

Summer – 15 EXAMINATION

Subject Code: 17645

Model Answer

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Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1.

A. Attempt any THREE of the following:

12

a) List the types of energy sources with one example of each.

(Each Type 1M)

The energy sources available can be divided in to three types.

1. Primary Energy Source:

Primary energy sources can be defined as source which provides a net supply of energy. Examples coal, oil, uranium etc.

2. Secondary Energy Source: Secondary fuel produces no net energy. Though it may be necessary for the economy these may not yield net energy.

3. Supplementary Source: Supplementary Source are defines as those whose net energy yield is zero and those requiring highest investment in terms of energy insulation (thermal) is example for this source.

b) State the types of renewable energy sources.

(Definition 1M Any 6 types 3M)

Renewable energy is energy obtained from sources that are essentially inexhaustible. Example of renewable energy sources includes solar energy, wind power, geothermal energy, tidal power, Ocean power and hydroelectric power.

c) Define solar constant and write its expression.

(Definition 2M, Expression 1M (each))

The extra terrestrial solar radiation often given in terms of solar constant. It is defined as average radiation intensity received per unit area perpendicular to earth surface at mean sun-earth distance. Value solar constant is

$$I_{sc} = 1367 \text{ w/mt}^2 = 432 \text{ btu/H}^2/\text{hr} = 4.921 \text{ MJ/m}^2/\text{hr}$$

The distance between earth and the sun varies a little through the year. i.e. the earth is closest to the sun in summer and farthest in the winter. This produces a nearly sinusoidal variation in the intensity of solar radiation. Hence

$$I_n = I_{sc} \left[1 + 0.033 \cos \frac{360n}{365} \right] \text{ Where } n \text{ is the day of the year}$$

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Solar radiation reaching the earth is essentially equivalent to blackbody radiation. According to Stefan-Boltzmann law, the equivalent black body temperature is 5779K for a solar constant of 1367 W/m^2 .

d) Give the classification of solar collectors.

(Types of collector 2Meach, types of Concentrating collector 1M each)

A solar collector is a device for collecting solar radiation and transfers the energy to a fluid passing in contact with it. Utilization of solar energy requires solar collectors. These are general of two types:

- 1) Non concentrating of flat plate type solar collector.
- 2) Concentrating (focusing) type solar collector.

Concentrating (focusing) type solar collector are further classified into two types

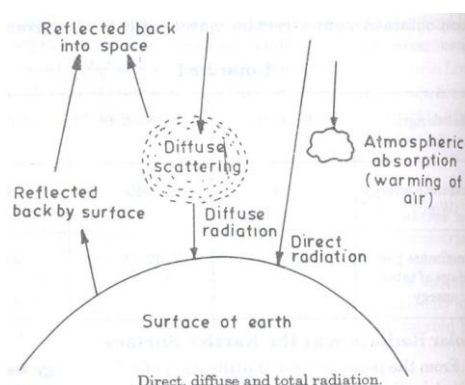
- 1) Cylindrical parabolic collectors(line focusing)
- 2) Paraboloid-trough collectors (point focusing)

B. Attempt any ONE of the following:

6

a) Describe the distribution of solar energy as direct, diffused and total radiation with the help of neat diagram.

(Diagram 3M, Explanation 3M)



Solar radiation pass through the earth's atmosphere and are subjected to scattering and atmospheric absorption a part of scattered radiation is reflected back into space.

Short wave ultraviolet rays are absorbed by ozone and long wave infrared rays are absorbed by CO_2 and water vapor scattering is due to air molecules, dust, particles and water droplets. When the sky is clear, earth's surface receives maximum radiations.

Beam radiation or Direct radiation (I_b):

If the solar radiation that directly reached the earth's surface without changing the direction is called beam or direct radiation.

Diffuse radiation (I_d): the radiation that received in terrestrial region and get scattered by dust particles, aerosols from all parts of the sky done is known as diffuse radiation

Total radiation (I_T): the sum of direct and diffuse radiation ($I_b + I_d$) is referred as total radiation. When measured at a location on the earth's surface it is called 'solar insolation' at the place.

