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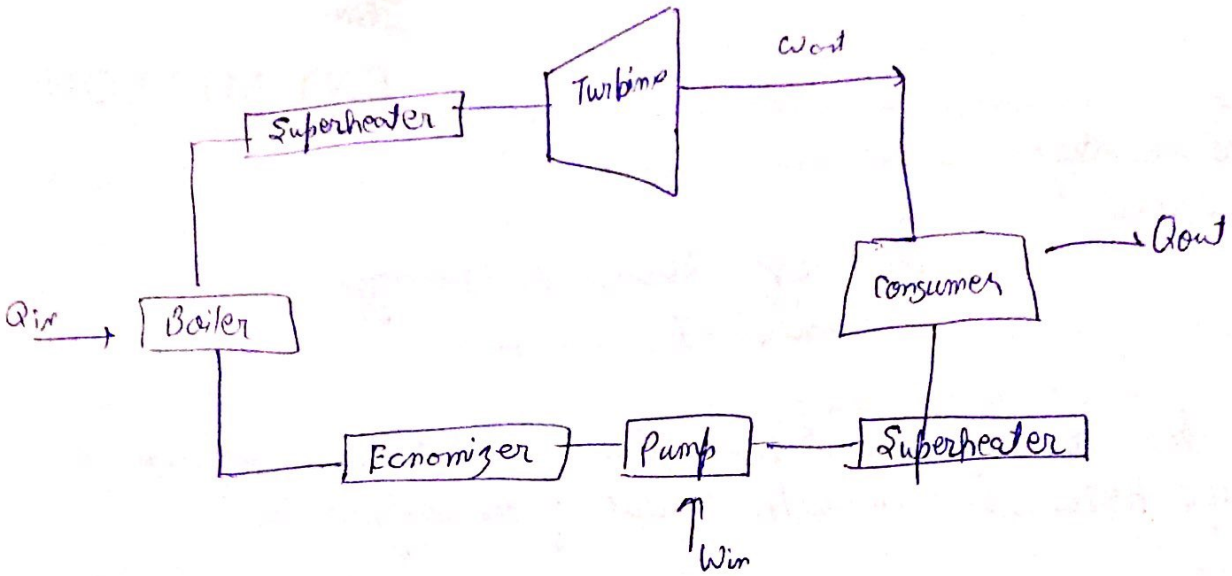
Renewable Energy Science & Technology
Assignment II

Q1. In the case of thermal power plant, what is the use of a "Super Heater"? [Discuss with concept of thermodynamics].

Ans1. A superheater is a vital part of a solar system that is used to increase the overall efficiency of a thermal power plant. More specifically it is a device which converts wet steam (saturated steam) into dry steam as dry steam contains more thermal energy. Dry steam is also less likely to condense within the engine cylinders or the casing of a steam turbine.
Superheated steam is used in steam turbines for electricity generation steam engines and in process such as steam reforming. Industrial super heaters are classified as follows.
Radian Superheaters
Convection Superheater
Separately Fired Superheater.
Benefits of Superheaters in Boilers.
- Increase in efficiency of the steam power plant
- Minimised erosion of turbine blade
- Less steam consumption
- Reduction of Condensation loss in the boiler Steam Pipes.



Superheater is a Part of a Boiler

The proces of Superheater is the only way to increas the peak temp. of the Rankine-cycle (and to increase efficiency) without increasing the boiler pressure.

Q2. What is your understanding about the "Criticaley" in a controlled nuclear chain reaction?

Ans2. Nuclear fission is the proces of splitting apart (nuclei) (usually large nuclei). When large nuclei such as Uranium-235 fisions, energy is released. Amount of energy released is so huge that there is measurable decrease in mass from mass energy equivalence. This means some of the mass gets converted to energy.

$$ {}^{1}_{0}n \longrightarrow {}^{236}_{92}U \longrightarrow {}^{144}_{56}Ba + {}^{89}_{36}Kr + 3\,{}^{1}_{0}n + \Delta $$

U_{236} (compound nucleus is instable) oscillates.

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Nuclear Chain Reactions are reactions when nuclear energy is obtained, generally through nuclear fission these chain reaction provide nuclear power plants with energy that is then converted to ~~ex~~ electricity. In these reaction neutrons generated by fission process continue to indicate fission in other atoms. These reaction usually occur with heavy isotopes like U-235 where there is continuous telescope & absorption of neutrons. If atleast one neutron from each fission strikes another U-235 nucleus and initiates fission, the chain reaction is sustained and is said to be critical

In criticality there is a steady rate of power generation by controlling the nuclear chain reaction. The reproduction constant k is defined as the average number of neutron from each fission which subsequently cause another fission. In nuclear reactors, the reaction is moderated and progress at a slow pace to release is energy over a period of time so that it can be harnessed and used for peaceful purposes.

