Wave energy

Waves are continuously generated in oceans & large lakes.

Waves are created by the gravitational action of the sun & the moon, as also by the forces of winds. Oceans are efficient collectors of wind energy; indeed waves are a source of energy steadier than the wind, because wind generates a wave.

Wave energy fluxes in the open sea or against coasts may vary from a few watts to kilowatts per metre. They are smallest in summer & greatest in winter.

Wave motion consists of both vertical & horizontal movement of water. Individual particles of water undergo almost a circular motion, moving up as the crest approaches, forward at the crest, down as it recedes, and backward in the trough.

Wave energy generation

Potential Energy

Potential energy arises from the elevation of water above mean level (i.e $y = 0$). considering a differential volume $y\,dx$, & a mean height y, the potential energy is

$$dPE = \frac{mgy}{2} = \frac{(\rho y\,dx\,L)\,gy}{2}$$

$$\left[D = \frac{m}{V} \right.$$

$$\Rightarrow m = D \cdot V = \rho \cdot y\,dx$$

$$\boxed{dPE = \frac{g \rho y^2 L\,dx}{2}} \quad \text{---------- (1)}$$

[D → density, V → volume]

where, m = mass of the liquid, $y.dx$, kg
g = gravitational const = $9.8\ m/s^2$
ρ = water density in kg/m^3
L = arbitrary width of the two-dimensional wave perpendicular to the dir^n of wave propagation in m.

The equation of wave is given by

$$\boxed{y = a \sin(mx - nt)}$$

where, $m = 2\pi/\lambda$ m^{-1}
$n = 2\pi/\lambda$ = phase rate, second^{-1}
y = height above its mean level in m.
λ = period in seconds

Advantages

(1) It is free & renewable energy source.
(2) These devices are relatively pollution free.
(3) A much greater extent of power is concentrated in the motion of waves than in the movement of air.

Disadvantages

(1) The major disadvantages of wave energy as compared to wind is that the energy is available in the ocean. Therefore the extraction equipment must operate in a marine environment which will have to be taken into account during its construction & its maintenance.

(2) Wave energy converters must be capable of withstanding very severe peak stresses in storms.

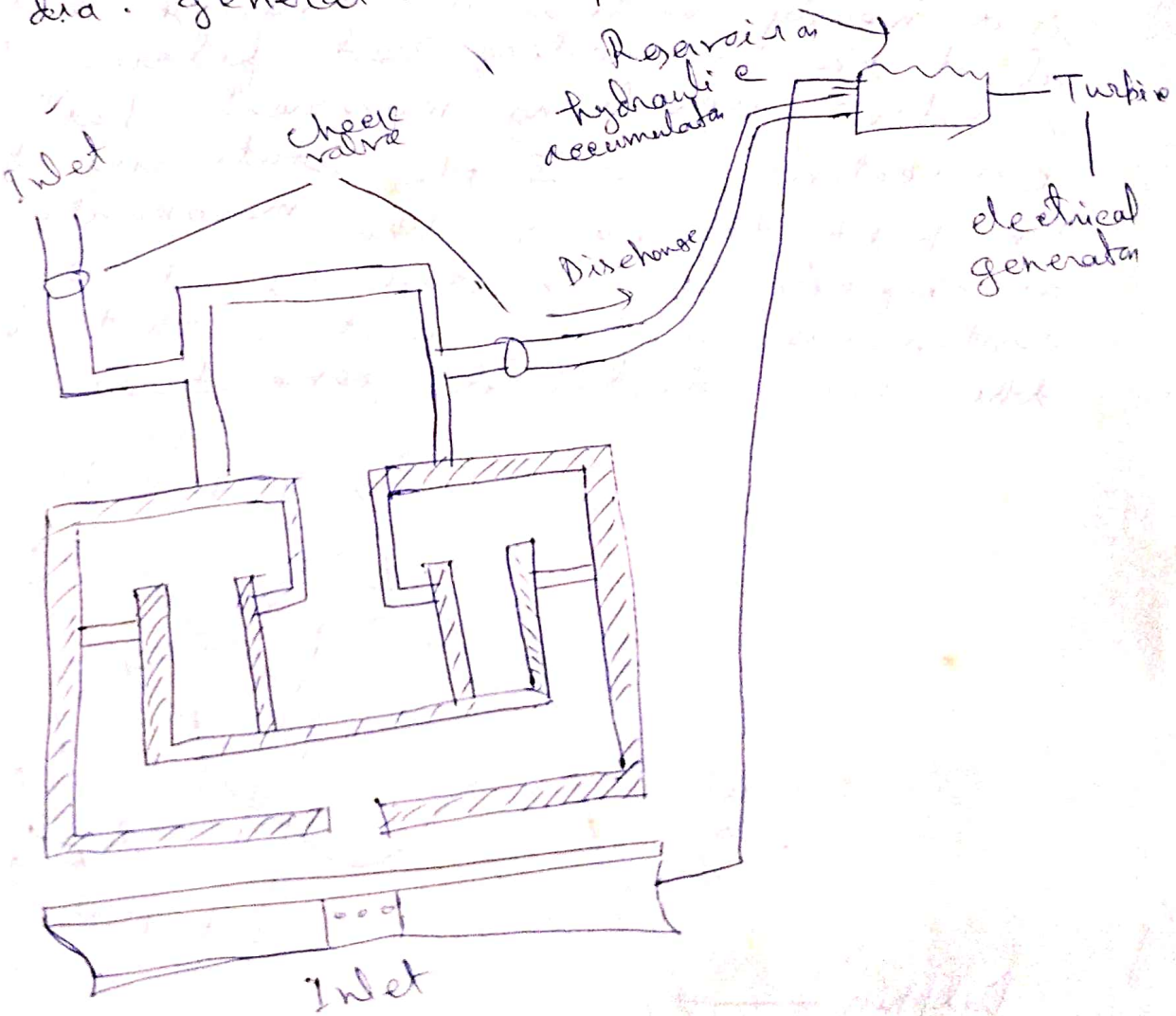
(3) Wave energy conversion devices that have been proposed are relatively complicated.

Wave energy and India

The annual wave energy potential for the Indian coast is around 175 - 200 MWh/m.
Wave power potential varies from 5 KW/m to about 47 KW/m.

High-Level Reservoir wave machine

This wave machine used a magnification piston. The pressurized water is elevated to a natural reservoir above the wave generator which would have to be near a shore line, or to an artificial water reservoir. The water in the reservoir is made to flow through a turbine coupled with an electric generator & then back to sea level.
20 m dia. generator can produce 1MW power.



Dolphin - Type Wave - Power Machine

This sys consists of the following components
i) a dolphin
ii) a float
iii) a connecting rod &
iv) two electrical generators.

This device uses the float which has two motions. The 1st is a rolling motion about its own fulcrum with the connecting rod, which gives rise to revolving movements b/t the float & the connecting rod. The other is a nearly vertical or heaving motion about the connecting rod fulcrum. It causes relative revolving movements b/t the connecting rod & the stationary dolphin. In both the cases, the movements are amplified & converted by gears into continuous rotary motion that drives the two electrical generators.