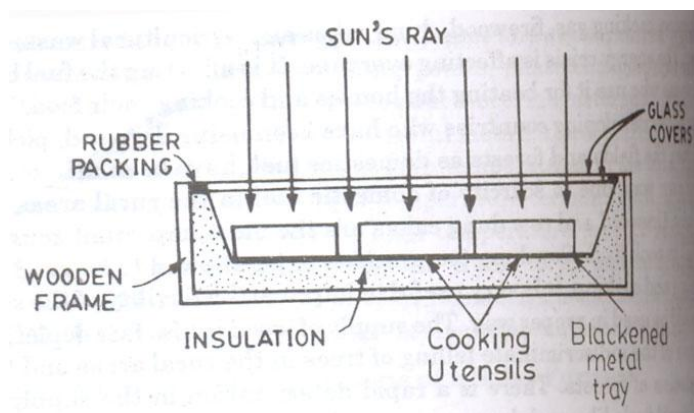
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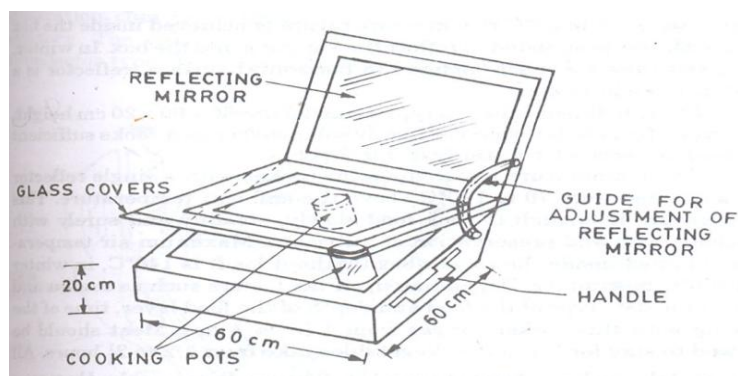
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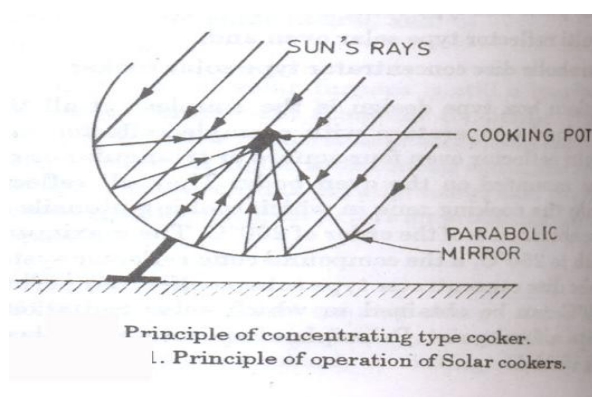
- b) Draw neat labeled diagram of box type and dish type solar cooker. List the components and material used for both.
(Diagram 2M each, Any Components name with Material 4M)



OR



System components	Material
Reflector flat mirror or metal foil	Glass, Aluminum
Box (a) Outer Box (b) Inner Box	GI Aluminum sheet FRP
Transparent Cover	Glass or Plastics
Insulation	Wool, cotton, features, or even crumpled newspaper
Cooking utensils	Aluminum copper or stainless steel



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System components	Material
Reflector flat mirror or metal foil	Glass, Anodized Al
Supporting stand	GI, Mild steel
Cooking utensils	Aluminum copper or stainless steel

Q.2. Attempt any FOUR:

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a) Describe the necessity of alternative energy sources.

(Any four points 4M)

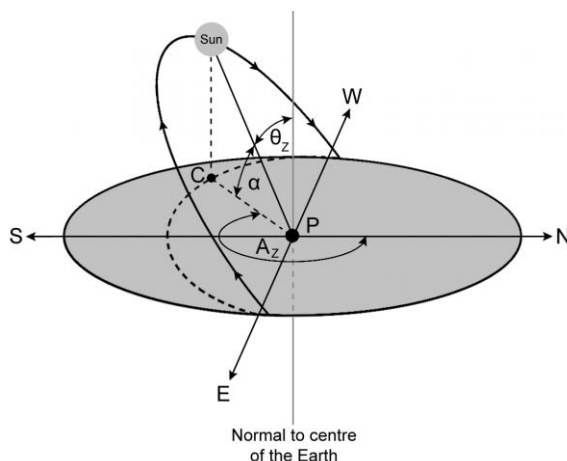
1. Conventional sources of energy are depleting oil is likely to last upto 2025 and coal another 200 year.
2. Oil, gas and coal cause air pollution which is causing global warming and climate changes all over the world. it is also increasing the level of sea, elimination of certain species, impacting the life of plant, animals and marine life.
3. Import of oil bill is increasing due to increasing energy needs.
4. Causing reduction in agricultural production per capita.
5. Scarcity of fresh water supply.
6. Causing increased health problems.

In view of the above, we need to reduce our dependency on oil coal and nuclear fuels and their imports. Therefore, we need to increase our oil and gas production and look for alternate sources of energy for our power needs.

b) Define following terms:

- i. Hour angle
- ii. Solar azimuth angle
- iii. Zenith angle
- iv. Incident angle

(Each Definition 1M)



i. Hour angle

It is the angle through which earth must rotate to bring the meridian of the point directly under the sun. it is the angular measure of time at the rate of 15° per hour. Hour angle is measure from noon based on local apparent time in the forenoon.

