

POWER STATION ENGINEERING

(Diploma 6th SEM)



Education for a World Stage

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PPE

(Power Plant Engineering)

Sources of Energy:-

① Fuels:

Solid fuels :- Various solid fuels are wood, coal (bituminous coal, anthracite, lignite), peat, wood ($3000 - 4000 \text{ cal/kg}$).

Liquid fuels :-

Petroleum & its derivatives (petrol, diesel, kerosene etc).

Gaseous fuels :-

Natural gas, producer gas, blast furnace gas, coal gas etc.

②. Energy stored in water :-

The potential energy of water at higher level is utilized for generation of electrical energy.

Hydro power

Capital cost of hydroelectric power plant is higher but running cost is low.

③ Nuclear Energy :-

Wind Power

Wind is a renewable source of energy. Velocity of wind can be utilized to generate small amount of electrical energy.

eg:- Water pump from deep wells.
Wind turbine.

But wind energy is noisy & large area is required.

In India avg wind speed 10-16 km/h.

Modern wind mill runs at low speed 3-7 km/h.
more efficient at 10-12 km/h.

④ Solar Energy :-

The heat energy contained in the rays of sun can be utilised.

- Electric power generation
- Solar water pumps. is used for pumping water

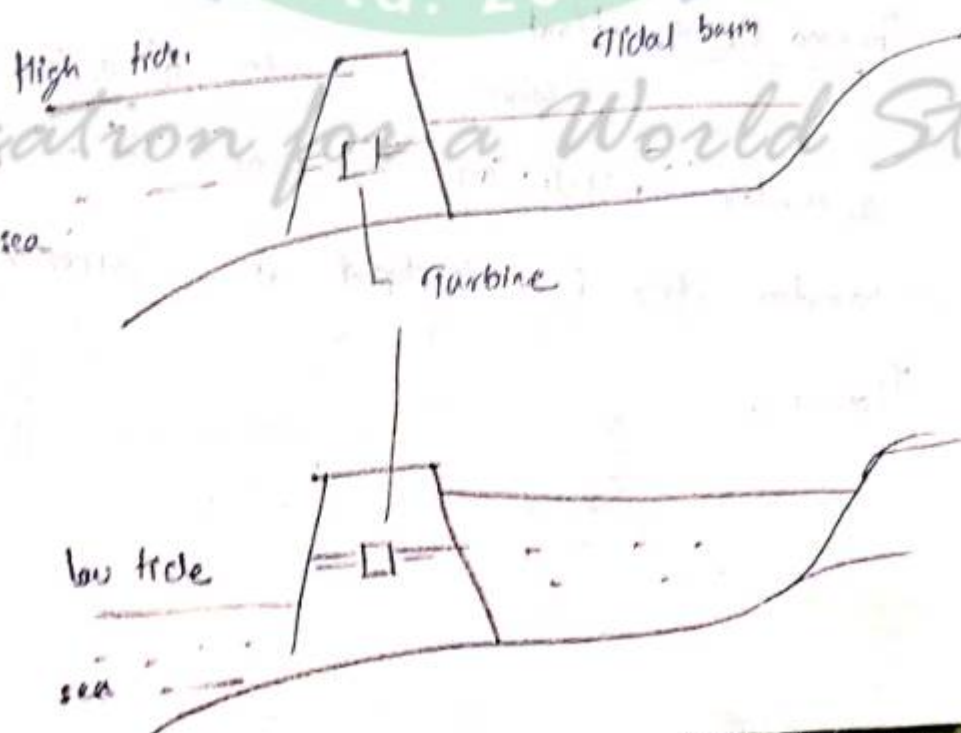
- Solar water heaters used for water heating.
- Solar cabinet type drier for drying of food grains.
- Solar kilns for drying wood etc.

Solar energy is available in the day time & can be stored in storage battery.

- It is free from pollution & noise.

③ Tidal power :-

Ocean waves & tides contains large amount of energy. In tidal power plant tidal basin is there & turbine generator is used for generating power.



Advantages:-

- There is ~~no~~ ^{no} ~~cost~~ ^{cost}.
- Does not depend upon rain.
- Free from pollution.
- less space is required.

Disadvantages:-

- Capital cost is high.
- Supply of power is not continuous.
- Away from load centres.

⑥ Geothermal Energy

The earth has a molten core. Due to volcanic action steam vents & hot springs are formed. These natural steam vents is used for generation of plant.

⑦ Thermoelectric Plant:-

when 2 junctions of a loop of 2 dissimilar metals are kept at diff. temp., an electromotive force is developed. & current starts flowing.

⑧ Nuclear Energy

Heavier unstable atoms such as U^{235} , Th^{232} and Pu^{239} (Plutonium) liberate large amount of heat energy.

1 kg U^{235} = 4500 tonnes of high grade coal.

Captive Power plant

It is used to provide a localised source of power to an energy user.

The plant may operate in grid parallel mode with the ability to export surplus power to the local electricity distribution network.

Central power plant :-

It is the distribution point for campus utilities, including electricity, heat, cooling, natural gas.

It has cogeneration aspects.

It can produce 30% of campus electricity as a by product of steam production.

Classification of Power plants

1. On the basis of fuel.

i) Steam power plant

 a) Condensing P.P.

 b) non- " "

ii) Diesel P.P.

iii) Nuclear P.P.

iv) Hydro-electric P.P.

v) Gas turbine "

2. On the basis of nature of load.

i) Base load. P.P.

ii) Peak " "

3. On the basis of location.

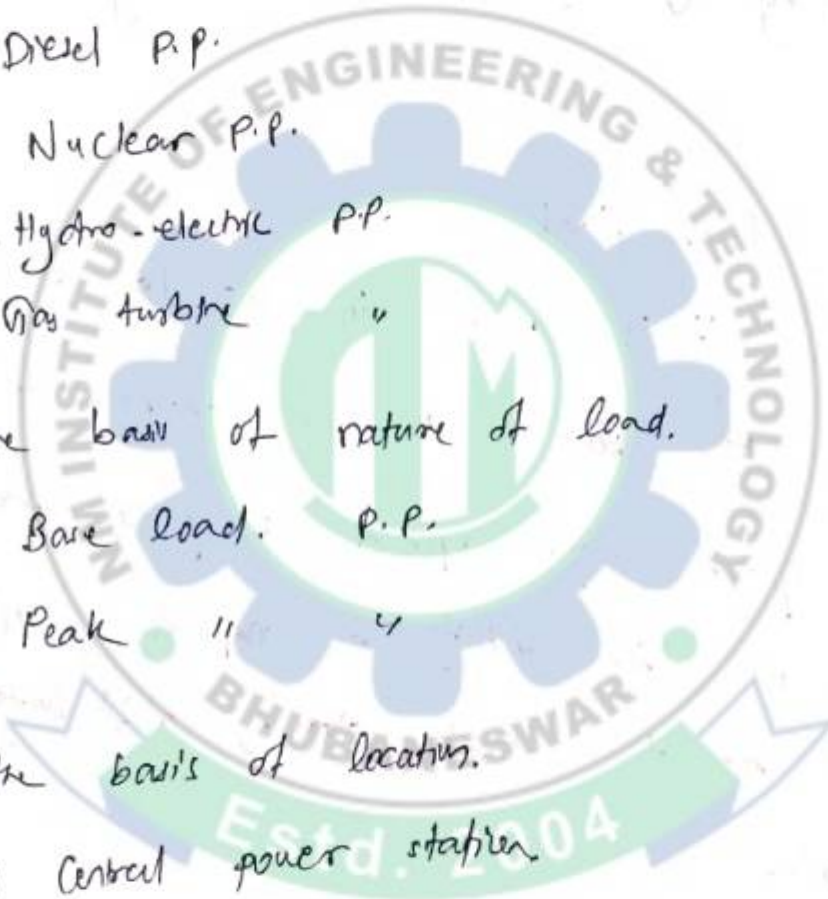
i) Central power station.

ii) Isolated " "

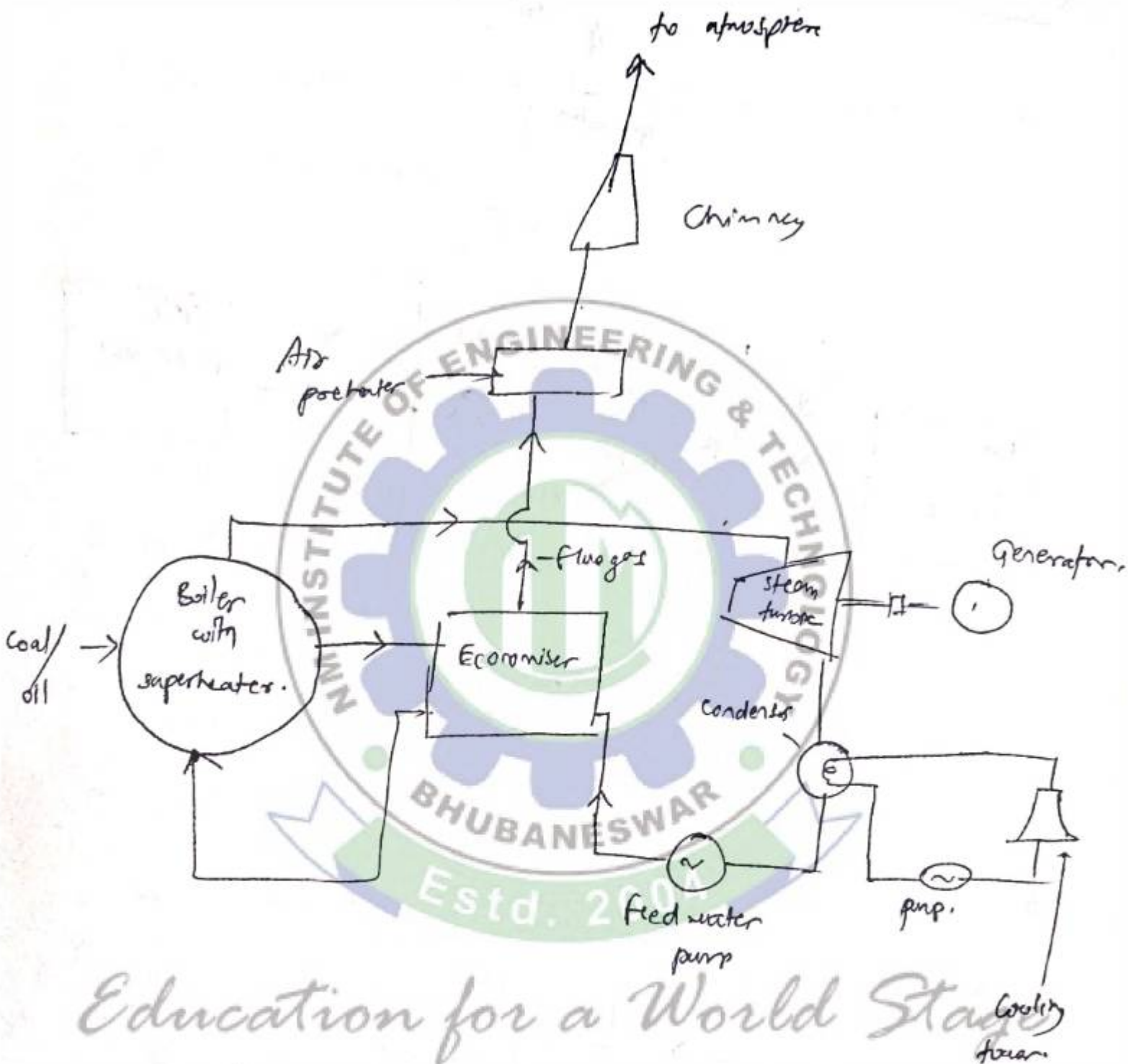
4. On the basis of service

i) Stationary

ii) Locomotive.