Let N be the number of generation required to double the reaction rate

$$N = \frac{\ln 2}{\ln(1.001)} = 693 \text{ generations to double the reaction rate}$$

Total time for double generation if 0.001 sec is generation time of a fission $= \frac{693}{0.001} = 0.693$ seconds

Q3. Explain the working principle of ground source Heat Pump (GSHP) with the concept of thermodynamics? Why GSHP is a better choice for heating than a conventional fuel Heater in term of energy saving?

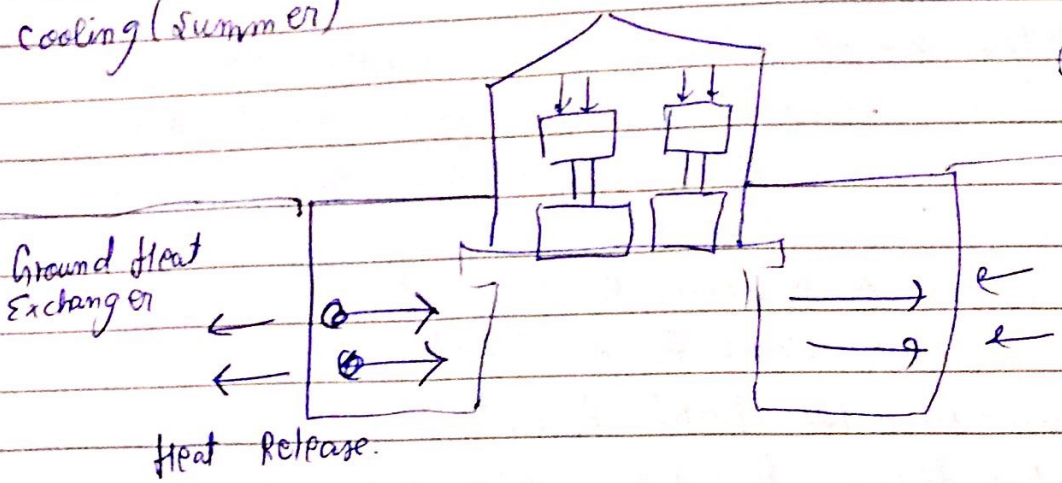
Ans 3. The purpose of heat pump is to absorb low grade heat pump (GSHP) is a central heating and/or cooling system that transfer that to or from the ground it uses. Earth's relativity constant temperature b/w 16-24°C at a dept of 20 feet to provide heating, cooling of hot water for homes and commercial buildings. GSHP harvests heat absorbed at the Earth's surface from solar energy. The temp in the ground below 6 meters (20 ft) is equal to the mean annual air temperature at the latitude at the surface. The mean annual air temperature at that latitude at the surface. It uses earth as heat source (in winter) or heat sink (summer)

Working Principle of GSHP

~~Ref~~ Refrigeration Cycle → It ~~or~~ carries heat from one space to another. The heat pump's process can be reversed. The earth is the main source & sink of a heat. In winter it provides heat and in summer it takes heat.

Common GHPs

- Earth-Couple (Closed loop)
- Water-Source (Open loop)



Q4. Explain the following terms.

(1) Installed capacity of a Power Plant :- Is the nominal / design rated power output which it can supply continuously under normal operating ~~System~~ conditions. This is the capacity counted when estimating overall installed capacity of a state or a nation.

(2.) Capacity factor of a power plant : Is the ration of total actual ~~or~~ energy produced or supply over a definite period, to the energy that would have been produced if the plant (generating) had operated had operated continuously at the maximum rating. Capacity factor vary greatly depending on the type of fuel that is used and the design of the plants. This ratio is imp because it indicates how fully a unit's capacity is used.

(3)(a) Base load Power Plant : Usually provides a continuous supply of electricity throughout the year with some minimum power generation requirement.

Characteristics are → 1) very large and highly efficient
→ 2) often called slow assets due to its slow response to changes in demand.

Examples are
- Nuclear Power Plant
- Coal Power Plant.

(b) Intermediate load Power Plant: Power Plant that are used during the transition between base load & peak load demand. These plants are not as difficult to ramp up as base load or as expensive to operate as peak load plant.

Example are
- ~~Wind~~ Solar Plant
- Wind Plant

(c) Peak load Power Plant: Is a plant that generally runs only when there is a high demand known as peak demand for electricity. These are dispatched in combination with base load power plants to meet the minimum demand.

example are :
- Gas Plant
- Wind Turbine

(d) Binary Geothermal Power Plant: Allow cooler geothermal reserves to be used than is necessary for dry steam and flash steam plants. Binary cycle geothermal plant differ from dry Steam and flash steam systems in that the water or steam from geothermal reservoir never comes in contact with turbine/ generator units.