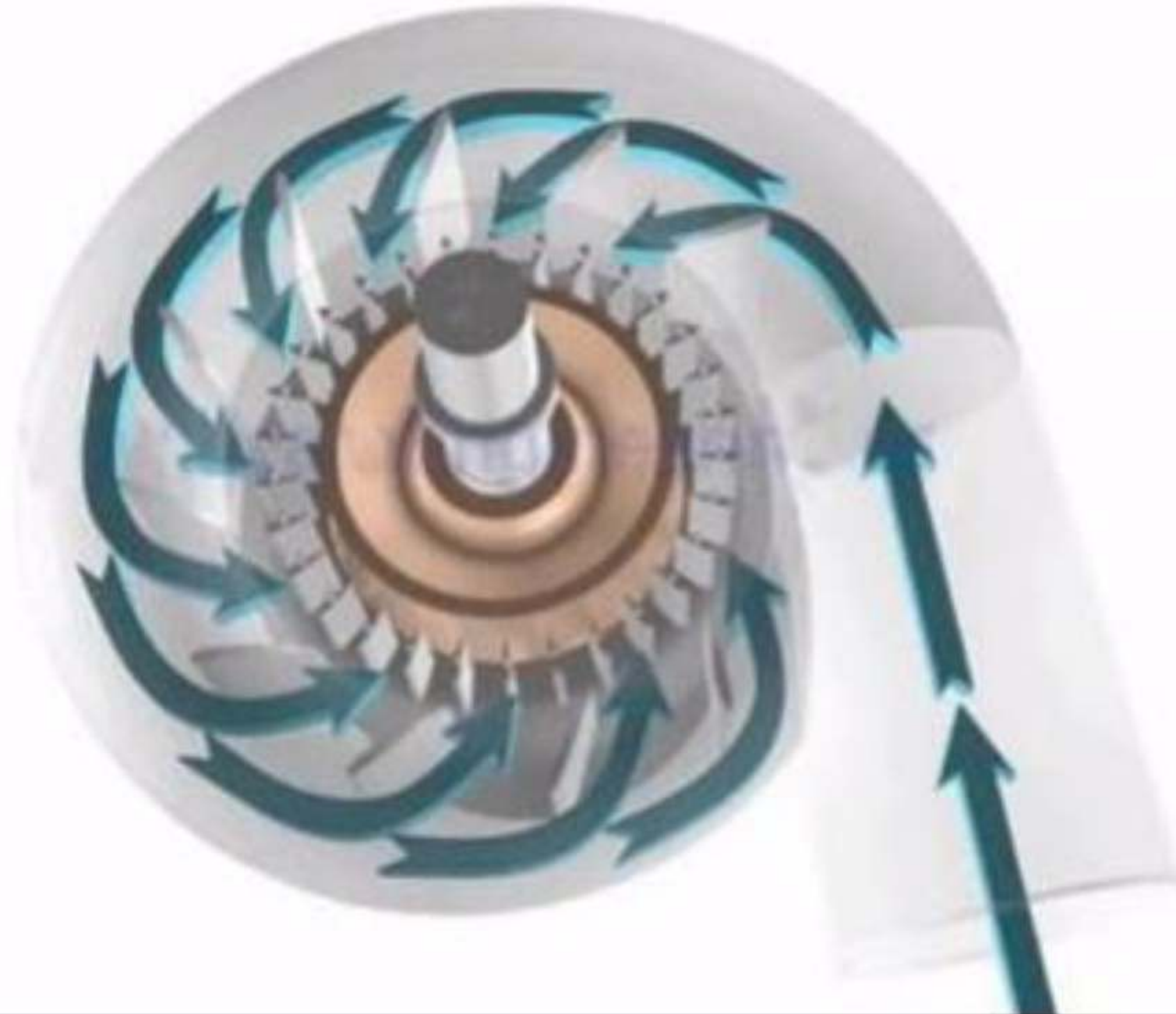




Francis Turbine (Reaction Turbine)

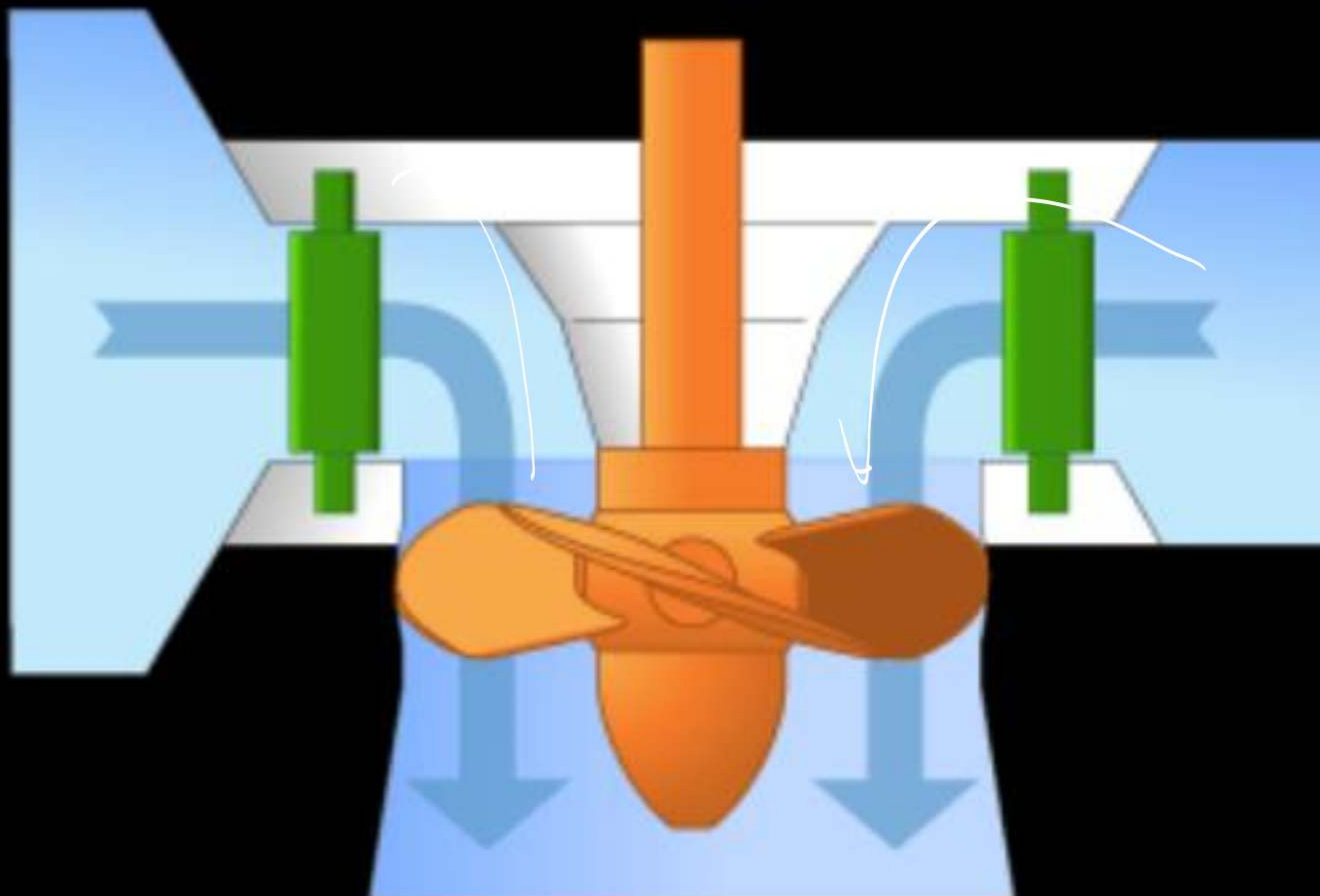
- It develop the power partially due to velocity of water and partially due to difference in pressure acting on front and back runner bucket.
- It is suitable for medium head and medium flows.
- They are vertical type.
- Water flows radially in runner and flow out of axially.
- ✓ Head---30 to 200 m
- ✓ Specific speed---60to 300
- ✓ 16 to 24 blade.

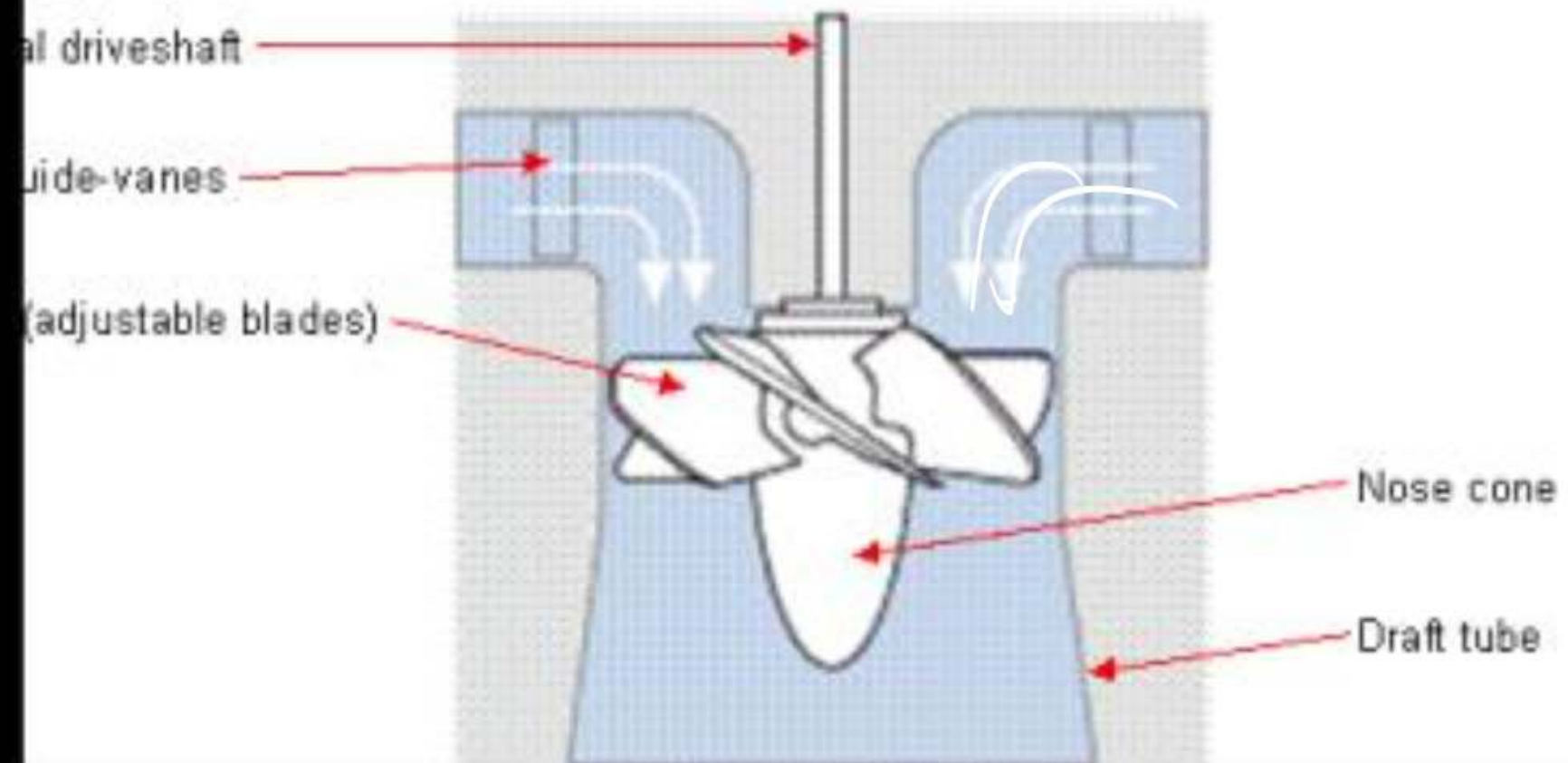




Kaplan/propeller Turbine (Reaction)

- It is suitable for low head and large quantity of water.
- Kaplan is special propeller turbine with adjustable blade so it can operate at high efficiency at all load.
- It has vertical configuration.
- In this turbine water strike the blade axially.
- It is capable of reverse operation as a pump so suited for pump storage plant.
xxx
- It has less blade than Francis turbine. (3 to 6 blade)
- Less than 30 m head ✓
- Specific speed 300-1000 ✓





