CBCS SCHEME

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18EE653

Sixth Semester B.E. Degree Examination, June/July 2023
Renewable Energy Resources

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Discuss causes of energy scarcity. Mention factors to be considered for solving energy crunch problems. (10 Marks)

b. Explain the classification of energy resources. (10 Marks)

OR

2 a. With a neat sketch explain layers of sun. (10 Marks)

b. Define the following terms with help of diagram.
i) Heur angle ii) Declination angle. (10 Marks)

Module-2

3 a. Explain with a neat sketch Heliostat electric generating plant. (10 Marks)

b. With the help of neat diagram, explain any of the dryer. (10 Marks)

OR

4 a. With a neat sketch explain key elements of photo - voltaic cell. (10 Marks)

b. Find the number of solar cells for the array area of $28.5m^2$ if each cell has a diameter of 2.25 inches. (04 Marks)

c. Discuss photovoltaic panels with appropriate equations. (06 Marks)

Module-3

5 a. Discuss the applications, advantages and disadvantages hydrogen energy. (10 Marks)

b. Explain the thermochemical hydrogen production technology. (10 Marks)

OR

6 a. Describe the main considerations in selecting site for mind generations. (06 Marks)

b. With a neat sketch explain dry steam geothermal electric power plant. (10 Marks)

c. Discuss advantages of waste recycling system. (04 Marks)

Module-4

7 a. Draw the sketch of updraft – draft gasifier and discuss its working and applications. (06 Marks)

b. Explain construction parts of Biogas plant with the help of neat sketch. (10 Marks)

c. Discuss factors affecting the selection of a bio gas plant. (04 Marks)

OR

8 a. Discuss tidal power generation in India. (04 Marks)

b. Explain the single basin and two basin systems of tidal power harnessing. (10 Marks)

c. Explain applications of bio – mass Gasifiers. (06 Marks)

Module-5

9 a. With net sketch explain two types of ocean thermal energy conversion plants. (10 Marks)

b. Explain oscillating water column devices to harness sea wave energy. (10 Marks)

OR

10 a. Write a short note on ocean thermal energy for closed cycle. (10 Marks)

b. Explain the devices used for harnessing wave energy. (10 Marks)

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1 @ Causes of Energy scarcity.

1) Increasing population worldwide is increasing at an alarming rate.

2) Increasing energy usage or consumption.

3) Uneven distribution of energy & resource trade among countries is a paramount imp to environmental stability.

4). Lack of technical knowledge, of conversion, transmission, distribution & utilization.

Factors to be considered for solving energy crunch problems.

1) Minimizing population growth. exploitation & harnessing the large utilization. of known & unknown energy resources.

D Kokare

⇒ Development of energy conversion techniques to convert basic energy available from energy reservoirs.

(3) Keep the new energy system pollution free as far as possible, thereby environmentally acceptable to human beings.

(4) Development of cheap & reliable energy storage systems.

(5) Energy management.

1 (b) Classification of energy resources :-

Energy resources are broadly classified into two types.

- Primary energy resources.
- Secondary

Primary energy resources are derived directly from natural source. They are used either in basic raw energy form or by converting them to usable form.

eg :- chemical fuels, solar, wind, geothermal, nuclear hydro power etc.

follow

Secondary energy resources are usable forms of energy generated by means of suitable plants to convert the primary energy.
eg :- electrical energy, steam power, hot water power, hydrogen energy etc.

Primary energy resources may be further sub-classified as.
- conventional energy resources are stored within the earth & the sea. They include fossil fuels (coal, oil, gas) & nuclear energy. These require human intervention to release the energy from them.

Non conventional energy sources:
also known as infinite energy resources - sun, earth - sea. They are obtained from the energy flowing through the natural environment.

D Vekaria

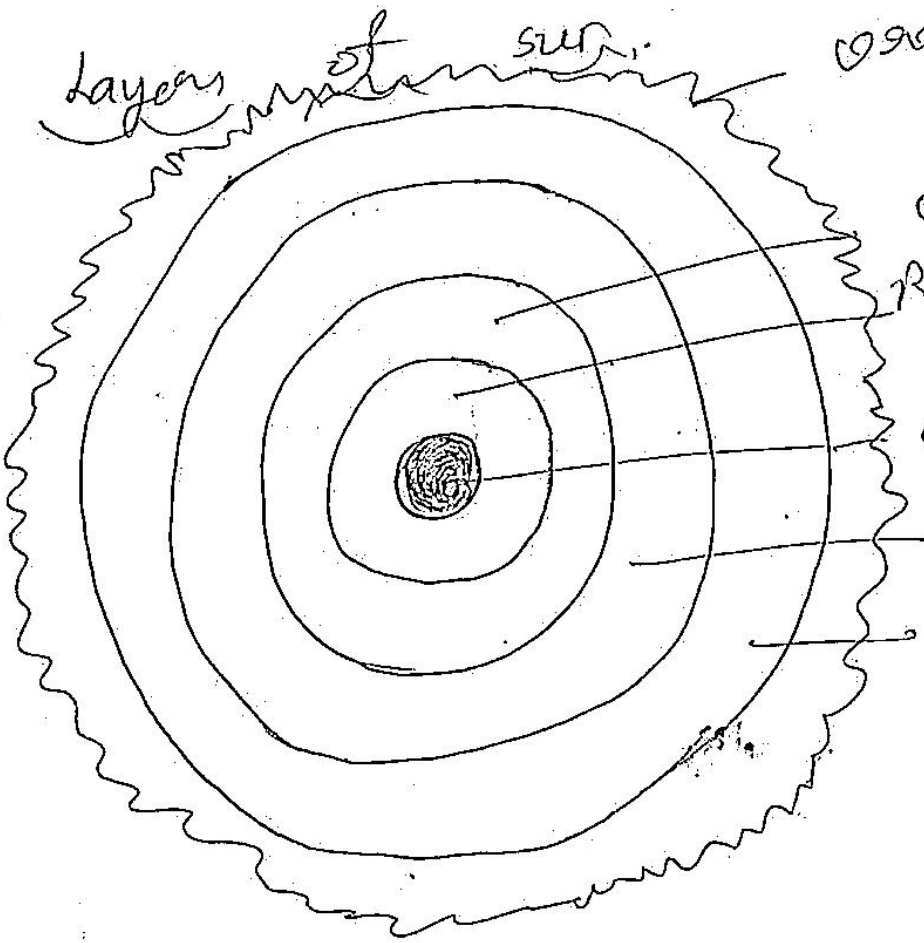
Renewable energy resources:

These are continuously restored by nature
eg :- solar, water, wind.

