14CE706/14OE706/EE02

Hall Ticket Number:

IV/IV B. Tech (Regular\Supplementary) DEGREE EXAMINATION

November, 2019 — **Common to CE, ECE and ME**

Seventh Semester — **Non -Conventional Energy Sources**

Time: Three Hours — **Maximum:**60 Marks

Answer Question No.1 compulsorily. (1X12 = 12 Marks)

Answer ONE question from each unit. (4X12=48 Marks)

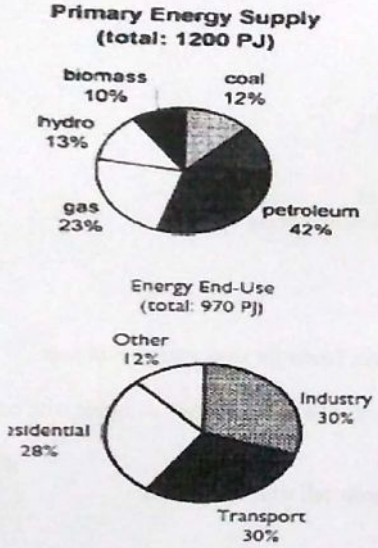
1		Answer all questions		(1X12=12 Marks)
	a)	classify different sources of energy		
	b)	Write the limitations of renewable energy resources.		
	c)	Draw pie diagram to show primary energy supply and energy supply to end-use.		
	d)	Define the terms Latitude and Longitude		
	e)	Why do you say solar energy option is the best preferable?		
	f)	Can you draw a neat sketch of flat plate collector		
	g)	What are different types of winds?		
	h)	Define actual power of wind.		
	i)	What is wake effect?		
	j)	How would you explain the principle of OTEC?		
	k)	What are the different biomass energy conversion principles?		
	l)	Can you state the combustion characteristics of bio gas?		
		UNIT I		
2	a)	Explain the reasons for non-conventional energy requirement.		5M
	b)	Compare Renewable and conventional energy systems in various aspects		7M
		(OR)		
3	a)	Explain about energy planning.		6M
	b)	Explain the scientific principles of renewable energy		6M
		UNIT II		
4	a)	Can you describe construction and working of Central Power Tower for solar energy with neat sketch?		5M
	b)	How would you summarize the function of main Components of a flat-plate solar collector with neat sketch?		7M
		(OR)		
5	a)	Explain the working principle of Monocrystalline silicon solar cell with neat sketch		8M
	b)	Explain the Advantages and limitations of solar cells.		4M
		UNIT III		
6	a)	Give the detailed classification of wind turbines.		6M
	b)	Enumerate the differences between Horizontal axis wind turbine and Vertical Axis Wind Turbine.		6M
		(OR)		
7	a)	Explain the components of Horizontal axis wind turbine with neat sketch.		8M
	b)	Enumerate the advantages and limitations of Vertical Axis Wind Turbine.		4M
		UNIT IV		
8	a)	Write about Geothermal energy conversion system.		8M
	b)	Write about single pool tidal energy conversion system		4M
		(OR)		
9	a)	Can you summarize the process of gasification of solid bio-fuels using any one of the pyrolysis methods?		6M
	b)	Explain the working principle of batch type of bio digester plant with neat sketch.		6M

1.

a) **Energy sources** could be **classified** as conventional (coal, oil, hydro, nuclear, etc.) and non - conventional (solar, wind, tidal, geothermal, biogas, etc.) **sources**.

b) It is difficult to generate the quantities of electricity that are as large as those produced by traditional fossil fuel generators and the reliability of supply.

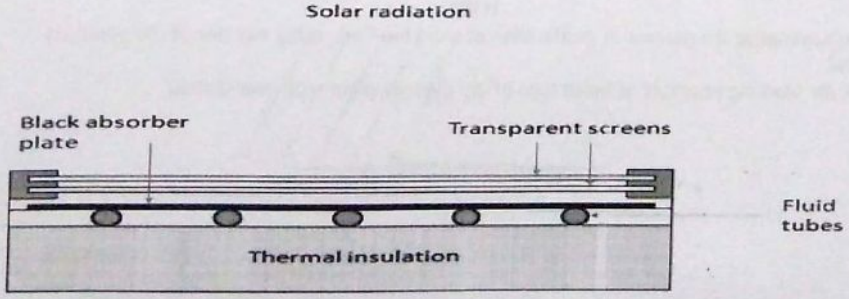
c)



d) **Latitude**: is a geographical coordinates that specifies north south position on earth surface. **Longitude**: is a geographical coordinates which specifies east- west position on earth surface.

e) Solar Power Is Good for the Environment The most commonly known fact about **solar energy** is that it represents a clean, green source of **energy**. **Solar power** is a great way to reduce your carbon footprint.

f)



g) Planetary winds and local winds.

h) At most only 59.3% of the kinetic energy from wind can be used to spin the turbine and generate electricity. This is called actual power of wind.

i) The **wake effect** is the aggregated influence on the energy production of the wind farm, which results from the changes in wind speed caused by the **impact** of the turbines on each other.

j) The warm water is used to evaporate a working fluid with a low boiling point. The high pressure vapour that is produced drives a turbine-generator to produce electricity. The cold deep seawater is used to condense the working fluid vapour back into a liquid.

k) Direct combustion
Thermo chemical conversion
Bio chemical conversion

l) The flameless combustion temperature of a biogas furnace is lower than traditional combustion throughout a combustion chamber.

UNIT I

2.

⇒ a) As the consumption of energy grows, the population depends more and more on fossil fuels such as coal, oil and gas day by day. There is a need to secure the energy supply for future since the prices of gas and oil keep rising by each passing day. So we need to use more and more renewable sources of energy. For the effective exploitation of non-conventional sources, there has been an establishment of a separate department namely "Department of non-conventional sources of energy" by the government of India.

2M

As the fossil fuels are one of the most the biggest pollutants on the planet, demand for the non-conventional sources is developing. These sources not only instigate greenhouse effects but also reduce the dependence on oil and gas. Therefore in order to meet the energy demand of the increasing population, the scientists are developing methods for us to tap into various non-conventional sources of energy, which are not only renewable but also non-polluting.