Specific speed

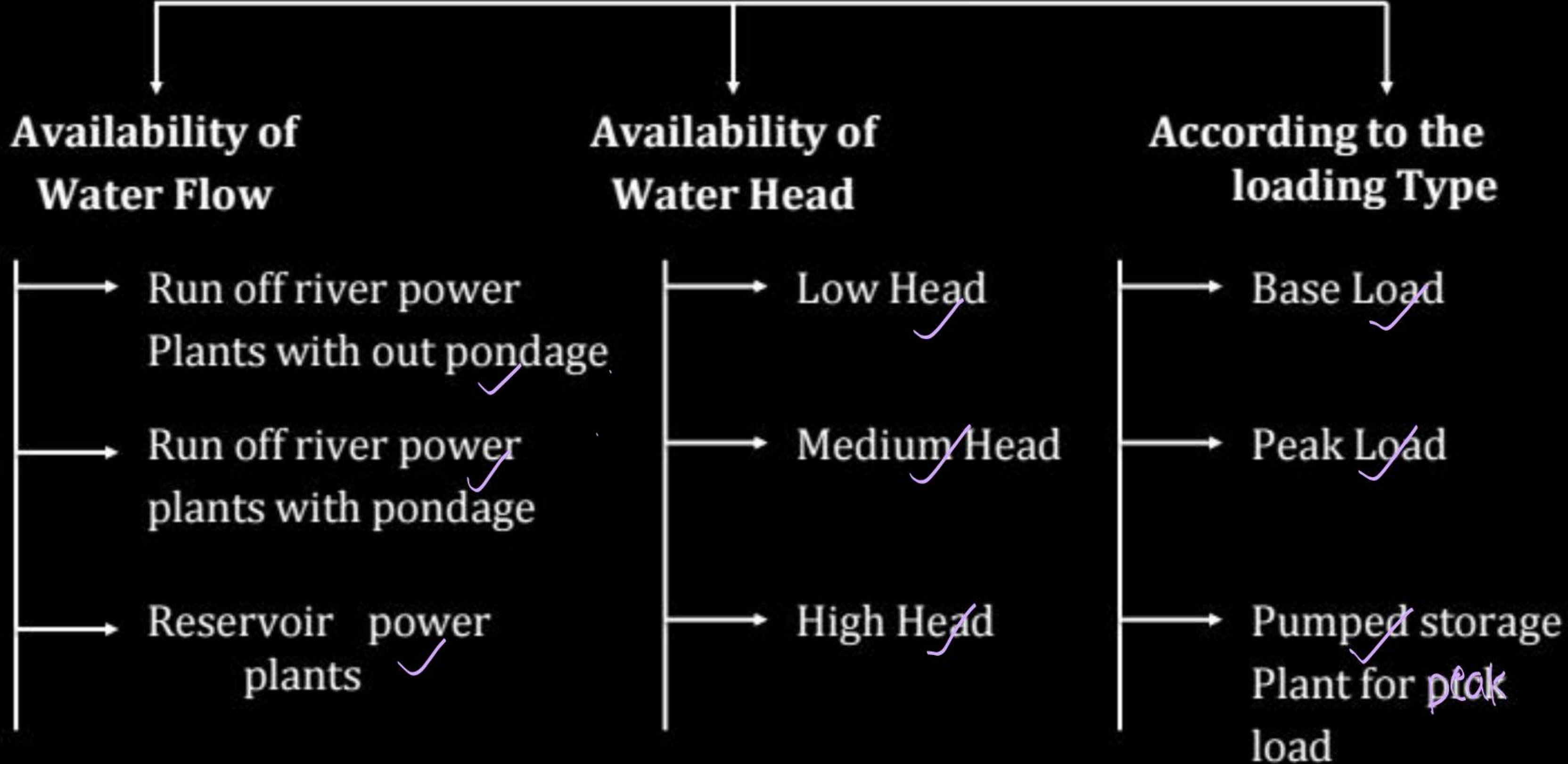
- Specific speed of a turbine is the speed of a scale model of turbine which develop 1 metric h.p under head of 1 meter.

$$N_s = \frac{N\sqrt{P}}{H^{1.25}}$$

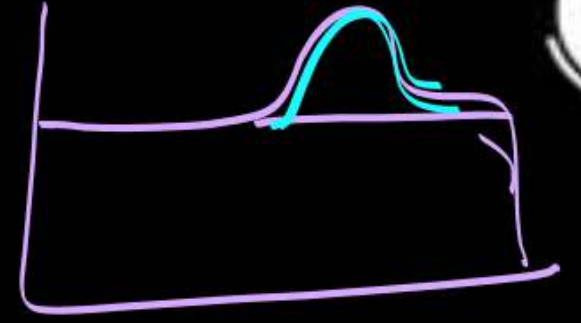
$$N_s = N$$

- N_s -specific speed ✓
- N - speed of turbine ✓
- P -output in metric h.p.
- H -effective head in meter.

Hydro-Electric Power Plant



Classification of hydro plant



According to load:

Base load plant:

- They supply at constant load and operate at high load factor.
- Run off river plant and reservoir plant is used as a base load plant.
- Per Unit cost of plant should be low.

Peak load plant:

- Run off river plant with pondage can be used during lean flow period
- Reservoir plant can also used.
- They store water during off peak period and run during peak load period.
- They operate at low load factor

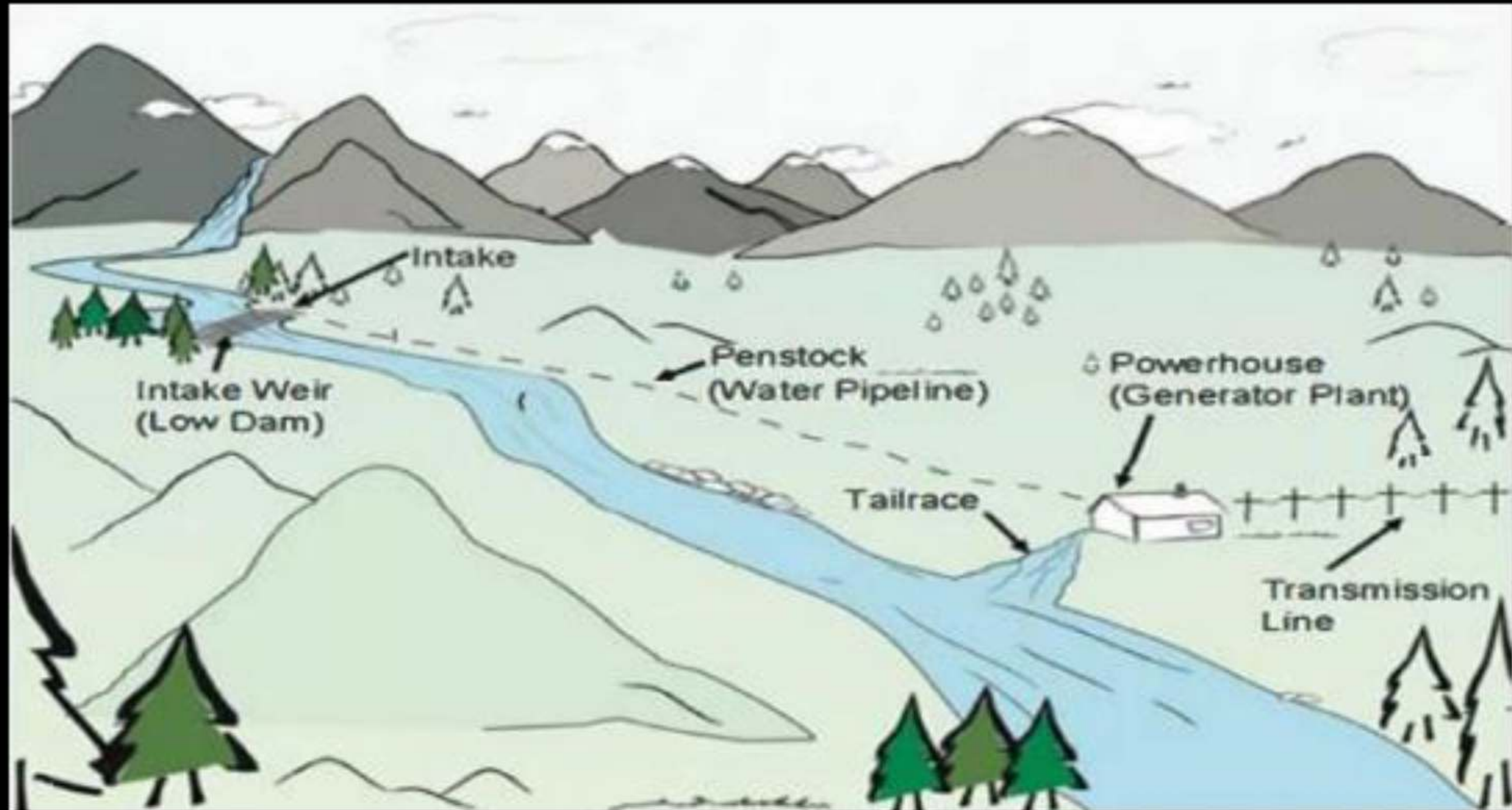
Pump storage plant:

- It is mainly used to supply peak load.

According to water flow:

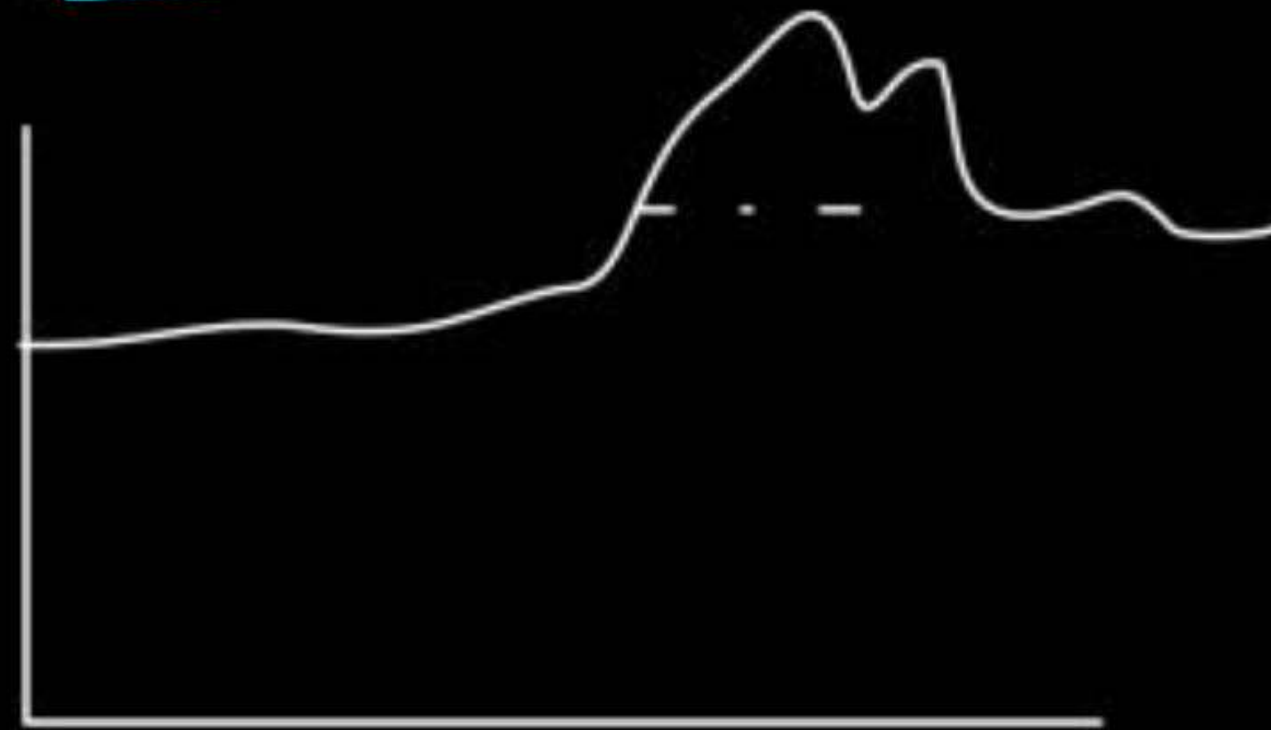
Runoff river plant without pondage:

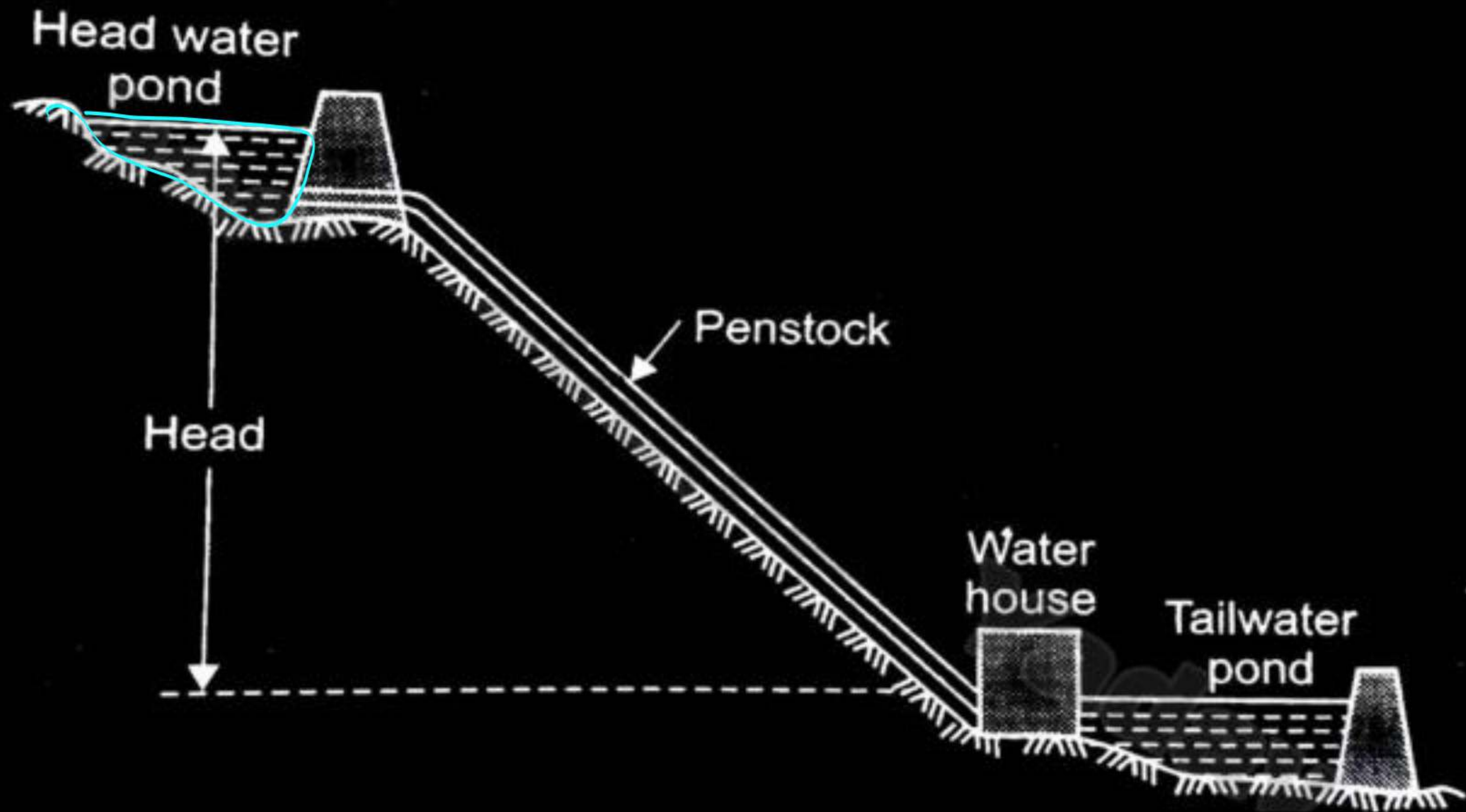
- These plant use water as it come without any storage
- It has very less firm capacity.
- Such site is mainly used for irrigation and navigation purpose
- Plant can built in low cost but generally power generated is low.
- During high flow it can be used as a base load plant.



Runoff river plant with pondage:

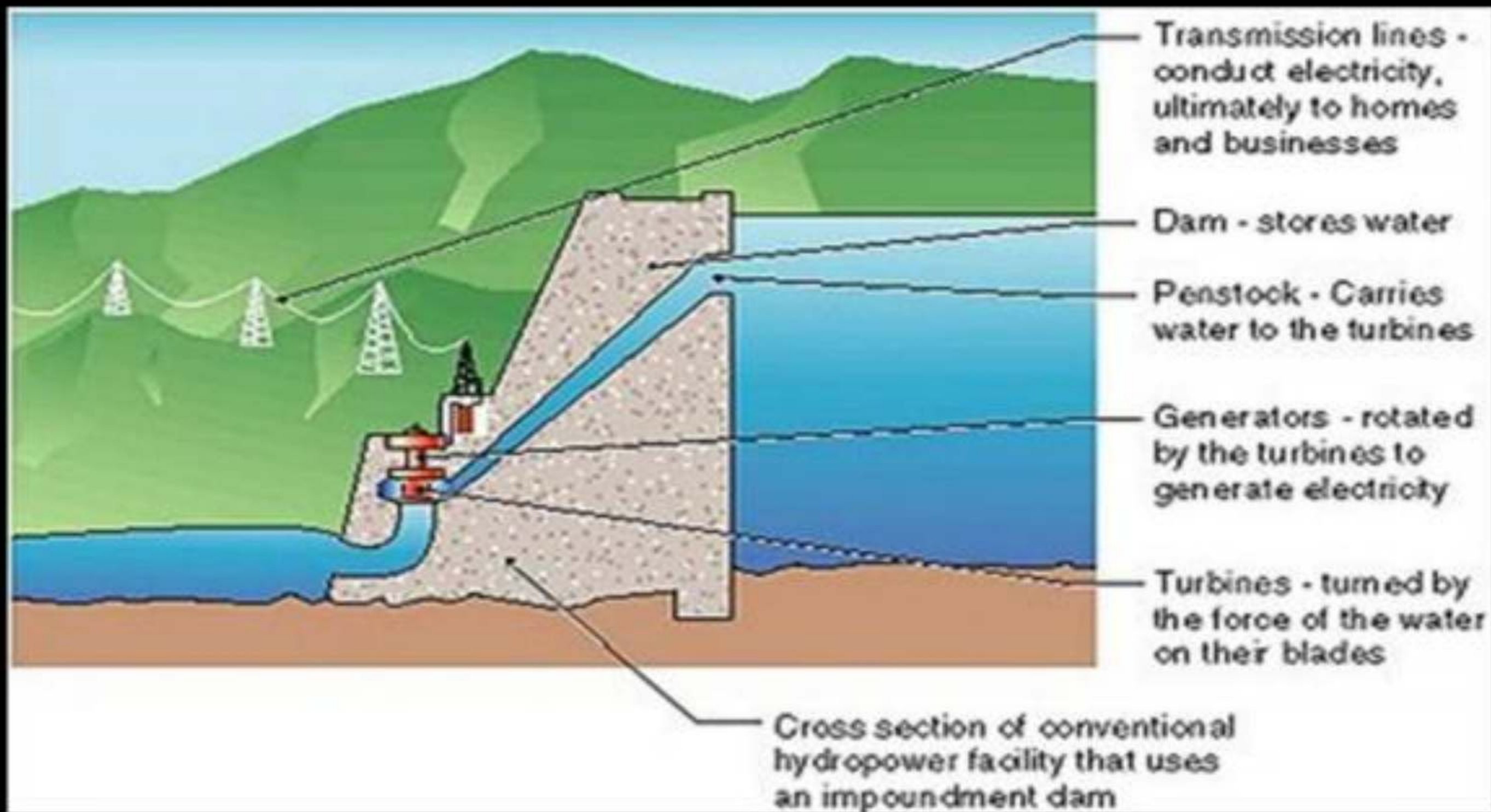
- Pondage is the storage which will take care of hourly fluctuation in load.
- Pondage increase the firm capacity.
- It can be used both as a base loads and peak load plant.
- During high stream---base load
- During low stream---peak load





Reservoir plant:

- Most of the plant in the world belong to this category.
- Water is stored in a big reservoir behind the dam. It is possible to control the water and use it most efficiently.
- This plant may be use as a base as well as peak load plant .
- It firm capacity will be high.



According to head:

Low head plant:

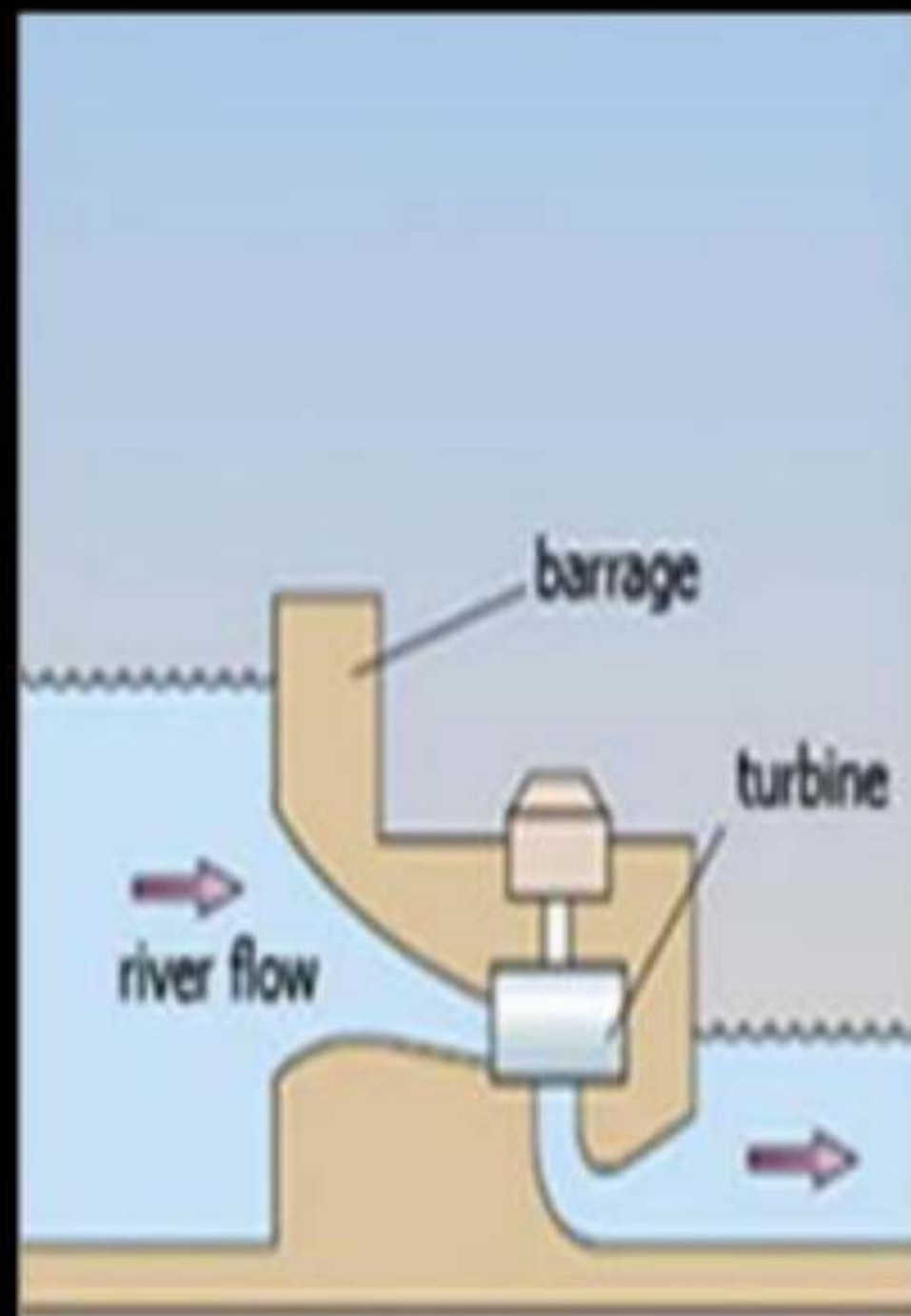
- Water head is less than 30 meter ✓
- Plant is located near the dam so no surge tank is required.
- Francis/Kaplan turbine is used

Medium head plant:

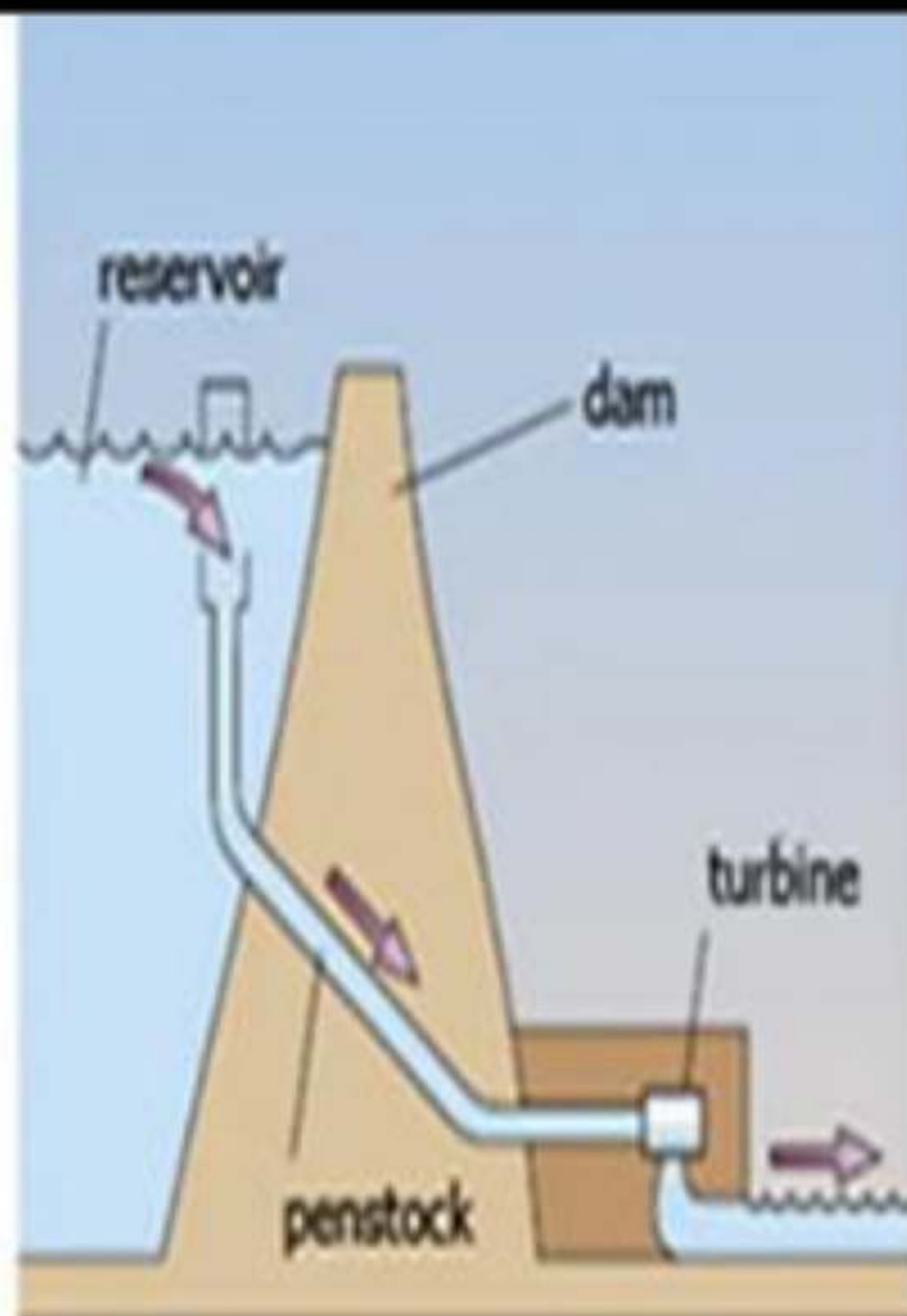
- Water head is 30-100 meter
- Open channel bring water from main reservoir to forebay from where penstock carry water to turbine.
- Francis/Kaplan turbine is used