Non renewable energy resources :-

are the reserve that is once accumulated in nature has practically ceased to form under new geological condition. They are also known as expendable energy. eg :- coal, oil, gas, nuclear et

2 @ Layers of sun.



Core :-

The innermost layer of the sun is called the core, the core temp. is about 1,50,00,000°c, which keep it in gaseous state, in the core fusion reaction produce energy.

Solar envelope :-

Outside of the core is the radioactive envelope which is surrounded by a convective envelope. Temp is 4 million kelvin. Density of the solar envelope is much less than that of core.

Photosphere :- It is the zone from which the sunlight is both seen & emitted. It is a thin layer of low pr gases surrounding the envelope.

Chromosphere :-

During an eclipse, a red circle can sometimes be seen outside the sun. It is called chromosphere. Its red colour is caused by the abundant of oxygen.

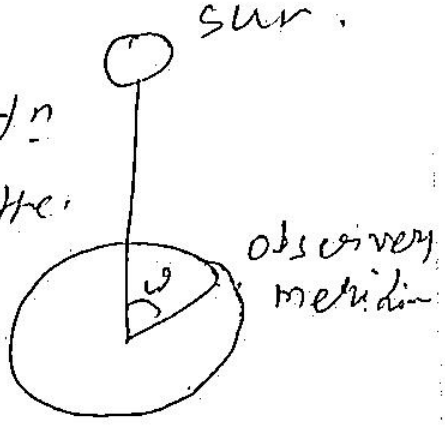
Akshara

Corona :-

The outermost layer of the sun is called corona or the crown. Corona is very thin & faint. ∴ difficult to observe the earth. It is hottest.

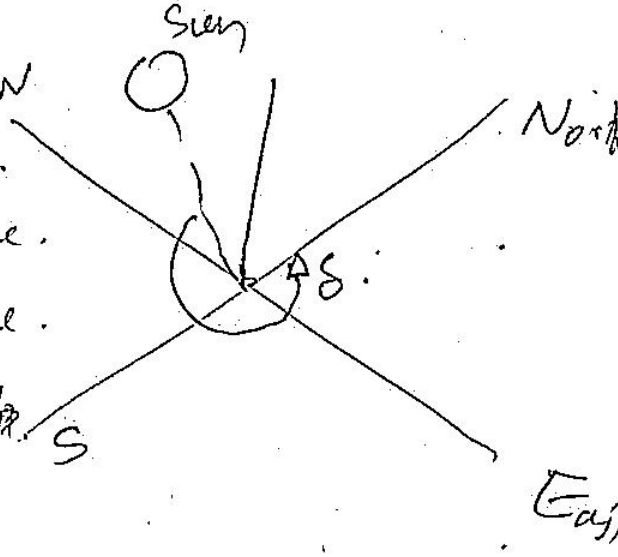
2 (b) :- Hour angle (ω)

It is the angular distance bet^n the meridian of the observer & the meridian whose plane contains the sun.



Declination angle (δ).

Declination angle of the sun is the angle bet^n the rays of the sun & the plane of the earth's equator.



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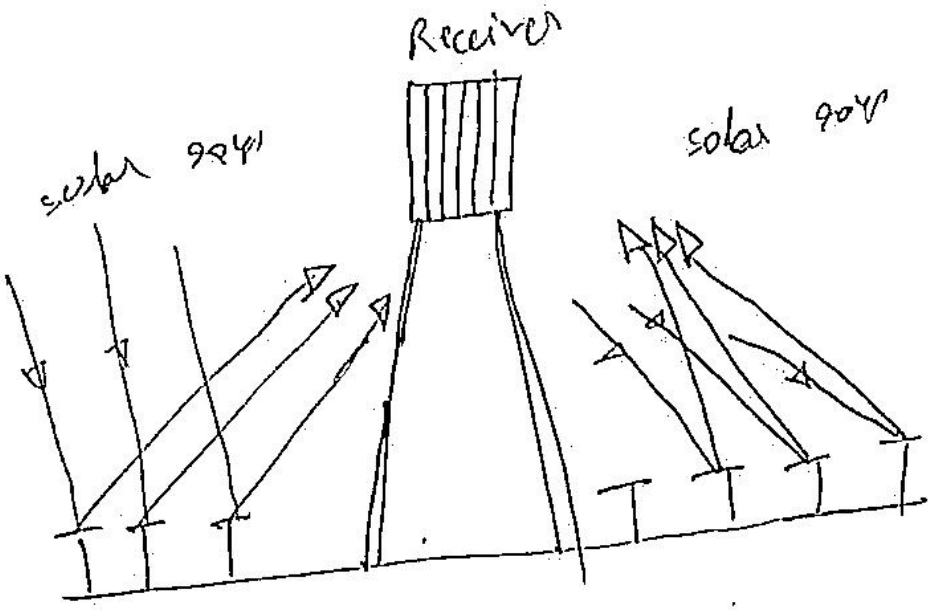
3 @ Heliostat field solar collector



Heliostat is a mirror based system that is used continuously to reflect sunlight onto a central received. The collected solar is then converted into electrical power.

