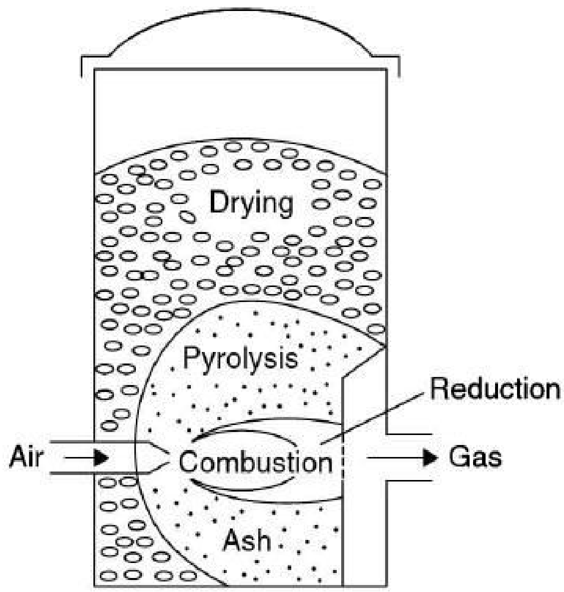
Solution of Renewable Energy Resources IAT3
Subject Code: 18EE653

1. With neat diagram, briefly explain about Cross draft gasifier and Fluidized bed gasifier.
Answer:

CROSS DRAFT GASIFIER



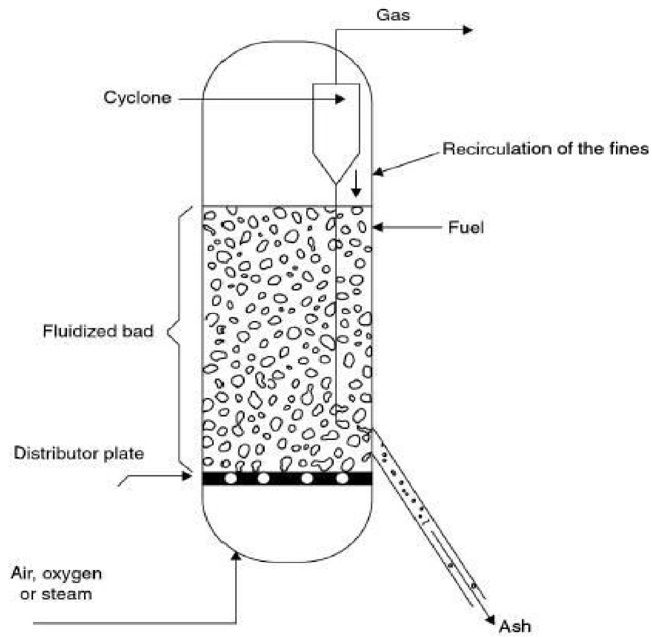
- Here the biomass is fed through one side of the gasifier and the producer gas leaves through the other side
- In crossdraft gasifier, the ash bin, fire and reduction zone and reduction zone in crossdraft gasifiers are separated
- Air enters the gasifier through a water cooled nozzle mounted on one side of the firebox
- Confines its combustion and reduction near the air nozzle
- High operating temperature
- The high operating temperature will affect the gas composition such as high CO, and low hydrogen and methane content when dry fuels like charcoal is used
- Operates well with low ash, dry biomass feed fuels.

FLUIDIZED BED GASIFIER

- Improved version of fixed bed gasifiers
- The bed is made of an inert material (such as sand ,ash,or char) is heated initially and the fuel is introduced when the temperature has reached the appropriate level.
- The bed material transfers heat to the fuel
- Fluidized bed gasifiers have no distinct reaction zones and drying, pyrolysis and gasification occur simultaneously.
- The fuel particles are introduced at the bottom of the reactor ,very quickly mixed with the

bed material and almost instantaneously heated up to the bed temperature

- As a result fuel is pyrolysed fast resulting in a component mix with a relatively large amount of gaseous materials
- Further gasification and tar conversion reactions occur in the gas phase

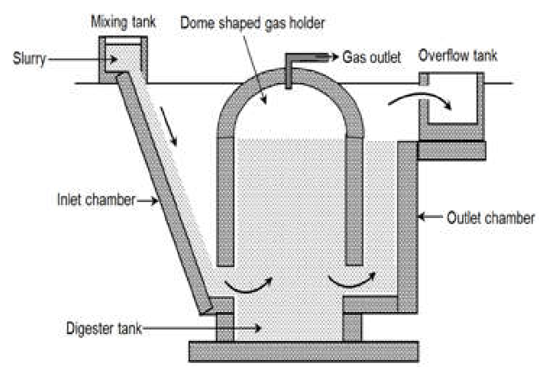


2. Using the schematic diagram, explain about Fixed dome type bio gas plant. Mention the advantages and disadvantages of Fixed dome type bio gas plant.

