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Chapter – 1 Thermal Power Station

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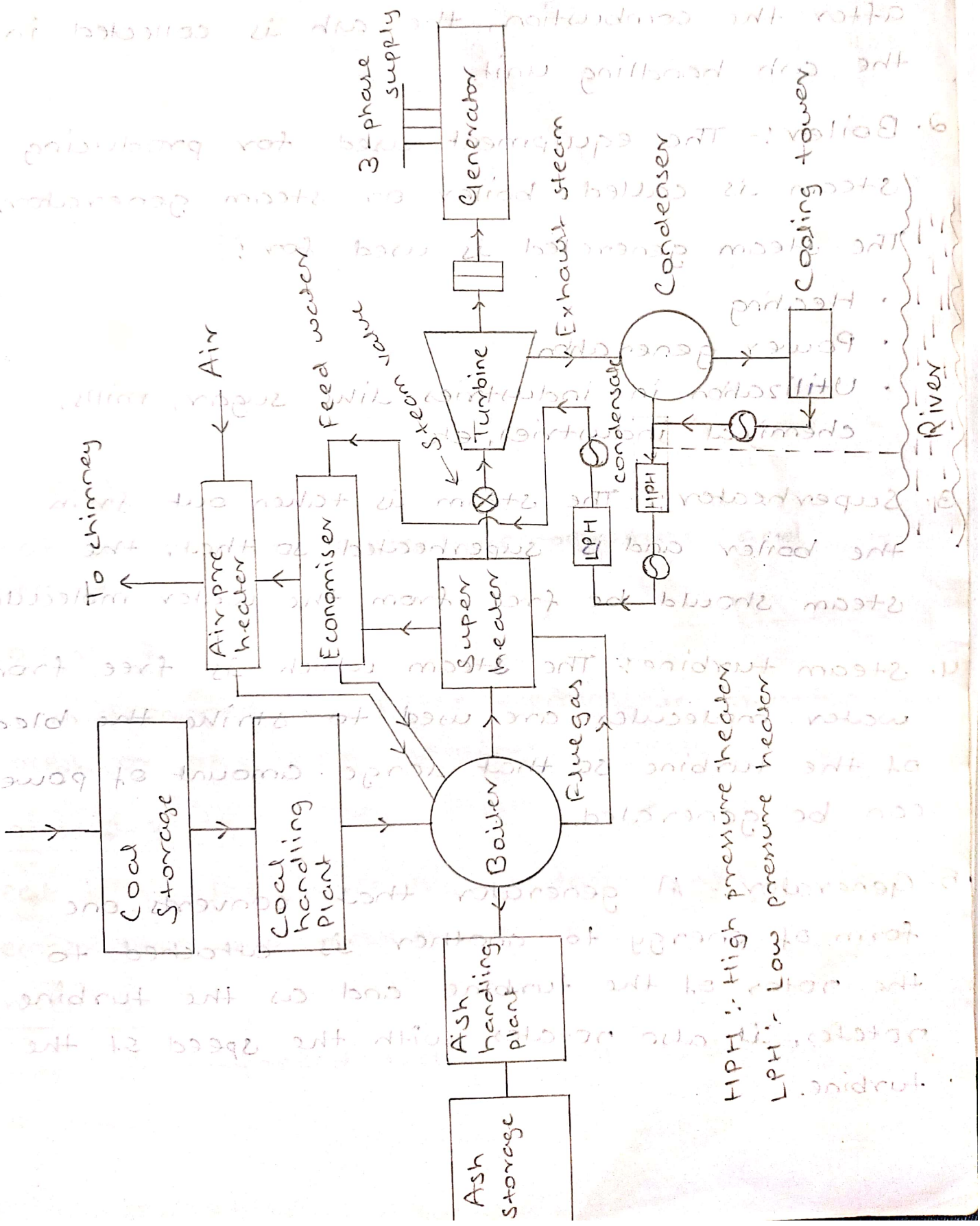
Steam power plant:-

layout of steam power plant :-



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1. Coal and Ash handling unit :-
Before feeding the coal to the furnance, it is to be converted into pulverized form and after the combustion, the ash is collected in the ash handling unit.