It is a two axis solar tracking flat mirrors that reflects sunlight onto a fixed receiver or on target. The geometry between the sun, mirrors & receiver are constantly changing throughout the day.

Heliostat use a field of dual axis sun trackers that direct solar energy to a large absorber on a tower.

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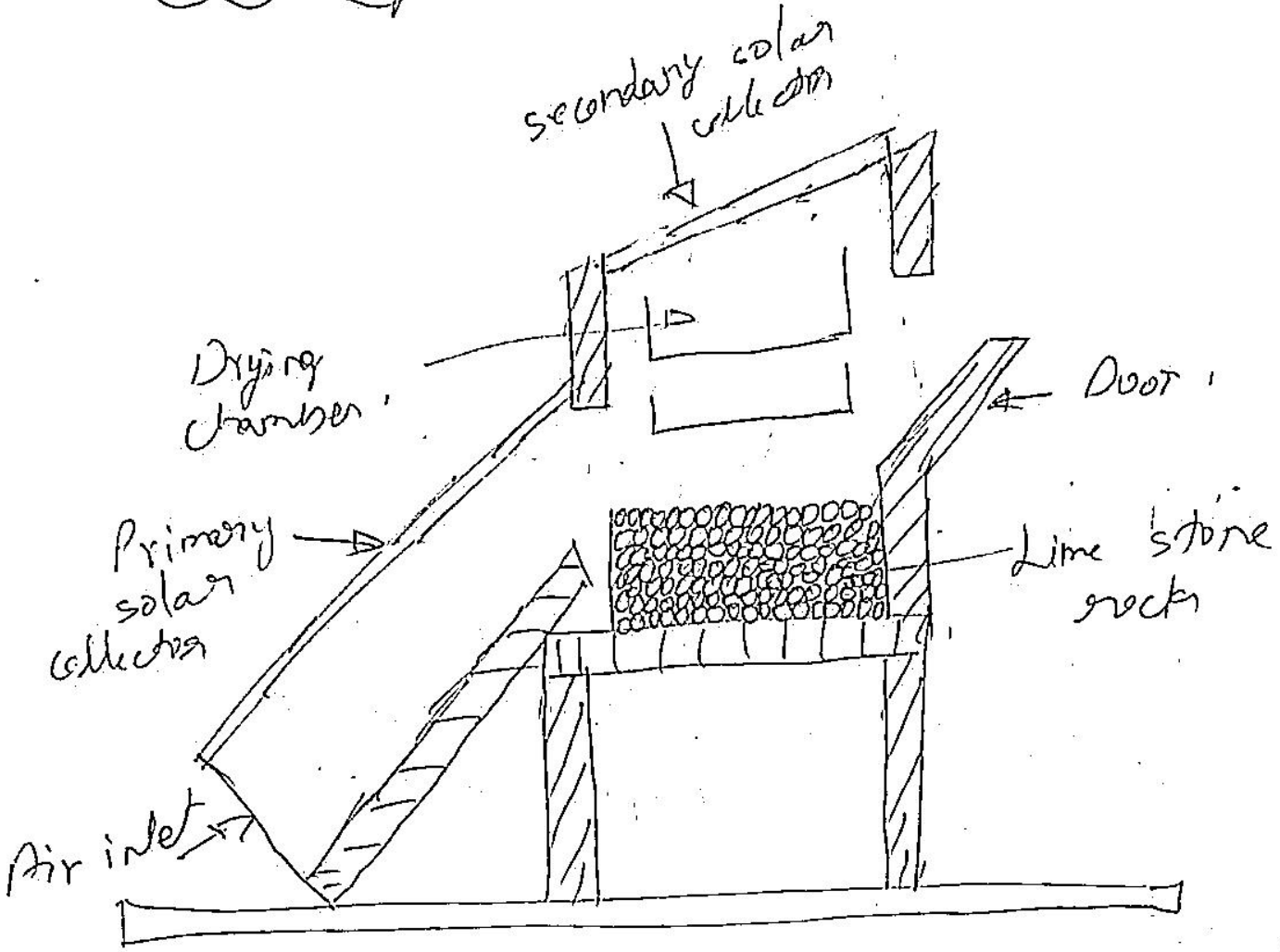
solar dryers



In a rock bed ~~solar~~ dryer, air drawn by natural convection through an air inlet (A), circulates the heat collected by the primary solar energy collector, throughout the drying chamber, which is packed with limestone rocks of relatively uniform diameter. The heat would then stratify across the rock bed. The samples positioned above the rock bed can continue drying during the night.

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This type of solar dryer requires less maintenance solar heated air can be used for drying most crops that require warm air.

4@ key elements of a photo voltaic cell.

- substrate.

It is an unpolished P-type water material. referred to as P-region base Imp parameters to be kept in mind while choosing are its orientation, resistivity, thickness & doping.

- Emitter:-

Emitter formation involves the doping of silicon with reverse polarity impurities such as phosphorous, arsenic & antimony. Doping can be done by the process of diffusion.

Electrical contacts:-

These are essential to a photo voltaic cell. Since they bridge the connection bet^n the semiconductor material & external electrical lead.

It includes.

- Back contact:

It is a metallic contact completely covering back. It is usually consists of a layer of aluminium.

- Front contact.

current collection grid of metallic finger type is arranged in such a way that photon energy falls on n-region diffused layers.

- Anti reflective coating.

Anti reflective coatings are applied to reduce surface reflection & maximize cell efficiency. It helps to reduce the reflection of desirable wavelength from the cell allowing more light to reach the semiconductor film layer increasing solar cell efficiency.