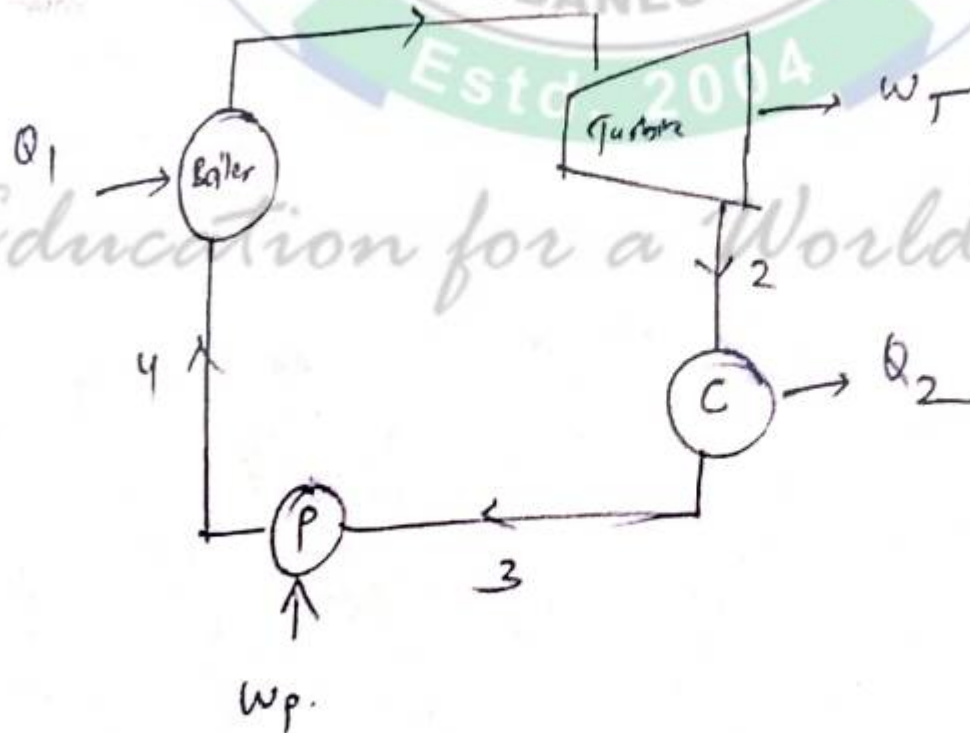
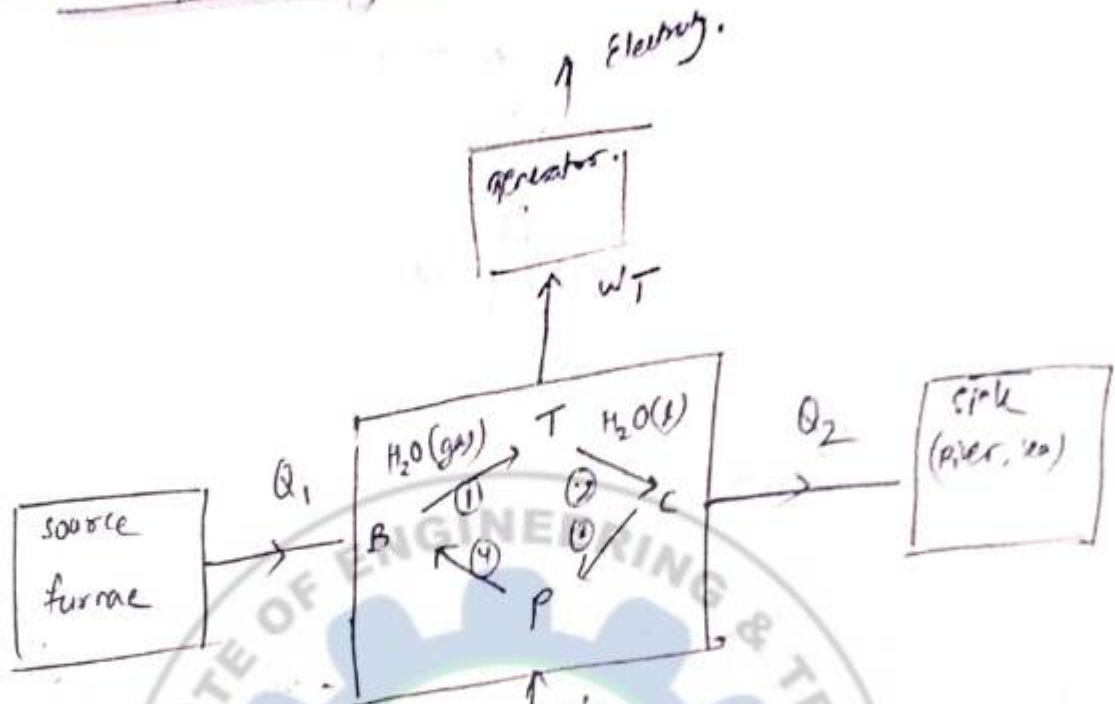


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Steam Power Cycle:-



A steam power plant continuously converts the energy stored in fuel (coal, oil, gas) into work. & ultimately into electricity.

The working fluid is water, which is in the form of liquid or gaseous state (operation).

The energy released by burning the fuel is transferred to water in boiler (B) to generate steam at a high pr. & temp.

It expands in turbine (T) to a low pr. to produce work.

The steam leaving turbine is condensed into water in condenser (C). Heat is rejected to sink or river.

Then the water fed back to the boiler.

by pump (P) for a World Stage

This cycle goes on repeating.

The water flows through B - T - C - P.

Internal energy is constant.

$$\text{so } \oint dE = 0.$$

$$\sum Q_{net} = \sum W_{net}$$

$$Q_1 - Q_2 = W_T - W_P$$

Q_1 = heat transferred to the working fluid (K.J/kg)

Q_2 = " rejected from " "

W_T = work transferred from the working fluid

W_P = work " into the " "

Efficiency of steam power cycle

$$\eta_{cycle} = \frac{W_{net}}{Q_1}$$

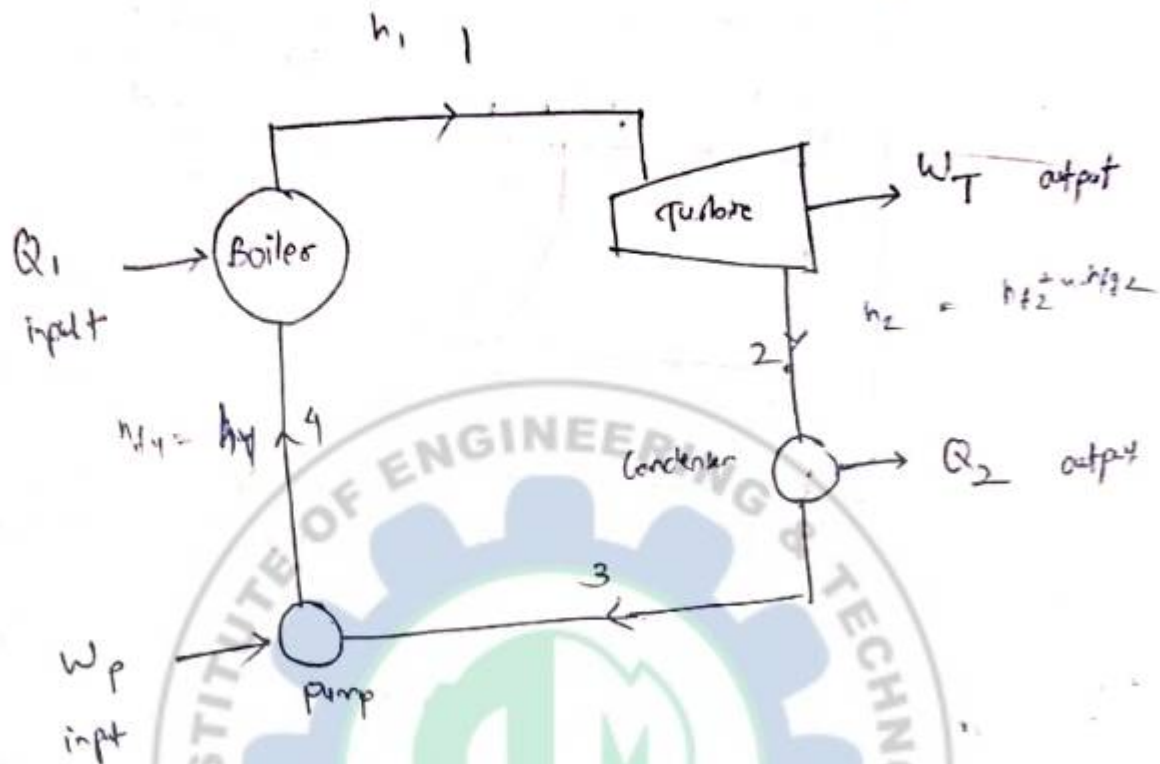
$$= \frac{W_T - W_P}{Q_1}$$

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$$= \frac{Q_1 - Q_2}{Q_1}$$

$$\boxed{\eta = 1 - \frac{Q_2}{Q_1}}$$

Rankine Cycle :-



for the steam boiler it would be a reversible constant heating process of water to form steam.

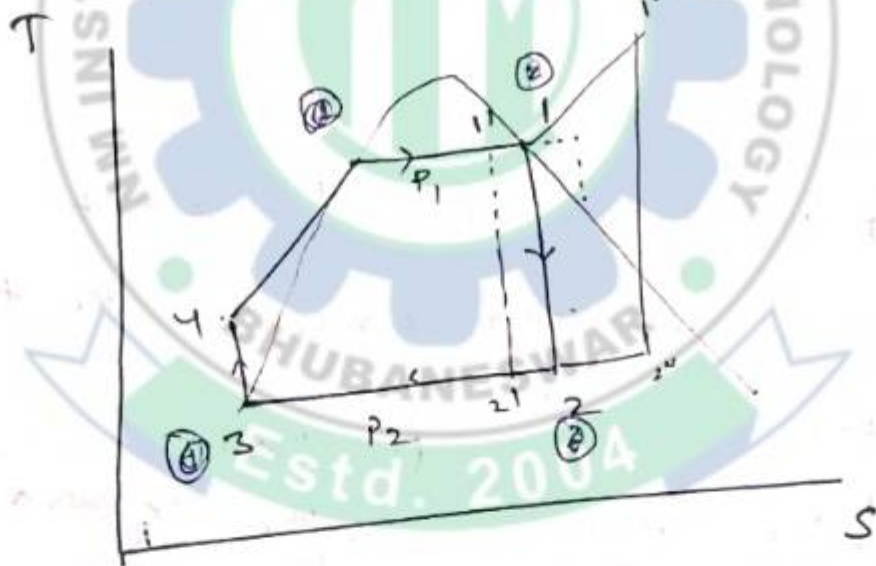
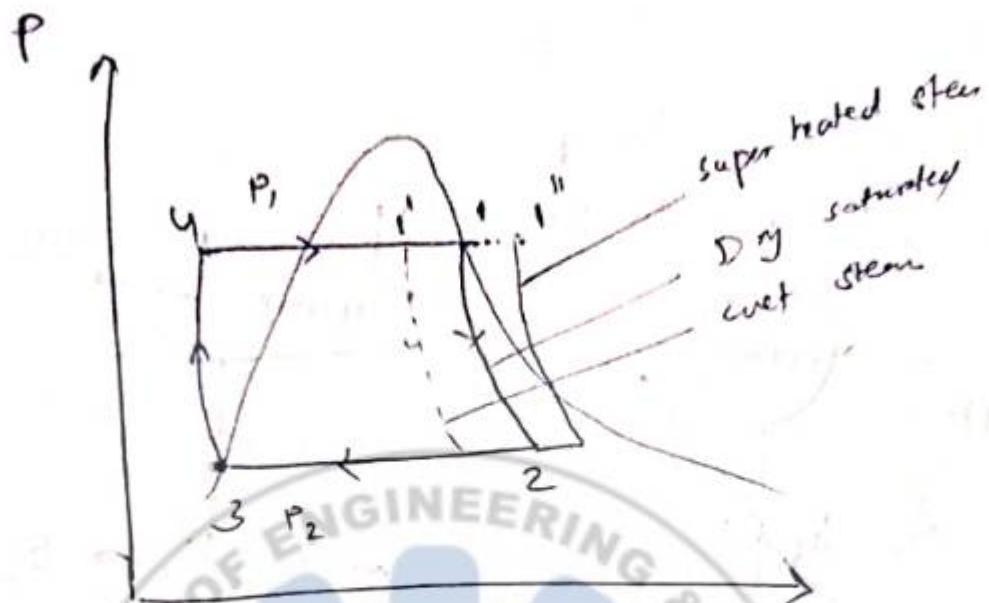
for turbine reversible adiabatic expansion.
(control vol.)
Entropy - temp. constant

for condenser reversible const pressure heat rejection process.

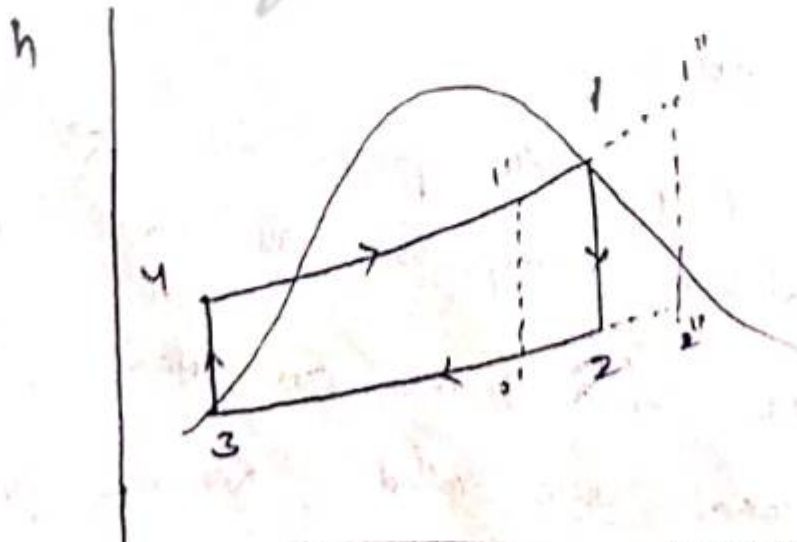
for the pump the process will be reversible adiabatic compression of the liquid

when all these four processes are ideal, the cycle is an ideal cycle called Rankine cycle.

This is a reversible cycle.