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ii. **Solar azimuth angle:**

It is the angle subtended in the horizontal plane of the normal to the surface of the horizontal plane. The angle is taken positive if the normal is west of south and negative when east of south in northern hemisphere.

iii. **Zenith angle θ_z :**

It is the vertical angle between the sun's ray and the line perpendicular to the horizontal plane through the point. It is complimentary angle of the sun's altitude angle.

$$\theta_z + \alpha = \frac{\pi}{2}$$

iv. **Incident angle θ**

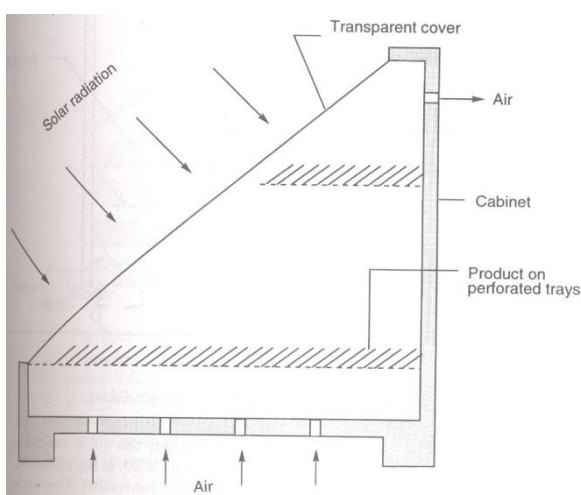
It is the angle being measured between the beam of rays and normal to the plane.

c) **Describe the construction and operation of solar dryer.**

(Diagram 2M, explanation 2M)

One of the traditional uses of solar energy has been for drying of agricultural products. The drying process removes moisture and help in the preservation of the product. Traditionally, drying is done on open ground. The disadvantages associated with this are that the process is slow and that insects and dust get mixed with the product. The uses of dryers help to eliminate these disadvantages. Drying can then be done faster and in a controlled fashion. In addition, a better-quality product is obtained.

Diagram:



A cabinet type solar dryer, suitable for small-scale use, is shown in fig. the dryer consist of an enclosure with a transparent cover.

The material to be dried is placed on perforated trays. Solar radiation entering the enclosure is absorbed in the product itself and the surrounding internal surfaces of the enclosure. As a result, moisture is removed from the product and the air inside is heated. Suitable openings at the bottom and top ensure a natural circulation. Temperatures ranging from 50 to 80 °C are

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usually attained and the drying time ranges from 2 to 4 days. Typical products which can be drained in such devices are dates, apricots, chilies, grapes, etc.

d) List the applications of solar space heating and cooling. (1M each)

1. Solar heating & cooling technologies collect the thermal energy from the sun and use this heat to provide hot water,
2. Space heating cooling and pool heating for residential,
3. Space heating cooling and pool heating commercial
4. Space heating cooling and pool heating industrial process application.

**e) List the factors considered for site selection of wind mill.
(Any 8 factors 4M)**

1. High annual average wind speed
2. Availability of anemometry
3. Availability of wind curve at the proposed site
4. Wind structure at the proposed site
5. Altitude of the proposed site
6. Terrain and its aerodynamic
7. Local ecology
8. Distance to road and railway
9. Nature of ground
10. Nearness of site to local center
11. Favorable land cost
12. Other condition such as icing problem

**f) State the types of wind turbines.
(Each type 1M & Explanation of each Type 2M)**

Wind aerogenerators or wind turbine generators of WECS are generally classified as

1. Horizontal axis type and
2. Vertical axis type

Depending on their axis of rotation, relative to the wind stream. Some author refer to them as wind axis rotors and cross wind axis rotor respectively. In the former types, the rotors are oriented normal to the direction of wind, while in the latter types, the effective surface of the rotor moves in the same direction as the wind.

Horizontal axis wind machines are further sub-classified as single bladed, multibladed and by-cycle multibladdes type. Sail, wind, multibladed are example of horizontal axis wind machines, Savonius and Darrius rotor are example of vertical axis machines.

The vertical axis windmill or machine is again sub-divided into two major types:

- i. Savonius or 'S' type rotor mill(low velocity wind)
 - ii. Darrius type rotor mill (high velocity wind) based on the working speed of the machine and the velocity ranges required by the machine for operation.
- Vertical axis machines are of simple design as compared to the horizontal axis type.

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Q.3. Attempt any FOUR:

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a) Describe the environmental aspect of energy.

Environmental Aspects of energy: (4M)

- 1) Energy development that meet the need of present ability and future generation to meet their own needs.
- 2) Energy pattern is economic growth. Resources are used to meet human needs as well as preserving environmental issue for generation.
- 3) The rate of fossil fuel being used is phenomenal and is no way the nature can replace them. This will lead to a situation of scarcity of fuel.
- 4) The fuel used by power plants such as coal, gas, oil are producing pollutant which disturbs environment stability
- 5) Emphasis on use of renewable sources of energy can prevent the environmental disaster. Use of hydropower, wind, solar energy can give some retrieve.
- 6) Similarly excessive use of land, water, forest and living resources can lead to irrespirable harm to environment.

b) Describe the working of Pyranometer for measurement of total radiation.

