CMR INSTITUTE OF TECHNOLOGY

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Internal Assesment Test – 2

Sub: ENERGY ENGINEERING				Code: 18ME81
Date: 04/06/2022	Duration: 90 mins	Max Marks: 50	Sem: 8	Branch (sections): ME (A,B)

Answer all five questions.

		Marks	OBE CO	OBE RBT
1	What are the major problems associated with wind power? Explain with neat sketch, Vertical axis type wind mill.	[10]	CO3	L2
2	With a sketch, explain the working of "Hot dry rock" geothermal plant.	[10]	CO3	L2
3	Explain the typical horizontal axis wind mill, with a neat sketch.	[10]	CO3	L2
4	A horizontal shaft, propeller type wind turbine is located in area having the following wind characteristics: Speed of wind 10 m/s at 1 atm and 15 deg C. Calculate the following: i) Total power density in wind stream, W/m^2. ii) Maximum possible obtainable power density in W/m^2. iii) Actual obtainable power density in W/m^2 assuming 40% efficiency. iv) Total power from the wind turbine of 120 m diameter.	[10]	CO3	L3
5	With a schematic diagram, explain the working of vapour dominated geothermal power plant.	[10]	CO3	L2

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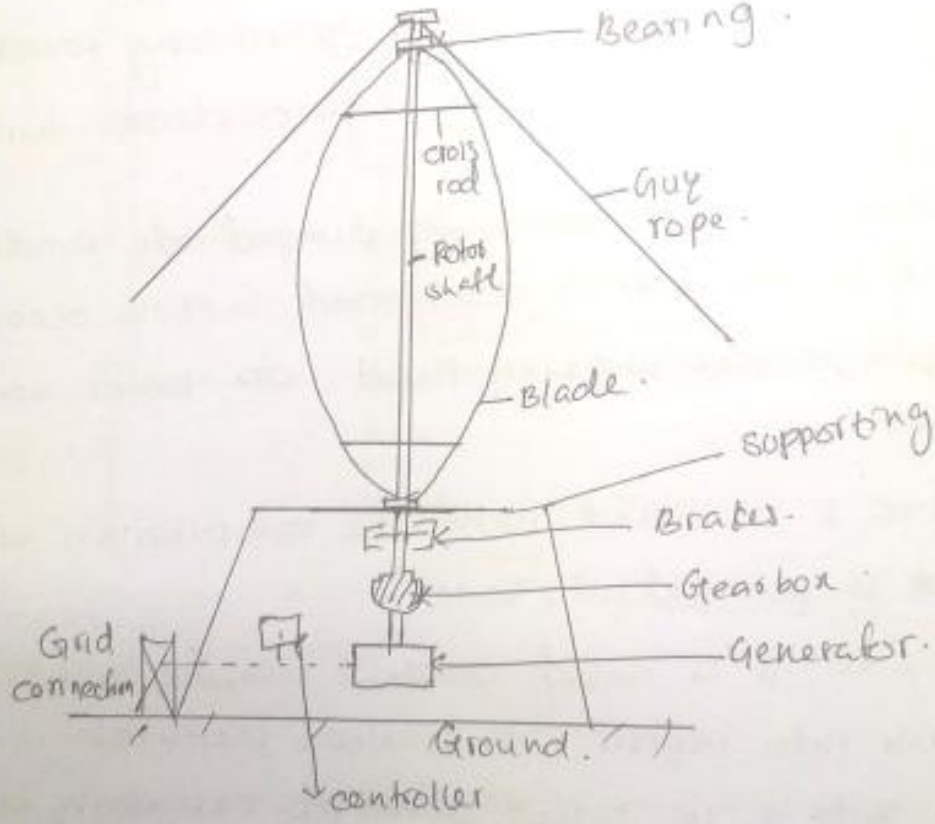
IAT-2.

2. Major problems associated with wind power
- The area/site to install wind turbines should be vast and open
- There should be channel through which the wind can be directed to the wind turbines.
- It needs to be installed on hilly areas and the soil condition of the area must be such that it can hold the tower and must be suitable for the construction of transport system.
- Direction of wind and its velocity changes constantly.