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- Process 1-2 - Reversible adiabatic expansion (turbine)
 " 2-3 - constant pr. heat transfer (condenser)
 " 3-4 - Reversible adiabatic pumping process (pump)
 " 4-1 - constant pr. transfer of heat (boiler)

$$\left[\begin{array}{l} \text{Enthalpy} \\ \text{Entropy} \end{array} \right. \left. \begin{array}{l} h = u + pv \\ s = \frac{dq}{T} \end{array} \right] \quad \left. \begin{array}{l} u = \text{internal energy.} \\ \text{Applying steady flow energy eq}^n. \end{array} \right\}$$

For boiler

$$h_4 + Q_1 = h_1$$

$$Q_1 = h_1 - h_4$$

Turbine

$$h_1 = w_T + h_2$$

$$w_T = h_1 - h_2$$

Condenser

$$h_2 = Q_2 + h_3$$

$$Q_2 = h_2 - h_3$$

Pump

$$h_3 + w_P = h_4$$

$$w_P = h_4 - h_3$$

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Thermal efficiency of Rankine cycle

$$\eta = \frac{w_{\text{net}}}{Q_1} = \frac{w_T - w_P}{Q_1} = \frac{(h_1 - h_2) - (h_4 - h_3)}{h_1 - h_4}$$

$$\eta = \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_4)}$$

As compare to turbine, the pump work is small.
 so it can be neglected.

$$\eta = \frac{h_1 - h_2}{h_1 - h_4}$$

$$\frac{h_1 - h_2}{h_4 - h_3}$$

$$h_4 - h_2$$

$$\eta = \frac{h_1 - h_2}{h_1 - h_2}$$

work Ratio

=

$$\frac{W_{net}}{W_T}$$

$$= \frac{W_T - W_P}{W_T}$$

$$= 1 - \frac{W_P}{W_T}$$

$$= 1 - \left(\frac{h_4 - h_3}{h_1 - h_2} \right)$$

Specific steam consumption or

heat rate (S.R) = $\frac{1}{W_{net}} \left(\frac{kJ}{kWh} \right)$

H.R Heat Rate = $\frac{Q_1}{W_T - W_P} = \frac{1}{\eta} \left(\frac{kJ}{kWh} \right)$

Reheat cycle

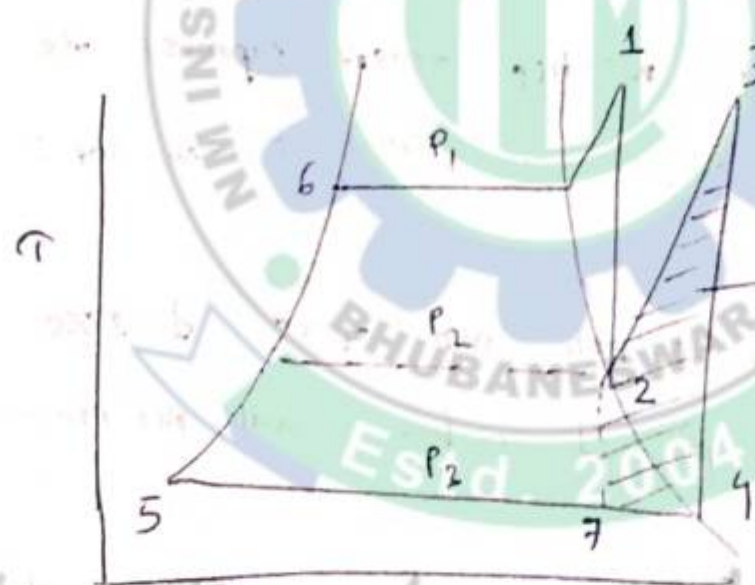
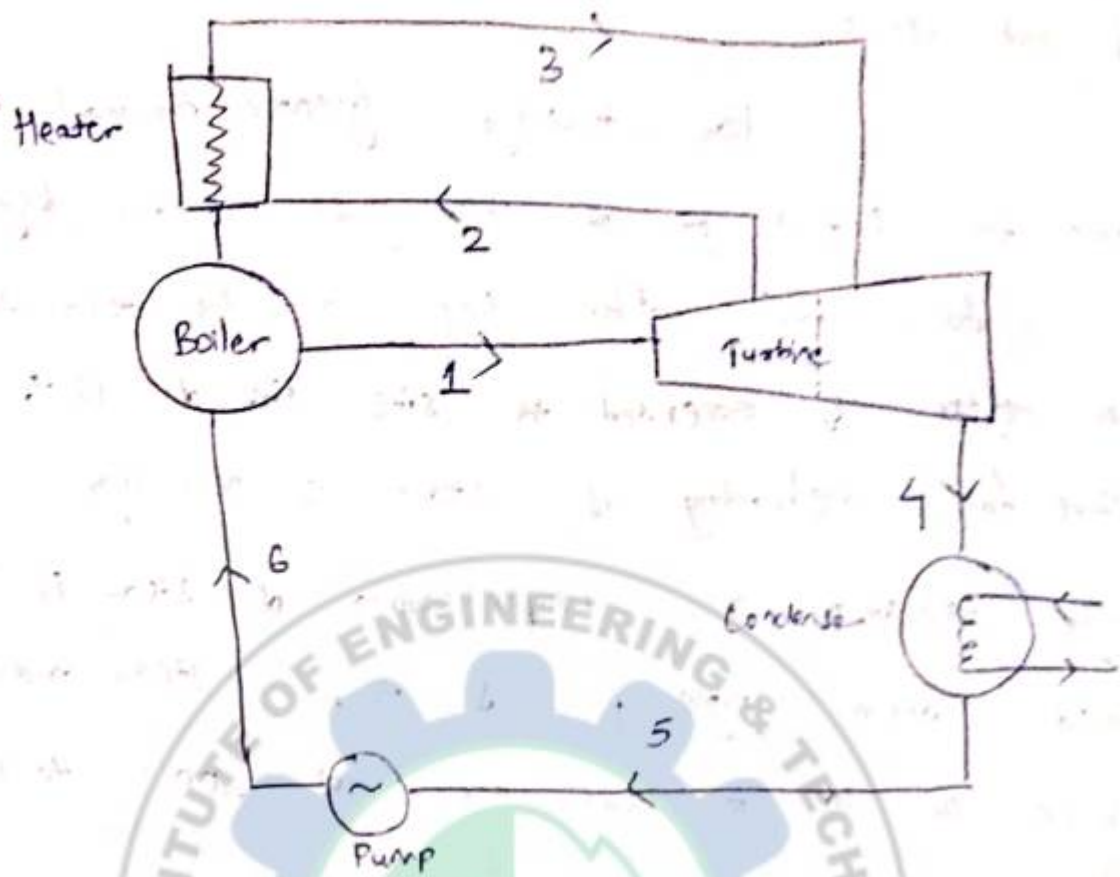
for attaining greater thermal efficiency when the initial pr. of steam was raised beyond 42 bar it is found that, after expansion the steam condition was better & exceeded the safe limit of 12%. Therefore reheating of steam is necessary.

The reheating or resuperheating of steam is now used when high pr. & temp. steam condition such as 100 to 250 bar and 500°C to 600°C , are employed.

In actual practice reheat improves the cycle efficiency by 5%. The increase is 5% to 10%.

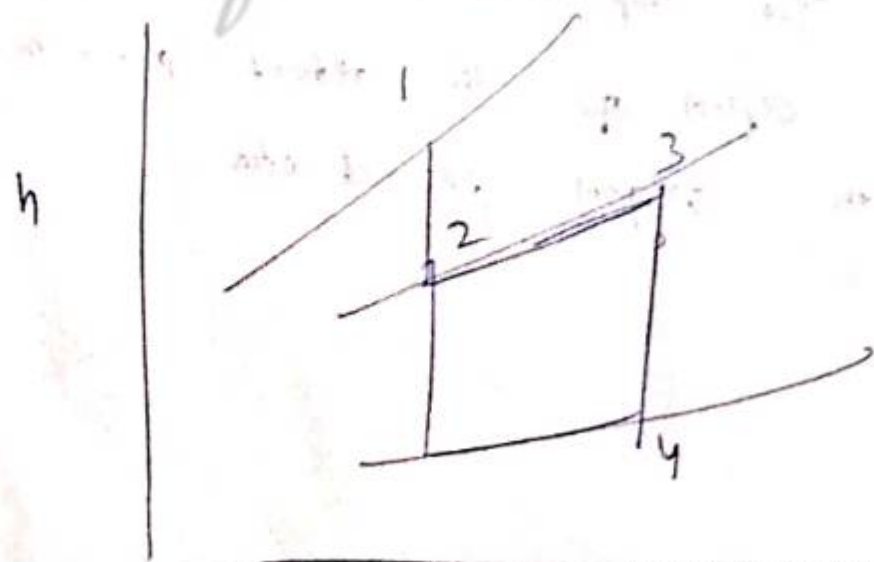
A plant with a base load capacity of 5000 kW & initial steam pr. of 42 bar will run economically by reheating.

The improvement of thermal efficiency due to reheat depends upon the reheat pr. with respect to the original pr. of steam.



Increase in work
 done.
 due to reheat.

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$$\text{Heat supplied} = (h_1 - h_{f4}) + (h_2 - h_2)$$

$$\text{Heat rejected} = h_4 - h_{f4}$$

$$\text{Work done by turbine} = \text{Heat supplied} - \text{Heat rejected}$$

$$= (h_1 - h_{f4}) + (h_2 - h_2) - (h_4 - h_{f4})$$

$$= (h_1 - h_2) + (h_3 - h_4)$$

$$\eta_{\text{thermal}} = \frac{(h_1 - h_2) + (h_3 - h_4)}{(h_1 - h_{f1}) + (h_3 - h_2)}$$

$$w_p = \frac{v_f (P_1 - P_b)}{1000} \text{ kJ/kg}$$

$$\eta = \frac{(h_1 - h_2) + (h_3 - h_4) - w_p}{(h_1 - h_{f1}) + (h_3 - h_2) - w_p}$$

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Efficiency with out reheat

$$\left(\eta = \frac{h_1 - h_7}{h_1 - h_{f4}} \right) \quad (\because h_{f4} = h_{f7})$$

Regenerative cycle

In Rankine cycle, the condensate, liquid is at a low temperature, which mixed with hot boiler water, irreversibly.

It results in decrease in efficiency.

So the condensate, water is heated before feeding to the boiler. This heating method is called regenerative feed heating & the cycle is called regenerative cycle.

Steam is extracted from turbine at several locations & it is supplied to the regenerative heaters.

Heating arrangement

Medium capacity turbines - 3 heaters.

High pr. " - 5-7 "

Supercritical " - 8-9 "

The temp is kept 50° to 60° below the boiler steam.

$m_1 =$ kg of h.p. steam per kg of steam for

$m_2 =$ " " " " " " " " " " " "

$(1 - m_1 - m_2) =$ kg of steam entering condenser per kg of steam flow

Energy or heat balance eqⁿ for H.P. heater

$$m_1 (h_1 - h_{f6}) = (1 - m_1) (h_{f6} - h_{f5})$$

$$\Rightarrow m_1 (h_1 - h_{f6}) = (h_{f6} - h_{f5}) - m_1 (h_{f6} - h_{f5})$$

$$\Rightarrow m_1 [(h_1 - h_{f6}) + (h_{f6} - h_{f5})] = (h_{f6} - h_{f5})$$

$$\Rightarrow m_1 = \left[\frac{h_{f6} - h_{f5}}{h_1 - h_{f6}} \right]$$

for L.P heater.

$$m_2 (h_2 - h_{f5}) = (1 - m_1 - m_2) (h_{f5} - h_{f3})$$

$$\Rightarrow m_2 (h_2 - h_{f5}) = (1 - m_1) (h_{f5} - h_{f3}) - m_2 (h_{f5} - h_{f3})$$

$$\Rightarrow m_2 \left[(h_2 - h_{f5}) + (h_{f5} - h_{f3}) \right] = (1 - m_1) (h_{f5} - h_{f3})$$

$$m_2 = \left[\frac{(1 - m_1) (h_{f5} - h_{f3})}{(h_2 - h_{f3})} \right]$$

Here pump work is neglected.
Heat supplied = $(h_0 - h_{f6})$

Isentropic work done =

$$m_1 (h_0 - h_1) + m_2 (h_3 - h_2) + (1 - m_1 - m_2) (h_0 - h_3)$$

Thermal efficiency of regenerative cycle

$$\eta = \frac{\text{Work done}}{\text{Heat supplied}}$$

work done

work done by turbine

$$= (h_0 - h_1) + (1 - m_1)(h_1 - h_2) + (1 - m_1 - m_2)(h_2 - h_3)$$

Advantages of regenerative cycle:-

1. Heating process becomes reversible
2. Thermal stress set up in boiler is minimised.
3. Thermal efficiency improved.
4. Heat rate reduced.
5. Erosion & corrosion in turbine reduces
6. Small size condenser is required.

Dis. point:-

1. Plant becomes more complicated.
2. Maintenance is req.
3. Large boiler is req.
4. Heaters are costly.

Boiler Accessories :-

Air pre heater

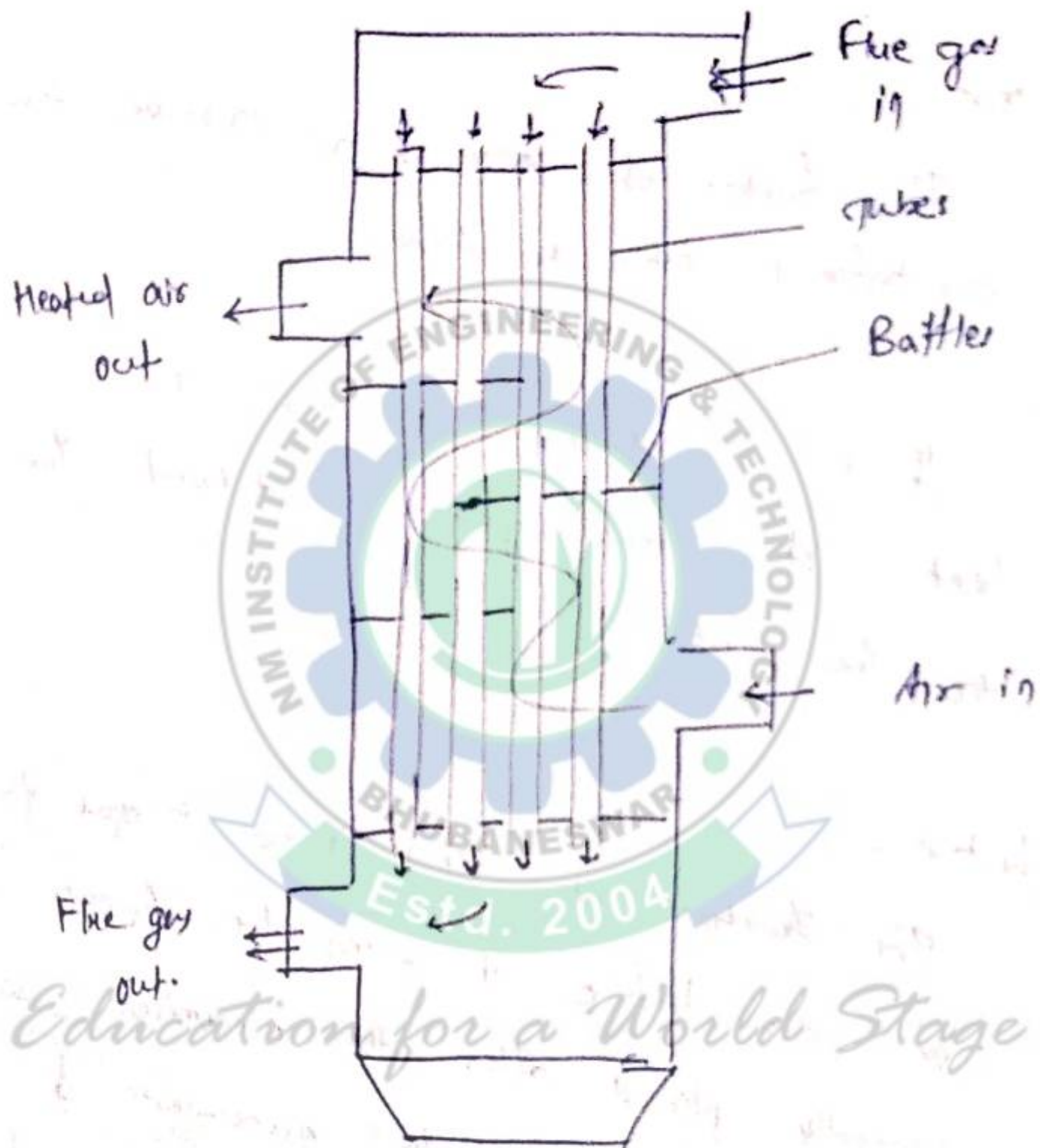
The function of APH is to increase the temp. of air before it enters the furnace.