Renewable resources provide energy in four important areas like :

- Electricity generation
- Water heating or cooling
- Transporting
- Rural

Types of Non-convention sources

2M

- Solar Energy
- Wind Energy
- Tidal Energy
- Geothermal Energy
- Biomass

ADVANTAGES OF NON-CONVENTIONAL ENERGY TECHNOLOGIES-

- Non-conventional/renewable energy is an indigenous source available in considerable quantities to all developing nations and capable, in principle of having a significant local, regional or national economic impact.
- There is a great scope of research and development in non-conventional/renewable energy sectors regarding its future development and scientific utilization.
- The power plants based on renewable do not have any fuel cost and hence negligible running cost.
- Renewable have low energy density and more or less there is no pollution or ecological balance problem. Provide energy in environmentally benign manner.
- The use of non-conventional/renewable energy could help to conserve foreign exchange and generate local employment if conservation technologies are designed, manufactured, assembled and installed locally.
- Short gestation period and low investment.

1M

b)

Renewable Resources	Non-renewable Resources
(i) Resources whose quantity is not reduced due to use and which can be repeatedly used without fear of exhaustion are termed as renewable resources. They are inexhaustible resources.	Substances whose stock gets reduced and are gradually exhausted with use are termed as Non-renewable resources. They are exhaustible resources.
(ii) They can be renewed or reproduced by physical, chemical or mechanical process.	They cannot be increased or recovered.
(iii) Renewable resources like sunlight, wind, water are flow resources whose stock is continuous and are being used since time immemorial.	Their quantity is more or less fixed because their formation takes long geological period of million of years, e.g. minerals. Fossil fuels are exhausted totally with use while metals can be recycled.
(iv) Biotic resources that are renewable, may be temporarily diminished but may be renewed again by natural process and proper management.	These resources can never be renewed or replenished.
(v) **Example :** Solar and wind energy, water, forests, wildlife etc.	**Examples :** Fossil fuels like coal and petroleum, minerals.

2.5M

3.5M

(OR)

3.

a) The energy plan development exercise consists of the following components:

- (i) Database Development: Energy planning depends on the availability and quality of data, and gaps and deficiencies in the database can be identified as a result from planning. The database serve as input to demand and supply analyses. The objective of the database is to identify, generate and assemble information required for energy analyses. It is part of the iterative and continuous process of energy planning.
- (ii) Sectorwise energy demand: This involves the survey of the present energy consumption in different sectors for various end uses covering the type, magnitude and composition of fuel, trends, seasonal constraints and preferences in consumption; and estimation of energy demand based on the sample survey data.
- (iii) Assessment of the supply situation: This involves analysis of present energy supply system; assessment of woody and other bioresources; assessment of renewable sources potential, such as, solar, wind and hydro; and study of supply system of commercial energy.
- (iv) Development of an energy plan for the district: Based on the estimated supply and demand, an energy plan to meet the energy demand would be worked out in accordance with the development priorities. Techno-economic analyses of various energy technologies would be carried out to find out the technical and economic viability of the system. An energy plan at district level would be proposed based on the Decision Support System approach. Analyses of the importance of community participation in energy conservation,planning and identification of measures that will enhance the level of participation.
- (v) Implementation and management: With the knowledge of administrative structure at district level and agencies implementing the energy development program, a suitable institutional structure would be suggested for implementing and managing the energy plan.

3M

3M

District is taken as the unit of energy planning since (i) district is the basic administrative unit for implementing all developmental programs and (ii) district level planning will facilitate integration between national planning exercises and planning at lower levels.

b) The definitions of renewable (green) and finite (brown) energy supplies indicate the fundamental differences between the two forms of supply. As a consequence the efficient use of renewable energy requires the correct application of certain principles.

Energy currents

It is essential that a sufficient renewable current is already present in the local environment. It is not good practice to try to create this energy current especially for a particular system. Renewable energy was once ridiculed by calculating the number of pigs required to produce dung for sufficient methane generation to power a whole city. It is obvious, however, that biogas (methane) production should only be contemplated as a by-product of an animal industry already established, and not vice versa. Likewise for a biomass energy station, the biomass resource must exist locally to avoid large inefficiencies in transportation. The practical implication of this principle is that the local environment has to be monitored and analysed over a long period to establish precisely what energy flows are present.

2M

Dynamic characteristics

End-use requirements for energy vary with time. For example, electricity demand on a power network often peaks in the morning and evening, and reaches a minimum through the night. If power is provided from a finite source, such as oil, the input can be adjusted in response to demand. Unused energy is not wasted, but remains with the source fuel. However, with renewable energy systems, not only does end-use vary uncontrollably with time but so too does the natural supply in the environment.

2M

Quality of supply

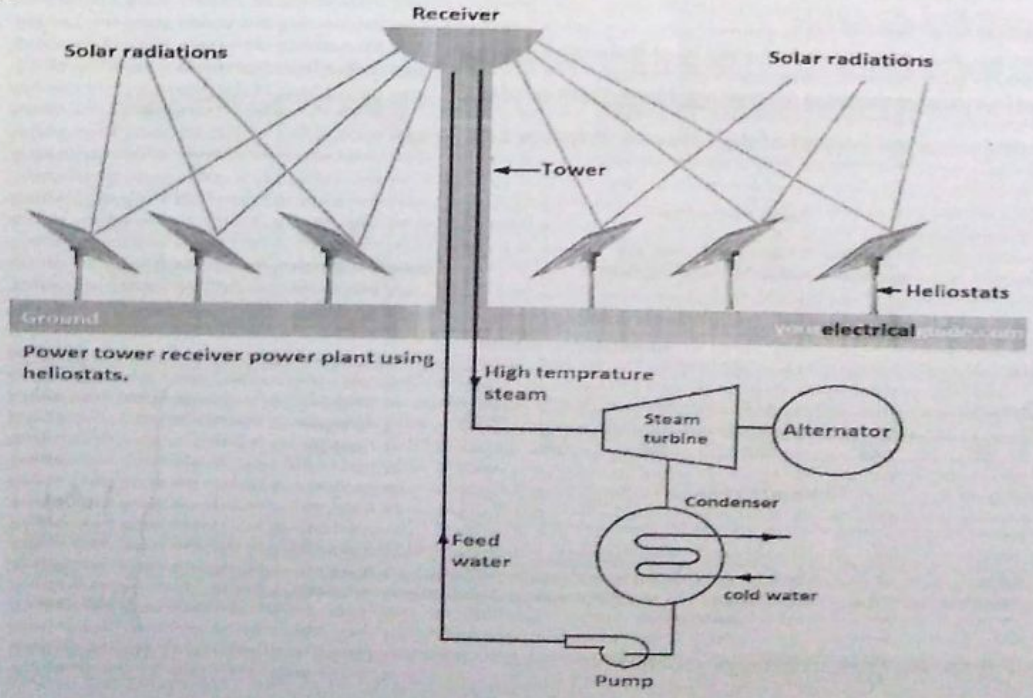
The quality of an energy supply or store is often discussed, but usually remains undefined. We define quality as the proportion of an energy source that can be converted to mechanical work. Thus electricity has high quality because when consumed in an electric motor >95% of the input energy may be converted to mechanical work, say to lift a weight; the heat losses are correspondingly small, <5%. The quality of nuclear, fossil or biomass fuel in a single stage thermal power station is moderately low, because only about 33% of the calorific value of the fuel can be made to appear as mechanical work and about 67% is lost as heat to the environment. If the fuel is used in a combined cycle power station (e.g. methane gas turbine stage followed by steam turbine), then the quality is increased to ~50%. It is possible to analyse such factors in terms of the thermodynamic variable energy, defined here as 'the theoretical maximum amount of work obtainable, at a particular environmental temperature, from an energy source'.