High head plant:

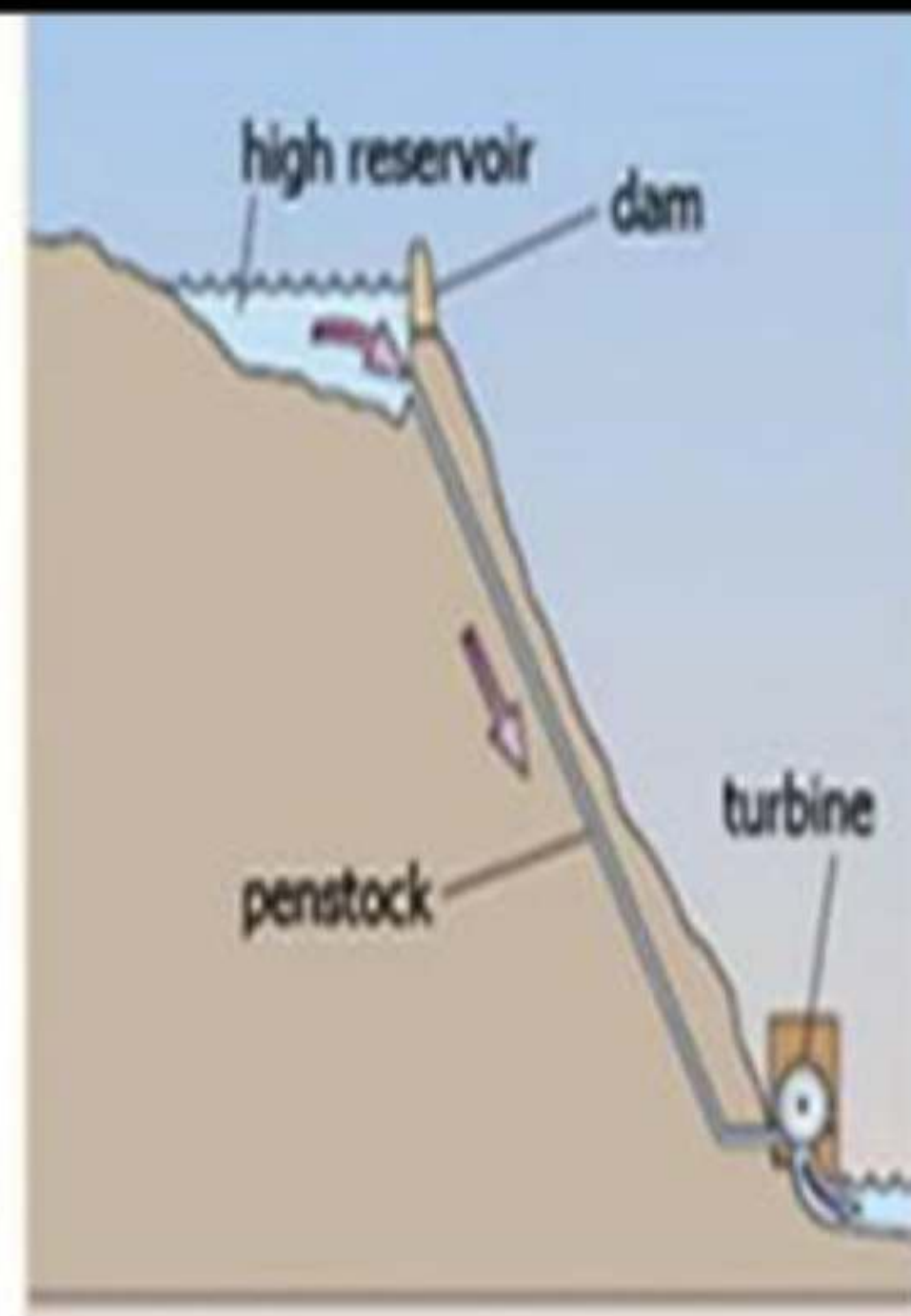
- Head above 100 m is required.
- Pelton and Francis turbine may be used.



(a) low head



(b) medium head

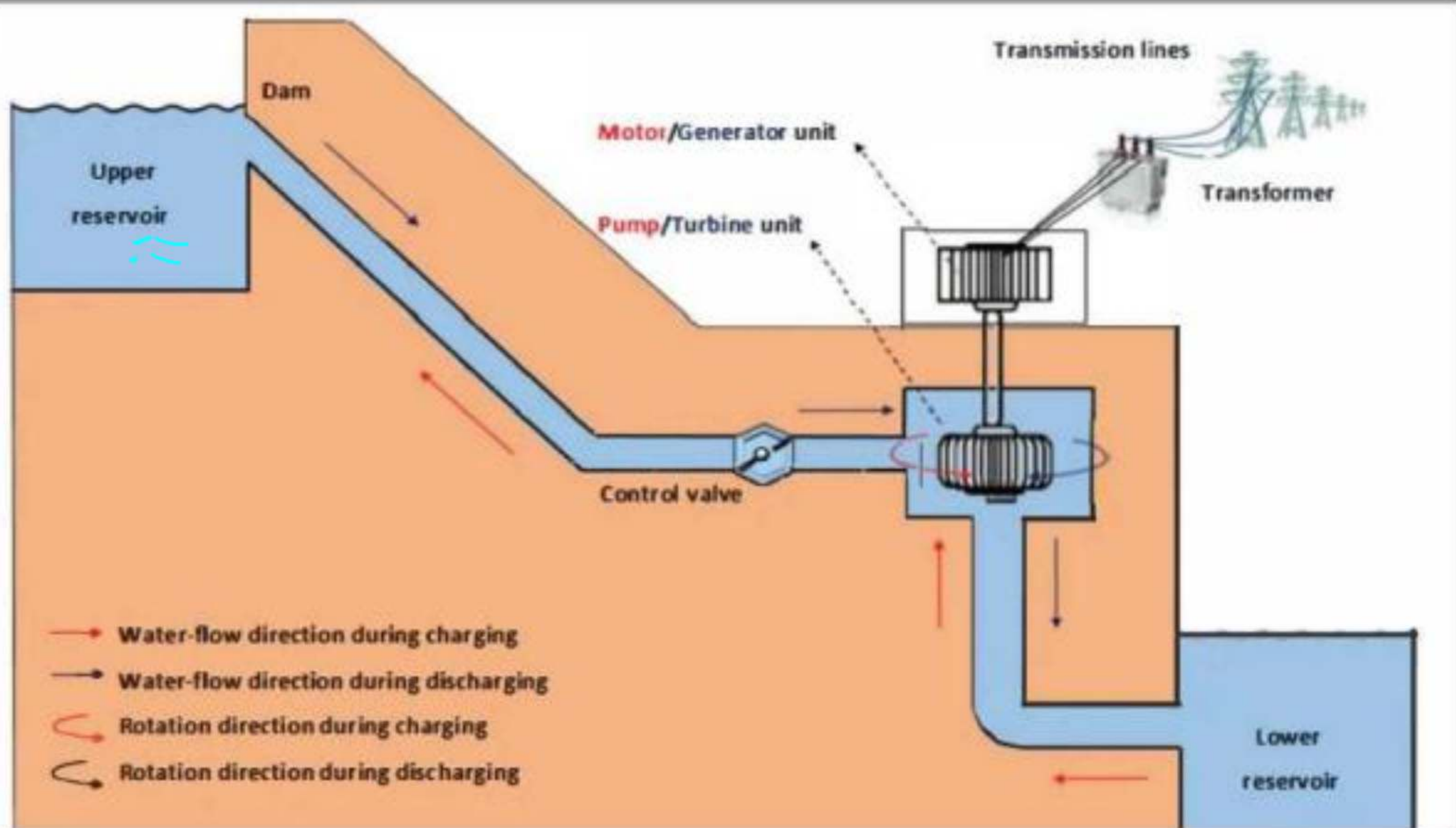


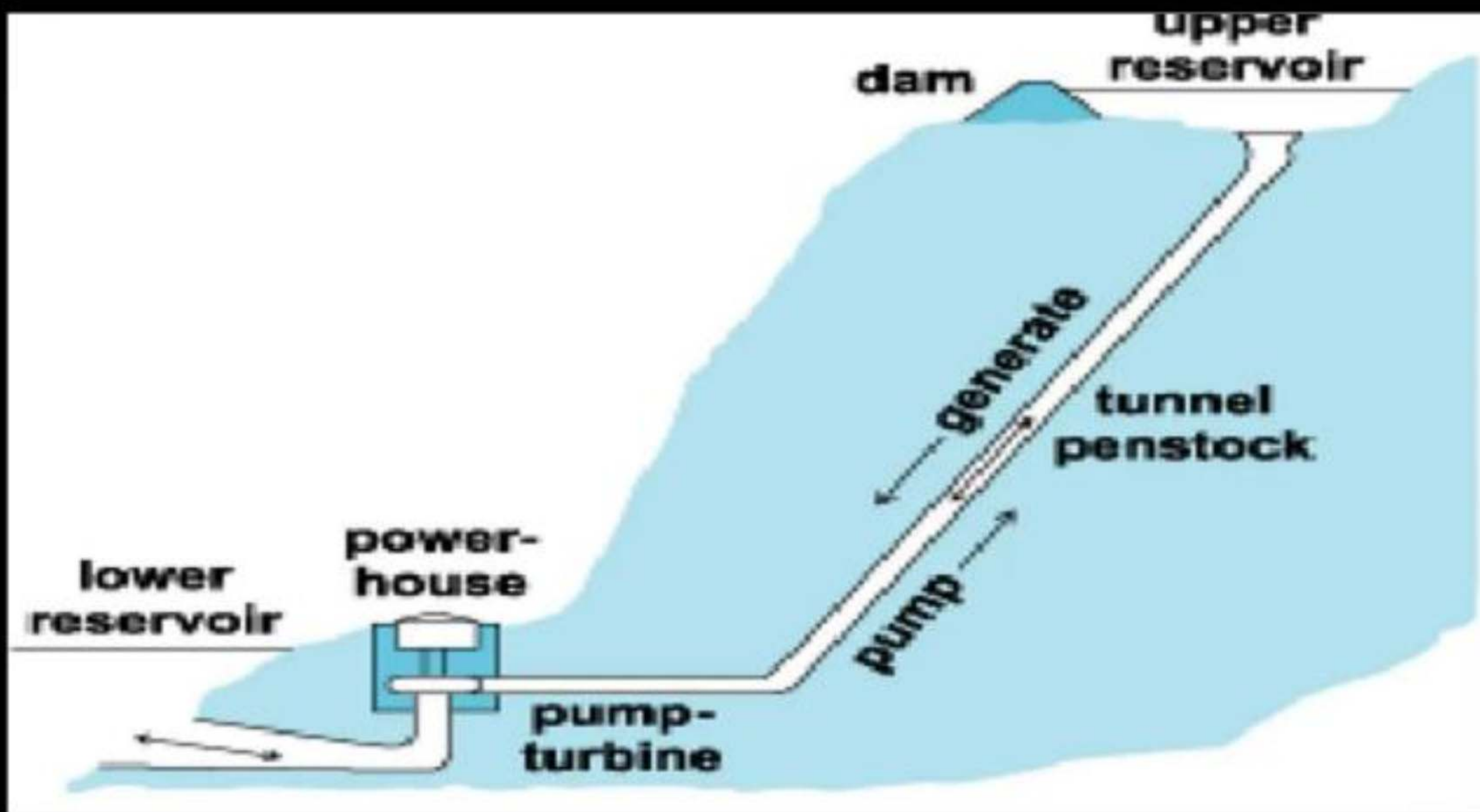
(c) high head

Pump storage power plant

- It is a special type of plant which is mainly used to supply peak load. -
- During peak load water is drawn from head water pond through penstock and generate electricity.
- During off period same water is pumped back from tail water pond to head water pond so same water is used to generate electricity.
- Generally pumping is done at night when load is low
- So firm capacity of plant is increased.
- Nowadays we use reversible turbine pump. During peak load turbine drive alternator and generate energy but at low load alternator run as a motor and drive the pump.

103
960 — 150







2 Minutes Summary

- Advantage / Disadvantage of Hydro plant
- Classification of Hydro plant
- Basic component of hydro plant.