D Nalkar

4 (b) Area of each cell (A_c):

$$A_c = \left(\frac{\pi d^2}{4}\right) = \pi (2.25)^2/4$$

$$A_c = 25.6 \text{ cm}^2.$$

The no of solar cells for the array area required $= S_m / A_c = \frac{28.5 \times 10^4}{25.6}$

$= 11,100$ //.

Akshara

4 (c) Photovoltaic panels.

Single solar cell has a working voltage & current of about 0.5 V & 50 mA. They are connected in series to provide larger voltage & connected in parallel to increase the current o/p. Photo voltaic panels are divided into three basic categories.

1) Low voltage.

connection b/n 3 to 12 small segments of amorphous silicon voltaic.

voltage rating → 1.5 & 6 V. o/p → few milliwatts

Small panels

Voltage rating → 3 – 12V.

o/p → 1 – 10W.

application → radios, toys, small fans, electric fence.

area → 100 cm² ⟷ 1000 cm²

Large panels

Voltage rating → 6 ⟷ 12V.

application → small pumps & caravan power

area → 1000 cm² ⟷ 5000 cm².

o/p → 10 ⟷ 60W.

5 @ Applications of hydrogen energy

— Hydrogen is used to power commercial buses both by IC engines burning a combination of hydrogen & other fuels & by solely hydrogen used in fuel cells.

— Hydrogen can be utilised for
a) residential uses.
b) domestic cooking purposes

c) Industrial uses.

d) alternative transport fuel.

e) " fuel for aircraft.

f) for electric power generation.

Advantages of Hydrogen Energy:

- Uncoupling of primary energy sources & utilization
- Hydrogen is a gas, thus it is easier to store than to store electricity.
- can be obtained from any primary energy source including renewable energy source.
- efficient when used in fuel cell.
- good safety records.
- good experience of hydrogen as a chemical reactant.

Disadvantages:-

- Poor overall energy efficiency when produced with fossil fuels.
- very low density & poor specific volume energy density.
- Need for high pr & very low temp. if stored in the liquid phase.

Mahesh

- specific safety problem & poor public acceptance.
- High cost.

5 (b) Thermo chemical hydrogen production technology

Hydrogen bound in organic matter & in water makes up 70% of the earth surface. Breaking these bonds in water allows us produce hydrogen.

Steam Reforming

Steam reforming uses the thermal energy to separate hydrogen from the carbon components in methane & methanol. These reaction occurs at temp of 200°c or greater.

$$CH_4 + H_2O + 206\ kJ/kg \rightarrow CO + 3H_2.$$

$$CO + H_2O \rightarrow CO_2 + H_2 + 41\ (kJ/kg).$$

∴ overall reaction is

$$CH_4 + 2H_2O + (165\ kJ/kg) \rightarrow CO_2 + 4H_2.$$

Partial oxidation or ceramic membrane.

Reaction.

$$CH_4 + \frac{1}{2}O_2 \rightarrow CO_2 + 2H_2 + heat$$

Water gas shift reactor.

$$CO + H_2O \rightarrow CO_2 + H_2 \quad (\text{small amount of heat})$$

The process is typically much faster than the steam reforming & requires a small reactor vessel.

Bioman gasification & Pyrolysis

Using agricultural residues & wastes or biomass specifically grown for energy uses, hydrogen can be produced via pyrolysis or gasification.

Bioman pyrolysis produces a liquid product that like petroleum, contains a wide spectrum of components that can be separated into valuable chemicals & fuels.

Alfeka

6@ Selecting site for wind generation.

- High annual average wind speed
- Availability of anemometry data.
- No tall obstructions for some distance in upwind direction.
- A wide open view i.e open plain, open shoreline or offshore location.
- An island in a lake or the sea.
- A narrow mountain gap through which wind is channelled
- Site reasonably close to power grid.
- Production results of existing wind turbines in the area to act as a guide to local wind conditions.
- Top of smooth, well rounded hill with gentle slopes on a flat plain,
- other conditions such as icing problem, salt spray or blowing dust should not present at the site