(Diagram 2M, Explanation 2M)



A pyranometer is instrument which measures total or global radiation. If shading ring is attached, the beam radiation is prevented from falling on instrument sensor and then measures only the diffuse component of the radiation is allowed to fall on a black surface to which hot junctions of thermopile are attached. The cold junctions of thermopile are located in such a way that they do not receive the radiation. As a result an e.m.f. proportional to the solar radiation is generated. This e.m.f which is usually in the range of 0 to 10mv can be read or integrated over a period of time obtained

c) List the sources of biomass energy.

(4M)

Source of Biomass energy

Solid: wood, straw, agricultural residues municipal refuse

Liquid: Alcohol, Vegetable oil, methanol, Ethanol

Gas: Methane, fuel gas

d) Classify the biomass plants.

(4M)

Biomass or biogas plants are classified as follows

- 1) Continues and type biogas plant
- 2) Batch type biogas plant
- 3) Floating drum biogas plant
- 4) Fixed dome type

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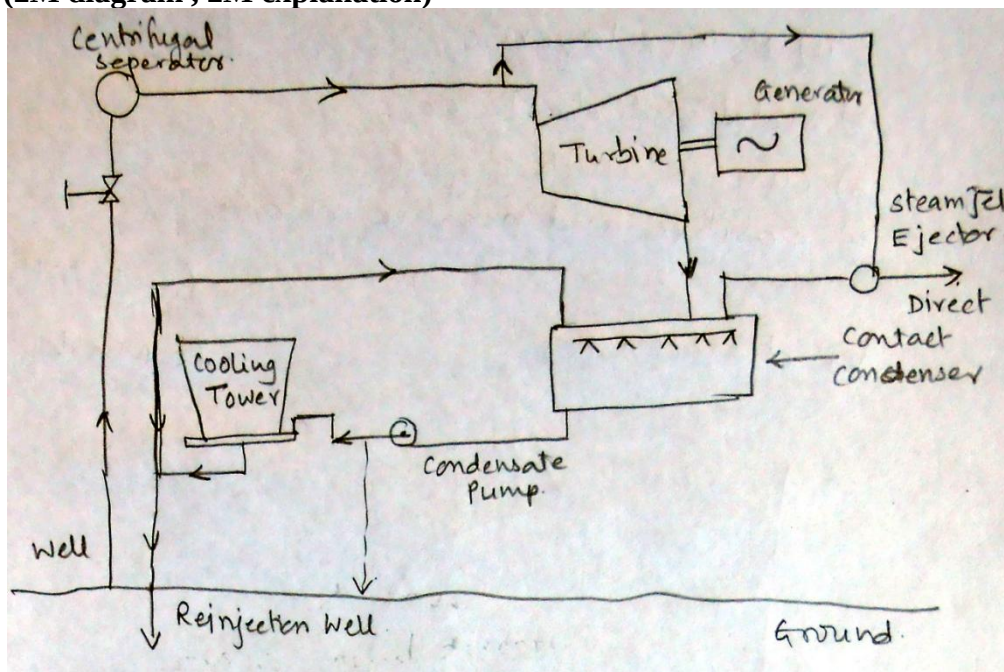
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- 5) Modified fixed dome type
- 6) Floating gas holder plant

e) Describe the operation of geothermal power plant with labeled diagram.
(2M diagram , 2M explanation)



Operation

Dry steam from well is collected filtered and passed through turbines which drive electric generators

The dry steam goes to first centrifugal separator and then enters to turbine.

Because turbine flow is not returned to the cycle but re-injected back to earth, the direct contact condenser may be used.

Here the turbine exhaust steam is condensates with cooling water. The resulting warm water is circulated through cooling tower and returned to the condenser.

Q.4.

A. Attempt any THREE of the following:

12

a) State the components of solar cell and draw VI characteristic of solar cell.

(Components of solar cell 2M, VI characteristic 2M)

Component of solar cell are

- 1) P-type semiconductor layer, N-type layer or PN junction.
- 2) Metal conductor layer
- 3) Current collection grid
- 4) Positive and negative contacts

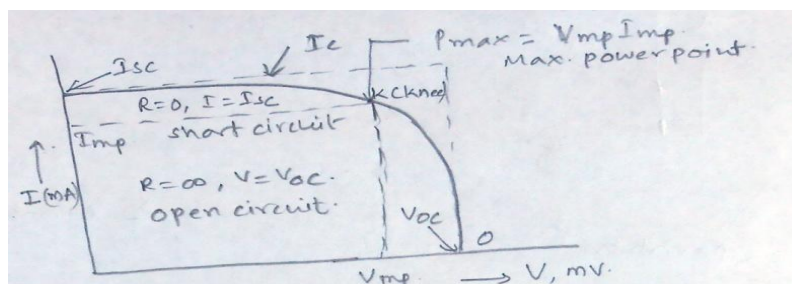
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VI characteristic