Answer:

The parts of the fixed dome biogas plants are

1.Mixing tank
2.Digester
3.Inlet chamber
4.Outlet chamber
5.Fixed Dome
6.Overflow tank
7.Gas pipe & Gas control valve



Working of Fixed Dome type Biogas Plant

- The various forms of biomass are mixed with an equal quantity of water in the mixing tank. This forms the **slurry**.
- The slurry is fed into the digester through the inlet chamber.
- When the digester is partially filled with the slurry, the introduction of slurry is stopped and the plant is left unused for about two months.
- During these two months, anaerobic bacteria present in the slurry decomposes or ferments the biomass in the presence of water.
- As a result of anaerobic fermentation, biogas is formed, which starts collecting in the dome of the digester.

- As more and more biogas starts collecting, the pressure exerted by the biogas forces the spent slurry into the outlet chamber.
- From the outlet chamber, the spent slurry overflows into the overflow tank.
- The spent slurry is manually removed from the overflow tank and used as manure for plants.
- The gas valve connected to a system of pipelines is opened when a supply of biogas is required.
- To obtain a continuous supply of biogas, a functioning plant can be fed continuously with the prepared slurry.

- Advantages:
- Low cost compared to floating dome type
- Simple construction as there is no moving dome
- Long life can be expected(20 yrs or so)
- Underground and almost ground level dome construction prevents damage to plant
- The anaerobic digestion inside digester is less influenced by temperature variations during day and night
- Disadvantages:
- Porosity and cracks in walls of the plant may occur
- Difficult to maintain

3. Explain the Co-operating Two-basin Tidal System. Discuss about the problems faced in exploiting tidal energy.

Answer:

Co-operating Two-basin Systems

• This scheme consists of two basins at different elevation connected through the turbine.
The sluices in the high- and low-level basin communicate with seawater directly, as shown in Figure.
The high-level basin sluices are called the inlet sluices and the low level as outlet sluices.

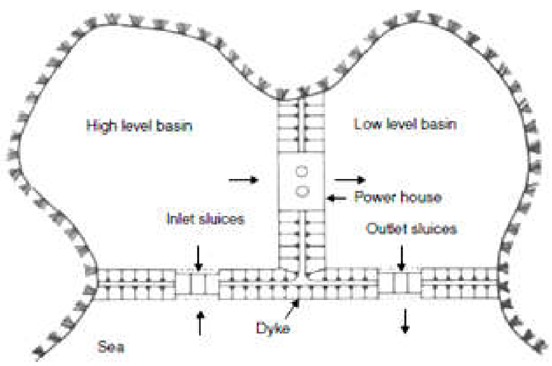


Figure Co-operating two-basin systems

The basic operation of the scheme is as follows:
1. The rising tide fills the high-level basin through the sluiceways.
2. When the falling seawater level is equal to the water level in the high-level basin, the sluiceways are closed to prevent the out flowing high-level basin water back to the sea.
3. The water from high-level basin is then allowed to flow through the turbine generators to the low-level basin.
4. When the falling seawater level becomes lower than the rising water level in the low-level basin, the sluiceways are opened to allow water to flow into the sea from the low-level basin. This process continues until the water level in the low-level basin equals to the rising sea level. Then, the sluiceways are closed to prevent the filling of low-level basin from the seawater.
5. When the seawater again rises during the next rising tide equals to low level of high-level basin, sluices of high-level basin is again open for filling of water in high-level basin. Thus, the cycle is repeated.

PROBLEMS FACED IN EXPLOITING TIDAL ENERGY

1. Usually the places where tidal energy is produced are far away from the places where it is consumed. This transmission is expensive and difficult.
2. *Intermittent supply: Cost and environmental problems, particularly barrage systems are less* attractive than some other forms of renewable energy.
3. *Cost: The disadvantages of using tidal and wave energy must be considered before jumping* to conclusion that this renewable, clean resource is the answer to all our problems. The main detriment is the cost of those plants.
4. *Altering the ecosystem at the bay: Damages such as reduced flushing, winter icing, and erosion* can change the vegetation of the area and disrupt the balance. Similar to other ocean energies, tidal energy has several prerequisites that make it only available in a small number of regions.

4. Derive the expression for energy available in tides and calculate the tidal power.

Answer:

ENERGY AVAILABILITY IN TIDES

Potential energy and kinetic energy are the two energy components of energy of the tide waves. The potential energy is the work done in lifting the mass of water above the ocean surface.

This energy can be calculated as

$$E = \rho g A \int z\,dz = 0.5\,\rho g A h^2$$

where E = the energy; g = acceleration of gravity; ρ = the seawater density (which equals its mass per unit volume); A = sea area under consideration; z = vertical coordinate of the ocean surface; and h = the tide amplitude.