. Boiler :- The equipment used for producing steam is called boiler or steam generator.
The steam generated is used for :

- Heating
- Power generation
- Utilization in industries like sugar, mills, chemical industries, etc.

. Superheater :- The steam is taken out from the boiler and is superheated so that, the steam should be free from the water molecules.

1. Steam turbine :- The steam which is free from water molecules are used to strike the blade of the turbine so that large amount of power can be generated.

5. Generator :- A generator that converts one form of energy to another is attached to the rotor of the turbine and as the turbine rotates, it also rotates with the speed of the turbine.

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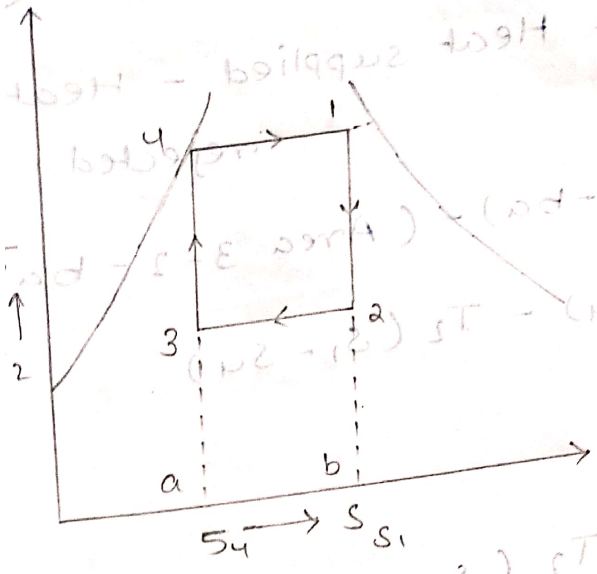
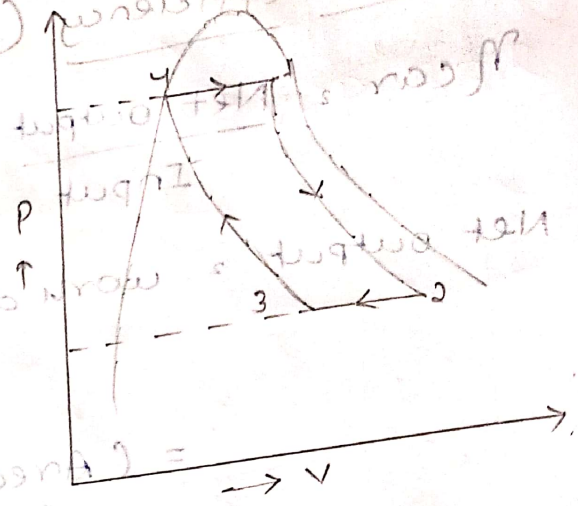
Carnot cycle





Process 4-1

Heat supplied at constant temperature and pressure.

Process 1-2

Steam expanded inside the turbine in isentropic process. or reversible adiabatic process.

Process 2-3

Heat is rejected inside the condenser at constant temperature and pressure process.

Process 3-4

Steam is compressed isentropically inside the compressor.

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* Carnot efficiency (η_{car})

$$\eta_{car} = \frac{\text{Net output}}{\text{Input}}$$

Net output = work done = Heat supplied − Heat rejected

$$= (\text{Area } 4\text{-}1\text{-}b\text{-}a) - (\text{Area } 3\text{-}2\text{-}b\text{-}a$$

$$= T_1 (S_1 - S_4) - T_2 (S_1 - S_4)$$

$$\text{Input} = T_1 (S_1 - S_4)$$

$$\eta_{car} = \frac{T_1 (S_1 - S_4) - T_2 (S_1 - S_4)}{T_1 (S_1 - S_4)}$$

$$\boxed{\eta_{car} = \frac{T_1 - T_2}{T_1}}$$

Carnot efficiency is an ideal efficiency. It is used for comparison of efficiency with other cycles. Carnot cycle cannot be applied in steam power plant due to following reasons.