2M

UNIT II

4.

a)



Power tower receiver power plant using heliostats.

2M

In this collector, the receiver is located at the top of the tower. It has a large number of independently-moving flat mirrors (heliostats) spread over a large area of ground to focus the reflected solar radiations on the receiver. The heliostats are installed all around the central tower. Each heliostat is rotated into two directions so as to track the sun. The solar radiations reflected from heliostats are absorbed by the receiver mounted on a tower of about 500 m height.

The tower supports a bundle of vertical tubes containing the working fluid. The working fluid in the absorber receiver is converted into the high-temperature steam of about 600oC – 700oC. This steam is supplied to a conventional steam power plant coupled to an electric generator to generate electric power. This steam is used to drive a turbine coupled to an electric generator. The mechanical energy produced by the turbine is converted into electrical power by the generator.

3M

The exhaust of the steam turbine is condensed in the condenser with the help of circulating cold water. The condensate is returned to the boiler with the help of a feed pump.

b) The flat-plate solar collectors are probably the most fundamental and most studied technology for solar-powered domestic hot water systems. The overall idea behind this technology is pretty simple. The Sun heats a dark flat surface, which collect as much energy as possible, and then the energy is transferred to water, air, or other fluid for further use.

These are the main components of a typical flat-plate solar collector:

- Black surface - absorbent of the incident solar energy
- Glazing cover - a transparent layer that transmits radiation to the absorber, but prevents radiative and convective heat loss from the surface
- Tubes containing heating fluid to transfer the heat from the collector
- Support structure to protect the components and hold them in place
- Insulation covering sides and bottom of the collector to reduce heat losses

2M

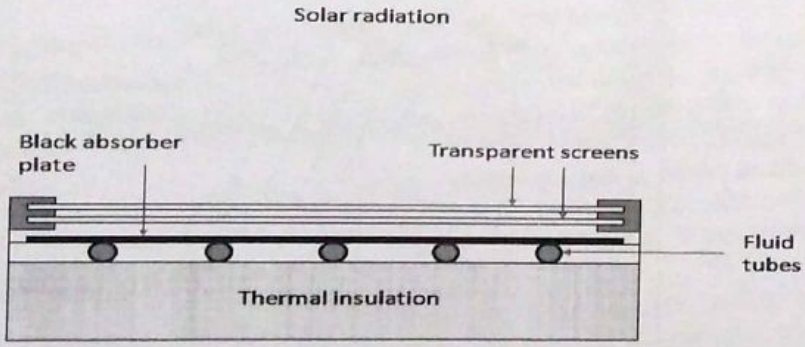


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Figure 3.1: Schematic of a flat plate solar collector with liquid transport medium. The solar radiation is absorbed by the black plate and transfers heat to the fluid in the tubes. The thermal insulation prevents heat loss during fluid transfer; the screens reduce the heat loss due to convection and radiation to the atmosphere

Some advantages of the flat-plate collectors are that they are:

Easy to manufacture

Low cost

Collect both beam and diffuse radiation

Permanently fixed (no sophisticated positioning or tracking equipment is required)

Little maintenance

Transport fluid options

1M

The flat plate collectors can involve liquid or air heat transport.

Water is one of the common options as liquid fluid due to its accessibility and good thermal properties:

It has a relatively high volumetric heat capacity. It is incompressible (or almost incompressible)

It has a high mass density (which allows using small tubes and pipes for transport)

One disadvantage of water is that it freezes during winter, which can damage the collector or piping system. This can be managed by draining down the collector at low solar inputs (below a critical insolation threshold).

Antifreeze mixtures can be used instead of pure water to alleviate the above-said problems. The common antifreeze components are ethylene glycol or propylene glycol. Those chemicals are mixed with water require closed-loop systems and proper disposal due to toxicity. Nominal antifreeze service like is about 5 years, after which it needs to be replaced.

2M

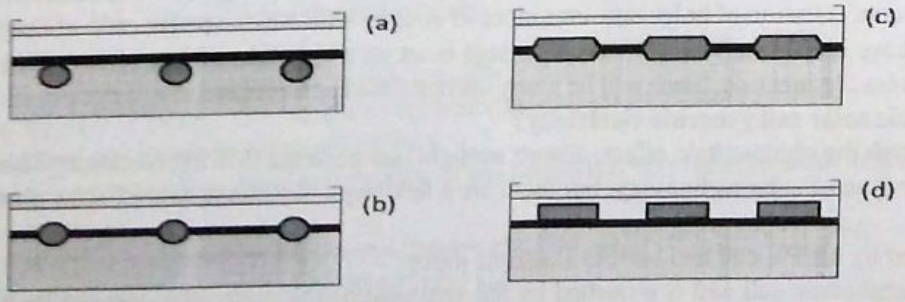
Air can be used as transport fluid in some designs of flat -plate collectors. This option is better suited to space heating applications or crop drying. A fan is usually required to facilitate air flow in the system and efficient heat transport. Certain designs can provide passive (no fan) movement of air due to thermal buoyancy.

Phase-change liquids can also be used with flat-plate collectors. Some refrigerants are included in this group of fluids. They do not freeze, which eliminates troubles explained above for water, and, due to their low boiling point can change from liquid to gas as temperature increases. Those fluids can be practical in settings where quick response to rapid temperature fluctuation is needed.

Collector construction

The key considerations in flat plate collector design are maximizing absorption, minimizing reflection and radiation losses, and effective heat transfer from the collector plate to the fluids. One of the important issues is obtaining a good thermal bond between the absorber plate and changes (tubes or ducts containing the heat-transfer fluids). Different construction designs (shown below) try to address this issue.