Taking an average of the product of (ρg) = 10.15 kN/m^3 for seawater, energy for a tidal cycle per m^2 of ocean surface can be approximated as:

$$E = 1.4\,h^2 \quad \text{(Watt-hour)}$$

or

$$= 5.04\,h^2 \quad \text{(kJ)}$$

Since extracting all the available stream power could be environmentally damaging, it is necessary to use a factor that expresses the usable power percentage with apparently no damaging consequences. It is called α (significant extraction factor) that may vary from 0.2 to 0.6.

The kinetic energy (KE) of the water mass (m) is its capacity to do work by virtue of its velocity (V). It is defined by

$$KE = 0.5 m V^2$$

The total energy of tide waves equals the sum of its potential and kinetic energy components.

Calculation of Tidal Power

Potential tidal power can be reckoned based on a mathematical calculation. Let us assume that the surface area of the reservoir as stable between the full stored water level and the emptied floor, the energy produced by the ebbing water could be expressed as

$$d(w) = \rho g h d(v) = \rho g A h d(h)$$

Here, $d(w)$ = energy unit; ρ = density of seawater (about $[1.02–1.04] \times 10^3$ kg/m^3); g = acceleration of gravity (9.8 m/s^2); A = surface area of the reservoir (m^2) assumed as a constant from high tide to low tide; h = instant water level height (m); v = volume of reservoirs (m^3).

Therefore, its power could be written as

$$P = \int d(w) / \int dt = \rho g A H^2 / 2T$$

Here, P = potential power (W); T = tidal period (s); and H = tidal ranges (m).

Let us assume $\rho = 1.04 \times 10^3$ kg/m^3 and $T = 6$ h.

This formula can be simplified as $P = 0.226 A H^2$ (W)

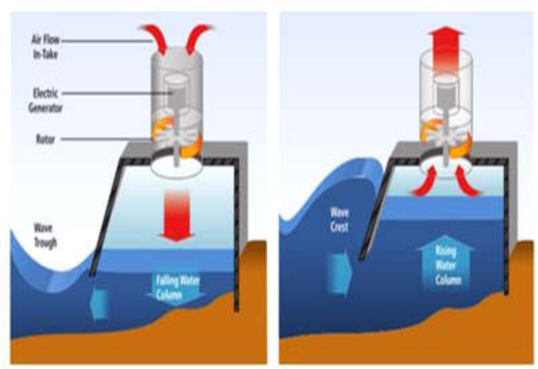
5. Discuss about the devices used for harnessing sea wave energy.

Answer:

- There are three basic technologies for converting wave energy to electricity.

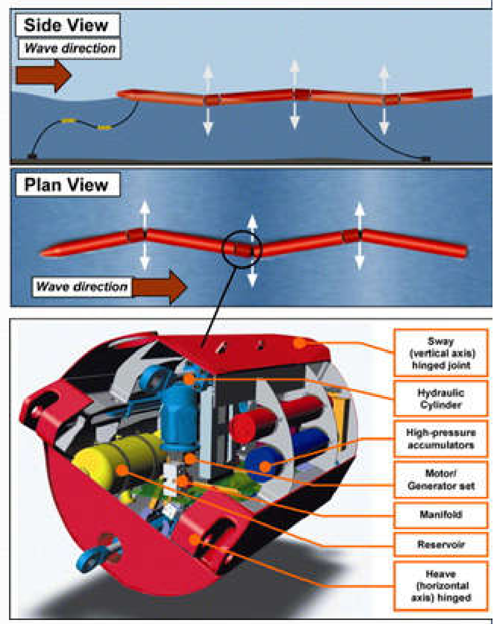
1. *Terminator devices*:

- It is a wave energy device oriented perpendicular to the direction of the wave and has one stationary and one moving part.
- The moving part moves up and down like a car piston in response to ocean waves and pressurizes air or oil to drive a turbine.
- An oscillating water column (OWC) converter is an example of terminator device.
- These devices generally have power ratings of 500 kW to 2 MW, depending on the wave parameters and the device dimensions.

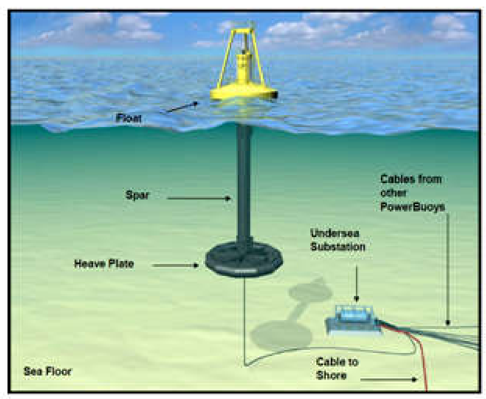


2. *Attenuator devices*:

- These devices are oriented parallel to the direction of the waves and are long multi-segment floating structures.
- It has a series of long cylindrical floating devices connected to each other with hinges and anchored to the seabed.
- They ride the waves like a ship, extracting energy by using restraints at the bow of the device and along its length.
- The segments are connected to hydraulic pumps or other converters to generate power as the waves move across.
- Pelamis wave energy converter is one of the known examples of attenuator devices.

