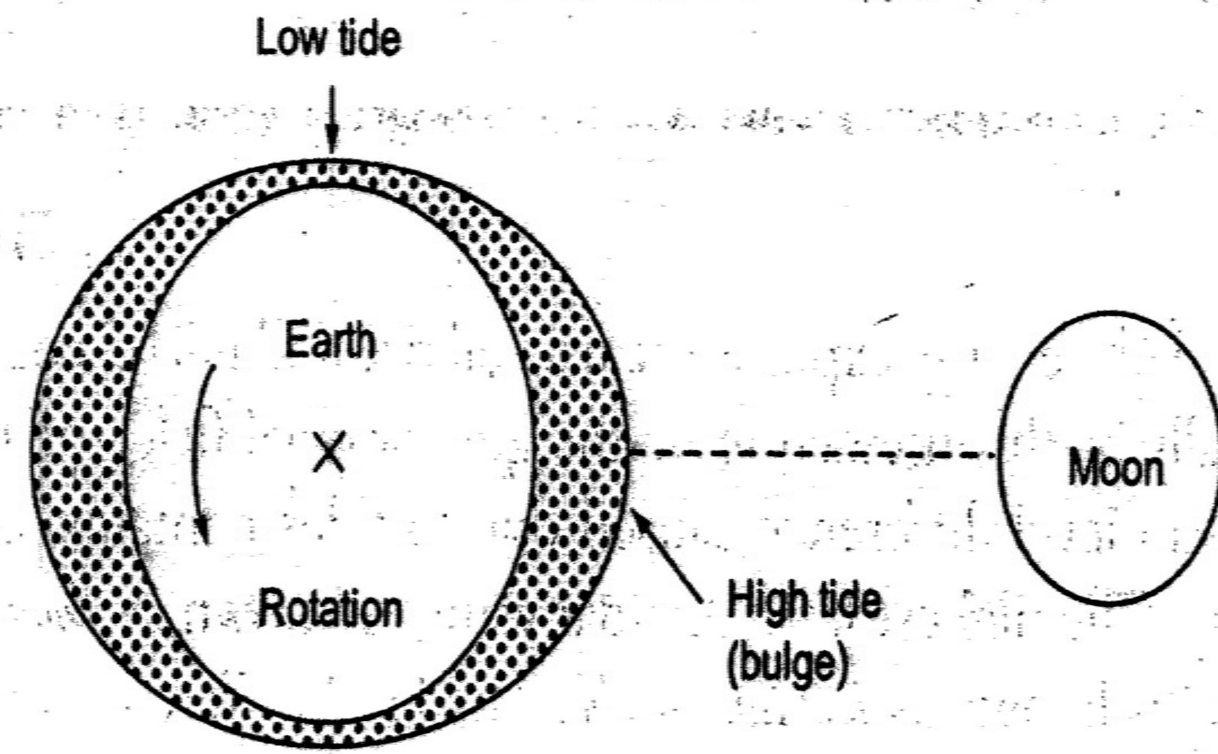
Tidal, Ocean Thermal (OTEC), Geothermal, Small Hydro

Tidal Energy:

Tidal energy exploits the natural rise and fall of coastal tidal waters caused principally by the interaction of the gravitational fields of the sun and the moon. The ocean level difference caused due to tides contains large amount of potential energy. The highest level of tidal water is known as *flood tide* or *high tide*. The lowest level is known as *low tide* or *ebb*. The level difference between the high and low tide is known as *tidal range*. The tidal range varies greatly with location. Only sites with large tidal ranges (about 5 m or more) are considered suitable for power generation. The total combined potential at these sites is estimated as 1,20,000 MW.