The plate - channel assembly may use a variety of methods of component attachment - thermal cement, solder, clips, clamps, brazing, mechanical pressure applicators. One of the considerations in choosing the assembly method is cost of labor and materials.



1M

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Figure 3.2: Various designs of flat-plate collector assembly. Color codes: light blue - glass cover, dark blue - fluid channels, black - absorber material, gray - insulation. Some constructions (b, c) include fluid channels in the absorber plate structure to maximize thermal conductance between the components. Other modifications (a, d) include tubes and channels soldered or cemented to the plate.

(OR)

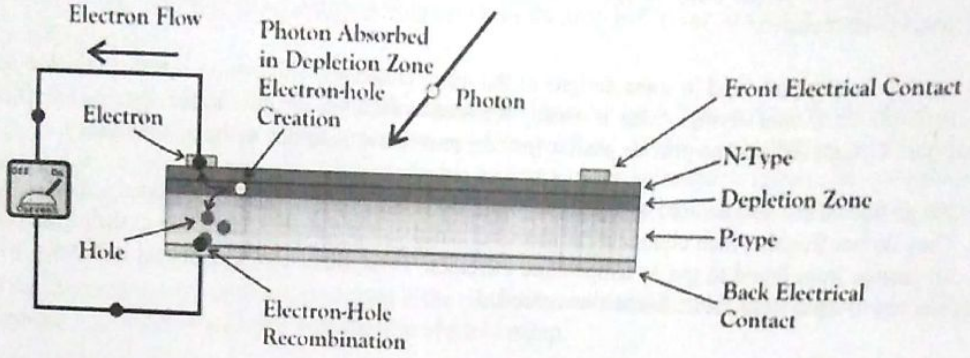
5.a) **Solar Cell** converts light energy into the electrical energy. A solar cell is basically a p-n junction diode. It utilizes photovoltaic effect to convert light energy into electrical energy.

Construction of Solar Cell

1M

Although this is basically a junction diode, but constructionally it is littlebit different form conventyional p-n junction diode. A very thin layer of p-type semiconductor is grown on a relatively thicker n-type semiconductor. We provide few finer electrodes on the top of the p-type semiconductor layer. These electrodes do not obstruct

light to reach the thin p-type layer. Just below the p-type layer there is a p-n junction. We also provide a current collecting electrode at the bottom of the n-type layer. We encapsulate the entire assembly by thin glass to protect the **solar cell** from any mechanical shock.



Working Principle of Solar Cell

When light reaches the p-n junction, the light photons can easily enter in the junction, through very thin p-type layer. The light energy, in the form of photons, supplies sufficient energy to the junction to create a number of electron-hole pairs. The incident light breaks the thermal equilibrium condition of the junction. The free electrons in the depletion region can quickly come to the n-type side of the junction. Similarly, the holes in the depletion can quickly come to the p-type side of the junction. Once, the newly created free electrons come to the n-type side, cannot further cross the junction because of barrier potential of the junction. Similarly, the newly created holes once come to the p-type side cannot further cross the junction became of same barrier potential of the junction. As the concentration of electrons becomes higher in one side, i.e. n-type side of the junction and concentration of holes becomes more in another side, i.e. the p-type side of the junction, the p-n junction will behave like a small battery cell. A voltage is set up which is known as photo voltage. If we connect a small load across the junction, there will be a tiny current flowing through it.

How does a photovoltaic solar cell generate electricity?

Photovoltaic cells, through the photovoltaic effect, absorb sunlight and generate flowing electricity.This process varies depending on the type of solar technology, but there are a few steps commonacross all solar photovoltaic cells.

Step 1: Light is absorbed by the PV cell and knocks electrons loose

First, light strikes a photovoltaic cell and is absorbed by the semiconducting material it is made from (usually silicon). This incoming light energy causes electrons in the silicon to be knocked loose, which will eventually become the solar electricity you can use in your home.

Step 2: Electrons begin to flow, creating an electrical current

There are two layers of silicon used in photovoltaic cells, and each one is specially treated, or "doped", to create an electric field, meaning one side has a net positive charge and one has a net negative charge. This electric field causes loose electrons to flow in one direction through the solar cell, generating an electrical current.

Step 3: The electrical current is captured and combined with other solar cells

Once an electrical current is generated by loose electrons, metal plates on the sides of each solar cell collect those electrons and transfer them to wires. At this point, electrons can flow as electricity through the wiring to a solar inverter and then throughout your home.

b) **Advantages of solar cells**

It is a clean and non-polluting energy source.
It is renewable energy.
Solar cells do not produce noise for electricity generation.
It requires very little maintenance.
Long lifetime.
There are no fuel costs or fuel supply problems in this electrical energy production.

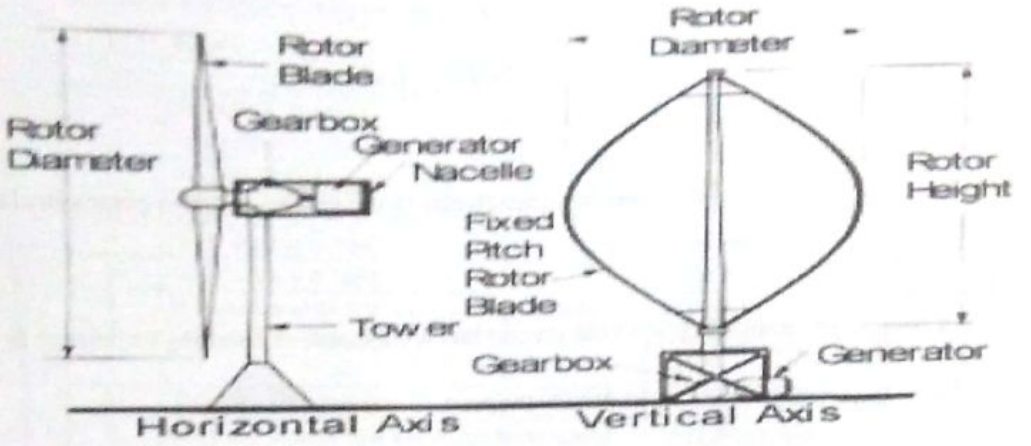
Disadvantages of solar cells

Intermittency issues during power generation.
Require extra elements like batteries, inverters.
High initial cost.
It requires a large area for installation.
It can be damaged easily.