Economiser

It is a device in which the waste heat of flue gases is utilised for heating the feed water.

Air pre heater :-

The function of APH is to increase the temp. of air before it enters the furnace, it is generally placed after the economiser, so the flue gas pass through the economiser & then to the air pre heater.



APH (Tubular type)

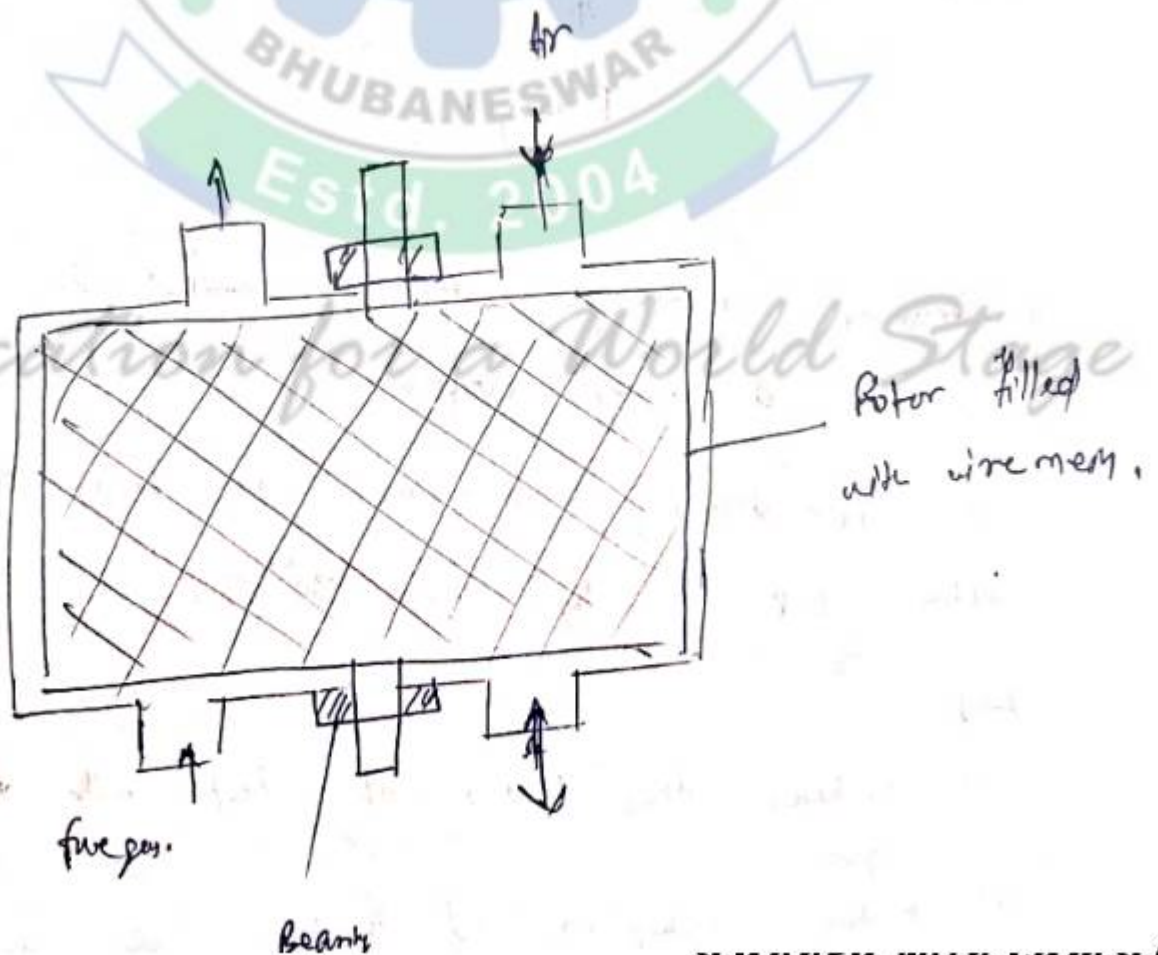
An APH consists of plates or tubes with hot gases on one side & air on another side. It preheats the air. Preheated air accelerates the combustion & facilitates the burning of coal.

The pre heating depends on

- Type of fuel.
- Type of fuel burning equipment.

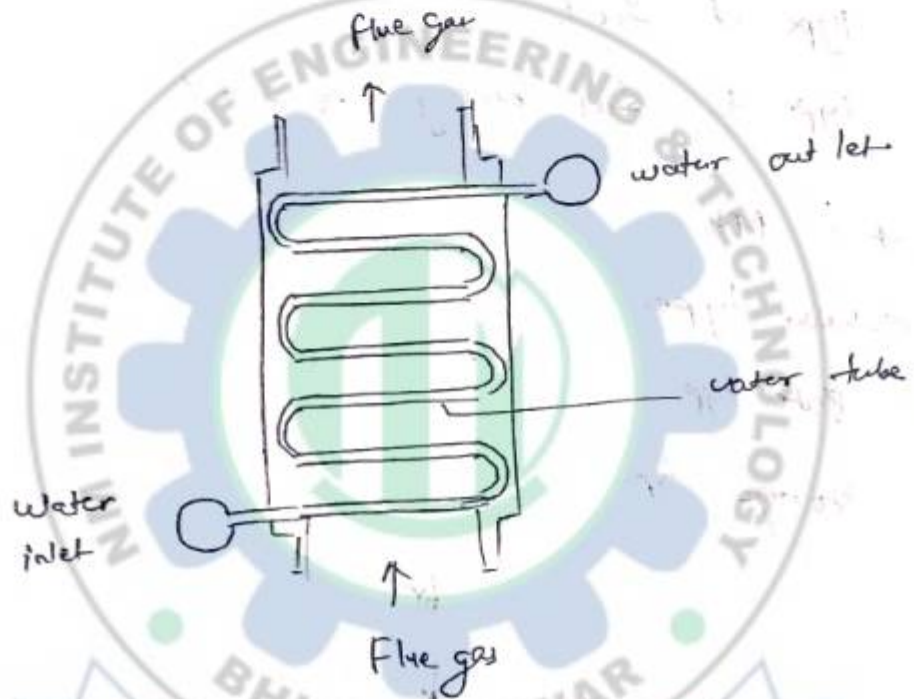
3 types of APH

- 1) Tubular type
- 2) Plate type
- 3) Storage type



Economiser

It is a device in which the waste heat of flue gas is utilised for heating the feed water.



In Steaming economiser water is heated to B.P.

10-12% of water evaporates

In non-steaming economiser the temp. is kept below B.P. by 20-30°C.

Adv.

- i) Reduces the losses of heat with the flue gas
- ii) Reduces consumption of fuel
- iii) Improves efficiency of boiler.

Economiser consists of series of steel tubes through which the feed water flows. The combustion gases pass over the tube & transfer some of their heat to the feed water. The boiler efficiency rises by 1% for each 10°F rise in water.

Economiser may be parallel flow or counter flow.



(By pass arrangement of flue gas)

The by pass arrangement enables to isolate or include the economiser in the path of flue gas.

Super heaters :-

The steam produced in the boiler is nearly saturated. This steam as such should not be used in the turbine because the dryness fraction of the steam leaving the boiler will be low. This results in the presence of moisture which causes corrosion of turbine blades. The function of super heater is to increase the temp. of steam above its saturation point.

Advantages of super heated steam :-

- i) Steam consumption of engine or turbine is reduced.
- ii) Losses due to condensation in the cylinders & the steam pipe are reduced.
- iii) Erosion of turbine reduces.
- iv) Efficiency of Power plant improved.

The super heater consists of several tubes circuits in parallel with one or more bends connected between headers. Super heater tubes ranges from 1 to 2 inches in dia.

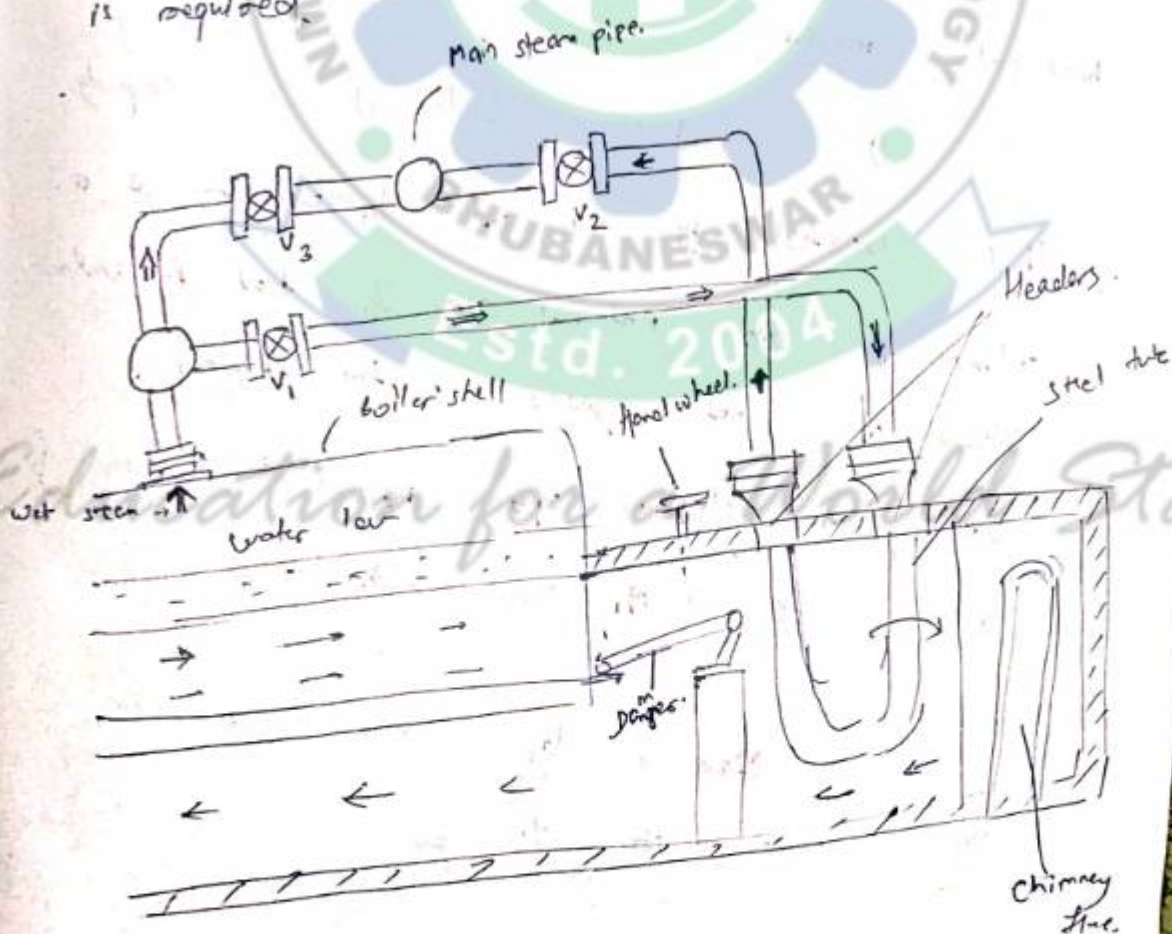
Super heater supplies steam at constant temp. at diff. loads.

There are 2 types of superheater

1. Convective superheater
2. Radiant superheater

Convective superheater makes use of heat in the gases above.

Radiant superheater is placed in the furnace & wall tubes receive heat from the burning fuel through radiation process. The radiant type of superheater is generally used where a high amount of super heat temp. is required.



→ Hot gas
→ water level
→ superheated steam

(Suggden's superheater)

Draught

The small pr. difference which causes a flow of gas to take place is termed as draught.

Purpose

- i) to supply req. amount of air to the furnace for the combustion of fuel.
- ii) To remove the gaseous products of combustion.

Natural draught

It is used in boiler of small capacity.

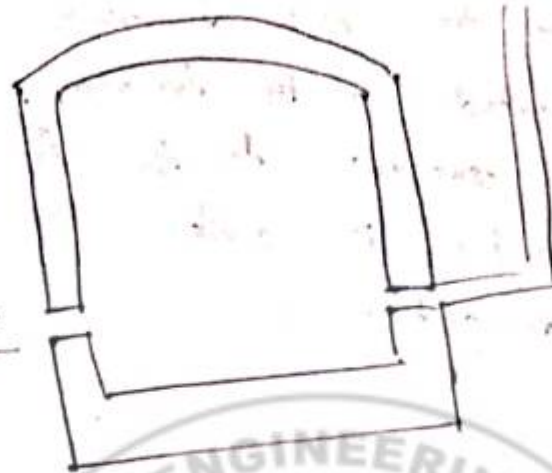
It is created by the diff. in weight of a column of cold external air & that of similar column of hot gases in the chimney.

This system depends upon height of chimney & avg. temp. of gases in the chimney.