- b) Compare horizontal axis wind mills to vertical axis wind mills.(any four points)
(Any four points 1M each)

Horizontal axis wind mill	Vertical axis wind mill
More power capture(for same tower height)	Less power capture(for same tower height)
No effect of fatigue in such structure	The structure suffers from fatigue effect.
No appearance of the unwanted power periodicity	appearance of the unwanted power periodicity
Less noise problem	More noise problem
There exists complexity of yaw mechanism	No such problem of complexity in yaw mechanism
More complex design	Less complex design

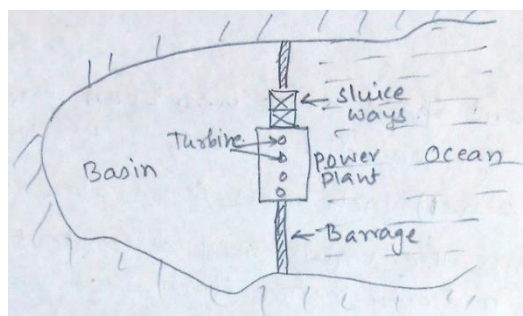
- c) List the methods of obtaining energy from biomass.
(each for 1 M)

Methods of obtaining energy from Biomass are

- 1) Combustion
- 2) Pyrolysis
- 3) Anaerobic digestion
- 4) Ethanol fermentation
- 5) Gasification.

- d) Describe the operation of single basin arrangement for tidal power generation with neat diagram.

(Diagram 2M, Explanation 2M)



There is only one basin interacting with the sea. The two are separated by a dam (or barrage) and the flow between them is through sluice way located conveniently along the dam. Potential head is

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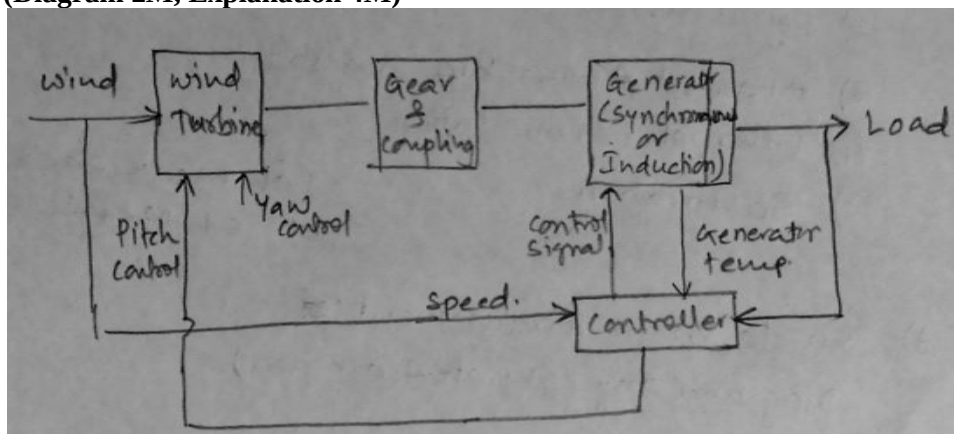
provided by rise and fall of tidal water levels this is usually accomplished by blocking the mouth of long narrow estuary with dam access it, thereby creating a reservoir. The dam or barrage embodies a number of sluice gates(ways) and low head turbine sets.

B. Attempt any THREE of the following:

6

- a) Draw block diagram of constant speed constant frequency system for wind generation. Also describe working of it.

(Diagram 2M, Explanation 4M)



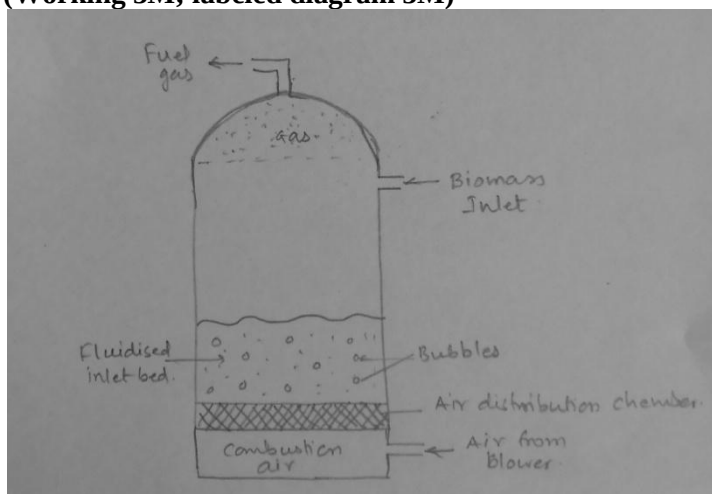
Constant speed drive has been used for large generators connected directly to the grid.

Synchronous generators: for such machine the requirement of constant speed is very rigid and only minor fluctuations about 1% of short durations could be allowed.