6. UNIT III

a) It is a mechanical machine that converts kinetic energy of the fast moving winds into electrical energy. On the basis of axis of rotation of the blades, it is divided into two parts.

1. Horizontal axis wind turbine (HAWT) 2. Vertical axis wind turbine (VAWT)



Wind Turbine Configurations

1. Horizontal Axis Wind Turbine (HAWT)

It is a turbine in which the axis of rotation of rotor is parallel to the ground and also parallel to wind direction. They are further divided into two types (i) Upwind turbine (ii) Downwind turbine

(i) Upwind Turbine

The turbine in which the rotor faces the wind first are called upwind turbine.

- Today most of the HAWT is manufactured with this design.
- This turbine must be inflexible and placed at some distance from the tower.
- The basic advantage of this turbine is that, it is capable of avoiding wind shade behind the tower.
- It requires yaw mechanism, so that its rotor always faces the wind.

(ii) Downwind Turbine

The turbine in which the rotor is present at the downside of the tower is called downwind turbine. In these types of wind turbines, the wind first faces the tower and after that it faces the rotor blades.

- Yaw mechanism is absent in this turbine. The rotors and nacelles are designed in such a way that the nacelle allows the wind to flow in a controlled manner.

It receives some fluctuation in wind power because here the rotor passes through the wind shade of the tower. In other words the rotor is present after nacelle of the tower and this create fluctuation in the wind power.

Advantages and Disadvantages of HAWTs

The various advantages and disadvantages of the horizontal axis types of wind turbines are:

Advantages

- It has self-starting ability. It does not require any external power source to start.
- It has high efficiency as compared with the HAWT.
- Capable of working in high wind speed condition.
- In the case of slow wind condition, its angle of attack can be varied to get maximum possible efficiency.
- Since all blades of this turbine work simultaneously, so it is capable of extracting maximum energy form the wind.

Disadvantages

- Its initial installation cost is high.
- It requires large ground area for its installation.
- Because of its giant size of blades and towers, it becomes difficult to transport it to the sites.
- High maintenance cost.
- Creates noise problem.
- It cannot be installed near human population.
- It is not good for the bird"s population. They are killed by its blades rotation.

2. Vertical Axis Wind Turbine (VAWT)

It is a turbine in which the axis of rotation of the rotor is perpendicular to the ground and also perpendicular to the wind direction.

- It can operates in low wind situation.
- It is easier to build and transport.
- These types of Wind turbines are mounted close to the ground and are capable of handling turbulence in far better way as compared with the HAWT.
- Because of its less efficiency, it is used only for the private purpose.

VAWTs are further classified as (i) Darrieus turbine (ii). Giromill turbine (iii) Savonius turbine

(i) Darrieus Turbine

Darrieus turbine is type of HAWT. It was first discovered and patented in 1931 by French aeronautical engineer, Georges Jean Marie Darrieus. It is also known as egg beater turbine because of its egg beater shaped rotor blades.

- It consists of vertically oriented blades which are mounted on a vertical rotor. It is not a self-starting turbine and hence a small powered motor is required to start its rotation.

First the Darrieus turbine is rotated by using a small powered motor. Once it attains sufficient speed, the wind flowing across its blades generates lift forces and this lift forces provides the necessary torque for the rotation. As the rotor rotates, it also rotates the generator and electricity is produced.

(ii) Savonius Turbine

Savonius turbine is HAWT.It was first discovered in 1922 by a Finnish Engineer Sigurd Johannes Savonius. It is one of the simplest turbine among all known turbines.

- It is a drag-type device and consists of two or three scoops. If we look it from above than it looks „S" shape in cross section. The scoops of these turbines have curvature shape and because of that, it experiences less drag when it moves against the wind instead of moving with the wind.
- Since it is a drag-type machine, it is capable of extracting very less amount of wind power as compared with other similar sized lift-type turbines.

3M

Advantages and Disadvantages of Vertical Axis Wind Turbine

Advantages

- It is simple in design and easy to construct and transport.
- It can be easily installed to desired location.
- It requires less ground area for its installation.
- Initial installation cost is very less as compared with the HAWT.
- It can work in turbulent wind condition.
- It is omni-directional and hence do not need to track winds.
- They are smaller in size and hence can be used for domestic or private purpose easily.
- They have low maintenance cost as compared with the HAWT.

Disadvantages

- It is less efficient. The efficiency of this turbine is about 30-35%.
- They are not self-starting. A small powered motor is needed to start it.
- Guy wires may required to support this turbine.

b)

Difference between Horizontal Axis Wind Turbine and Vertical Axis Wind Turbine

The various difference between horizontal axis and vertical axis types of wind turbines in tabular form are given below:

S.no	Horizontal Axis Wind Turbine	Vertical Axis Wind Turbine
1.	In HAWTs, the axis of rotation of the rotor is Horizontal to the ground.	In VAWTs the axis of rotation of the rotor is perpendicular to the ground.
2.	Yaw mechanism is present.	Absence of Yaw mechanism.
3.	It has high initial installation cost.	It has low initial installation cost.
4.	They are big in size.	They are small in size.
5.	Its efficiency is high.	It has low efficiency.
6.	It requires large ground area for installation.	It requires less ground area for installation.
7.	High maintenance cost.	Low maintenance cost as compared with HAWT.
8.	They are self-starting.	They are not self-starting.
9.	They are unable to work in low wind speed condition.	They are capable of working in low wind speed condition.
10.	Difficult in transportation.	Easy in transportation.
11.	They are mostly used commercially.	They are mostly used for private purpose only.
12.	It cannot be installed near human population.	It can be installed near human population.
13.	It is not good for the bird's population.	It is good for the bird's population.