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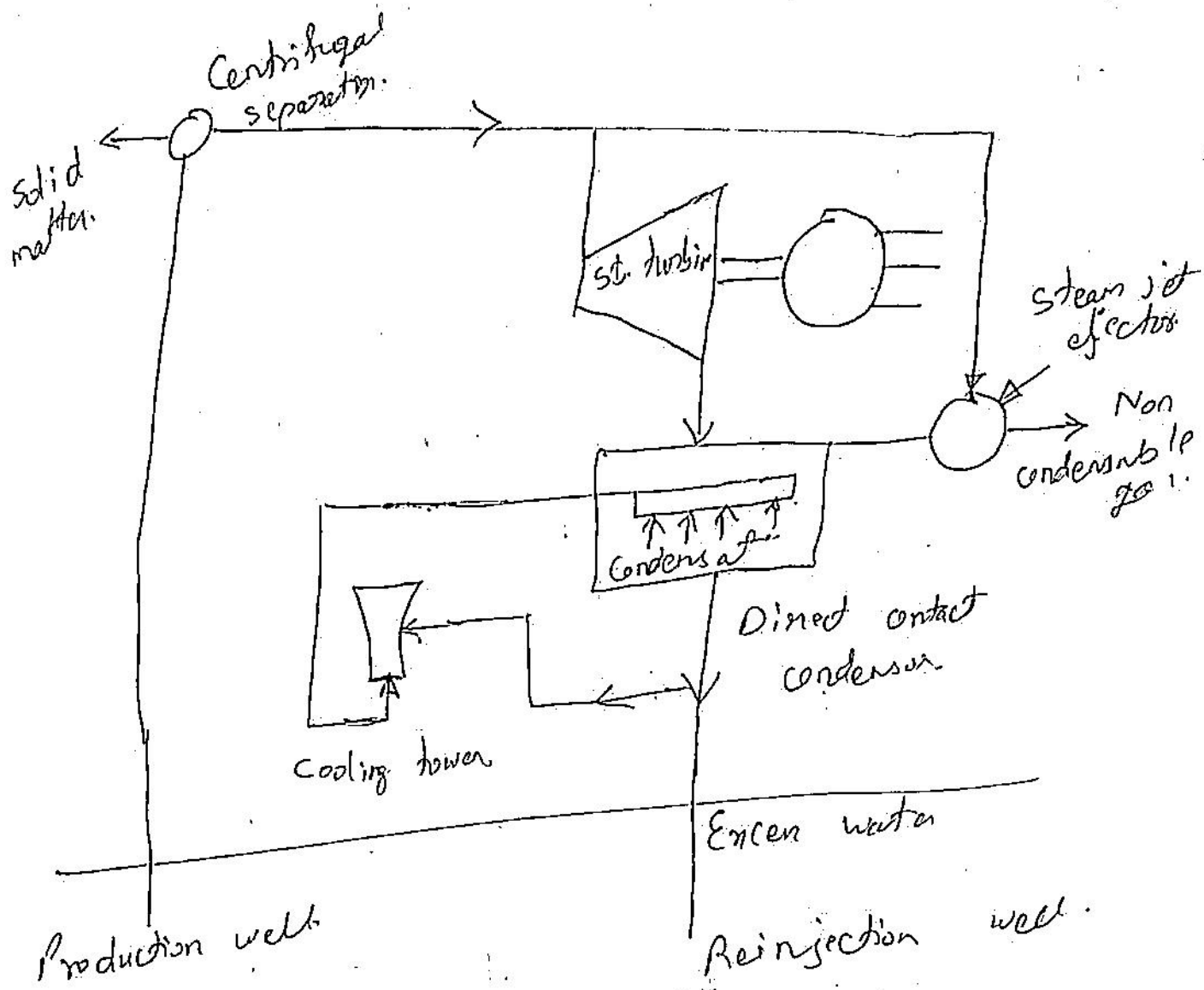
6 (b) Dry steam.



In dry steam plant, steam produced directly from the geothermal reservoir runs the turbine that power the generator.

Steam is extracted from the well, cleared in a centrifugal separator to remove solid matter.

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Then piped directly to a turbine. The exhaust steam of the turbine is condensed in a direct contact condenser. In which the steam is condensed by direct contact with cooling water. The resulting warm water is circulated & cooled in a cooling tower & returned to the condenser. 7@

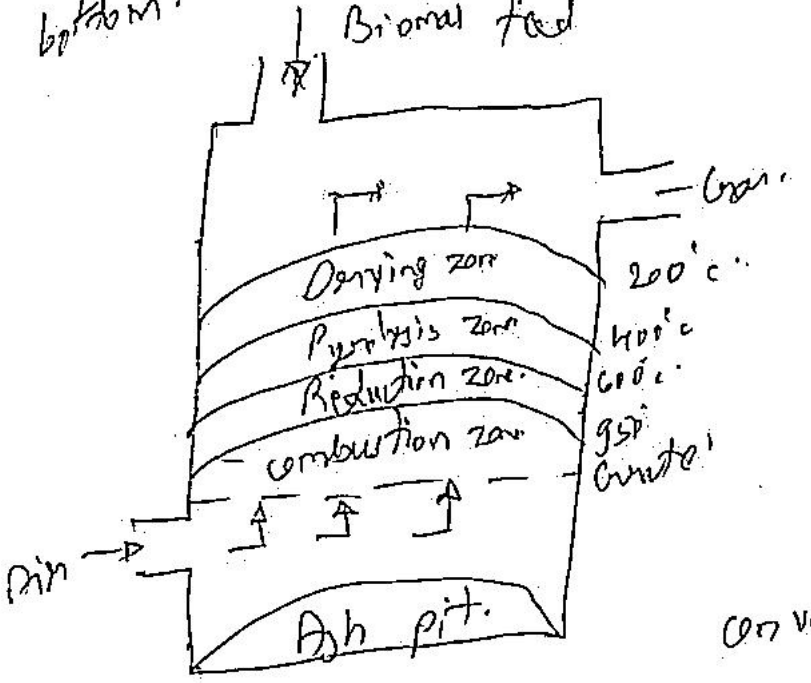
Condensation of steam continously increases the volume of cooling water. Non condensable gases are removed from the condenser by steam jet ejection.

6 © Advantages of waste recycling

- Reduced damage to environment.
- Reduced consumption of energy.
- Reduced environmental impact & pollution.
- Mitigate global warming.
- Promotes sustainable utilization of resources.

1@ Updraft gasifier

The air intake is at the bottom & gas leaves at the top. The reactive agent is injected at the bottom of the reactor & ascends to the top while the fuel is introduced at the top & descends to the bottom.



In the upper part of the gasifier, heating & pyrolysis of the feedstock occur as a result of heat transfer by forced convection & radiation from the lower zone