Thank
you

Electrical Engineering



Power System



Lecture No 4

Generation of Electric Power



By- Ajay Gupta Sir



Recap of Previous class

1. Hydro power plant ✓
2. Hydrology ✓
3. Component of hydro power plant ✓
4. Types of turbine ✓
5. Classification of hydro power plant ✓
6. Pump storage power plant ✓



Topics to be Covered

1. Nuclear power plant ✓
2. Nuclear Fission ✓
3. moderator ✓
4. Multiplication factor ✓
5. Classification of reactor ✓
6. Working of reactor ✓



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NUCLEAR POWER PLANT

Factor for selecting the site:

- Transportation facilities should be available.
- The cooling water requirement of nuclear plant is very heavy. It need more than twice the water requirement for coal plant
- The land substrata must be strong to support heavy reactor.
- It should be remote from public places due to radioactivity.

Advantage :

- The amount of fuel used is small.
- Low transportation problem.
- It need less area than conventional steam plant.
- Greater nuclear power lead conservation of coal.
- It is reliable source of energy . It can be used a base load.

Disadvantage:

- The capital cost is very high. Highest
- Produce radioactive waste
- Impact on environment, uranium mining is not environment friendly.
Limited fuel supply

$$\begin{aligned}
 & \underline{\underline{2500040}} \\
 E &= mc^2 \\
 &= 1 \times 10^3 \times (3 \times 10^8)^2 \\
 &= 9 \times 10^{13} \underline{\underline{J}}
 \end{aligned}$$

Energy mass relationship:

- The mass and energy are interchangeable.
If mass is destroyed energy is produced.

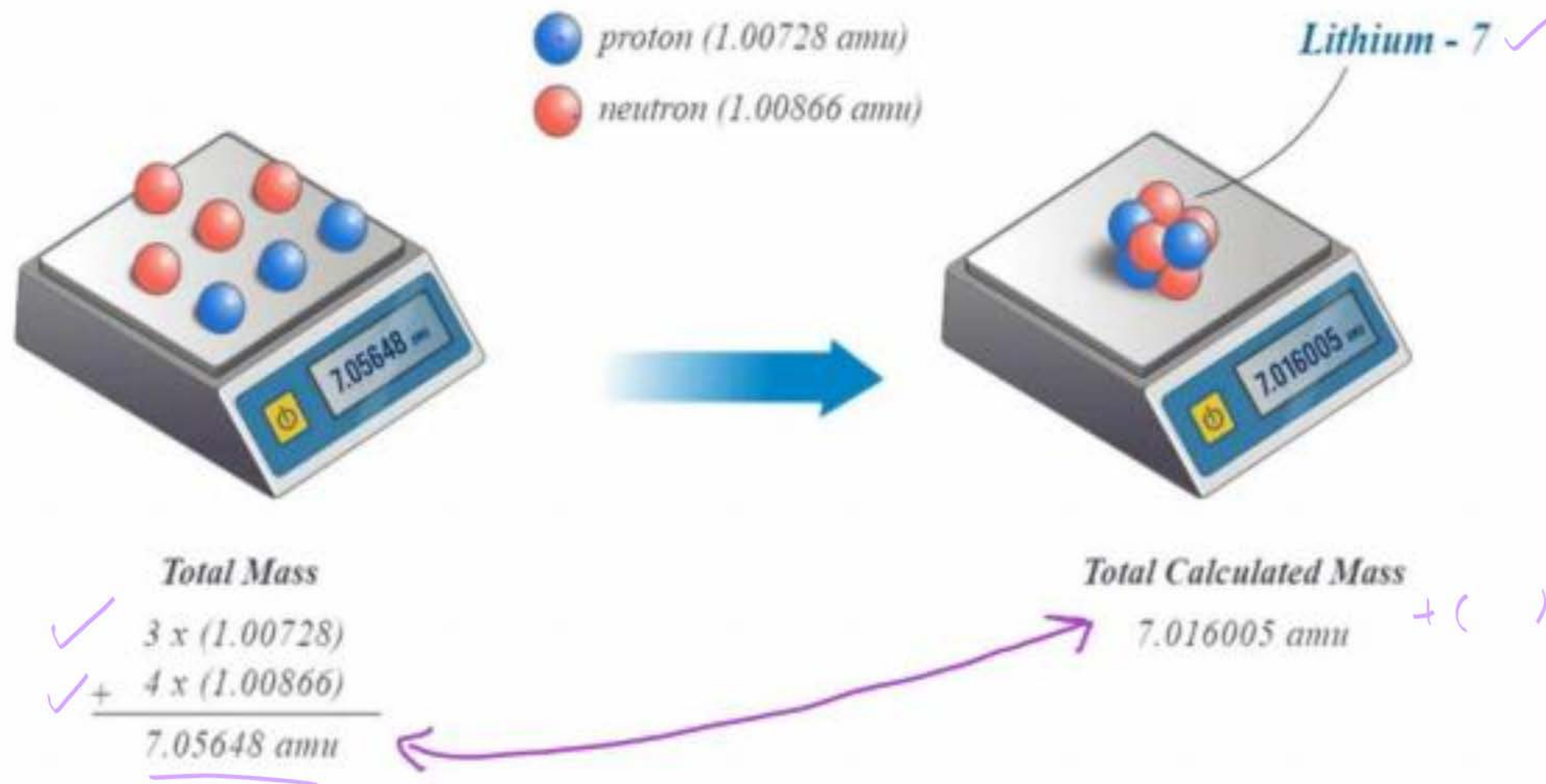
Mass defect and binding energy:

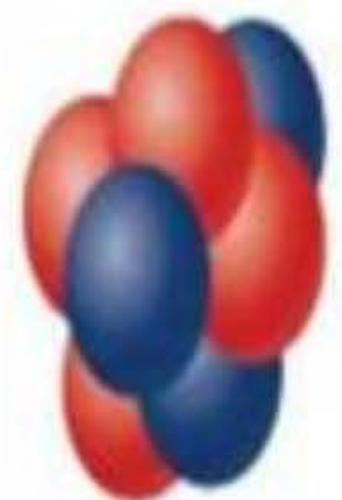
- The total mass of nucleus is always less than the sum of the masses of its constituent. This difference is called mass defect.
- The energy equivalent to mass defect is called binding energy

Mass defect and binding energy:

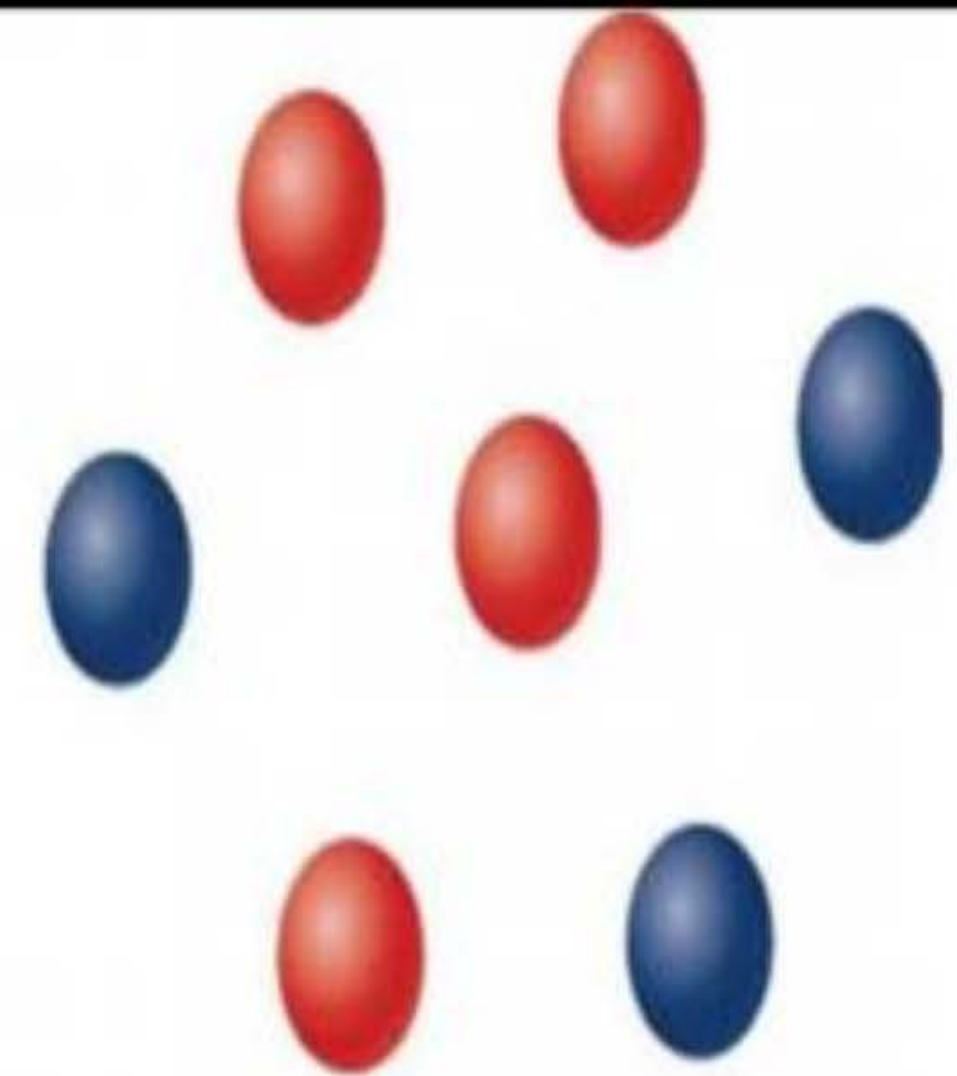
$$\begin{aligned} \text{Total No of neutron} \\ = A - Z \end{aligned}$$

- Mass defect = $Z m_p + (A - Z) m_n - \text{nuclear mass}$
 - ✓ Z = atomic number = number of proton in nucleus
 - ✓ A = Atomic mass number = Total no of proton and neutron
 - m_p = mass of proton = 1.007825 amu
 - m_n = mass of neutron = 1.008665 amu
- The energy equivalent to mass defect is called binding energy
- 1 amu of mass defect is equal to 931 Mev





+ Binding energy



Nucleus
(smaller mass)

Separated nucleons
(greater mass)

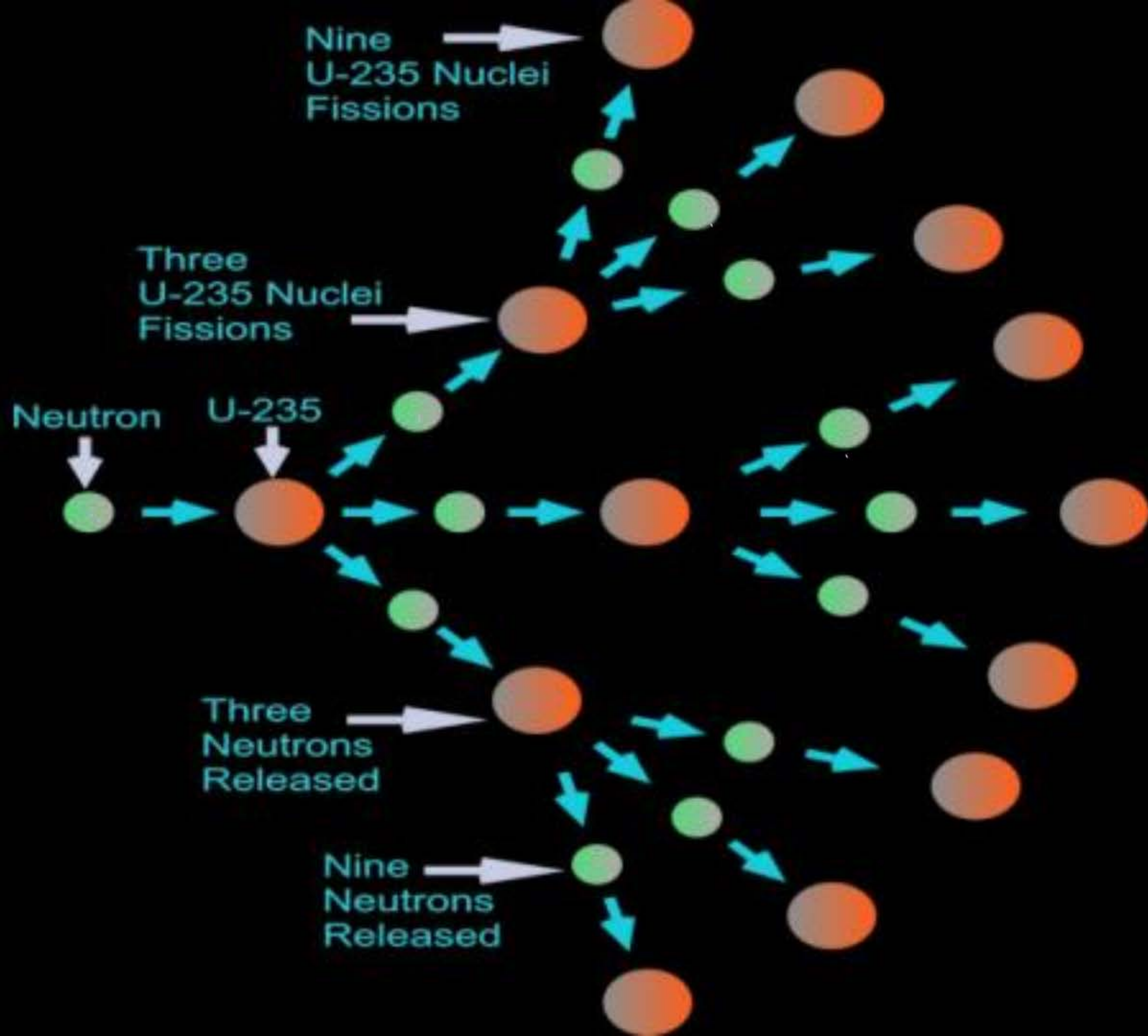
Fission:

- The fission of a heavy atoms is caused by bombarding it with neutron
- Uranium 235 + neutron = Lanthanum 148 + bromine 85 + 3 free neutron
- 1 fission of U235 create 200 MeV energy.
- Fission of 1 kg natural uranium give energy equivalent to 10500 kg of coal.

$$1 \text{ MeV} = 1.6 \times 10^{-13} \text{ J.}$$

Nuclear chain reaction:

- In fission reaction apart from releasing binding energy it also create two or more neutron.
- These neutron further fission reaction and make it as a continuous process. It is called a chain reaction.
- The neutron so produced is a fast neutron having velocity of 1.5×10^7 m/sec it can create fission with U233, U235 but natural uranium U238 absorb these fast neutron. If proportion of U235 is increased to 10% the chain reaction is possible such reactor is called fast reactor
- So it is common practice to slow down this neutron so it can be used with natural uranium such reactor is called thermal reactor

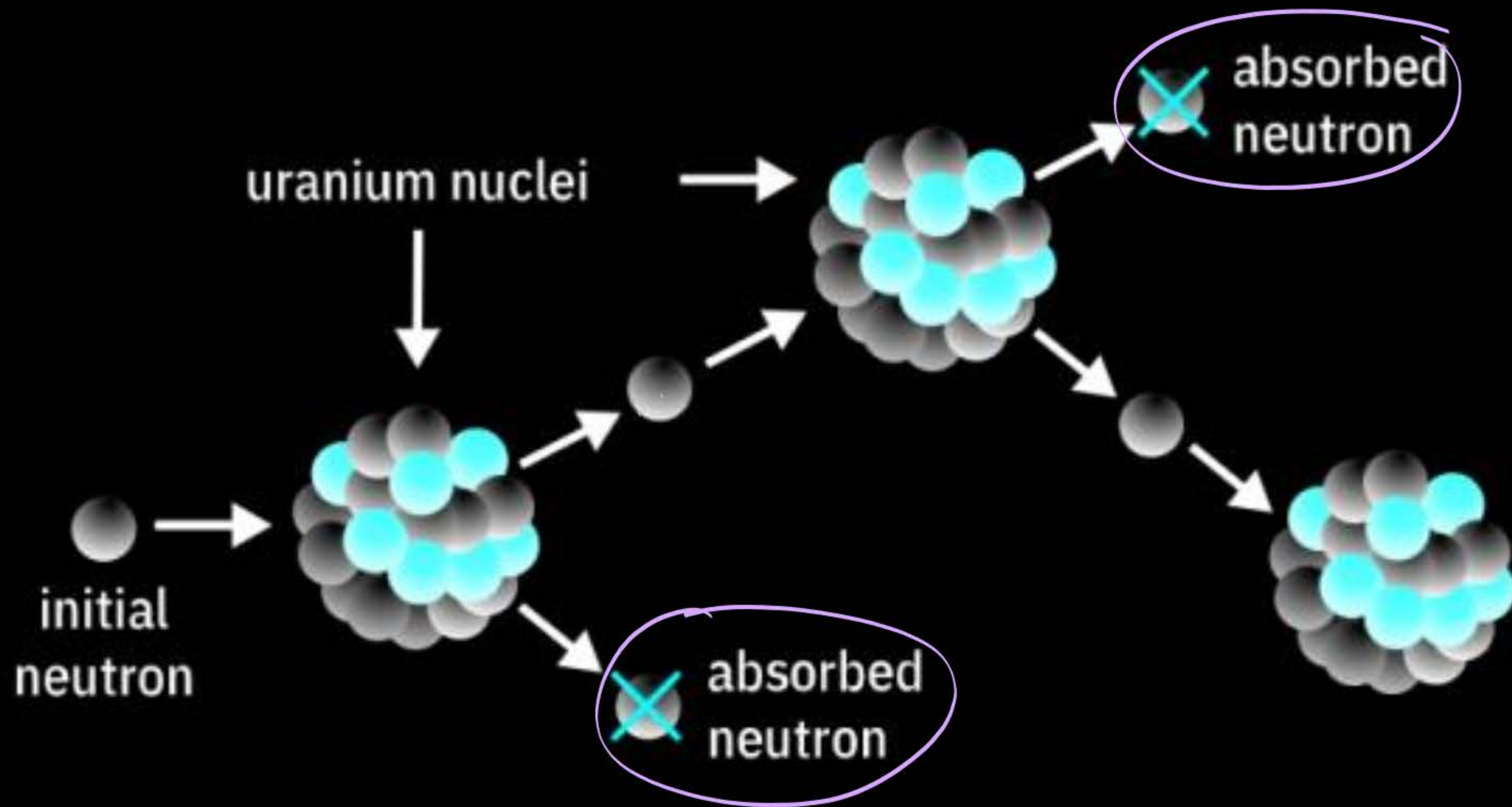


Multiplication factor :

- A chain reaction is possible if at least one neutron is created.

$$\text{Multiplication Factor (K)} = \frac{\text{number of neutron produced in any reaction}}{\text{number of neutron in preceding generation}} = \frac{3}{1}$$

- if $k < 1$ the fission will decrease. ✓
- If $k > 1$ the fission increase so nuclear explosion may occur. ✓
- So k should be $= 1$
- To overcome loss due to leakage k should be kept slightly greater than 1 (around 1.04)



Types of material

Fissile material:

- Fissile material is the material which can be split by neutron in a self sustaining chain reaction
- ✓ U-235 .
- ✓ U-233
- ✓ Pu-239

Fertile material

- A material which is not fissile but can be converted into fissile material by irradiation in reactor

1. U238 ✓
2. Th-232 ✓

When they absorb the electron they are converted into fissile pu239 and U23.

Nuclear Reactor

- A nuclear reactor produces and controls the release of energy from splitting the atoms of elements such as uranium and plutonium.
- In a nuclear power reactor, the energy released from continuous fission of the atoms in the fuel as heat
- This is used to make steam. The steam is used to drive the turbines which produce electricity (as in most fossil fuel plants)
- Several component is used in reactor

1. Fuel:

- Usually pellets of uranium oxide (UO_2) arranged in tubes to form fuel rods. The rods are arranged into fuel assemblies in the reactor core

2. Moderator:

- This is material which slows down the neutrons released from fission so that they cause more fission.
- The fast neutron collide with the nucleus of moderator and loose their energy.so they get slowed down.
- It is usually water, but may be heavy water or graphite.
- It should not react with neutron
- It should be cheap
- It should be chemically inert.

3. Control rod:

- It help to keep the multiplication factor to unity. $K = 1$
- These are made with neutron-absorbing material such as cadmium, hafnium or boron.
- They are generally alloyed with steel and made into control rod.
- When it is inserted in reactor it absorb the neutron it reduce the reaction.
- When withdrawn from the core the rate of reaction is increased.

It may be 3 types

1. Shutoff rod
2. Regulation rod
3. Coarse rod

4. Coolant :

- A liquid or gas circulating through the core so as to transfer the heat from it.
- In light water reactors the moderator functions also as coolant.

Classification of reactor

On the Basis of Neutron Energy :

(a) Fast Reactor:

- In these reactors, fission is effected by fast neutrons without any use of moderators.

(b) Thermal Reactors:

- In these reactors, fission is effected by fast neutrons are slowed down with the use of moderators. The slow neutrons are absorbed by the fissionable fuel and chain reaction is maintained.

Based on Fuel Used

(a) Natural Fuel:

- In this reactor, natural Uranium is used as fuel and generally heavy water or graphite is used as moderator.

(b) Enriched Uranium:

- In this reactor, the Uranium used contains 5 to 10% U235 and ordinary water can be used as moderator.