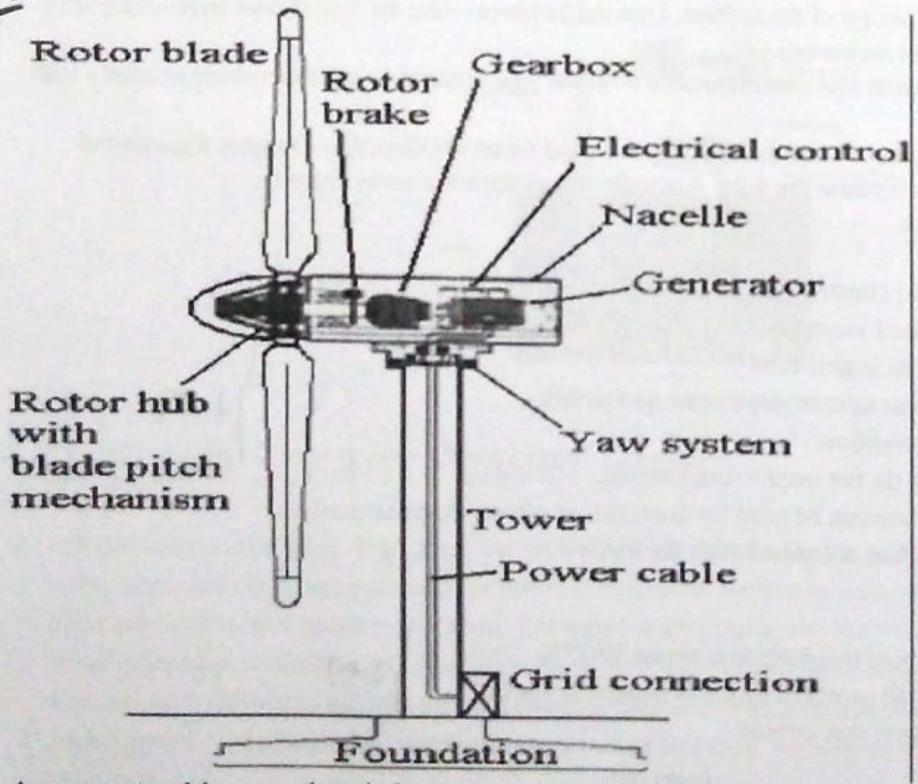
3M

3M

(OR)

7.

a)



2M

Anemometer: Measures the wind speed and transmits wind speed data to the controller.
Blades: Lifts and rotates when wind is blown over them, causing the rotor to spin. Most turbines have either two or three blades.
Brake: Stops the rotor mechanically, electrically, or hydraulically, in emergencies.

1M

Controller: Starts up the machine at wind speeds of about 8 to 16 miles per hour (mph) and shuts off the machine at about 55 mph. Turbines do not operate at wind speeds above about 55 mph because they may be damaged by the high winds.
Gear box: Connects the low-speed shaft to the high-speed shaft and increases the rotational speeds from about 30-60 rotations per minute (rpm), to about 1,000-1,800 rpm; this is the rotational speed required by most generators to produce electricity. The gear box is a costly (and heavy) part of the wind turbine and engineers are exploring "direct-drive" generators that operate at lower rotational speeds and don't need gear boxes.

2M

Generator:
Produces 60-cycle AC electricity; it is usually an off-the-shelf induction generator.
High-speed shaft: Drives the generator.
Low-speed shaft: Turns the low-speed shaft at about 30-60 rpm.
Nacelle: Sits atop the tower and contains the gear box, low- and high-speed shafts, generator, controller, and **brake**. Some nacelles are large enough for a helicopter to land on.
Pitch: Turns (or pitches) blades out of the wind to control the rotor speed, and to keep the rotor from turning in winds that are too high or too low to produce electricity.
Rotor: Blades and hub together form the rotor.
Tower: Made from tubular steel (shown here), concrete, or steel lattice. Supports the structure of the turbine. Because wind speed increases with height, taller towers enable turbines to capture more energy and generate more electricity.

2M

Wind direction: Determines the design of the turbine. Upwind turbines—like the one shown here—face into the wind while downwind turbines face away.
Wind vane: Measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.
Yaw drive: Orients upwind turbines to keep them facing the wind when the direction changes. Downwind turbines don't require a yaw drive because the wind manually blows the rotor away from it.
Yaw motor: Powers the yaw drive.

1M

b) Advantages
- It is simple in design and easy to construct and transport.
- It can be easily installed to desired location.
- It requires less ground area for its installation.
- Initial installation cost is very less as compared with the HAWT.
- It can work in turbulent wind condition.
- It is omni-directional and hence do not need to track winds.
- They are smaller in size and hence can be used for domestic or private purpose easily.
- They have low maintenance cost as compared with the HAWT.

2M

Disadvantages
- It is less efficient. The efficiency of this turbine is about 30-35%.
- They are not self-starting. A small powered motor is needed to start it.
- Guy wires may required to support this turbine.

1M

UNIT IV

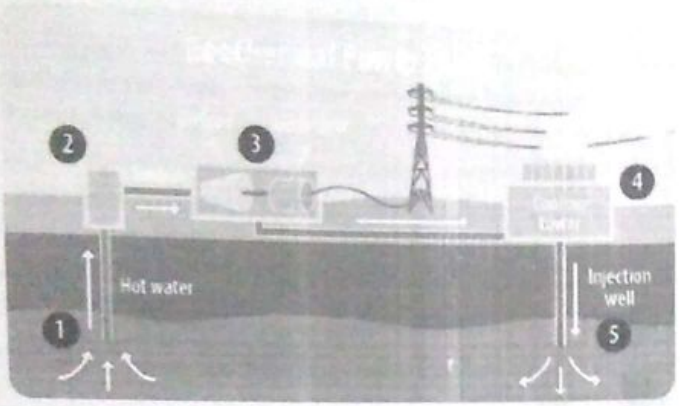
8.

a) Geothermal Energy
If you were to dig a big hole straight down into the Earth, you would notice the temperature getting warmer the deeper you go. That's because the inside of the Earth is full of heat. This heat is called geothermal energy. People can capture geothermal energy through:
- Geothermal power plants, which use heat from deep inside the Earth to generate steam to make electricity.
- Geothermal heat pumps, which tap into heat close to the Earth's surface to heat water or provide heat for buildings.

2M

Geothermal Power Plants
At a geothermal power plant, wells are drilled 1 or 2 miles deep into the Earth to pump steam or hot water to the surface. You're most likely to find one of these power plants in an area that has a lot of hot springs, geysers, or volcanic activity, because these are places where the Earth is particularly hot just below the surface.

How It Works



1. Hot water is pumped from deep underground through a well under high pressure.
2. When the water reaches the surface, the pressure is dropped, which causes the water to turn into steam.
3. The steam spins a turbine, which is connected to a generator that produces electricity.
4. The steam cools off in a cooling tower and condenses back to water.
5. The cooled water is pumped back into the Earth to begin the process again.