(a) Bulge on near and far sides of the earth

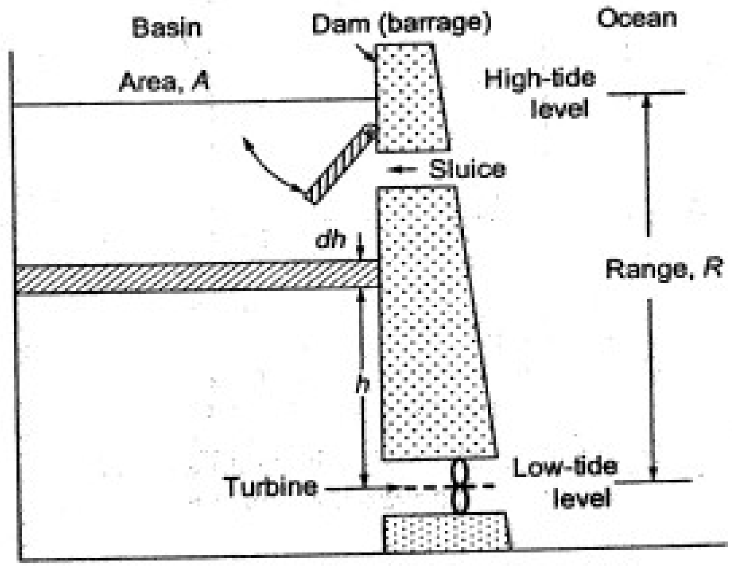
The main components of a tidal plant, as shown

(i) *dam, barrage or dyke*—a barrier constructed to hold water,
(ii) *sluice ways* rapid controlled gates, used to fill a basin during high tides or emptying it during low tides, and
(iii) *a special, bulb-type power turbine-generator set* steel shell containing an alternator and special Kaplan turbine with variable pitch blades. The tidal power associated with single filling or emptying of a basin may be estimated as follows.

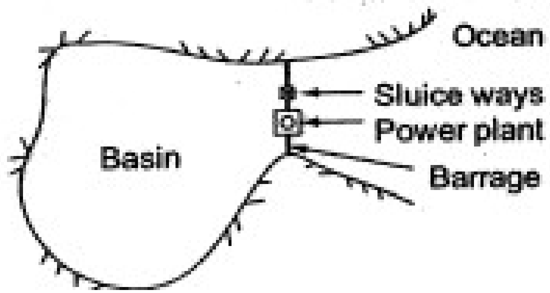
m²

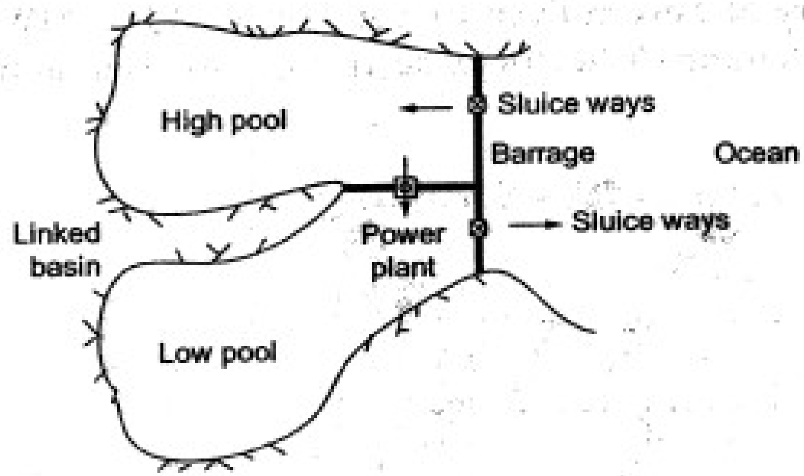
on

on



(i) Single Basin: Single-effect Scheme The single-basin scheme has only one basin as shown in Fig. 10.4. In the single-effect scheme, power is generated either during filling or emptying the basin.





(iii) Two Basin: Linked-basin Scheme In order to maintain continuity of power supply, linked and paired basins schemes are used. The linked-basin scheme consists of two basins, one topped up at high tide, and the other emptied at low tide. Thus, a permanent head is created between the two basins. Water flows through a turbine from the high basin to the low basin. The layout of such a scheme is shown in Fig. 10.6.

The main limitations of tidal energy are the following:

(i) Economic recovery of energy from tides is feasible only at those sites where energy is concentrated in the form of tidal range of about 5 m or more and the geography provides a favourable site for economic construction of a tidal plant. Thus it is site specific.

(ii) Due to mismatch of lunar driven period of 12 hours 25 min and human (solar) period of 24 hours, the optimum tidal power generation is not in phase with demand.

(iii) Changing tidal range in two-week periods produces changing power.

