Tidal Energy

All flowing waters carry with them kinetic energy. When such water encounters a turbine, part of the momentum of the flowing water is transfered on to the turbine, causing it to rotate. The rotation of the turbine can then be used to generate electricity.

Tides are generated by the action of gravitational forces of the sun & the moon on the oceans, by the spinning of the earth around its axis & the relative positions of the earth, moon & the sun.

The tides are the periodic vertical rise & fall of ocean water. The period bet" consecutive high tides is 12.5 hours. The tidal rise & fall of water is accompanied by periodic horizontal to & fro motion of water called tidal currents. Tides & tidal currents are intimately related.

Tidal movement differs from wave-movement. Waves have a period of only about 6 s whereas tides have a period of 12.5 h. Waves are caused by surface winds, whereas tides are caused by the gravitational forces of moon & sun on ocean water.

The amplitude of tides covers a wide range from 25 cm to 10 m. The speed of tidal currents is in the range of 1.8 km/h to 18 km/h.

The rise & fall of the water level follows a sinusoidal curve: shown in fig below.

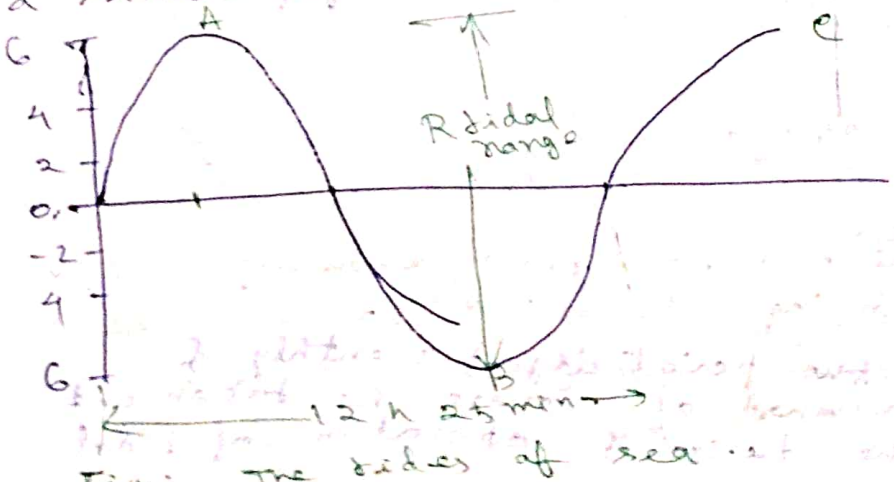


Fig:- The tides of sea.

In this fig. pt. A indicating the high tide pt. & pt. B indicating the low tide pt.
The average period of time for the water level to fall from A to B & then rise from B to C is each approximately equal to 6 hours 12.5 min.

The difference bet' high & low water levels is called the range of the tide.
The tidal range R is defined as:
R = water elevation at high tide − water elevation at low tide
Becoz of the changing positions of the moon & sun relative to the earth, the range varies continuously.

At times during full or new moon, when sun, moon & earth are approximately in a line, the gravitational forces of sun & moon are enhanced. The tidal range is then exceptionally large, the high tides are higher & low tides are lower than the average. These high tides are called spring tides. On the other hand, near the 1st & 3rd quarters of the moon, when the sun & moon are at right angles w.r.t. the earth, neap tides occur. In neap tides, the tidal range ~~are~~ is exceptionally small; the high tides are lower & the low tides higher than the average. Hence the range is not constant. It varies during the 29.5 day lunar month. The spring-neap tidal cycle lasts one-half of a lunar month.