Induction generator: if starter of an induction machine is connected to the power grid and if the rotor is driven above synchronous speed, the machine becomes a generator and delivered constant line frequency power to the grid the output power of wind driven induction generator is uniquely determined by the operating speed.

- b) Draw schematic diagram of fluidized bed gasifier and describe it's working.

(Working 3M; labeled diagram 3M)



Fluidized bed gasifier:

Working:

A fluidized bed gasifier constitutes a hot bed of inert solid particles of sand or crashed refractory supported on a fine grid. The pressurized gas start bubbling through the bed and particles attain a

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stage of high turbulence and bed exhibits fluid like properties a uniform temperature within range of 750 to 950°C is maintained so that ash zones do not get heated. In fluidized bed, a large surface is created and constantly changing area per unit volume provides higher conversion efficiency.

To put gasifier in use the bed material is heated to ignition temperature of the fuel and biomass is then injected causing rapid oxidation and gasification. The fuel gas thus obtained is conditioned and cleaned for utilization as an engine fuel.

Q.5. Attempt any FOUR of the following:

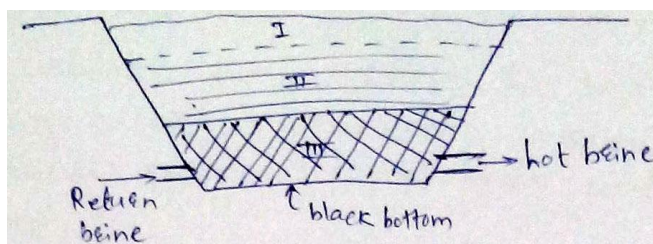
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a) State the limitation of pyrheliometer for measurement of beam radiation.

Limitation: (1M each any four)

1. Not possible to measure total radiation
2. Problem to measure aperture angle
3. Imprecision in tracking mechanism
4. Not possible to measure soircum solar contributions.

b) State and explain the principle and working of solar pond. (Diagram 2M & explanation 2M)



1. A solar pond is a mass of shallow water about 1 or 2 m deep with a large collection area, which acts as a heat trap. It contains dissolved salt to generate a stable density gradient.
2. Part of the incident solar radiation entering the pond surface is absorbed throughout the depth and the remainder which penetrates the pond is absorbed at the black bottom.
3. If the pond were initially filled with fresh water, the lower layer would heat up, expand and rise to the surface. Because of the convective mixing and heat loss at the surface, only a small temperature rise in the pond could be released.
4. Convection can be eliminated by initially creating a sufficient strong salt concentration gradient. Thermal expansion the hotter lower layer is insufficient to destabilize the pond.
5. At the bottom of the pond, a thick durable plastic liner is laid.

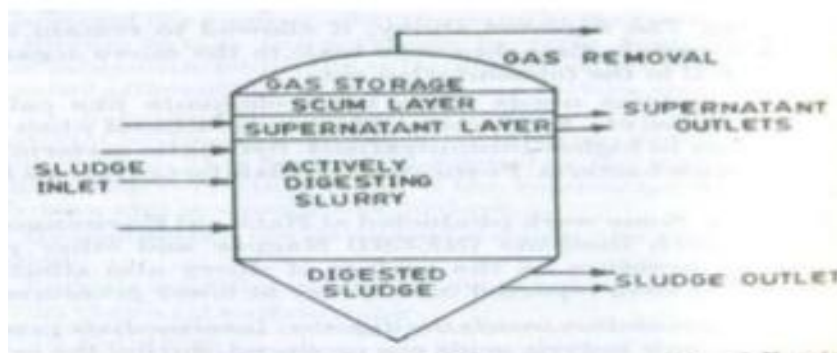
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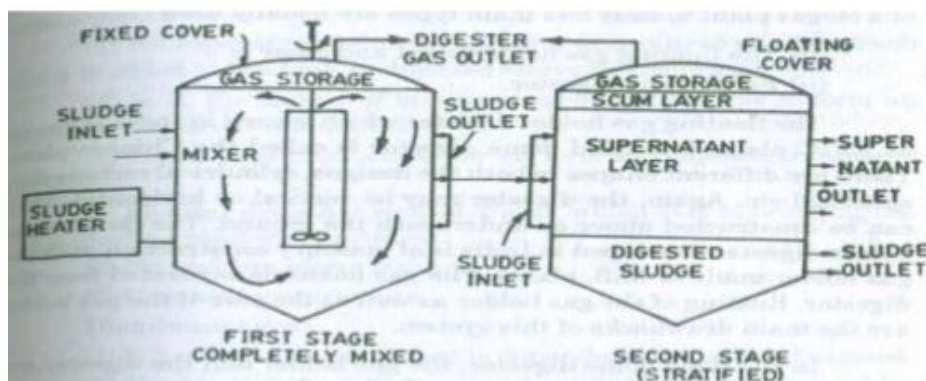
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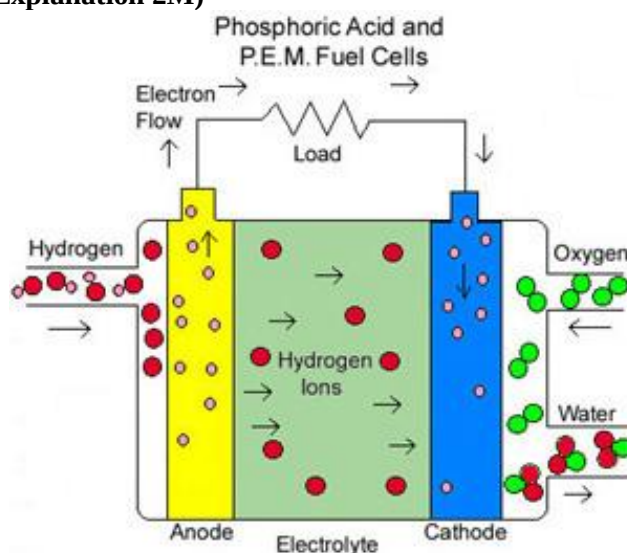
- c) Draw neat diagrams of continuous and batch type biomass plant.
(Diagram 4M)