* Limitations

i) It is very difficult to compress wet vapour inside the compressor as in process 3-4.

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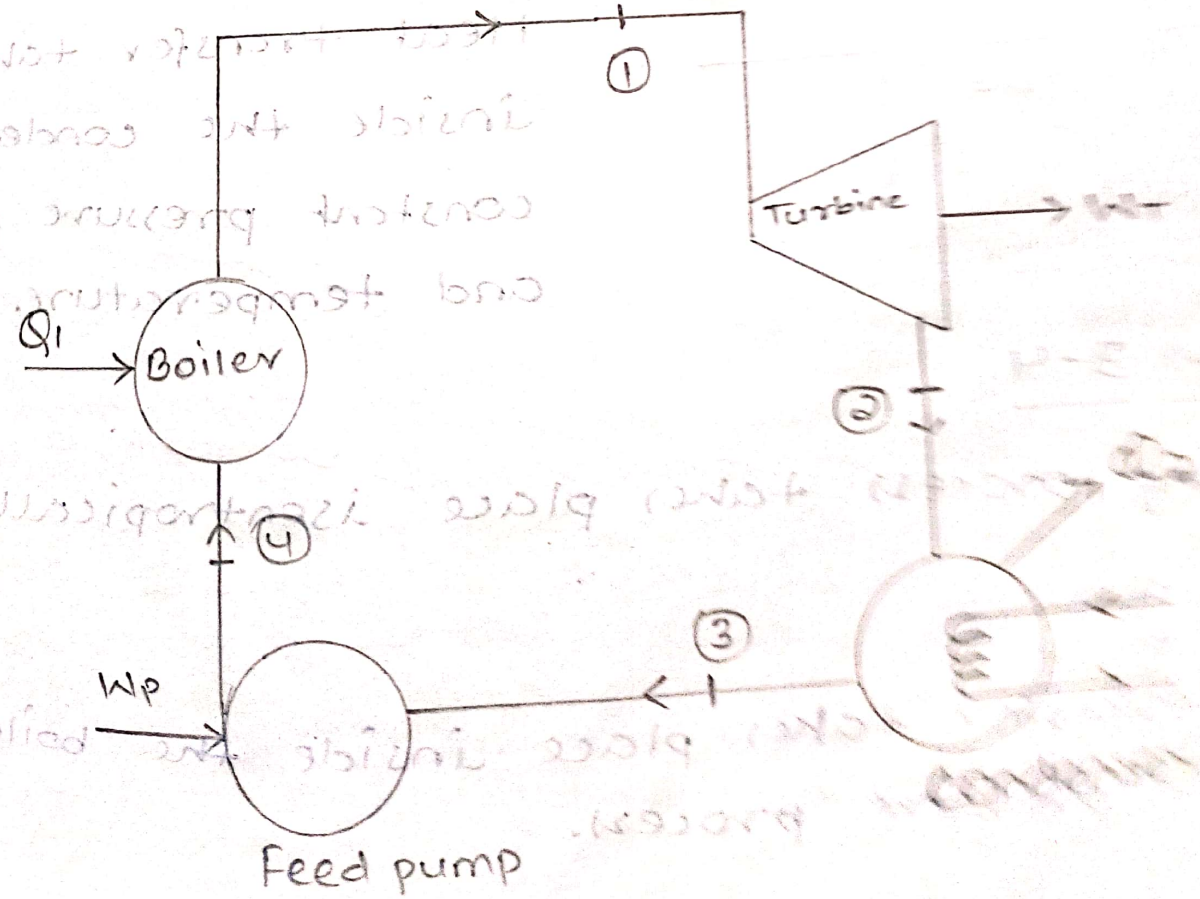
ii) It is difficult to maintain the quality of condensate coming out from condenser to acheive state 3.

iii) It is difficult to operate the cycle using superheated steam at constant temperature.

iv) Since carnot efficiency depends on temperature T_1, the efficiency will be affected by wet vapour.

* Rankine cycle



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