2M

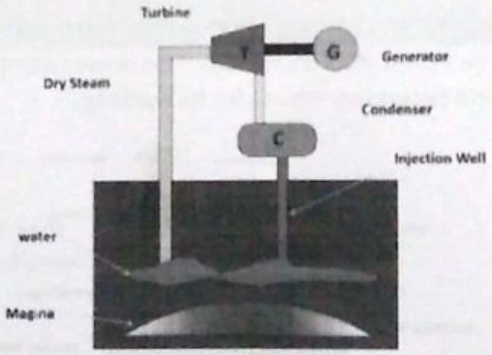
Types

The Geothermal power plant which is in working is of three types

1. Dry steam power plant
2. Flash steam power plant
3. Binary cycle power plant

1. Dry Steam Power Plant

In dry steam power plant, direct steam from the geothermal reservoir is used to turn the turbine and generator to produce electricity. The temperature of the geothermal steam needed in this plant is atleast 150 degreee Celsius.



Dry steam Geothermal Power plant

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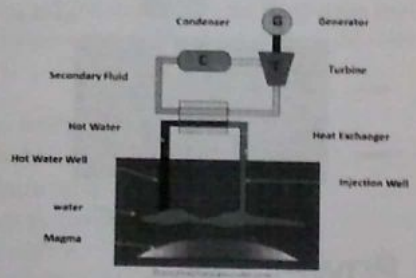
2. Flash Steam Power Plant

In flash steam power plant, high pressure hot water from deep inside the earth is taken out and collected in a steam separator. This high pressure hot water comes to the surface by its own and its pressure keeps on decreases as it moves upward, this allows hot water to gets converter into steam. Steam gets separated in steam separator, and allowed to turn the turbine generator. When the steam cools, it is again injected back into the earth surface to be used again. Nowadays most of the geothermal power plants used are of flash steam plants. This power plant requires a temperature of atleast 180 degree Celsius for its operation.

Flash Steam Geothermal Power plant

3. Binary Cycle Power plant

In binary cycle power plant, the heat of hot water is transferred to another liquid (called as secondary liquid). The heat of hot water causes another liquid to change into steam and then this steam is used to rotate turbine. It is the most recent developed power plant which may be operated at lowest temperature of atleast 57 degree Celsius. The secondary fluid (i.e. another liquid) used in this binary cycle geothermal power plant has much lower boiling point than water. It works on both Rankine and Kalina cycle. The thermal efficiency of this power station is expected to be lie in between 10-13%. This power plant is called as binary, since here we are using two liquids (hot water and secondary liquid) for its working.



Binary Cycle Geothermal Power plant

2M

Advantages

1. It requires no fuel for its working.
2. It requires minimal land and fresh water.
3. Geothermal power is a sustainable source of energy.

Disadvantages

1. The fluid taken out from deep earth contains mixtures of gases such as Hydrogen sulphide (H_2S), Carbon dioxide (CO_2), Ammonia (NH_3), methane (CH_4) and Radon (Rn). If these gases is released, it will contribute to global warming, acid rain, Radiation and noxious smell.
2. It requires emission control system to reduce the exhaust that may be produce form acids and volatile chemicals.
3. The hot water taken out from the geothermal sources is hold in a solution which may contain traces of toxic chemicals like mercury, boron, arsenic, antimonny and salt. when water cools these toxic chemicals comes out of the solution and can responsible for the environmental damage if released.
4. Geothermal power plant constructed at the site may adversely affect land stability.

b) Tides in the sea are produced due to the gravitational attraction of moon and sun upon the rotating earth. Rise and fall of tides occur twice a day.

The highest level of tidal water is called high tide or flood tide whereas the lowest level of tidal water is called low tide or ebb tide. The level difference between high and low tides is called tidal range.

The tidal range is time, season and location dependent. The maximum tidal range takes place at the time of new and full moon known as spring tides. Availability of 5 m tidal range or above in particular location can be used to operate a hydraulic turbine.

Tidal Power Plant Working Principle

In tidal energypower plants, the water during high tides is first collected in an artificial basin and it is released during the period of low tides. The water while escaping is used to spin a hydraulic turbine connected to a generator. The three main components of a tidal energy power plant are:

powerhouse,

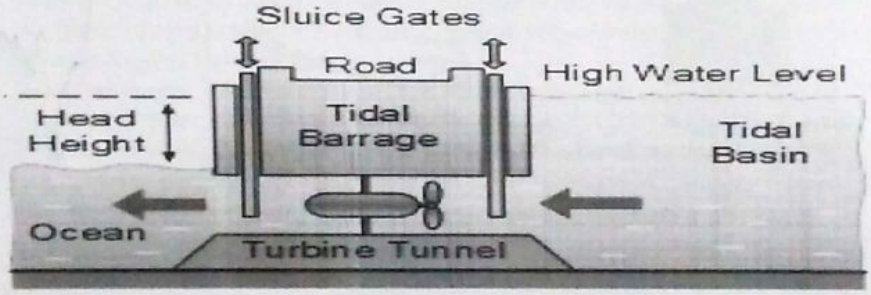
dam to form the basin,

sluiceways from the basin to sea and vice versa.

The function of the dam is to create an obstacle between sea and the basin. The sluiceways are used to either fill the basin during high tide or empty the basin during the low tide.

Single Basin Tidal Power Plant Working

In *single basin tidal power plant*, the powerhouse is located at the mouth of the basin. The hydraulic turbine in powerhouse only operates during the discharge of water from the basin during low tide. The basin is filled again during the high tide. Intermittent operation is the main disadvantage of this system.



Advantages:

- It is pollution free.
- Energy is freely available.
- Power is ensured around the year.
- It is unaffected by the unpredictability of monsoon.

Disadvantages:

- The capital cost of the plant is high.
- Every location is not suitable for installing such a system.
- Sedimentation of basins is a problem.
- Sea water is very corrosive.
- Marine life is affected.

(OR)

9.

a) Gasification is a process in which combustible materials are partially oxidized or partially combusted. The product of gasification is a combustible synthesis gas, or syngas. Because gasification involves the partial, rather than complete, oxidization of the feed, gasification processes operate in an oxygen-lean environment.

Types of Gasifiers:

1. Fixed bed/moving Gasifier

Moving Bed

A diagram of a generic moving bed gasifier is shown in figure 2. Moving bed gasifiers are countercurrent flow reactors in which the coal enters at the top of the reactor and air or oxygen enters at the bottom. As the coal slowly moves down through the reactor, it is gasified and the remaining ash drops out of the bottom of the reactor. Because of the countercurrent flow arrangement, the heat of reaction from the gasification reactions serves to pre-heat the coal before it enters the gasification reaction zone. Consequently, the temperature of the syngas exiting the gasifier is significantly lower than the temperature needed for complete conversion of the coal.