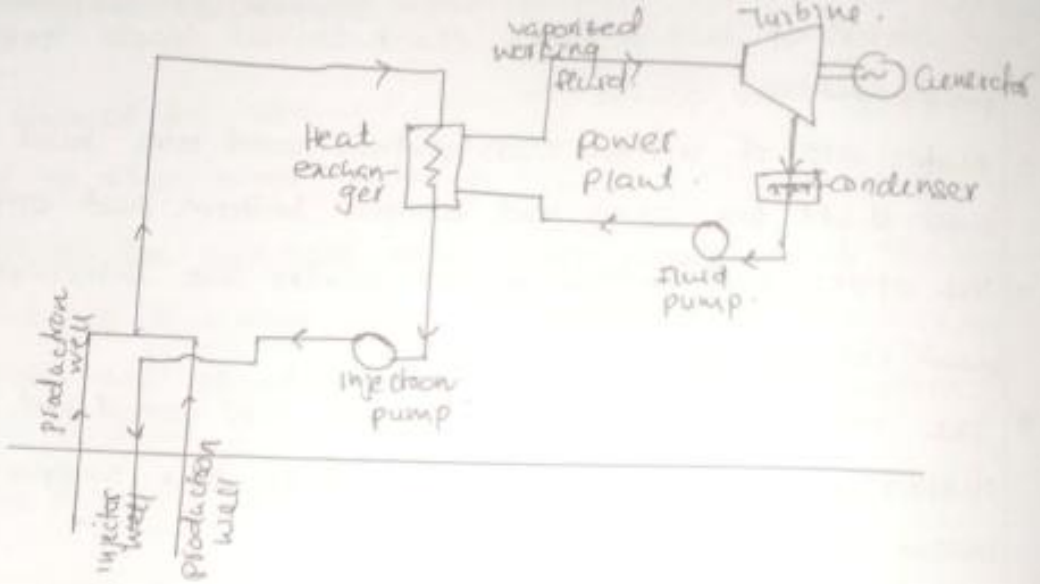
Vertical axis type wind mill



- Vertical axis type wind mill are installed on the ground.
- It does not require long and high tower.
- It consist of two or more than curved blade having a egg beafer profile.
- Blades are of airfoil cross section and are held around the rotor shaft by cross rod at the bottom and upper side.
- The upper and bottom of the blades are intersected with ~~blad~~ rotor shaft by bearings.
- The brakes, gear box, generator, low speed and high speed shafts and controlers are housed in the support structure below the blade.
- The upper vertical turbine is attached to guy rope.
- The brakes are given to regulate the movement in case the speed of the wind exceeds the given speed.
- The gear box enhances the rotational speed of the shaft.
- The generator converts the mechanical energy to electrical energy

* When the wind blows, the kinetic energy of the wind is changed to mechanical energy as the blades rotates. ~~The~~
- This energy is transmitted to the gear box and then to the generator by rotor shaft.
- The generator then converts the energy ~~to~~ from mechanical to electrical which is stored in rechargable battery.
- It accepts winds from all the direction hence eliminating the need of yaw control mechanism.

2 Hot dry rock geothermal plant.



HDR. Reservior

→ Hot dry rock geothermal plant has two subsystem, i.e, HDR reservior and power plant.

→ Well is drilled to a depth of 3-6 km beneath the earth surface where there are hot but dry rocks.

→ The hot dry rocks have temperature between 90°c to 625°c.

→ The water from the injector sources are pumped into the reservior.

→ Due to the process called hydrofracturing, the preexisting fracture in the rocks are fractured creating high volume heat exchange system.

→ The water gets heated due to the heat from the hot rocks.

→ This heated streams are recovered from the one or more production well.

→ In the plant power there is generation of electricity.

→ the recovered steam from the production well goes into the heat exchanger.

→ It gives away the heat to the secondary working fluid with low boiling point.