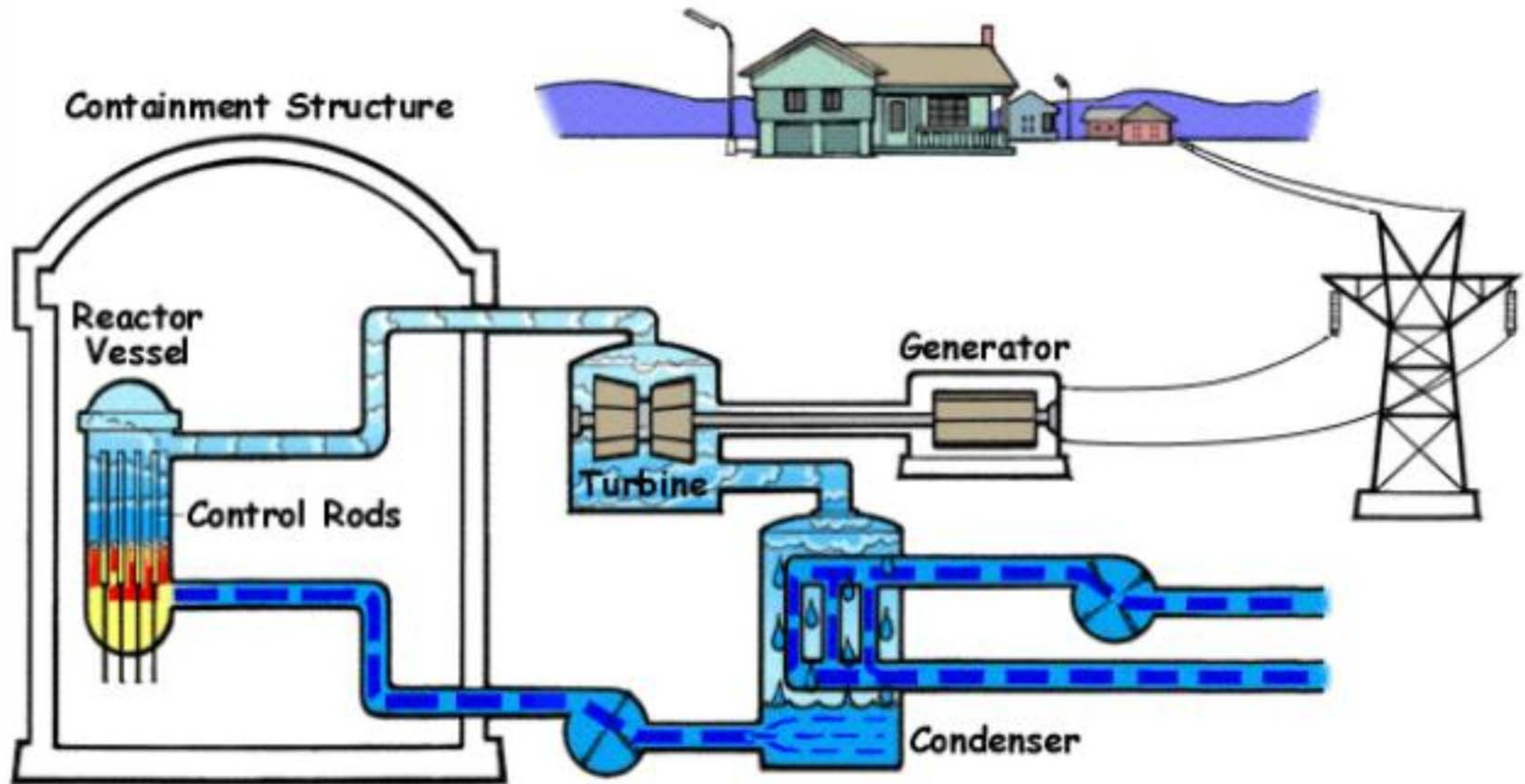
Based on Moderator Used

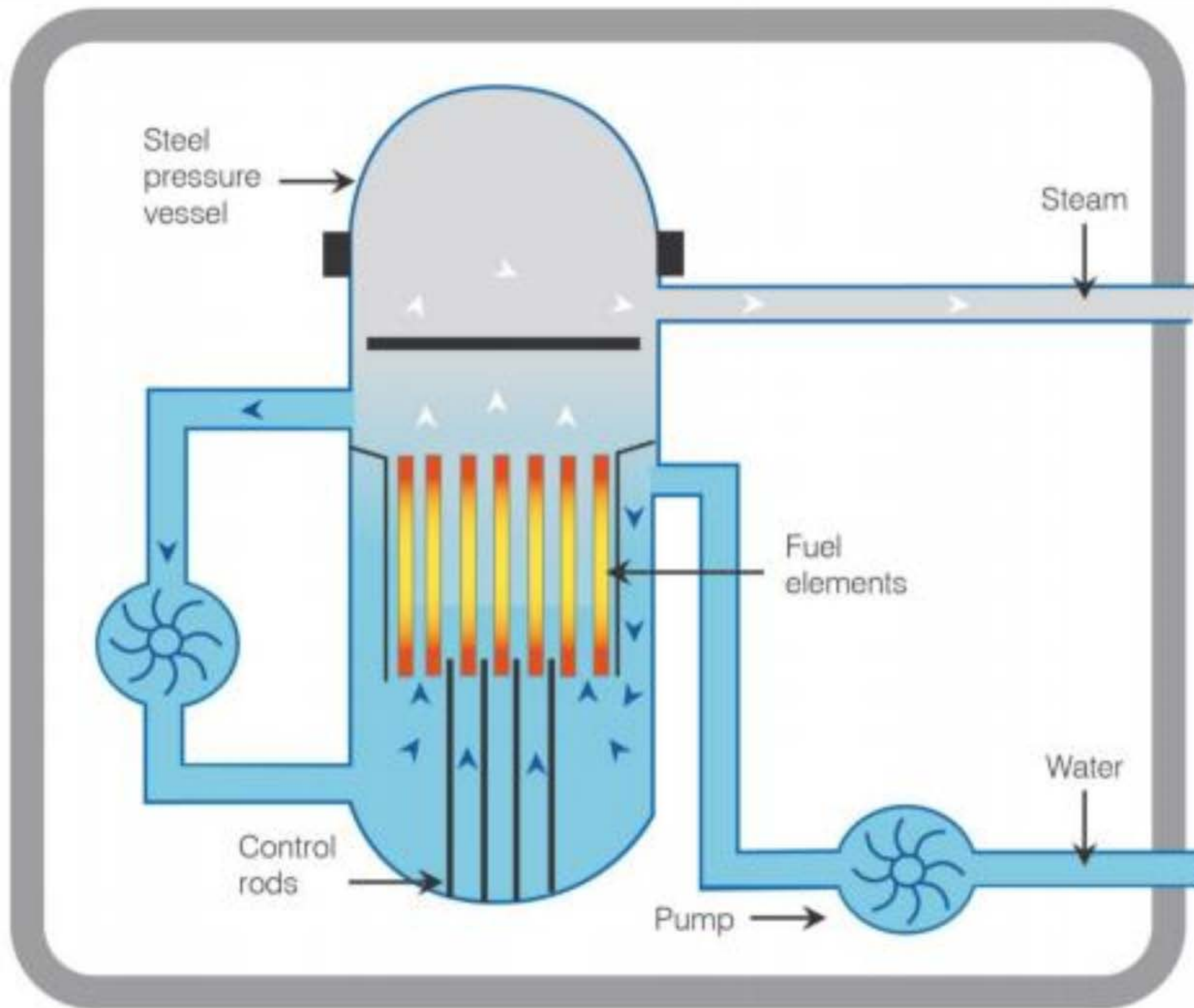
- (a) Water moderated ✓
- (b) Heavy water moderated ✓
- (c) Graphite moderated ✓
- (d) Beryllium moderated. ✓

BOILING WATER REACTOR :

- It used enriched uranium dioxide as a fuel and has a steel vessel surrounding by concrete shield.
- The BWR uses demineralized water (light water) as a coolant and neutron moderator.
- Heat is produced by nuclear fission in the reactor core, and this causes the cooling water to boil, producing steam.
- The steam is directly used to drive a turbine, after which is cooled in a condenser and converted back to liquid water.
- This water is then returned to the reactor core, completing the loop.
- Because of the danger of small amount of fissile material passing through along with coolant more biological protection is necessary.
- Tarupur reactor is such type.

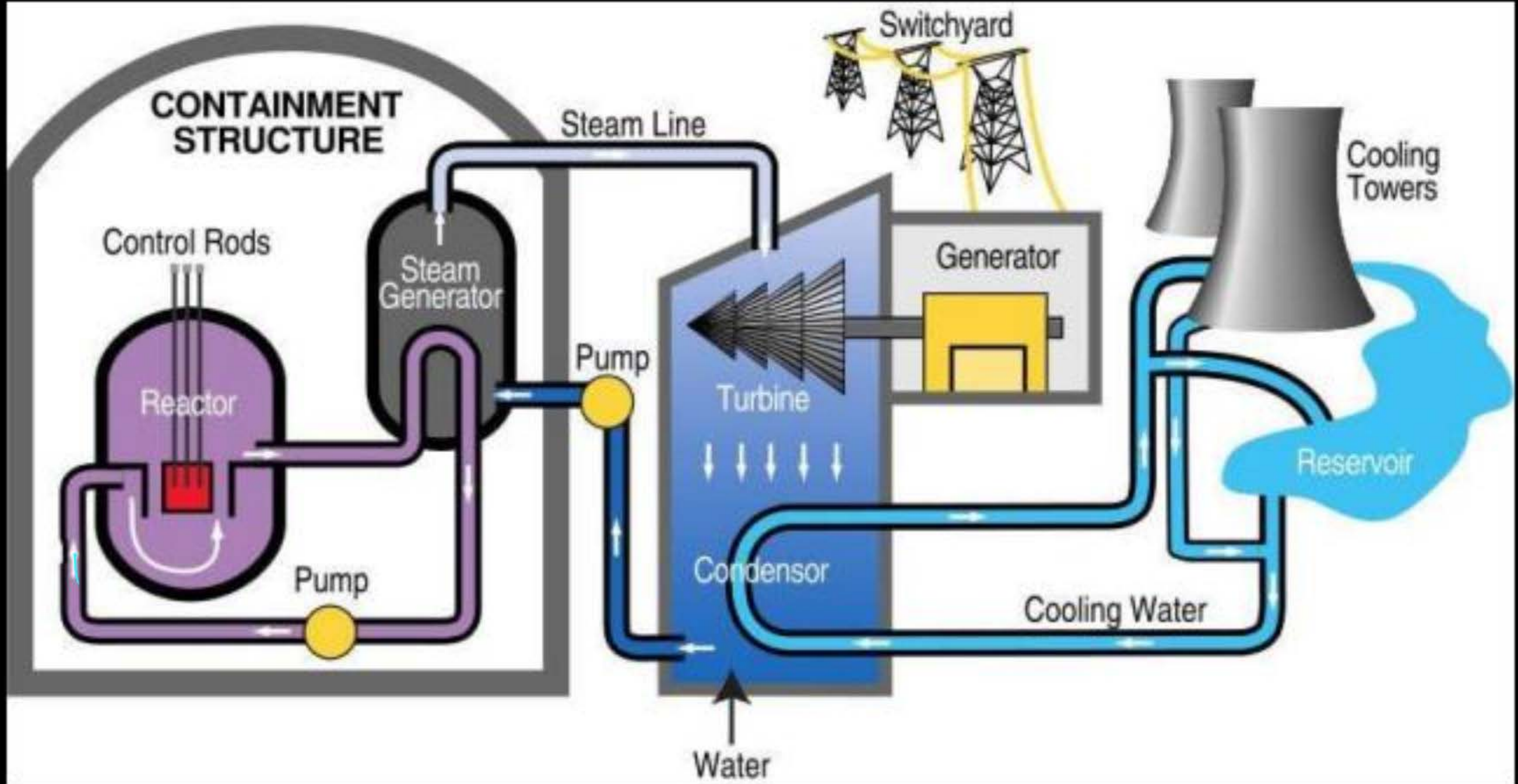
Containment Structure





Pressurised water reactor (PWR)

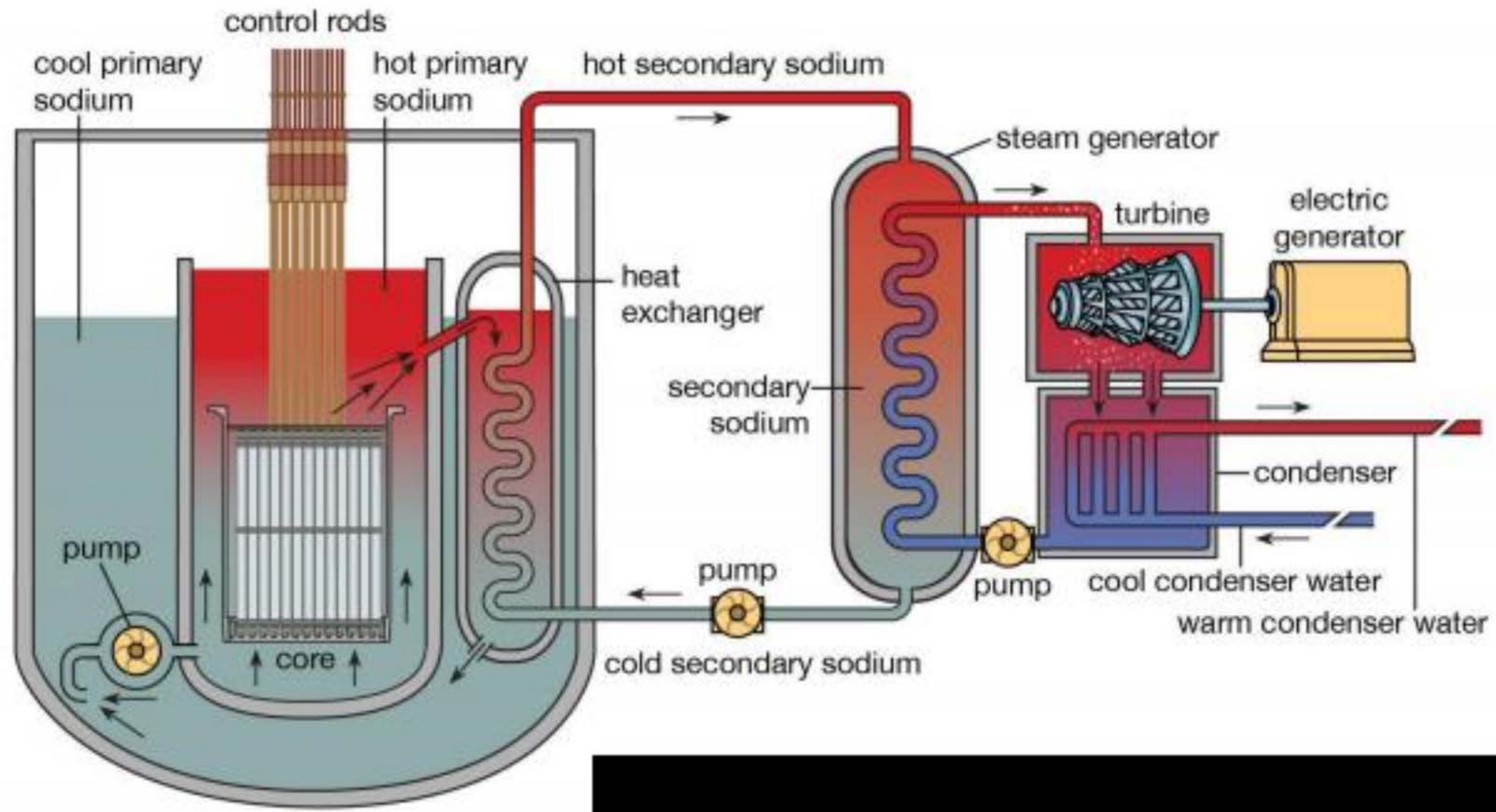
- The fuel used is enriched uranium dioxide clad in zircalloy and pressure vessel is of steel.
- The core inside the reactor vessel creates heat.
- Pressurized water in the primary coolant loop carries the heat to the steam generator.
- Pressurized water also act as a moderator
- Inside the steam generator, heat from the primary coolant loop vaporizes the water in a secondary loop, producing steam.
- The steam-line directs the steam to the main turbine, causing it to turn the turbine generator, which produces electricity.
- The unused steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps, reheated; and pumped back to the steam generator
- Kundalkulam power plant is used this reactor



Liquid metal fueled reactor:

- It is liquid metal as a fuel (uranium in sodium). Graphite as a moderator and liquid sodium as a coolant.
- Here liquid metal is used as a coolant. It has high heat transfer capability which permit high temperature and rating.
- Vapor pressure of liquid metal is low, so pressure vessel is simple.
- It has two heat exchanger
- Primary heat exchanger is sodium-sodium heat exchanger
- Secondary heat exchanger is sodium water heat exchanger.
- In secondary heat exchanger sodium give its energy to water and converted into steam.
- This steam is fed into steam turbine.