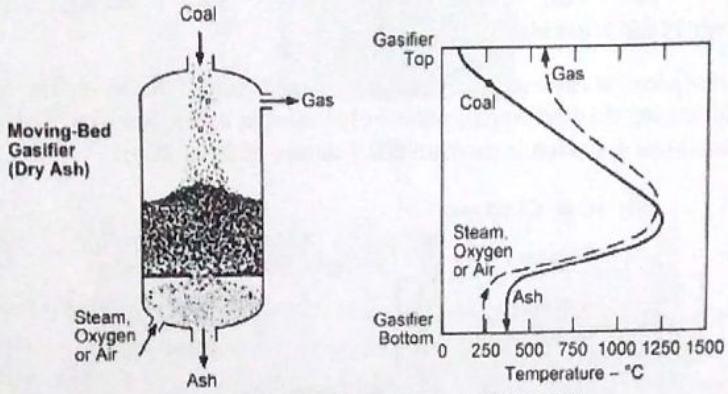


Fig. 2. Diagram of a generic moving bed gasifier

The residence time of the coal within a moving bed gasifier may be on the order of hours.

Moving bed gasifiers have the following characteristics:[1]

- Low oxidant requirements;
- Relatively high methane content in the produced gas;
- Production of hydrocarbon liquids, such as tars an oils;
- High "cold gas" thermal efficiency when the heating value of the hydrocarbon liquids are included;
- Limited ability to handle fines; and
- Special requirements for handling caking coal.

Fluidized Bed

A diagram of a generic fluidized bed gasifier is shown in figure 3. A fluidized bed gasifier is a back-mixed or well-stirred reactor in which there is a consistent mixture of new coal particles mixed in with older, partially gasified and fully gasified particles. The mixing also fosters uniform temperatures throughout the bed. The flow of gas into the reactor (oxidant, steam, recycled syngas) must be sufficient to float the coal particles within the bed but not so high as to entrained them out of the bed. However, as the particles are gasified, they will become smaller and lighter and will be entrained out of the reactor. It is also important that the temperatures within the bed are less than the initial ash fusion temperature of the coal to avoid particle agglomeration.

Typically a cyclone downstream of the gasifier will capture the larger particles that are entrained out and these particles are recycled back to the bed. Overall, the residence time of coal particles in a fluidized bed gasifier is shorter than that of a moving bed gasifier.

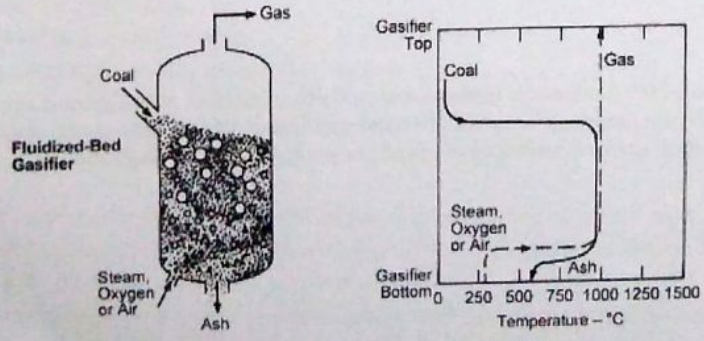


Fig. 3. Diagram of a generic fluidized bed gasifier

Generic characteristics of fluidized bed gasifiers include:[2]

- Extensive solids recycling,
- Uniform and moderate temperature; and
- Moderate oxygen and steam requirements.

5) b) Continuous OR Batch type biogas plants.:-

In the continuous type of biogas plant the biomass is fed regularly to the digester & it delivers the biogas continuously.

Continuous type biogas plants are of two types .

1. Single stage continuous type biogas plant.
2. Two stage continuous type biogas plant.

1) Single stage continuous type biogas plants:-

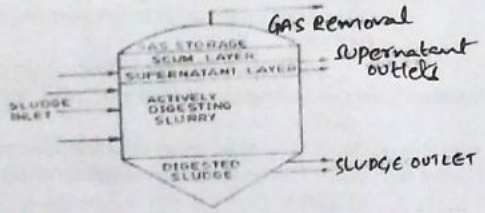
In this type of plants the entire process of conversion of biomass into biogas are carried out in the single chamber or digester without barrier construction of plant is simple in construction easy to operate & control. It does not need any skilled workers.

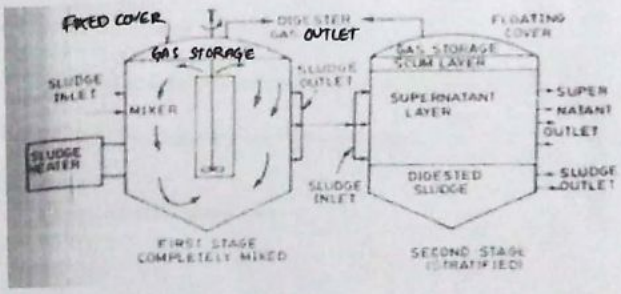
2) Two stage continuous type biogas plant :-

These plant have two chambers for digestion of biomass. In the first chamber the biomass is fed in which the Stage 1. of acid formation takes place. Then the diluted acids are only fed into the second chamber where the Stage 2. of methane formation is carried out. So produced is collected from the second chamber. Various factors affecting the production of biogas.

Following are the Imp. Factors of the rate of production of biogas. 4M

- **Solid concentration & loading Rate:-** The cow dung water & various organic residues from agricultural waste are supplied as feed to the digester. The proportions recommended are. Cow Dung + Solid sast;1 by weight & forming to about 10% of solid content& 90% of water. The amount of feed supply per day to the digester is called **Loading Rate.**
- Retention Period :- The Longer Retention Period needs larger size digester & it allows more complete digestion of feed.
- PH value or Hydrogen ion concentration :- PH value indicates the degree of acidity OR alkalinity of a solution the PH value is represented as the logarithm of the reciprocal of hydrogen ion concentration In gm equivalent per liter of solution.
- Toxic Substances :- The presence of ammonia , pesticides detergents, heavy metals are considered as toxic substance to micro- organisms since their presence reduces the fermentation rate.
- Digester Size & Shape :- It is found that the biogas production per unit volume of digester is high when its diameter to depth ratio ranges between 0.66 to 1.
- Stirring OR agitation of the content of digester :- Since bacteria in the digester has very limited reach to their food , it is necessary that the slurry is property mixed & bacteria get their food supply.





2M

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