OR



- d) Describe operation of fuel cell technology.
(Diagram 2M; Explanation 2M)



1. The fuel gas diffuses through the anode and is oxidized, this releasing electron to the external circuit.
2. The oxidizer diffuses through the cathode and is reduced by the electrons that have come from anode by products out of the external circuits.

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3. The fuel cell is a device that keeps the fuel molecules from mixing with the oxidizer molecules, permitting, however the transfer of electrons by a metallic path that may contain a load.
4. The available fuels, hydrogen has so far given the most promising results. Although cells consuming coal, oil or natural gas would be economically much more useful for large scale applications.

e) List the advantages and limitations of hydrogen energy.

Advantages: (Any four 2M)

1. Very high energy content
2. Burning is non polluting
3. Hydrogen produced from biomass and supplied to consumers in the transport sector
4. Fuel cell operated bus; hydrogen produced from biomass can compete well with gasoline operated vehicles.
5. It is a superior fuel for turbojet aircraft due to greater economy or lower noise level and little pollution
6. Hydrogen as a vehicular fuel can reduce dependence on fossil fuel which is increasing in cost every year.
7. Hydrogen can easily be transported and distributed through pipeline
8. Hydrogen being a high density fuel. Its low transport cost high product cost to make it can economically viable fuel

Limitations: (Any four 2M)

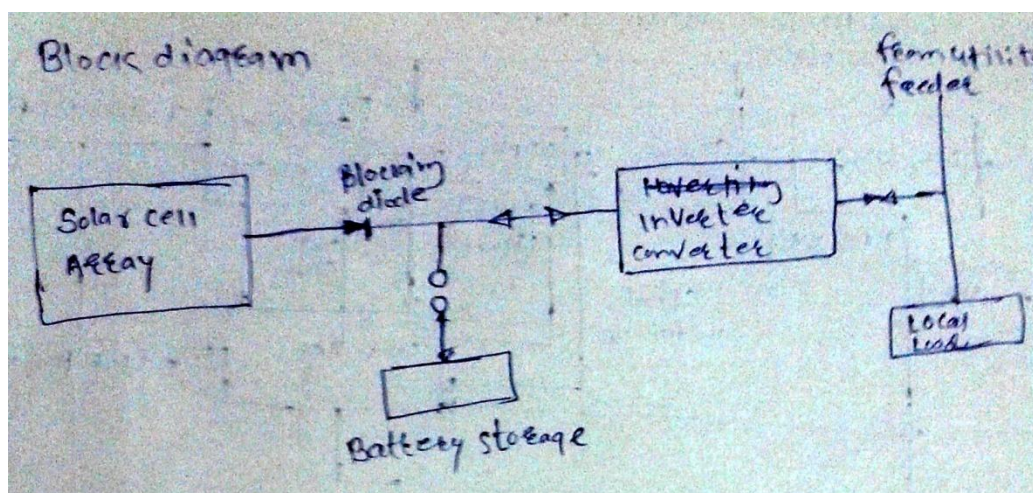
1. Commercial production of hydrogen at cheap cost.
2. Effective energy utilization
3. Difficulty in storage since it is highly explosive
4. Lack of safety and management

Q.6. Attempt any TWO of the following:

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- a) Draw functional block diagram of photovoltaic power generating system. State its advantages and disadvantages.