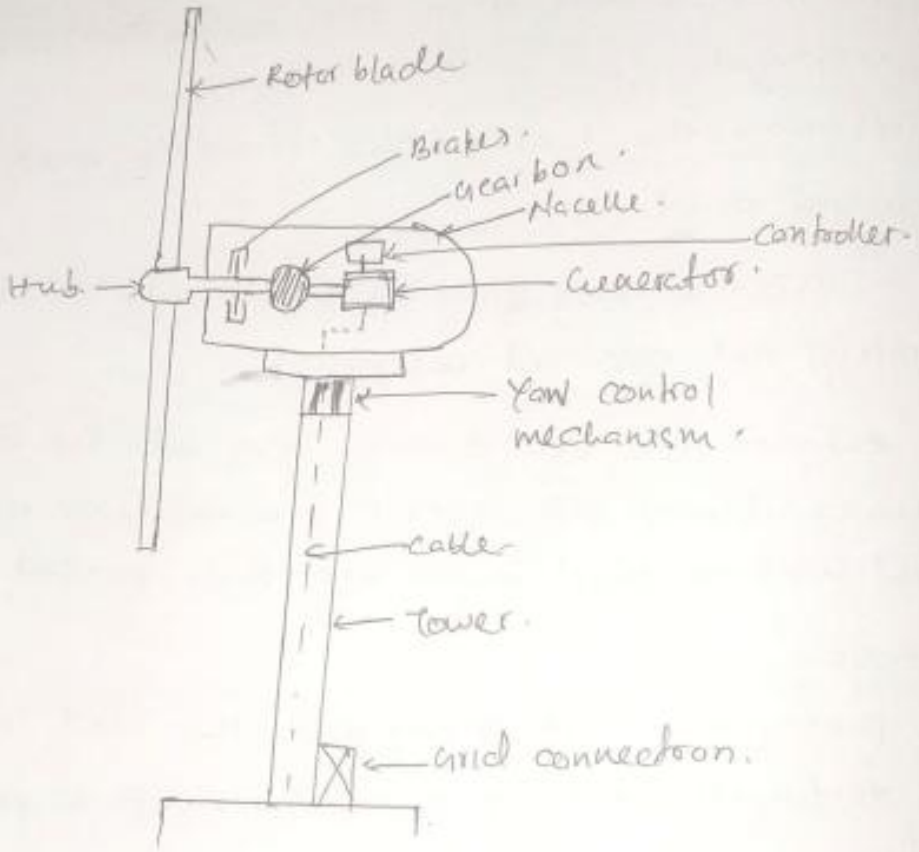
→ The vaporized working fluid then goes into the turbine hence generating the electrical energy.

→ The exhaust from the turbine goes into the condenser.

→ In the condenser, the vapour are converted into a normal / initial working fluid which are then pumped into ~~a~~ heat exchange.

→ The primary fluid after giving away the heat is reinjected back to the reservoir by a injector pump to produce more heat.

3. Horizontal axis wind mill.



→ Horizontal wind turbines consist of rotor blades, hub and nacelle.

→ The blades of horizontal wind mill are made of high density wood or glass fiber and epoxy composites.

→ Generally, most of the horizontal wind turbines have two or ~~three~~ three blades attached to hub.

→ The hub is connected to nacelle through a shaft.

→ The nacelle houses the brakes, gear box, generator, controller, & and shaft.

→ The brakes are provided to regulate the movement of blades in case if the speed of the wind exceeds the required/set speed.

→ The gearbox enhances the rotational speed and are connected to the generator which converts the mechanical energy into electrical.

→ The nacelle is provided at the top of the tower. and the yaw control mechanism is beneath the nacelle to control it according to the direction of wind.

→ When the wind blows the kinetic energy of the wind is changed to mechanical by the rotating blades.

→ This energy is passed to the generator through gear box

→ The generator then generates electrical energy.

→ Installation and maintenance of horizontal wind turbines are difficult as compared to vertical wind turbine.

→ The efficiency of this turbine is much higher than the vertical turbine as they are more accessable to wind.

4.

Given.

Wind speed (V_i) = 10m/s.

Pressure (P) = 1 atm = 1.01235×10^5 bar.

Temperature (T) = 15° = 273 + 15 = 288K.

efficiency (η) = 40% = 0.4.

Diameter of turbine (D) = 120m.

We have; density (ρ) = $\frac{P}{RT}$.

For air, R = 0.287 kJ/kg K.

$\therefore \rho = \frac{1.01235 \times 10^5}{0.287 \times 10^3 \times 288}$

$\rho = 1.209 \text{ kg/m}^3$.

i) Total power density

$\frac{P_{total}}{A} = \frac{\rho V_i^3}{2} = \frac{1.209}{2} \times 10^3 = 604.9 \text{ W/m}^2$

ii) Maximum power density.

$\frac{P_{max}}{A} = \frac{8}{27} \rho V_i^3 = 0.5925 \frac{P_{total}}{A} = 0.5925 \times 604$

$= 358.26 \text{ W/m}^2$

iii) Actual power density.