Application :-
- Packaged boiler
- Aluminium melting
- Thermal fluid heaters

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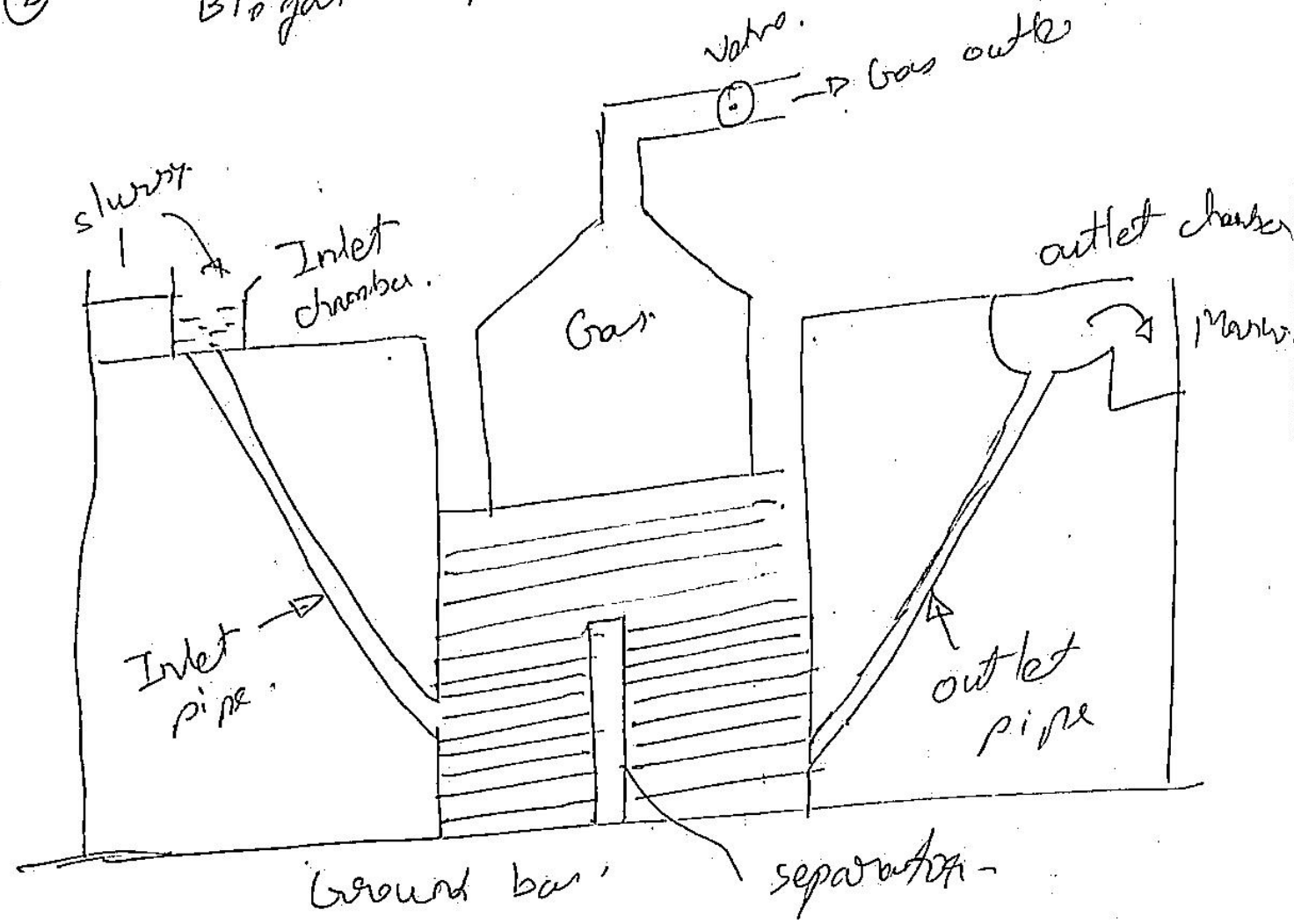
(b) Biogas plant.



1) Mixing tank:-

Biogas located above the ground level in which the water & cowdung are mixed together in equal proportion (1:1) to form the slurry that is fed into the inlet chamber.

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Digester tank :-

It is a deep underground well like structure
It is divided into two chambers by a partition
wall in b/w. In this chemical process or fermentation
of cow dung & prodn of biogas takes place.

Dome or Gas holder:

The hemispherical top portion of the digester
is called dome. It has fixed height in which
all the gas generated within the digester is collected.
The gas collected in the dome exerts pressure
slurry in the digester.

Inlet chamber :-

Cow dung slurry is supplied to the digester
of the biogas plant via inlet chamber which is
made at the ground level so that slurry can be
procured easily.

D Kakani

Outlet chamber :-

The digested slurry from the biogas plant is removed through the outlet chamber. Opening is at the ground level. Slurry from the outlet chamber flows to the pit made especially for this purpose.

7 © Factors affecting the selection of biogas plant

- Principal & maintenance cost of biogas plant should be as low as possible both to the user & society.
- Design should be simple not only for construction purposes but also for operation & maintenance.
- Longer life span of biogas plant is essential.
- in situations where people are to be motivated
- Suitability for use with available raw i/p
- Frequency of utilization of biogas & feedback inputting in biogas.

Dhekare

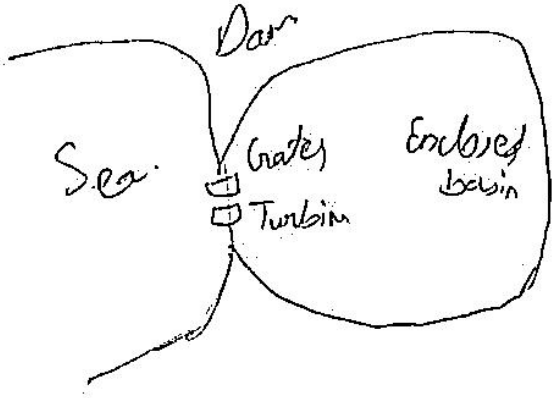
8@ Tidal power generation in India.

Tides are periodic rises & fall of large bodies of water. Spring tides are especially strong tides that occur when the earth, the sun & the moon are in a line. Tidal energy is a form of hydropower that converts the energy of the tides into electricity or other useful forms of power.

Site Location	Tidal Height	Estimated power potential
Gulf of cambay, Gujarat	11	7000.
Gulf of kutch, Gujarat	08	12,000
Ganges delta in the sundarbans, West Bengal	05	8,000

8 (b) Single Basin system.

Single water reservoir is closed off by constructing dam or barrage.