Now a days chimney is used for only removing the flue gas.

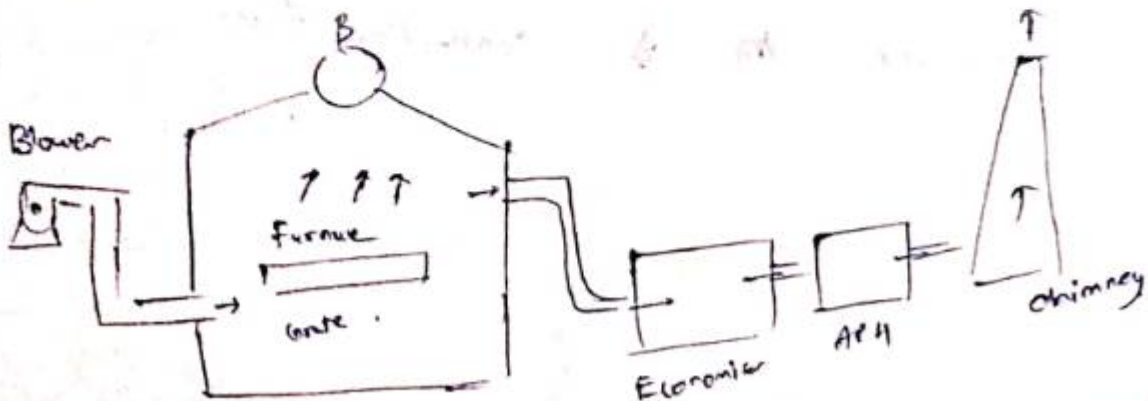
column of air

chimney



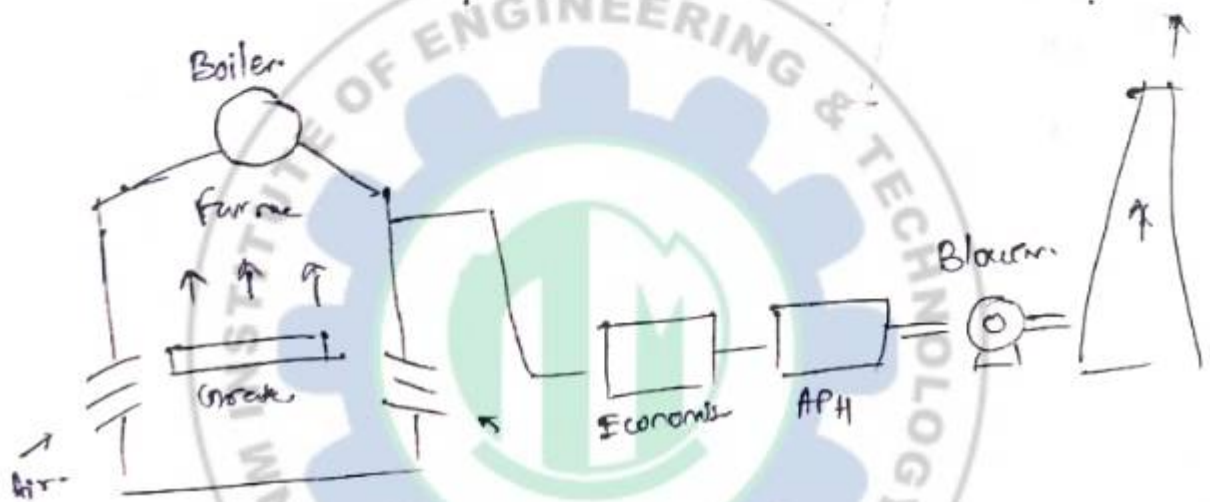
forced draft is

In a mechanical draft system the draught is produced by a fan. In a forced draught system a blower or a fan is installed near or at the base of boiler to force the air through the cold bed of the passage through the furnace.



Induced draft

In this system a fan or blower is located near the base of chimney. Partial vacuum is created in the furnace. Air is drawn from atmosphere to the furnace. The draft draught is similar in action to the natural draught.



Balanced draft

It is a combination of forced draft and induced draft system. The forced draft FD fan overcomes the resistance in the APH and the induced draft ID fan overcomes draft losses through boiler, economiser, APH & connecting flues.

Advantages of Mechanical Draft

- i) Easy control of combustion & evaporation.
- ii) Increase the evaporative power of boiler.
- iii) Improve efficiency.
- iv) Reduce chimney height.
- v) Prevention of smoke.
- vi) Capability of consuming low grade fuel.
- vii) High draft.

Advantages of Forced draft over induced draft

- i) FD fan does not require water cooled bearings.
- ii) Tendency to air leak into the boiler furnace is reduced.

iii) No loss due to inrush of cold air through the furnace door.

iv) FD fan handles cold air so fan size is $1/5$ to $1/2$ of ID fan.

Main turbines

The steam turbine is a prime-mover in which the P.E of steam is transformed into K.E. and its form is transferred to mechanical energy (rotation of turbine shaft).

- The main parts are :-
- 1) Rotor. The rotor is fitted with a series of blades on its circumference.
 - 2) Bearing to support the shaft.
 - 3) Metallic casing which surrounds blades, nozzles, rotor.
 - 4) Governor to control speed.
 - 5) Lubricating oil system.

Advantages :-

- i) The thermal efficiency is higher.
- ii) Power generation is uniform. (Absence of flywheel).
- iii) Much higher speed is possible.
- iv) Large thermal stations can be installed.
- v) Balancing problem is minimized because of no reciprocating parts.

- vi) Internal Lubricating is not required because there is no rubbing parts.
- vii) No loss due to condensation.
- viii) It can carry high overload.



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Hydel Power Plant

Hydro-electric Power Plant

The energy of water is utilized to move the turbine which runs the electric generator. The kinetic & Potential energy of water is utilized to generate power.

Eg Hirakud dam
Catchment area = 83400 km^2 (32201^2 mile^2)
Turbines = Kaplan type
Power = Total 347.5 MW
Burla = P.H I = 2×49.5 , 3×37.5 , $2 \times 32 \text{ MW}$
Chiplima = P.H II = $3 \times 29 \text{ MW}$
Started 1957.
Cost = 1.01 billion Rs.

Type of dam = Composite dam & reservoir.

Height = 60.96 m

Length = 4.8 Km (main section)

25.8 km entire dam.

Spill ways = 64 slice-gates, 34 - crest-gates

Spill way capacity = $42450 \text{ m}^3/\text{second}$.

Advantages of Hydro-electric Plants

- 1) No fuel charges.
- 2) It is highly reliable.
- 3) Maintenance & operation charges are very low.
- 4) Running cost is low.
- 5) The plant has no stand by losses.
- 6) The plant efficiency does not change with age.
- 7) It takes a few minutes to run & synchronise the plant.
- 8) Less supervising staff is required.
- 9) No fuel transportation problem.
- 10) There is no pollution.
- 11) Used for flood control & irrigation purposes.
- 12) Long life (100 - 125 years) but thermal plants 20-45 yr.
- 13) No. of operations required is small as compared to thermal plants.
- 14) The m/c runs at low speed so there is no mechanical problems.
- 15) No special alloys are required.
- 16) It is away from developed area so land cost is low.

Dis-advantages :-

- 1) Initial cost of plant is high.
- 2) It takes long time to construct.
- 3) Such plants are away from load centre, so transmission line cost & losses is high.
- 4) The power developed is dependent on the quantity of water (weather).

Classification

A. According to availability of head.

- 1) High head power plant
- 2) Medium head " "
- 3) Low head " "

B. According to the nature of load.

- 1) Base load plant
- 2) Peak load " "

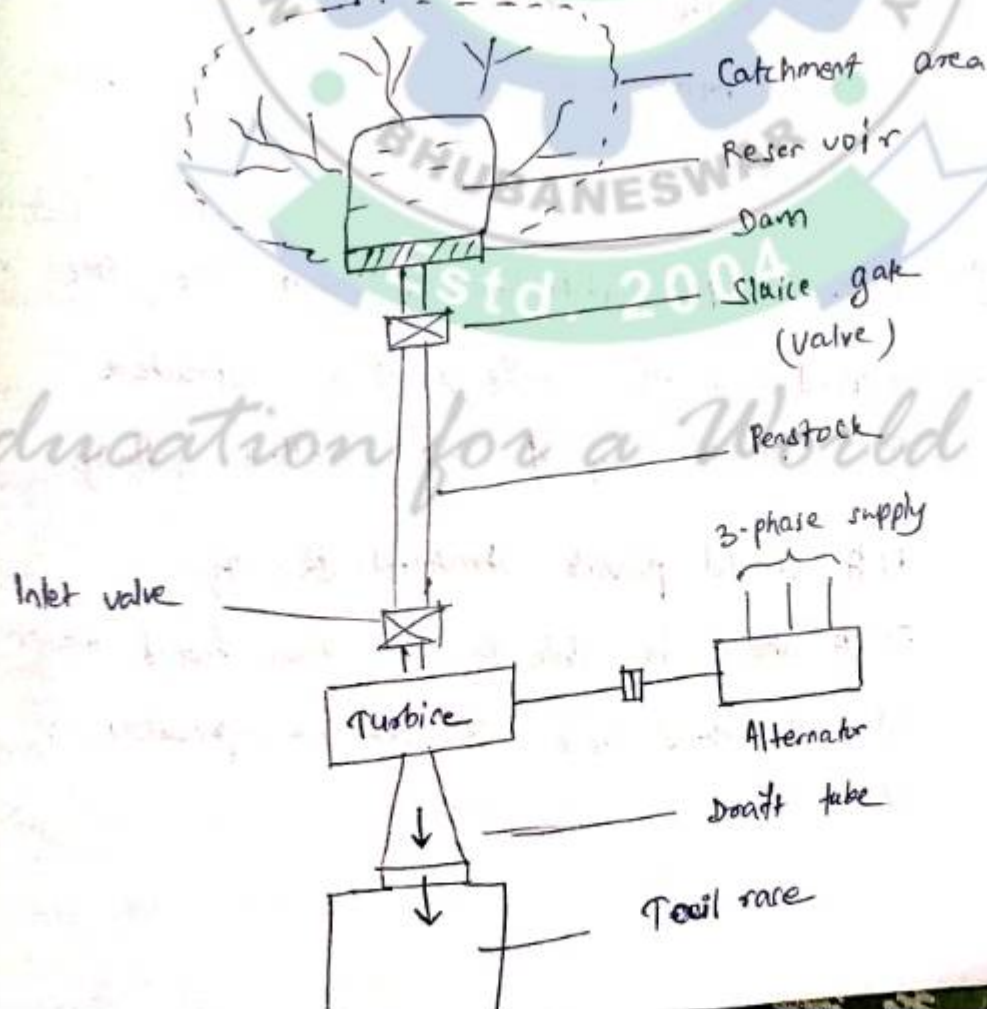
C. According to the quantity of water available.

- 1) Run-of-river plant without pondage
- 2) Run-of-river plant with pondage
- 3) Storage type plants.
- 4) Pump storage plants
- 5) Mini & micro-hydel plants.

Essential features of Hydro-electric power plant

1. Catchment area
2. Reservoir
3. Dam
4. Spill ways
5. Conduits
6. Surge tanks
7. Prime movers
8. Draft tubes
9. Power house & equipments.

Catchment area the whole area behind the dam draining into a stream or river across which the dam has been built at a suitable place is called catchment area.



Reservoir It is employed to store water -

1. Natural Reservoir (lake)
2. Artificial " (It is built by dam)

Dam It is a barrier to confine or raise water for storage or diversion to create a hydraulic head.

A. Fill dams

1. Earth dam
2. Rock-fill dam

B. Masonry dams

1. Solid gravity dam
2. Buttress dam
3. Arch dam

C. Timber dam.

Spill ways:- For stability of dam the excess water is relieved. This side channeling structure provided in the body of dam is called spillways.

- i) It should provide structural stability
- ii) It should be able to pass the flood water.
- iii) It should have an efficient operations
- iv) Economic.

Type of spillways

1. Overfall / solid gravity spillway.
2. Chute / through spillway.
3. Side channel "
4. Saddle spillway.
5. Emergency "
6. Shaft spillway.
7. Siphon spillway.

Conduits:-

It is a channel which leads water to a turbine and a tail race.

- 1) Open conduits → Canals, flumes
- 2) Close " → Tunnels, pipelines & penstock.

Canal:- It is a open water way excavated in natural ground.

Flume:- It is an open channel erected on the surface supported above ground on a trestle. (frame)

Tunnel:- It is a closed channel excavated through a natural obstruction such as ridge of higher land between the dam & powerhouse.

Pipeline:- It is a closed channel usually supported above the surface above the land.

Penstock :- It is a closed conduit for supplying water under pressure to a turbine.