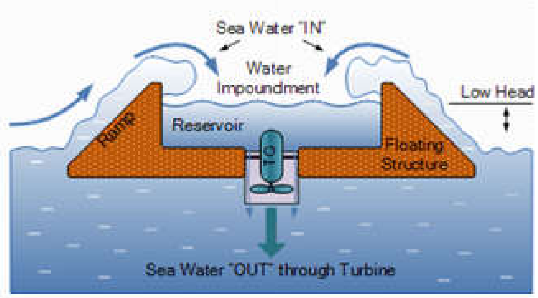


- 3. *Point absorber*:
- It is a floating structure with parts moving relative to each other owing to wave action but it has no orientation in any defined way towards the waves instead absorbs the wave energy coming from any direction.
- It utilizes the rise and fall of the wave height at a single point for energy conversion.
- The pressurized water creates up and down bobbin type motion and drives a built-in turbine generator system to generate electricity.
- AquaBuOY WEC is an example of point absorber devices.



4. *Overtopping devices*:

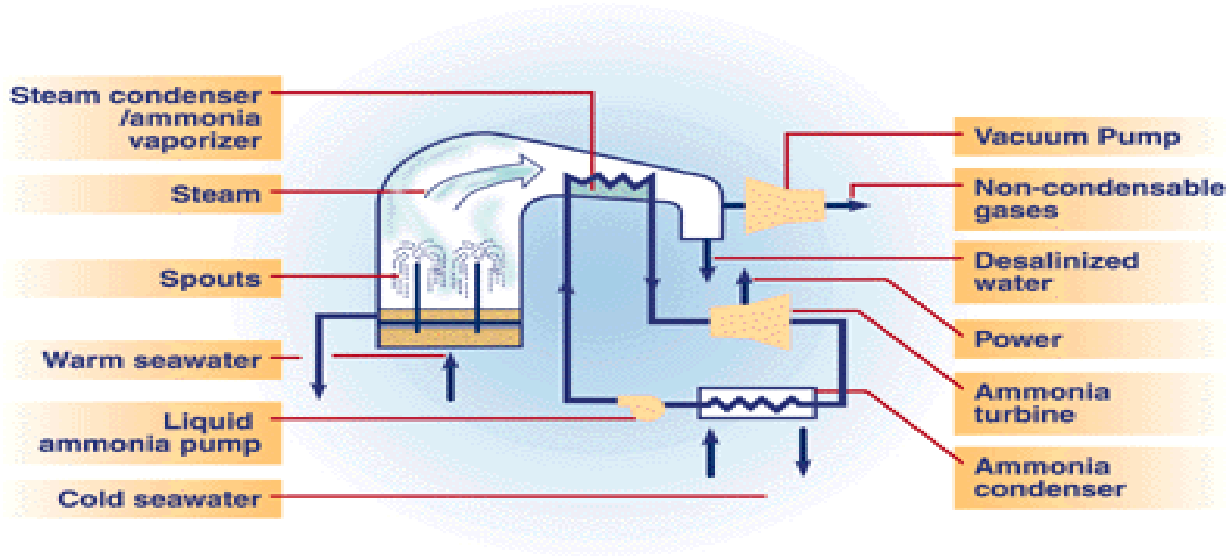
- These devices have reservoirs like a dam that are filled by incoming waves, causing a slight build-up of water pressure.
- Gravity causes released water from reservoir to flow back into the ocean through turbine coupled to an electrical generator.
- Salter Duck WEC is the example of overtopping devices.



6 (a) With a neat diagram, explain the working principle of Hybrid OTEC (b) Explain OTEC Rankine Cycle.

Answer:

(a)



- ∗ Hybrid cycle combines the features of both open and closed cycle OTEC.
- ∗ Warm sea water is pumped into vacuum chamber where it is flashed to steam. The steam produced will vaporize a working fluid.
- ∗ The vaporized working fluid will rotate the turbine and drive the generator to produce electricity.
- ∗ The fluid vapor will be condensed by cold sea water in a condenser and re circulated in a closed cycle.
- ∗ The condensed steam or desalinated water is used for marine culture plants
- ∗ Non condensable gases are exhausted

(b)

* Basic Rankine cycle consist
* 1.An evaporator
* 2.A turbine expander
* 3.A condenser
* 4.A pump
* 5.A working fluid

1. Steam Rankine Cycle
2. Organic Rankine cycle