Gate is large enough to admit the water during tide so that the loss of head is small is provided in the dam.

The single basin system has 2 components.

- One way single basin system.

The basin is filled by sea water passing through the sluice gate during the high tide period. This type of systems can allow power generation for about 5 h & is followed by refilling of the basin.

Two way single basin

This system allows power generation from the water moving from the sea to the basin & then at low tide moving back to the sea. Single basin system has the draw back of intermittent power supply.

Two basin system:

In this system, a constant & continuous o/p is maintained by suitable adjustment of the turbine valve to suit the head under which these turbines are operating. A two system basin regulates. power o/p of an individual tide. This type provides a partial soln to the problem of getting a steady o/p of power from a tidal scheme.

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8 (c). Application of biomass gasifier.

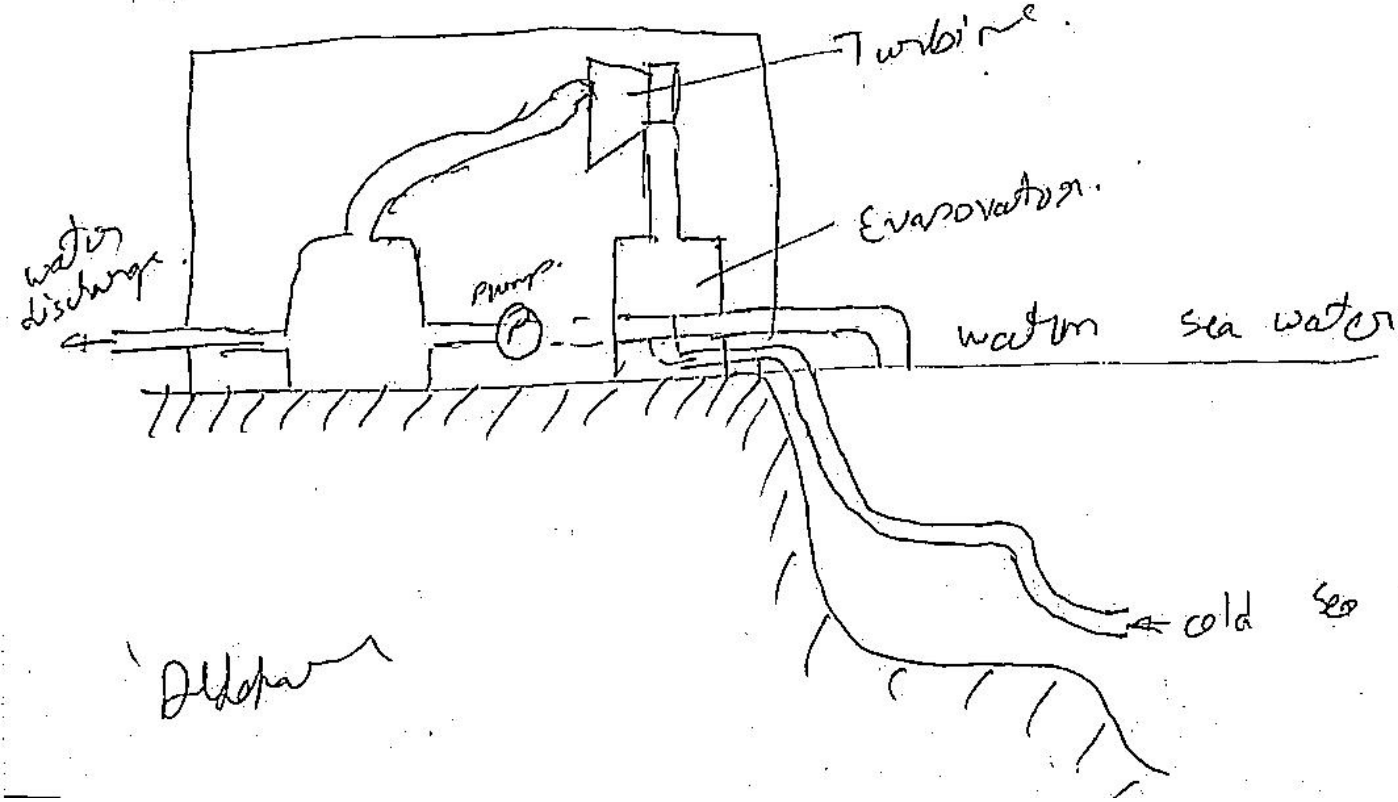
- Used to provide power to industrial & agricultural equipment & machinery such as diesel engines, tractors, water pumps.
- Drying of agricultural crops & food products such as cardamom, ginger, rubber & tea, baking of tiles & potteries for melting metals & alloys.
- Electric power generation from few kW to hundreds of kW for local consumption.
- Chemical production such as methanol & formic acid from producer gas.

Dilokar

9@ Ocean Thermal Energy Conversion plants.

i) Land based Power plant:-

It consists of a building, constructed on shore. & accomddate all parts of OTEC plants. It requires laying down long pipe from plant site on shore to two extreme points of necessary temp gradient. One pipe is used to collect warm ocean surface through screened onderwr near the shore. Another long pipe lay down on the slope deep into the ocean to collect cold water. A third pipe is used to discharge used water again in ocean via marine culture ponds deep down the ocean.