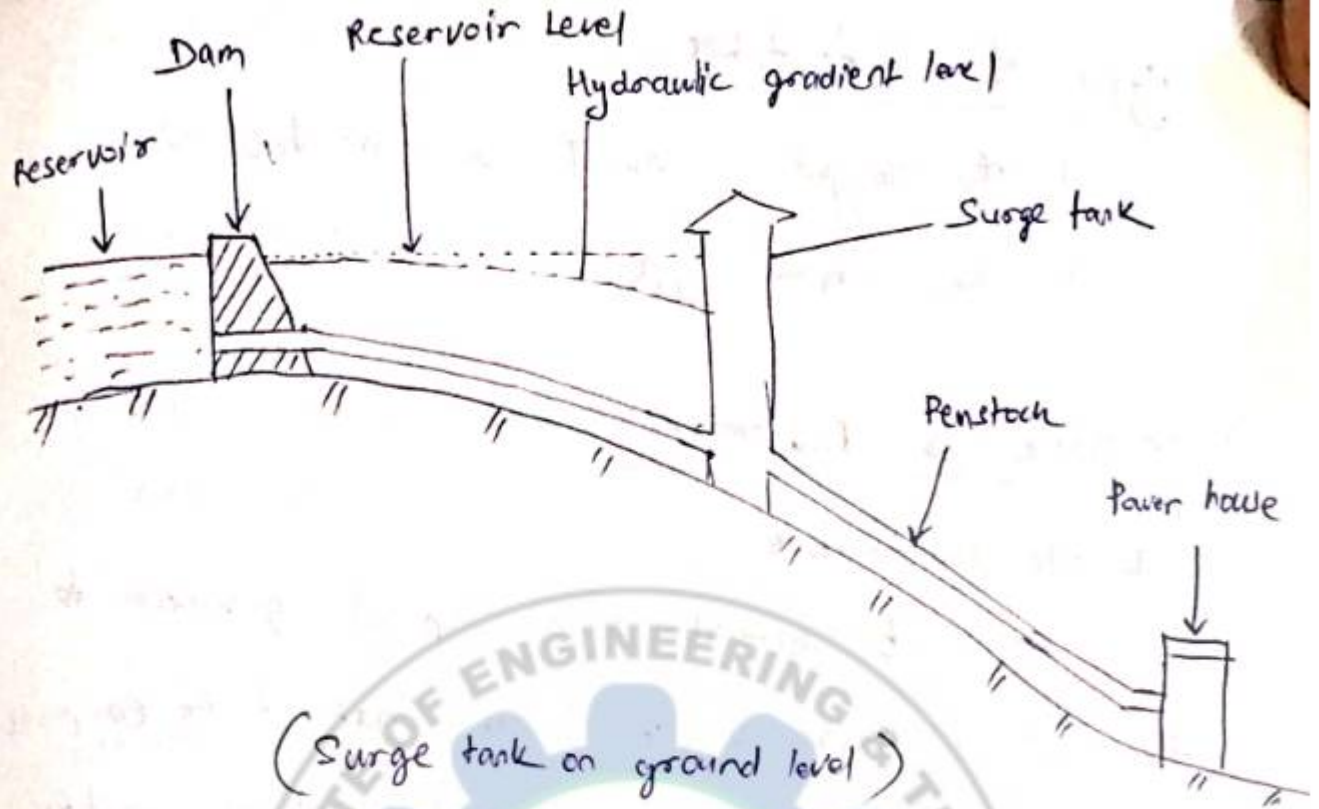
Surge tank :-

It is a small reservoir or tank in which the water level rises or falls to reduce the pressure.

- It reduces the distance between the free water surface & turbine.
- It serves as a supply tank to the turbine & also a storage tank.

Types of surge tanks

1. Simple surge tank.
2. Inclined "
3. The expansion chamber & gallery type "
4. Restricted orifice surge tank.
5. Differential " "



Prime movers :-

In an hydraulic power plant the prime mover converts the energy of water into mechanical energy & further into electrical energy.

1. Impulse turbine.
2. Reaction turbine.

Draft tubes :-

- It allows the turbine to be set above tail-water level with out loss of head to facilitate inspection & maintenance.
- It regains by diffuser action, the major portion of the K.E. delivered to it from the runner.

Types of draft tubes :

- 1) The straight conical or concentric tube
- 2) The elbow type.

Power House & Equipment

1. The substructure:-

This part extends from top of generator to the soil or rock & it houses most of the equipments. In case of Francis & Kaplan turbine it accommodates the draft tube also.

2. Intermediate structure It extends from to of the generator foundation to top of draft tube.

3. Super structure :- It is above the generation level.

It houses mostly cranes which handles heavy equipments

- i) Hydraulic turbines
- ii) Electric generator.
- iii) Governors
- iv) Gate valves
- v) Relief valve
- vi) Water circulating pump
- vii) Flow measuring equipments
- viii) Air duct.

x) Soften board equipments & instrument.

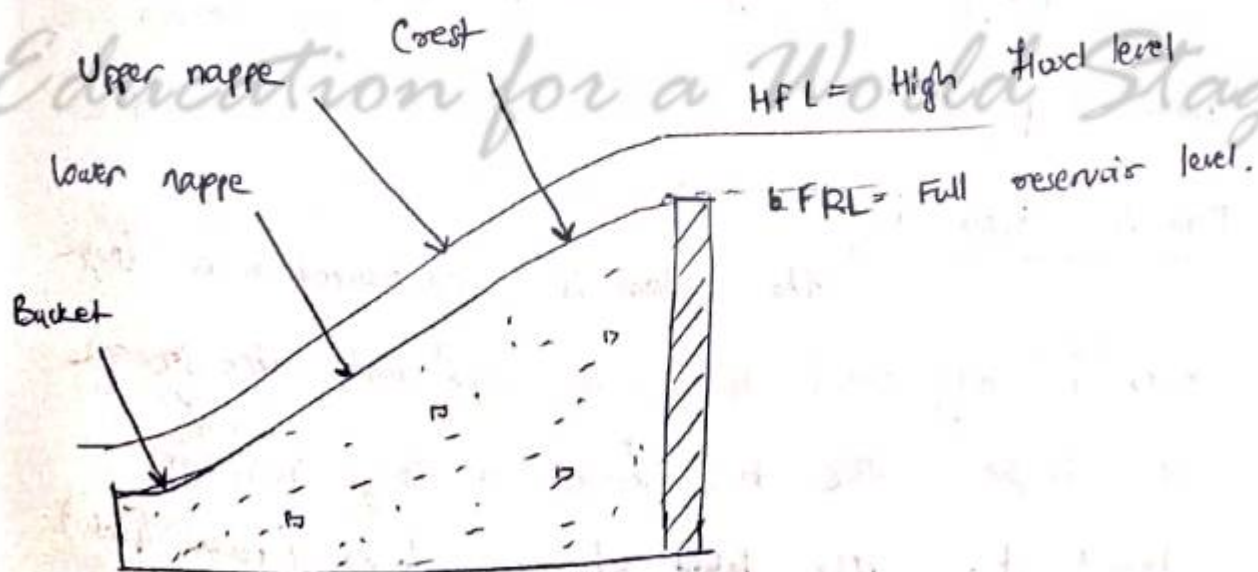
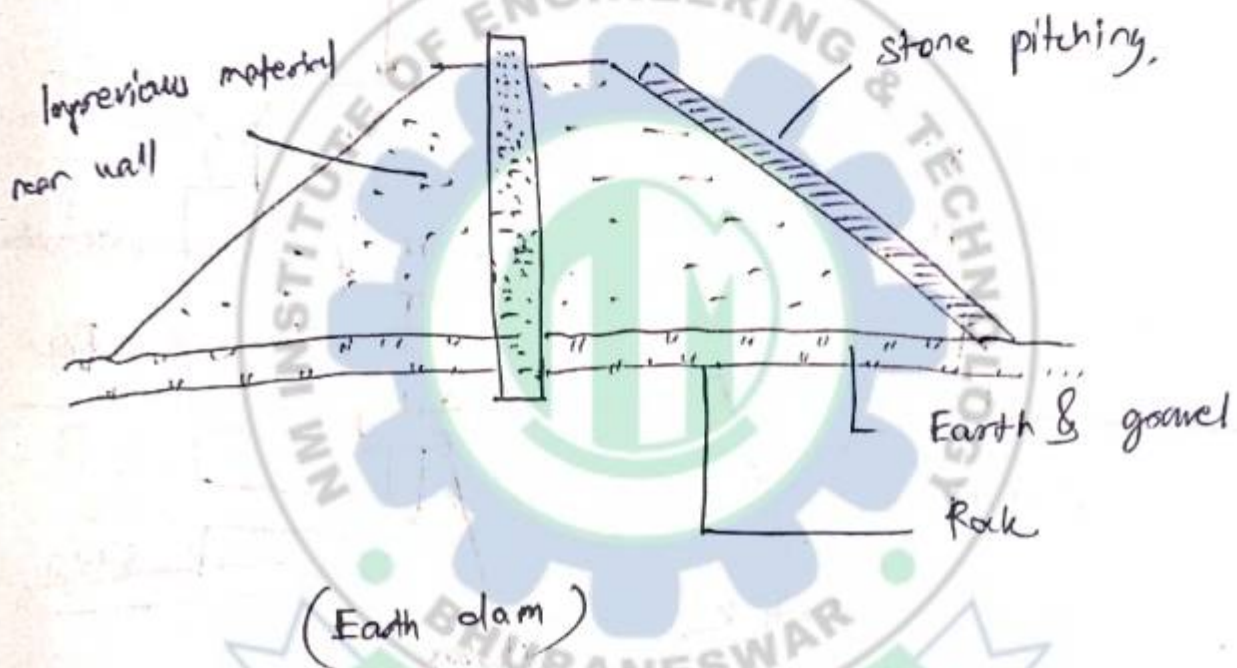
x) Oil circuit break

xi) Reactors

xii) low tension & high tension bar.

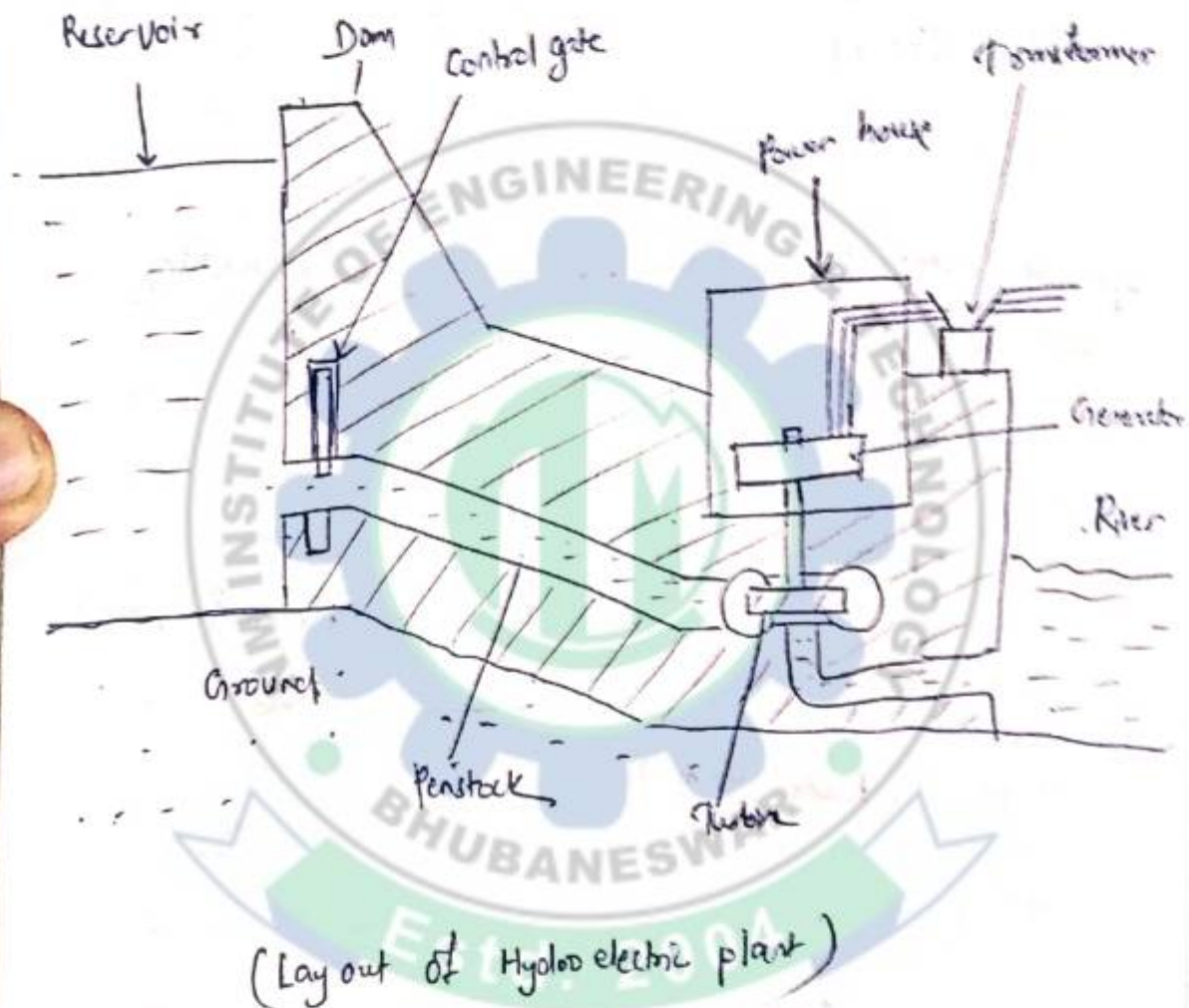
xiii) Storage batteries

xiv) Cranes.



(over fall spill way)

General arrangement of storage type hydroelectric power plant & its operation:



(Layout of Hydroelectric plant)

Basic components

Dam & Reservoir

The dam is constructed on a large river in hilly areas to ensure sufficient water storage at height. The dam forms a large reservoir behind it. The height of water level (water head) determines the amount of P.E. stored in water.

Control Gate

Water from the reservoir is allowed to flow through the penstock to the turbine. The amount of water that can be released in the penstock can be controlled by a control gate. When the control gate is fully open, maximum amount of water is released through the penstock.

Penstock

A penstock is a huge steel pipe which carries water from the reservoir to the turbine. P.E. of water is converted in to K.E. as it flows down through the penstock due to gravity.

Water Turbine :-

Water from the penstock is taken into the turbine. Turbine is mechanically coupled to an electric generator. K.E. of water drives the turbine and consequently the generator gets driven.

There are 2 main types turbine

- 1) Impulse turbine,
- 2) Reaction "

Impulse turbines are used for large heads.

Reaction turbines are used for low & medium head.

Generator :-

A generator is mounted in the power house and it is mechanically coupled to the turbine shaft. When the turbine blades are rotated, it drives the generator and electricity is generated which is then stepped up with the help of a transformer for transmission purpose.

Generation of electricity by hydro power is one of the cleanest method of producing electricity. It is the most widely used form of renewable energy.

DIESEL ENGINE POWER PLANT

A generating station in which diesel engine is used as the prime mover for the generation of electrical energy is known as Diesel engine power plant.