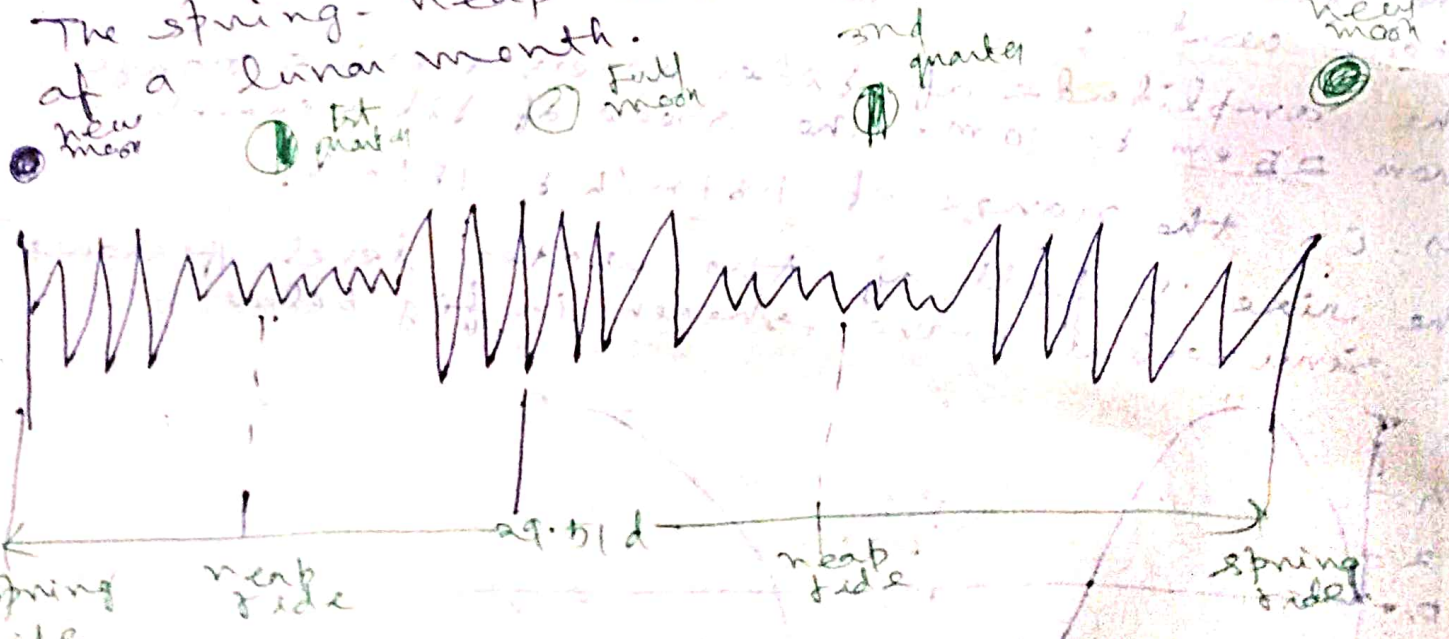


Fig → Relative high & low tides showing variation in range during lunar month.

The variation in the periodicity & monthly & seasonal ranges must of course be taken into account in the design & operation of tidal power plants.

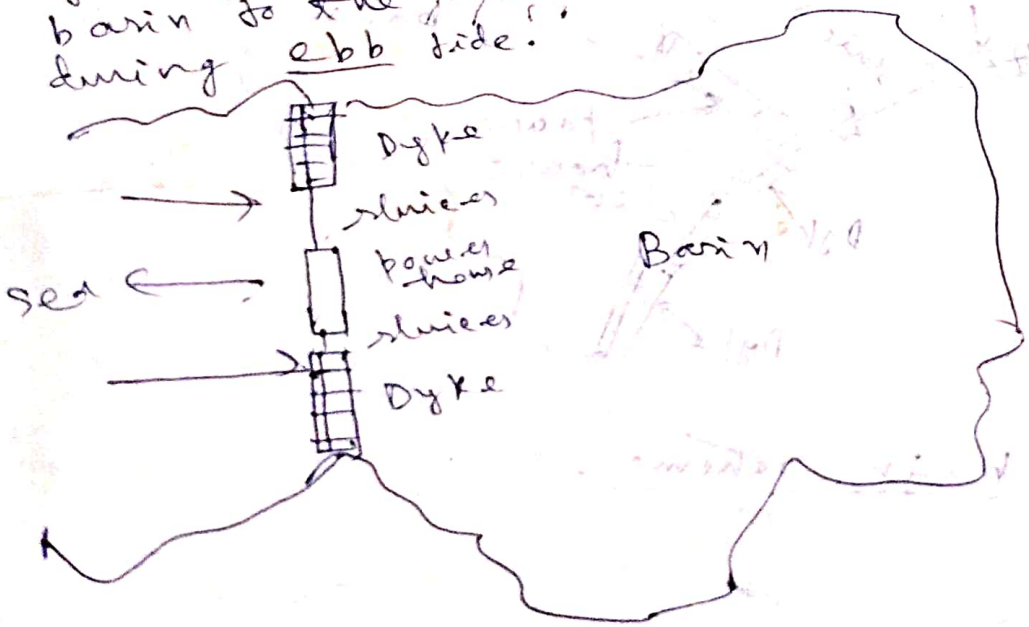
Main types of tidal power generation systems

A tidal power development scheme essentially involves the construction of a long barrier across a bay or an estuary to create a large basin on the landward side. The barrier includes dykes, gate-controlled sluices, & the power house. Tidal power schemes have the following different configurations in common use.

i) Single Basin, single effect tidal power scheme.
ii) Single Basin, Double Effect Tidal Power scheme.
iii) Linked Basin scheme.