$\frac{P}{A} = \eta \frac{P_{total}}{A} = 0.4 \times 604$

$\frac{P}{A} = 241.2 \text{ W/m}^2$

iv) Total power

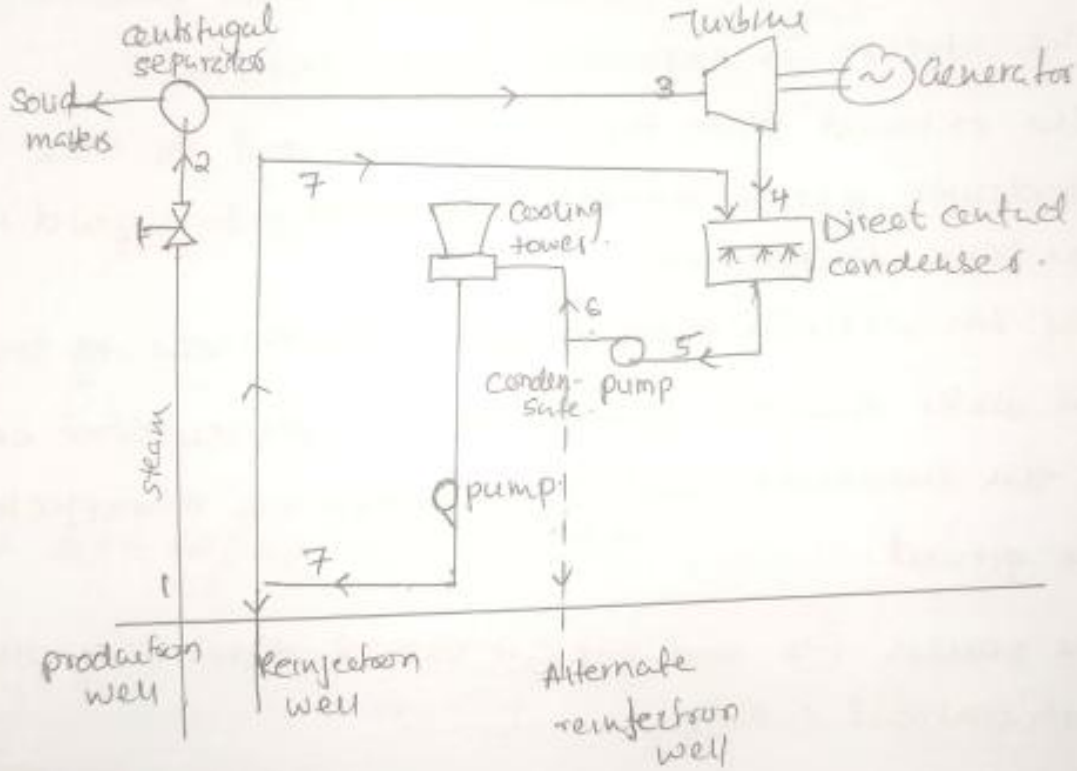
$P = A \times e$

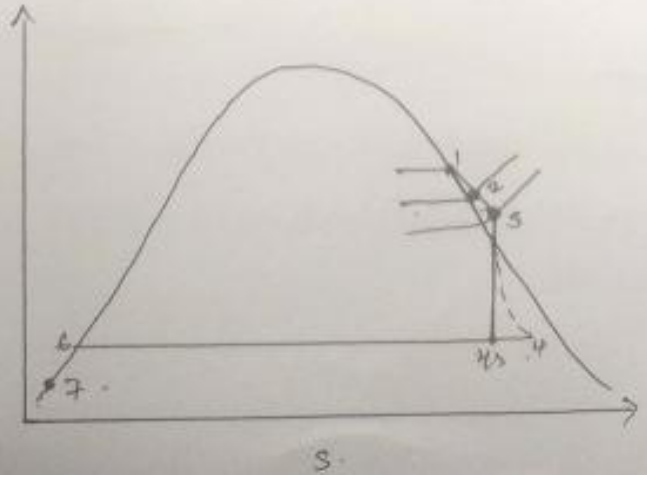
$P = \frac{1.209}{2445.2} \times \frac{D^2}{4}$

$= \frac{1.209}{2445.2} \times \frac{120^2}{4}$

$P = 4352.4 \text{ KW}$

5 vapour pomenated geothermal power plant.





- The saturated dry steam is recovered from the depth of earth surface which is about 6 km.
- → The steam has temperature of 200°c and 85 bar pressure.
- → The pressure drops as it comes to the surface becoming superheated steam (7 bars)
- → The steam goes into the separator where the abrasive particles are removed.
- → The dry stream is then passed to the turbine which is coupled with the generator to produce electricity.
- → The steam is expanded in the turbine.
- → The exhaust from the turbine is sent to the condenser which converts the vapor into liquid with the same temperature.
- → The hot water is then pumped into the cooling tower
- The water from the cooling tower is recirculated back to the condenser and some portion are reinterjected to the ground.
- → The process 1-2 and 2-3 are called throttling process with constant enthalpy.