These are installed where supply of coal & water is not available in sufficient quantity, or where power is required in small quantity and stand by sets are required like hospitals, telephone exchanges, petrol pumps, radio stations etc.

Range = 2 to 50 MW.

Advantages :-

Applications

- Peak load plant
- Mobile plant
- Stand-by unit
- Emergency plant
- Nursery station
- Starting station
- Central station
- Industrial use.

Advantages :-

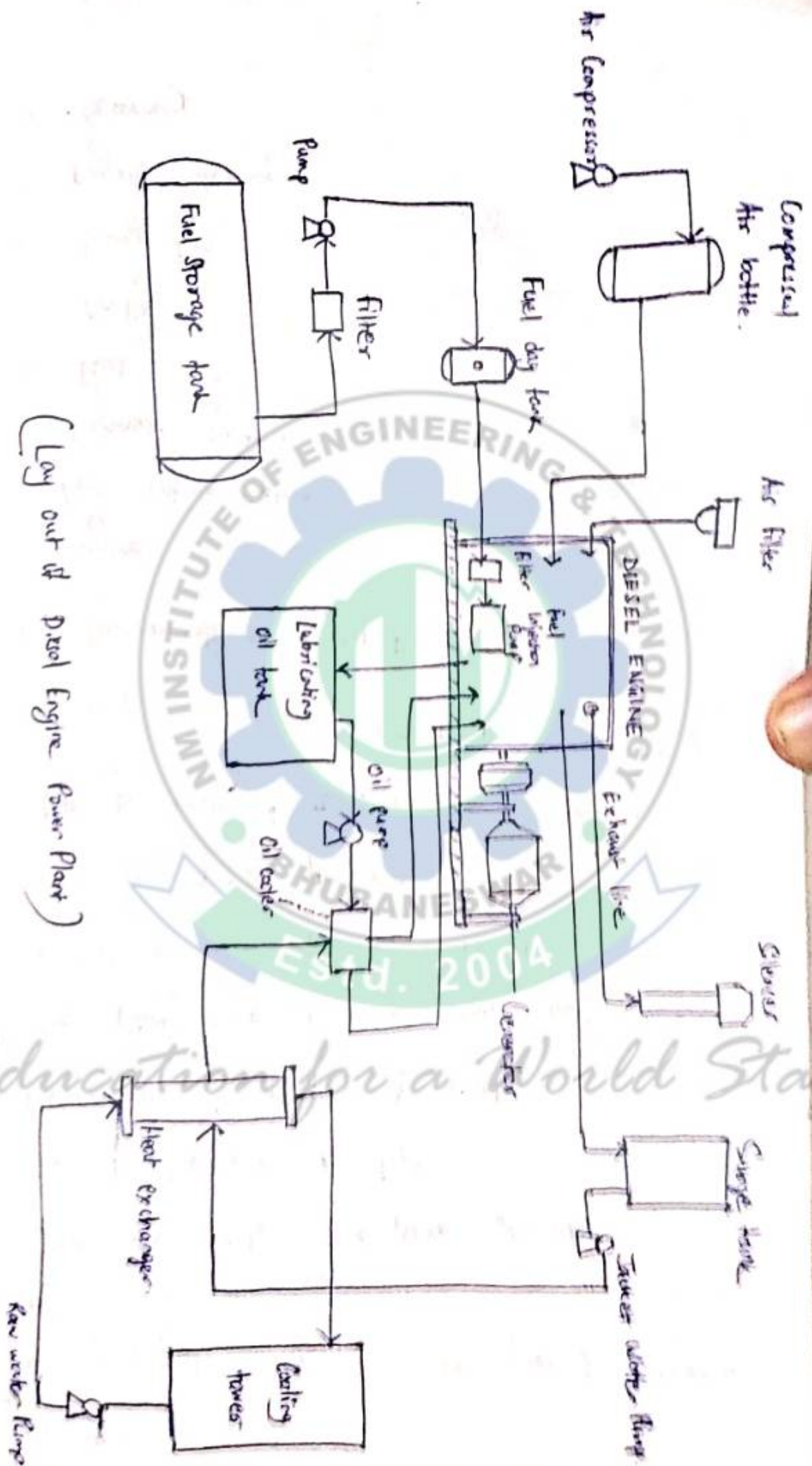
1. Design & installation are very simple.
2. It can respond to varying loads with out any difficulties.
3. Stand by losses are less.
4. Less space is required.
5. Can be started & put on load quickly.
6. It can also be designed for portable use.
7. It can be stopped quickly & easily.
8. Cooling system is easy & require less water.
9. Initial cost is less than other power station.
10. Thermal efficiency of diesel is higher than coal.
11. It requires less operating staff.
12. Overall cost is less.
13. It can use wide range of fuels.
14. These plants can be located very near to the load centre.
15. No need of ash handling.
16. Lubrication system is more economic.

Dis. advantages

1. Running cost is high as the price of diesel is high.
2. Used for only small power generation.
3. Cost of lubricants is high.
4. Maintenance is complex & costly.
5. The plant does not work satisfactorily under overload condition for longer period.
6. Noise is a big problem.
7. Life is small (2 to 5 year) where as (steam power plant 20 - 30 year)

Essential Components of Diesel Power Plant

1. Engine
2. Air Intake system
3. Exhaust system
4. Fuel
5. Cooling
6. Lubricating
7. Engine starting
8. Governing



(Lay out of Diesel Engine Power Plant)

Engine:-

It is the main component of the plant which develops power. It is directly coupled with the generator.

2 types:- i) four stroke diesel engine.

ii) 2 " " " "

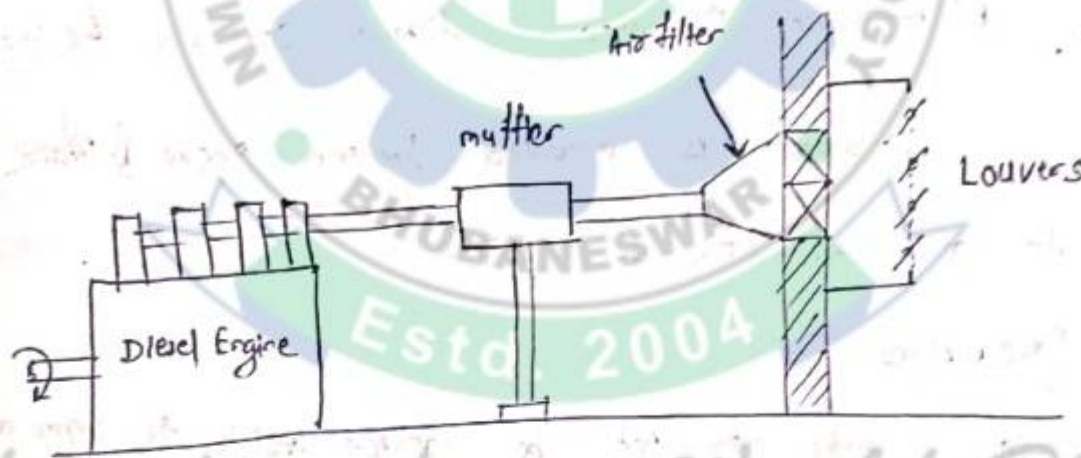
Air Intake system:-

It conveys fresh air to the

i) Air intake manifold of 4-stroke engines

ii) Scavenging pump inlet of a 2-stroke engine.

iii) Supercharger inlet of a supercharged engine.



The intake located outside the building provided with a filter to catch dust which would cause extensive wear in the engine.

Light weight steel pipe is used as inlet duct.

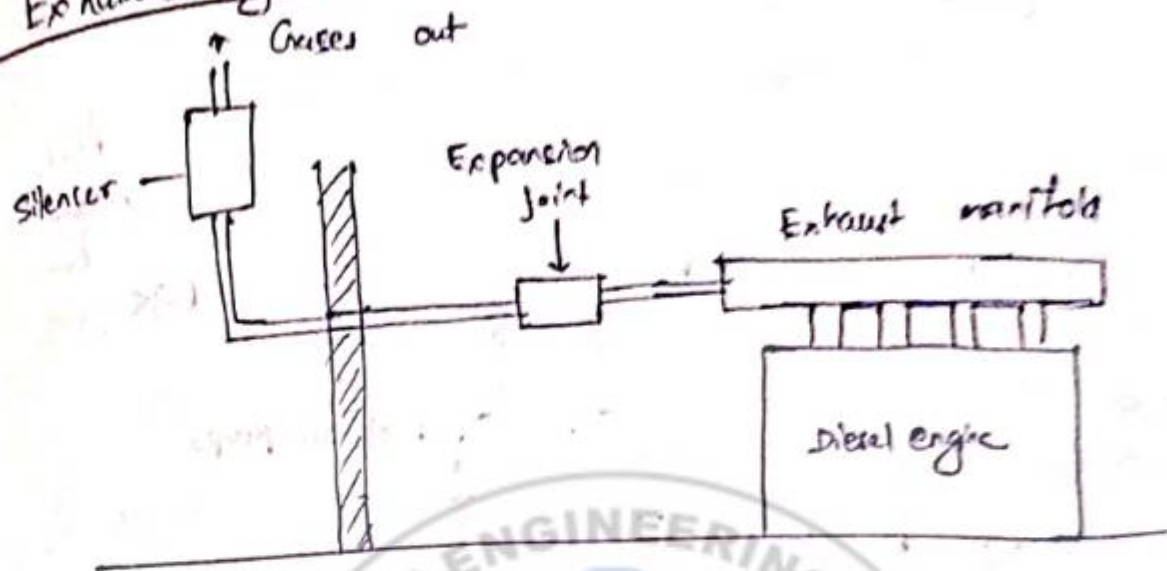
Many types of filters can be used.

- Oil impingement type of filter consists of a frame filled with metal shavings which are coated with oil so that the air passing through the ~~frame~~ frame can seize & hold the dirt particles.
- The dry type filters are made of cloth, felt, glass wool etc.
- In oil bath type of filter the air is swept over through a pool of oil so that the particles of dirt become coated.
- Electrostatic Precipitator filters can also be used.
- Silencer is provided between engine & intake to arrest the noise of engine.

Precautions

- Air intake may not be located inside the engine room.
- Air should not be taken from a confined space.
- The air intake pipe should neither have small diameter nor large diameter.
- Air intake filter may not be located close to the engine room roof.
- Air intake filter should not be located in an inaccessible location.

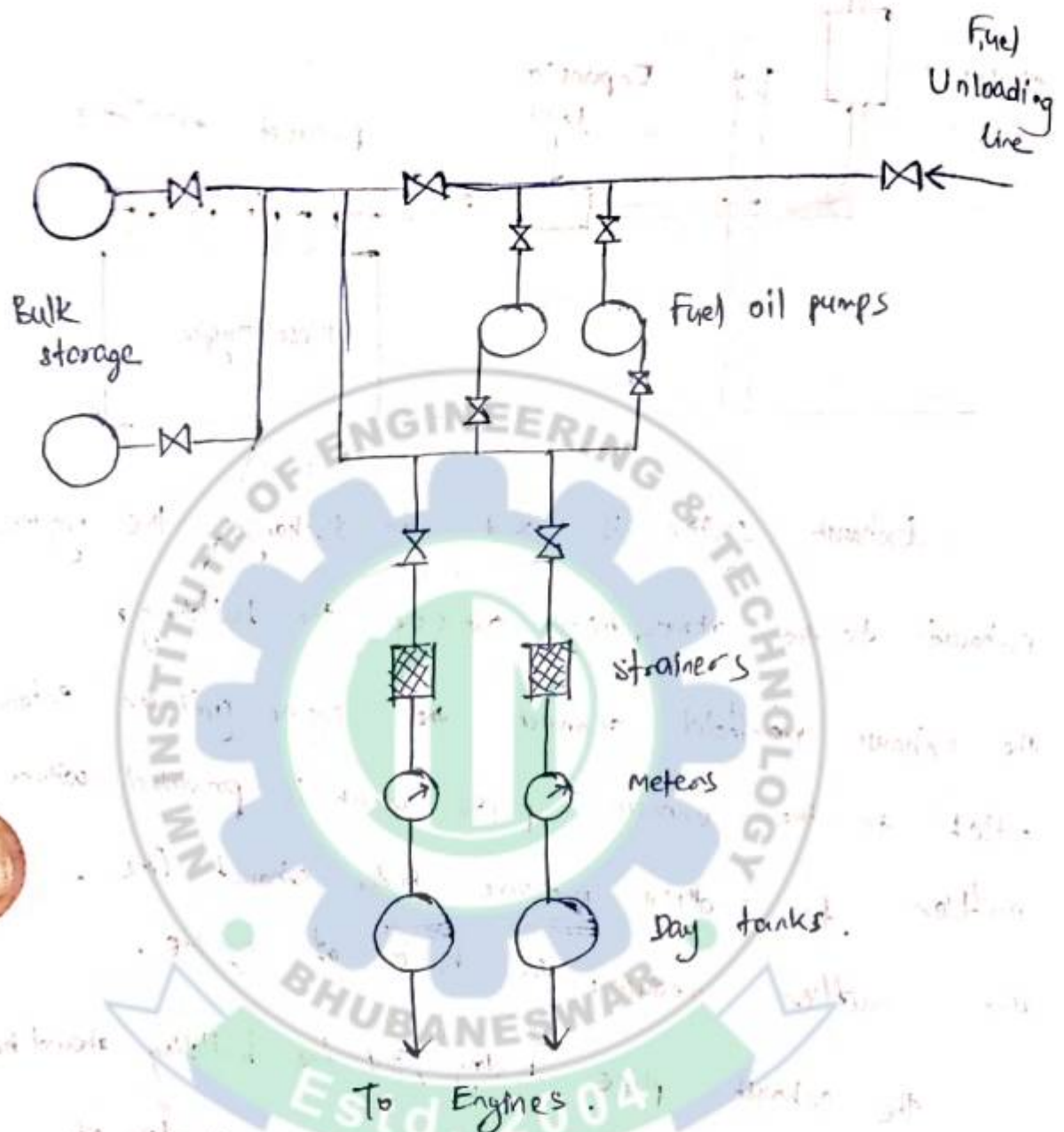
Exhaust system:-



Exhaust system is used to discharge the engine exhaust to the atmosphere outside the building. The exhaust manifold connects the engine cylinder exhaust outlet to the exhaust pipe which is provided with a muffler to reduce pressure in the exhaust line. The muffler reduces the noise of engine.