i) Single Basin, single effect tidal power scheme

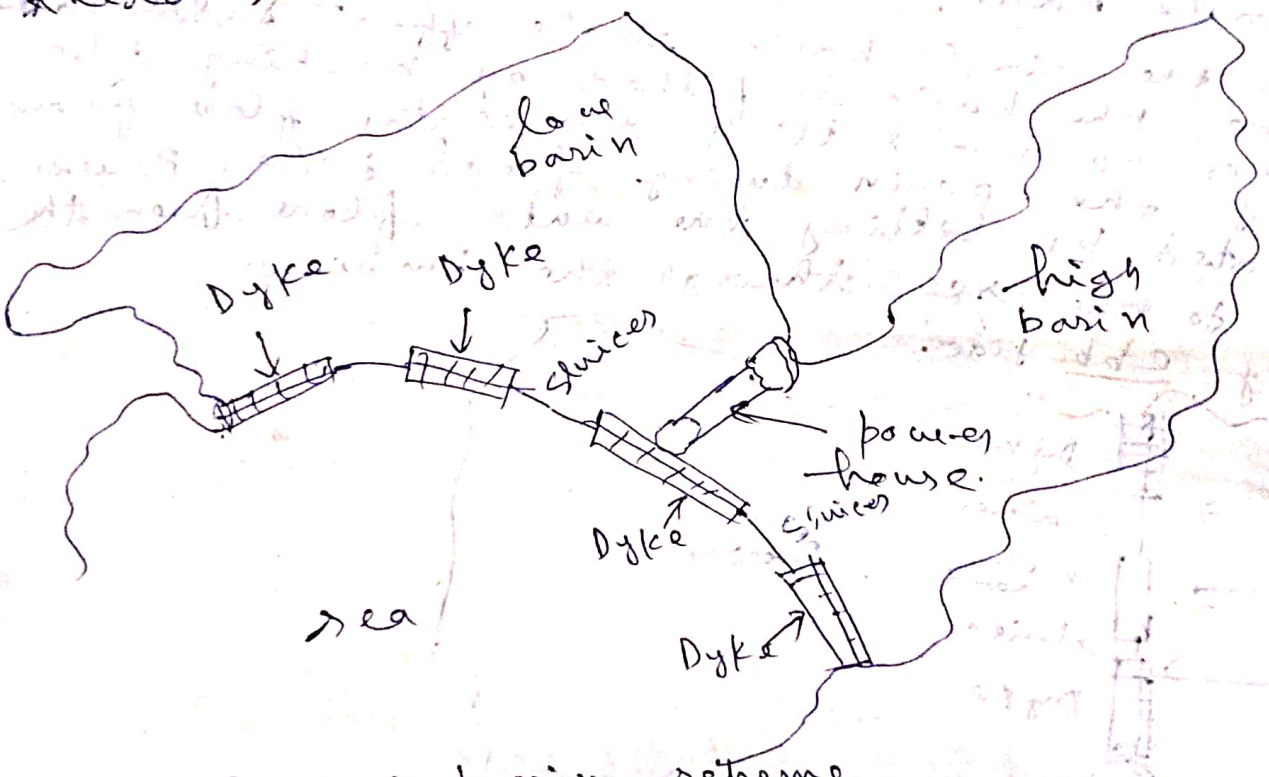
In the single basin, single effect tidal power scheme, the basin is filled by keeping the sluices open & letting the water flow from sea to the basin during flood tide. Power is generated by letting the water flow from the basin to the sea through the turbines during ebb tide.



Single basin double effect tidal power scheme

Power is generated during flood tide, as the water flowing from the sea to the basin through the turbines, & also during ebb tide, as the water flowing from the basin to the sea through the turbines. In this case, the turbine blades should be reversible with proper blade angles depending upon the direction of flow.

Linked Basin (Double Basin single effect tidal power scheme) there are two basins on the landward side with power house located in the barrier bet^{n} the two basins. Power is generated by water flowing from the high basin to the low basin through the turbines & water flowing from the low basin to the sea during ebb tide. Turbo-generators should be capable of efficient generation at low heads & consequently of handling large discharges. It may be seen from fig-1, 2, 3 that the energy availability in 1st two schemes is rather limited compared to the third scheme.



linked basin scheme.

Advantages of Tidal power generation

i) The biggest advantage of tidal power, besides being inexhaustible, is that it is completely independent of the uncertainty of rain. Even a continuous dry spell of any number of years will have no effect whatsoever on the tidal power generation.

ii) Tidal power generation is free from pollution, as it does not use any fuel & also does not produce any unhealthy waste like gases, ash or atomic refuse.

iii) These power plants do not require large areas of valuable land beeoz they are on the bays (sea shore).

iv) Peak power demand can be effectively met when it works in combination with thermal or hydroelectric systems.

Disadvantages or limitations

i) The fundamental drawback to all methods of generating tidal power is the variability in output caused by the variations in the tidal range.

ii) The tidal ranges are highly variable & thus the turbine have to work on a wide range of head variation. This affects the efficiency of the plant.

iii) sea water is corrosive & it was feared that the machinery may get corroded. Stainless steel with a high chromium content & a small amount of molybdenum & the aluminium bronzes proved to be good corrosion resistant at La Rance project. The vinyl paint exhibited good results.

iv) construction in sea or in estuaries is found difficult.

v) cost is favourable compared to the other sources of energy.

vi) It is feared that the tidal power plant would hamper the other natural uses of estuaries such as fishing or navigation.