(Diagram 4M)



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Advantages: (any four 2M)

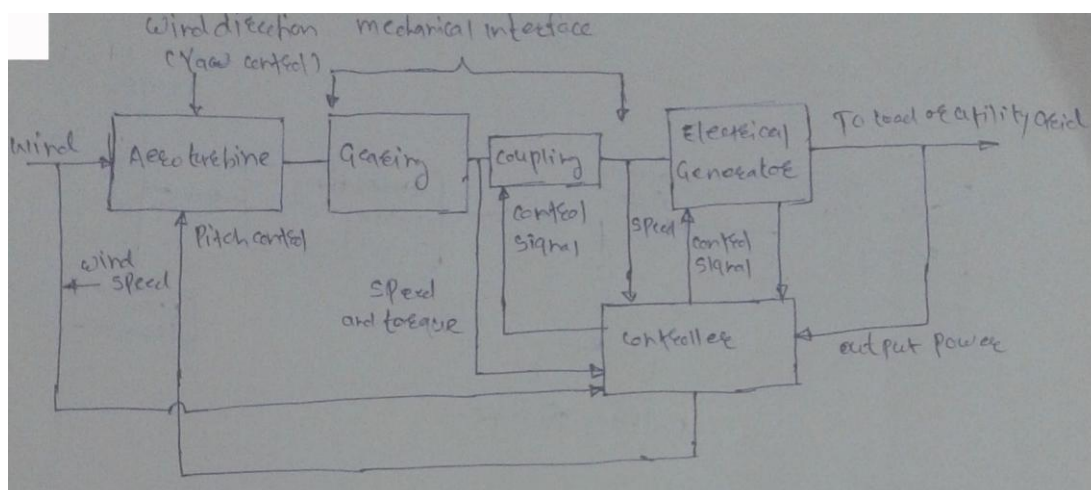
1. System are durable
2. No operational cost
3. Low maintenance
4. More flexibility available
5. Systems are eco-friendly
6. Highly reliable
7. Long effective life
8. Absence of moving parts
9. Can function unattended for long period
10. High power to weight ratio.

Disadvantages:(any four 2M)

1. Weather dependent
2. Low efficiency
3. High installation cost
4. Storage is required

b) Draw block diagram showing basic components of wind system and state function of each block.

(Block diagram 4M; each part 1M)



1. **Yaw control:** It senses the wind speed, wind direction, shafts speed and torques at one or more points, outputs power and generator temp. as necessary and appropriate control signals for matching the electrical output to the wind energy input and protect the system from extreme conditions.
2. **Aero-turbines:** it converts the energy of moving air into rotary mechanical energy.
3. **Mechanical interface:** it consists of step up gear and a suitable coupling transmits the rotary mechanical energy to an electrical generator.
4. **Controller:** it serves the purpose of sensing
 - i. Wind speed
 - ii. Wind direction, shaft speed
 - iii. Output power and generator temperature as necessary
 - iv. Appropriate control signal for matching the electrical output to wind energy input.
 - v. Protect the system from extreme conditions brought about by strong winds.

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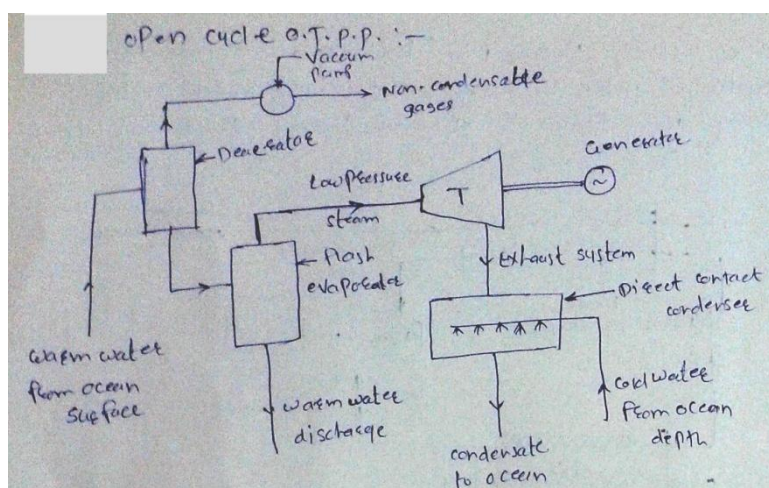
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- c) Draw schematic diagram of open cycle and closed cycle ocean thermal power plant. Describe the operation of each plant.
(Diagram 2M each ; working 2M for each)

Open cycle of ocean thermal power plant:

- The warm water from ocean surface is admitted through a deaerator to the flash evaporator which is maintained under high vacuum. As a result, low pressure steam is generating due to throttling effect and the remainder warm water is discharged back to the ocean high depth.
- The deaerator also removes the dissolved non-condensable gases from the water before supplied to the evaporate.
- The low pressure steam having very high specific volume is supplied to turbine where it expands and the mechanical power so developed is converted into electric power by the generator.



Closed cycle of ocean thermal power plant:

- Warm water from ocean surface is circulated through a pump to a heat exchanger which act as a boiler to generate working fluid ammonia vapor at high pressure.
- This vapor expands in the turbine to develop mechanical power which in turn runs an electric generator to produce electric power.
- The working vapor from turbine at low pressure is condensed into condenser with the help of cold water drawn from the depth of ocean through a pump.

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