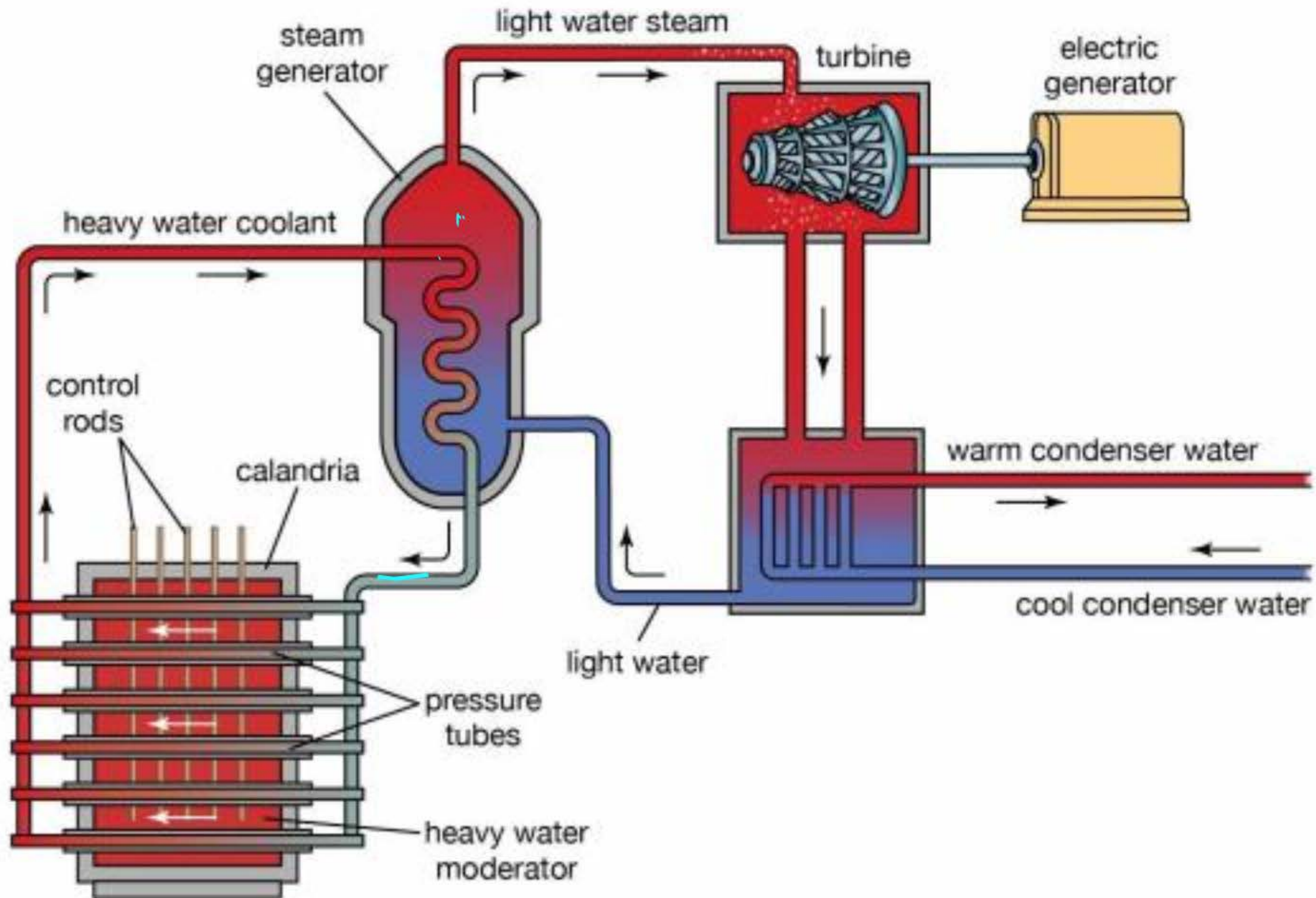
Sodium-cooled liquid-metal reactor



CANDU reactor:

- The CANDU nuclear reactor got its name because this heavy water reactor design was developed in Canada-it stands for Canada Deuterium Uranium.
- Unlike other nuclear reactors, which are designed to use enriched uranium fuel and light water as a moderator, CANDU heavy water D_2O reactors use non-enriched, natural uranium oxide as a fuel.
- Core is placed in horizontal.
- Heavy water is used as a moderator and coolant
- In heat exchanger heats transferred from heavy water to ordinary water. Which is converted into heat.
- This steam is used to run steam turbine.

Canada Deuterium Uranium (CANDU) reactor



Shielding

- Adequate shielding is required to guard the personnel and instruments.

Alpha particle:

- It can not penetrate the skin but may create contamination to environment
- A sheet of paper is sufficient to shield against alpha particle.

Beta particle:

- Overexposure of beta particle can cause skin burn. A thin sheet of lead and brick wall is used to shield against beta particle.

Gamma particle:

- It is very penetrating It create blood disease, genetic effect, anemia etc. Thick lead and concrete wall is required to shield against gamma particle.

#Q. Which one of the following statements is correct regarding superheaters in steam power plants? [ESE-2024]

- A** In modem utility high-pressure boilers, more than 40% of the total heat absorbed in the generation of steam takes place in the superheaters.
- B** In modem utility high-pressure boilers, less than 40% of the total heat absorbed in the generation of steam takes place in the superheaters.
- C** In modem utility high-pressure boilers, less than 20% of the total heat absorbed in the generation of steam takes place in the superheaters.
- D** In modem utility high-pressure boilers, less than 30% of the total heat absorbed in the generation of steam takes place in the superheaters.

#Q. Which type of hydro turbine is totally embedded in the fluid and powered from the pressure drop across the device? [ESE-2023]

- ☒ **A** Impulse turbine only ✓
- ☐ **B** Reaction turbine only
- ☐ **C** Squirrel cage turbine only
- ☐ **D** Both impulse turbine and reaction turbine

#Q. Which one of the following is not an example of renewable energy? [ESE-2022]

- A** Solar ✓
- B** Wind ✓
- C** Geothermal ✓
- D** Nuclear

#Q. Which one of the following power plants is the least reliable?

- A** Tidal
- B** Solar
- C** Wind
- D** Geothermal

#Q. Which of the following statements regarding steam boilers are correct?

1. The boiler must be capable of quick starting and loading. ✓
2. The boiler should have no joints exposed to flames. ✓
3. The boiler must be capable of burning low ash content coal efficiently.

[ESE-2020]

- A** 1 and 2 only
- B** 1 and 3 only
- C** 2 and 3 only
- D** 1, 2 and 3

#Q. Statement-I: Reaction turbines are generally used for sites with high head and low flow.

Statement-II: Kaplan and Francis turbines are reaction turbines. [ESE-2019]

- A** Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
- B** Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).
- C** Statement (I) is true but Statement (II) is false.
- D** Statement (I) is false but Statement (II) is true.

#Q. Air pollution due to smoke around a thermal power station can be reduced by installing [ESE-2016]

- A** Induced draft fan
- B** Super heater
- C** Economizer
- D** Electrostatic precipitator ✓

#Q. The load curve is useful in deciding.

- ✓ 1. The operating schedule of generating units.
2. The total installed capacity.

Which of the above statements is/are correct?

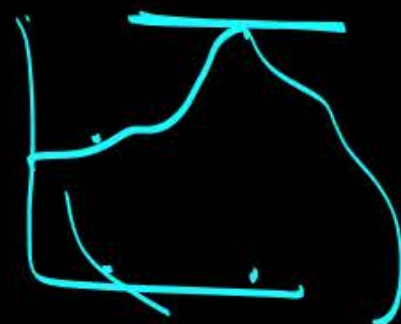
[ESE-2016]

A 1 only

B 2 only

C Both 1 and 2

D Neither 1 nor 2



#Q. The maximum demand on a steam power station is 480 MW. If the annual load factor is 40%, then the total energy generated annually is [ESE-2016]

A $19819.2 \times 10^5 \text{ kWh}$

B $18819.2 \times 10^5 \text{ kWh}$

C $17819.2 \times 10^5 \text{ kWh}$

D $16819.2 \times 10^5 \text{ kWh}$

$$\text{load factor} = \frac{\text{Avg load}}{\text{Max load}}$$

$$\text{Avg load} = 480 \times 0.4 \text{ MW}$$

$$\begin{aligned} \text{Energy} &= 480 \times 0.4 \times 365 \times 24 \text{ MWh} \\ &= \underline{1681920 \text{ MWh}} \end{aligned}$$

#Q. Compared to turbines in the conventional coalfired thermal stations, nuclear power plant turbines use steam at [ESE-2015]

- A** Higher pressure and higher temperature
- B** Lower pressure and lower temperature ✓
- C** Higher pressure and lower temperature
- D** Lower pressure and higher temperature

#Q. The power output from a hydro-electric power plant depends on [ESE-2015]

$$W = mg$$

$$m = \text{Volume} \times \text{density}$$

$$P = W H \eta - \text{eff}$$

head

- A** Head, type of dam and discharge
- B** Head, discharge and efficiency of the system
- C** Type of draft tube, type of turbine and efficiency of the system
- D** Type of dam, discharge and type of catchment area

#Q. A power station has a maximum demand of 2500 kW and number of kWh generated per year is 45×10^5 . The load factor is [ESE-2015]

A 10.25%

B 20.5%

C 41%

D 82%

$$\text{load factor} = \frac{\text{Average load} \times (365 \times 24)}{\text{Max load} \times (365 \times 24)}$$

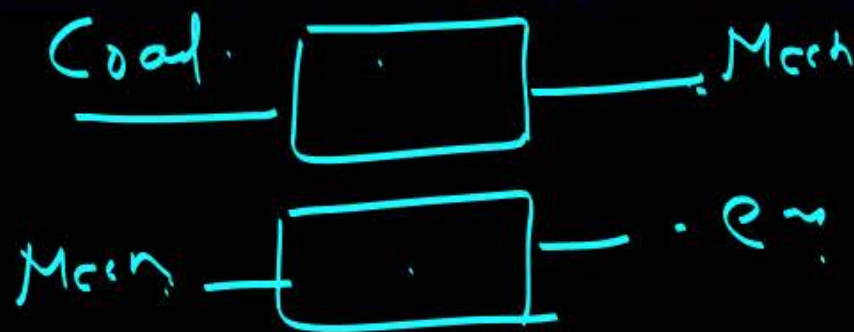
$$= \frac{45 \times 10^5}{2500 \times 365 \times 24}$$

$$= 0.205$$

$$= 20.5\%$$

#Q. The thermal and electrical efficiencies of a 100 MW steam station are respectively 30% and 92%. The coal used has a calorific value of 6400 kcal/kg. For the supply of full-load rated capacity the coal consumption in kg/hour would be approximately [ESE-2014]

- [A] 2340
- [B] 32450
- [C] 48690
- [D] 64910



$$\text{Total efficiency} = 0.30 \times 0.92$$

$$= \underline{0.276}$$

$$1 \text{ kWh} = \underline{860 \text{ kcal}}$$

Per hour
Energy reqs

$$= 100 \times 10^3 \text{ kWh}$$

$$= 100 \times 10^3 \times 860$$

$$= 86000 \times 10^3 \text{ kcal.}$$

$$\text{Coal input in kcal} = \frac{86000 \times 10^3}{0.276}$$

$$640 \longrightarrow 1 \text{ kg}$$

$$1 \longrightarrow \frac{1}{6400}$$

$$\frac{860,000 \times 10^3}{0.276} = \frac{1}{6400} \times \frac{86000 \times 10^3}{0.276}$$

$$= 48690 \text{ kg}$$

#Q. The term 'Surge Tank' is associated with which type of power plant? [ESE-2014]

- ☒ **A** High head hydro
- ☐ **B** Low head hydro
- ☐ **C** Medium head hydro
- ☐ **D** Thermal



#Q. Statement (I): In high level hydel stations, the action of governor due to sudden change in load, changes the water admitted to turbine blades leading to water hammering effect on penstocks. ✓

Statement (II): A surge tank in high head hydel stations is used to absorb the flow variations. ✓ [ESE-2014]

- A** Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I). ✓
- B** Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).
- C** Statement (I) is true but Statement (II) is false.
- D** Statement (I) is false but Statement (II) is true.

#Q. The advantage of hydro-electric power station over thermal power station is
[ESE-2013]

- A** The initial cost of hydro-electric power station is low.
- B** The operating cost of hydro-electric power station is low.
- C** Hydro-electric power station can supply the power throughout the year.
- D** Hydro-electric power station can be constructed at the place where the energy is required.

#Q. In a thermal power station, a typical heat balance sheet, for a large turbine and surface condenser taken together, is the percentage distribution of heat energy in

1. Work done or thermal efficiency
 2. Friction and windage loss
 3. Heat to circulating water
 4. Heat in condensate to be retained to the boiler
- The percentage amount of heat in the heads state above, in the descending order is [ESE-2011]

[A] 3, 4, 1 and 2

[B] 2, 1, 4 and 3

[C] 3, 1, 4 and 2

[D] 2, 4, 1 and 3

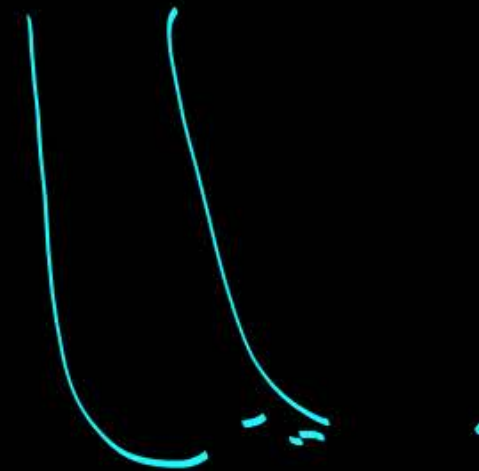
#Q. The radiation shield for a nuclear power reactor for biological safety is provided by having the reactor: [ESE-2011]

- A** Immersed in water pool
- B** Encased by thick metal walls
- C** Encased by thick concrete wall
- D** Isolated from outside world with strong magnetic fields

✓
B ✓
✓

#Q. Where is the draft tube of a hydropower station that is an airtight pipe located?
[ESE-2009]

- A** Near the surge tank
- B** In between the penstock and the runner
- C** In between the runner exhaust and the tailrace
- D** At the beginning of penstock





2 Minutes Summary



- Nuclear power plant
- Different Types of Reactor
- Moderator, Control Rod

Thank
you