Floating power plants:

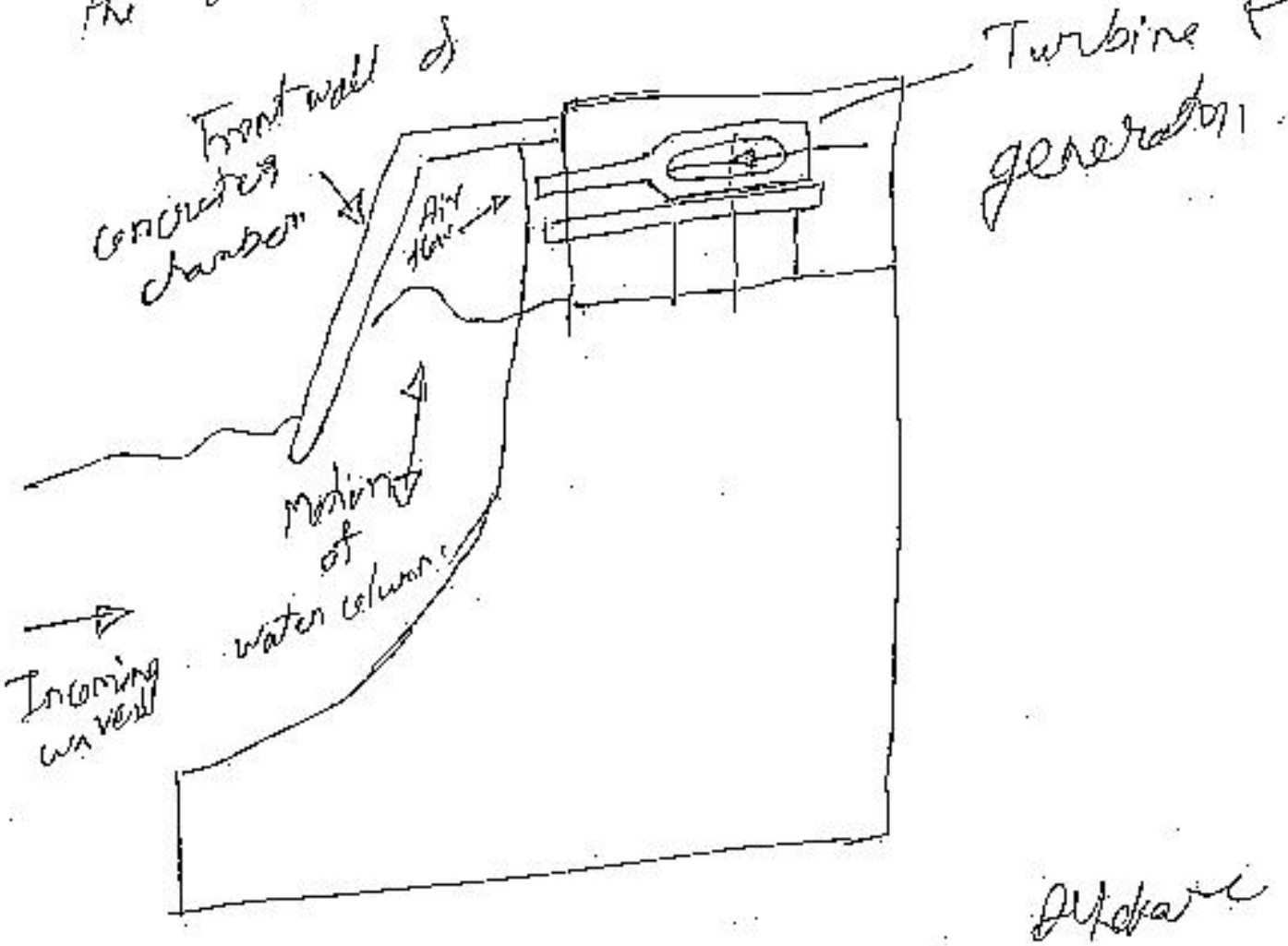
Floating power plant is built on a ship. platform exactly where required temp gradient sufficient for OTEC plant is available. Cost savings exist on piping system but long transmission line is required to transmit electrical power from plant to sea shore.

Owing to high installation cost of long underwater power cable & its inefficiency & many other associated problems, floating OTEC plants are considered for the prodn of fuels such as hydrogen.

9 (b) Oscillating water column devices:

It is a form of termination in which water enters through a subsurface opening into a chamber trapping air above. The wave action causes the captured water column to move up & down like a piston forcing the air through an opening connected to a turbine to generate power.

It is a shoreline based oscillating water column. build in UK. It is a concrete structure partially submerged in sea water enclosing a column of air on top of a column of water. The water column is partially submerged on the device. This wave action alternately compresses & depressurizes the air column, which is allowed to flow to & from the atmosphere via a turbine.



10 @ Ocean thermal energy for closed cycle.

In this organic fluid with low boiling point is used as working fluid.

Ammonia liquid is the most widely used working fluid.

Working fluid flows in a closed loop 4 partially sealed piping syster.

Working fluid circulate around the loop continously. Warm ocean surface water flows thro completely piping syster & discharges in upper surface of ocean.

Warm surface sea water & working fluid pipi are placed very closely to each other in a heat exchanger to transfer warm sea water heat into working fluid.

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Cold deep sea water piping system is in contact with working working fluid piping system in a condenser where working fluid condenses to its liquid state.

10 (b) Devices for harnessing wave energy:

i. Terminator devices.

It is a wave energy device oriented perpendicular to the direction of the wave. It has one stationary & moving part. moving part moves up & down like a car piston.

ex:- Oscillating water column.

power range 500 kW to 2 MW.

② Attenuator devices.

These devices are oriented, parallel to the direction of the waves & are long multi segment floating structures. It has a series of long cylindrical floating device connected to each other with hinges & anchored to the seabed. They ride the waves like a ship, extracting energy by using restraints at the bow of the device & along its length. Segments are connected to hydraulic pumps as other converters to generate power as the waves move across.

③ Point absorber.

It is a floating structure with parts moving relative to each other owing to wave action. But it has no orientation in any defined way towards the wave instead absorbs the wave energy arriving from any direction. It utilizes the rise & fall of the wave height at a single point for energy conversion. The pressurized water creates up and down bobbin type motion & drives a built in turbine generation system to generate electricity. Aqua buoy WEC is an ex. of point absorber device.

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