The exhaust pipe leading out the building should be short in length, with having minimum number of bends. It should have one or two flexible & tubing sections which take up the effects of expansions & isolate the system from engine vibration.

Every engine should have its independent exhaust system.



The fuel oil may be delivered at the plant site by tanks, railroad tank to the main storage tanks. Then it is transferred to the small storage tank called day tank.

The main flow line is arranged with necessary
reducers, by passes, shut-off, drain lines, relief
valve, strainers & filters, flow meters, & temperature
indicators.

The tank should contain man-hole for internal access
& repair, fill line to receive oil, vent lines to
discharge vapours & overflow line.

At least one month's requirement amount of oil
should be kept in the storage tank. The day
tank provide daily need of oil to the engine.
The day tanks are placed high so that oil may
flow to engine under gravity.

- There should be clean lines & provided for pipe lines.

- Changing over of lines during emergencies.

- In all section once the pipe joint should be made tight.

- Before covering the pipe line should be tested
through air pressure & joints should be tested by
soap solutions.

- Piping between filter & engine should be oil flushed.

- High grade filters should be used,

Fuel Injection System :-

A very small quantity of fuel is measured, injected, atomised and mixed with combustion air.

In diesel engine atomized fuel is sprayed in the cylinder under pressure usually ranging from approximately 100 to 120 kg/cm².

Functions of fuel injection system :-

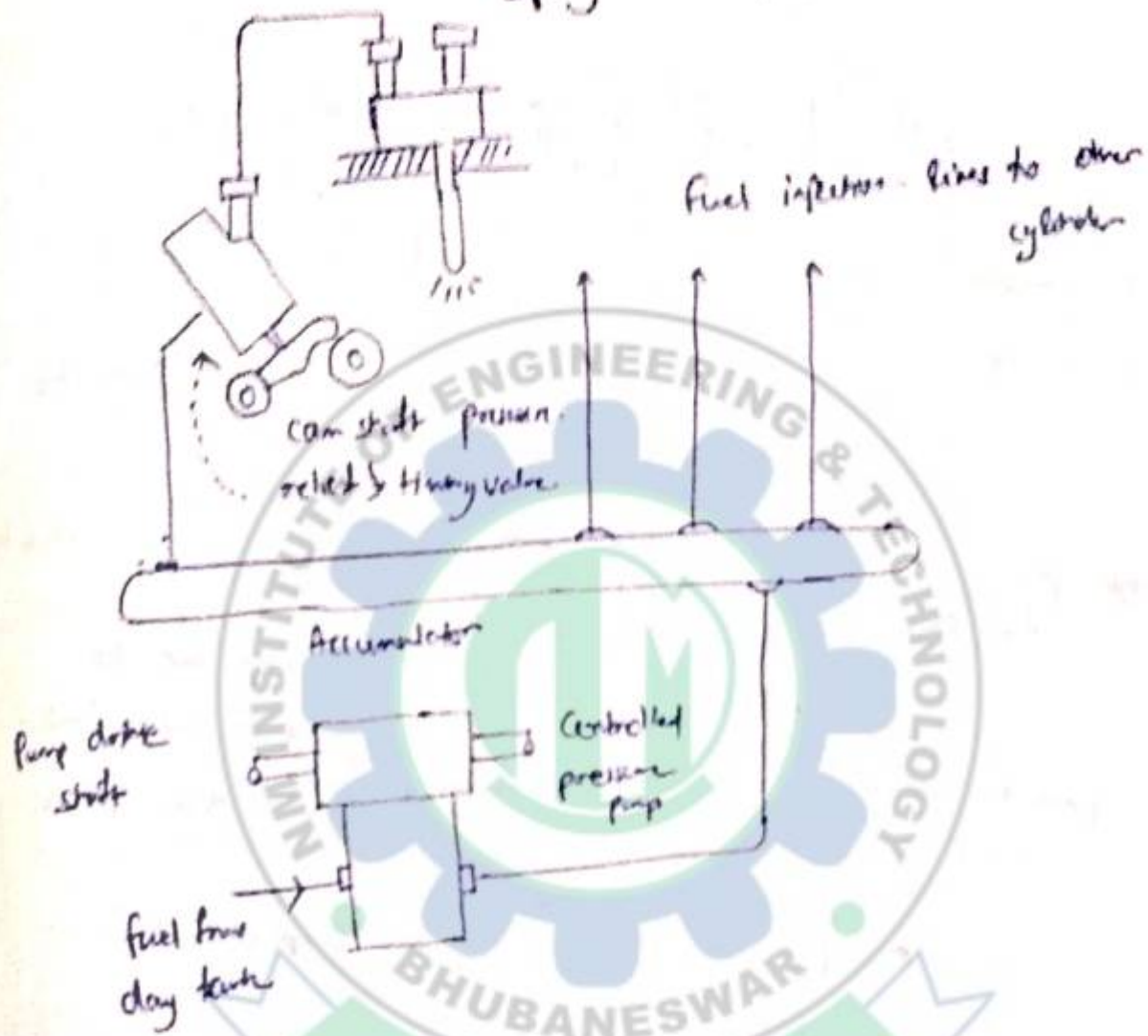
- Filter the fuel.
- Meter or measure the correct quantity of fuel.
- Time the fuel injection.
- Control the rate of fuel injection.
- Atomise the fuel.
- Properly distribute the fuel in the combustion chamber.

Types of fuel injection system

1. Common-rail injection system.
2. Individual pump.
3. Distributor.

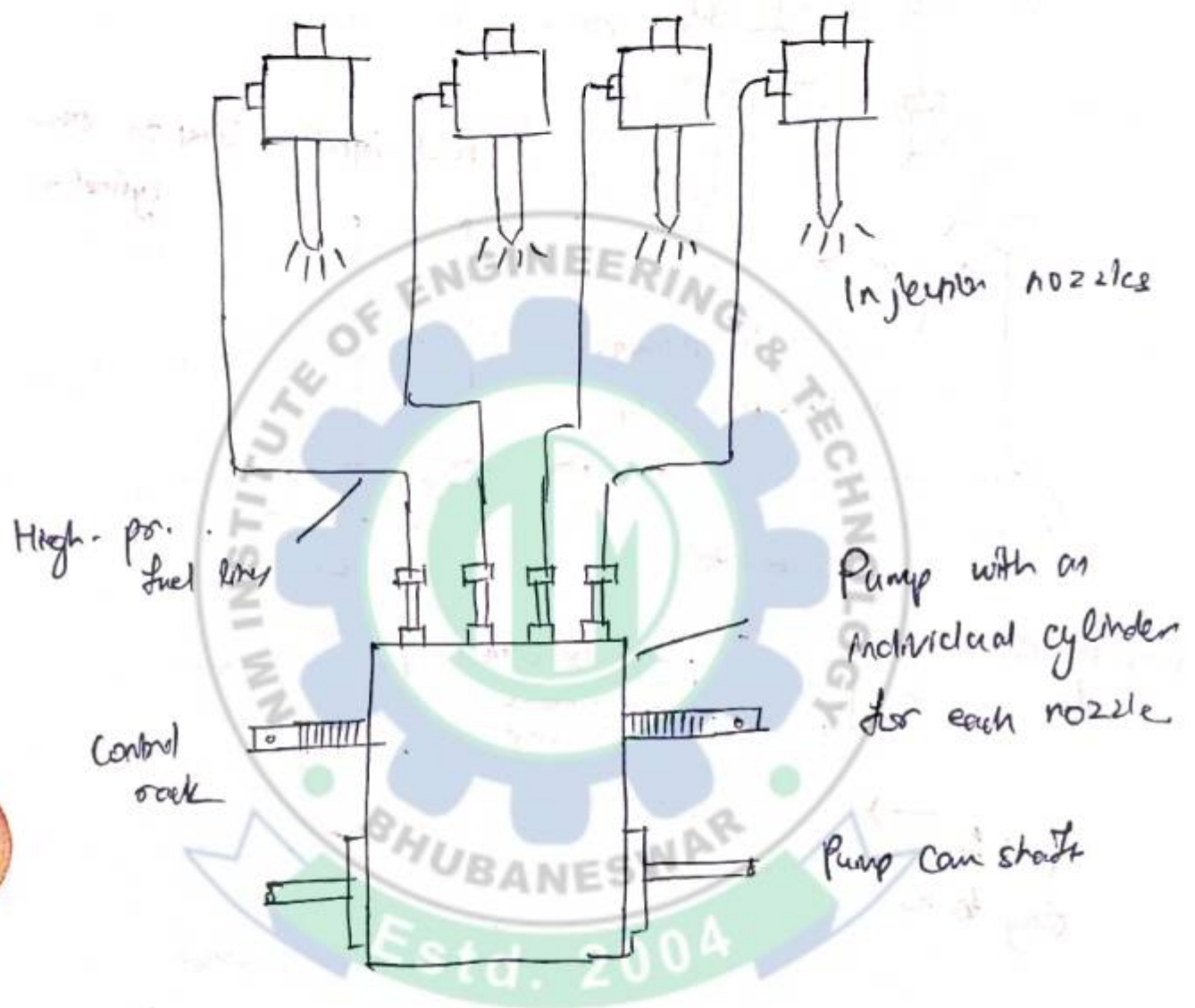
Common rail injection

Spring loaded spray valve



A single pump supplies high pressure fuel to header, a relief valve holds pressure constant. A controlled pressure system has pump which maintains set head pressure. pressure relief & timing valves regulate injection time & amount.

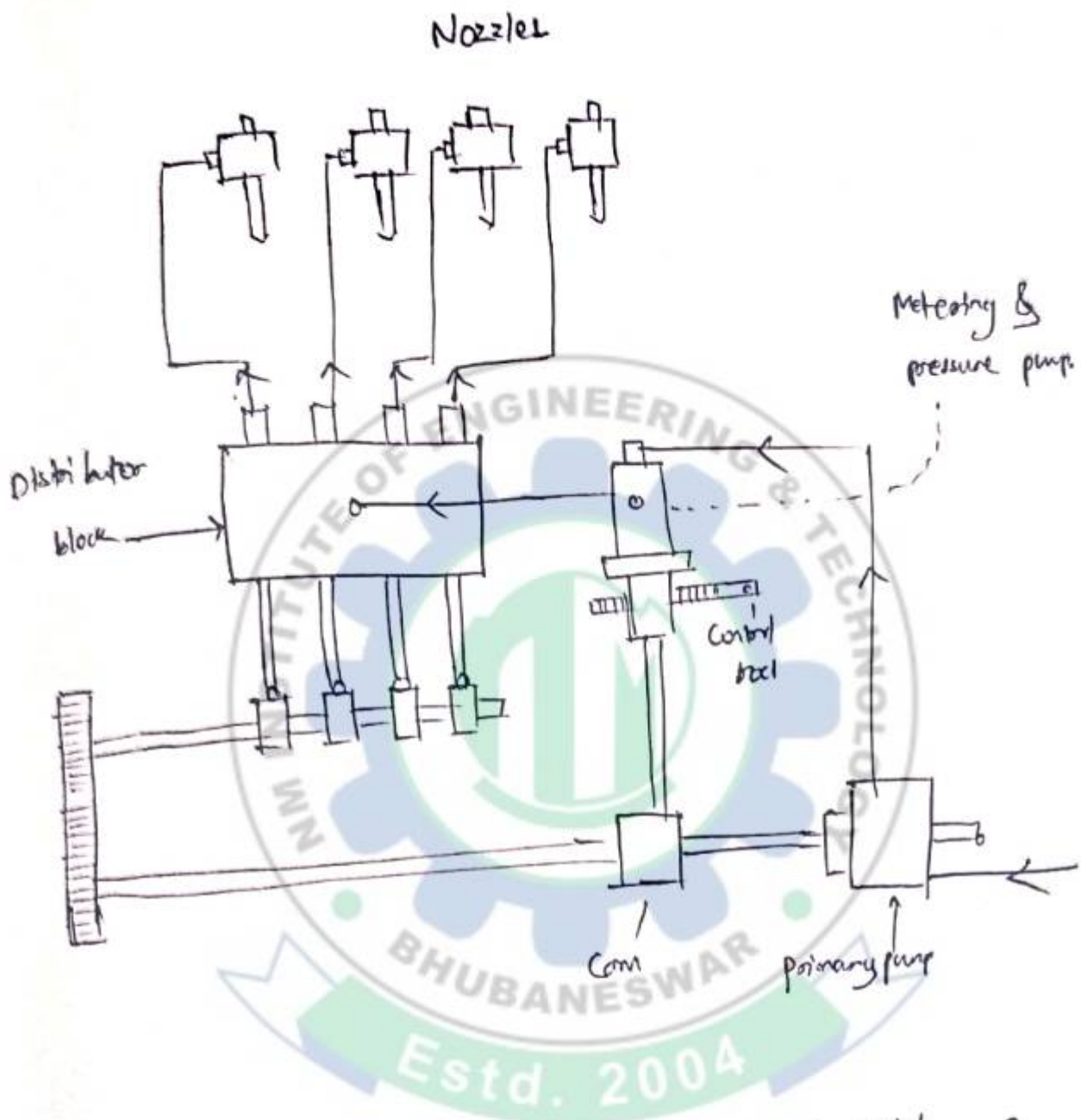
Individual pump injection



An individual pump or pump cylinder connects directly to each fuel nozzle.

Pump meter charge & control injection timing.
Nozzle contains a delivery valve actuated by the fuel-oil pressure.

Distributor injection



The fuel is metered at a central point, a pump pressurises the fuel & times the injection. From here; the fuel is distributed to cylinders in correct firing order by cam operated poppet valves which open to admit fuel to the nozzles.