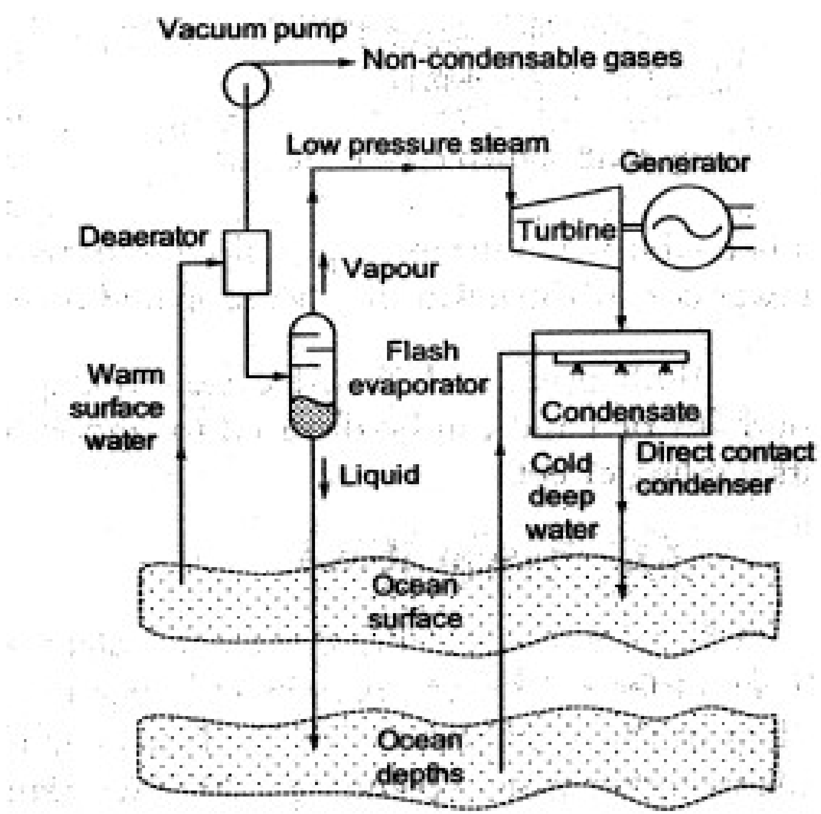
(iv) The turbines are required to operate at variable head.

(v) Requirement of large water volume flow at low head necessitates parallel operation of many turbines.

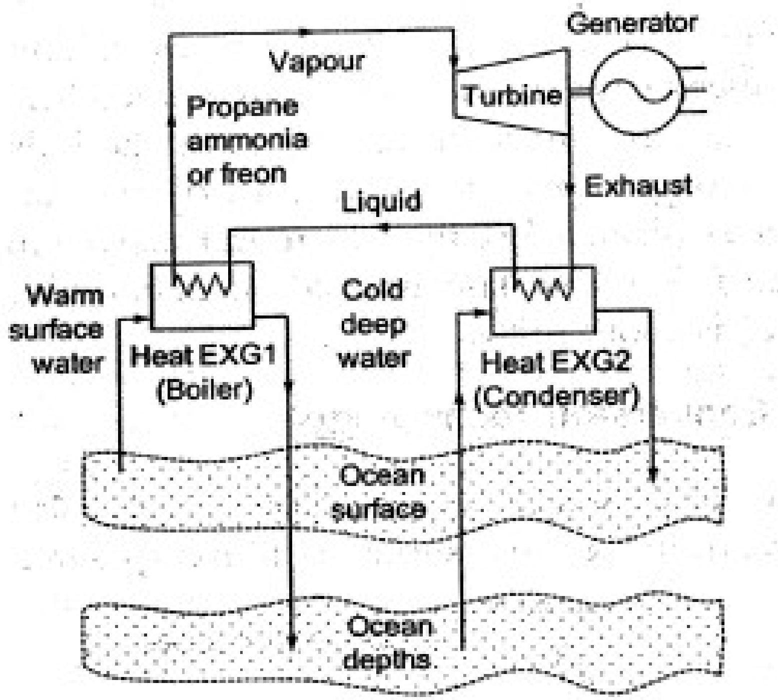
(vi) Tidal plant disrupts marine life at the location and can cause potential harm to ecology.

OCEAN THERMAL ENERGY

Ocean thermal energy exists in the form of temperature difference between the warm surface water and the colder deep water. A heat engine generates power utilizing a well-established thermodynamic principle,



Open cycle OTEC plant



Closed-cycle OTEC plant

Geothermal Energy

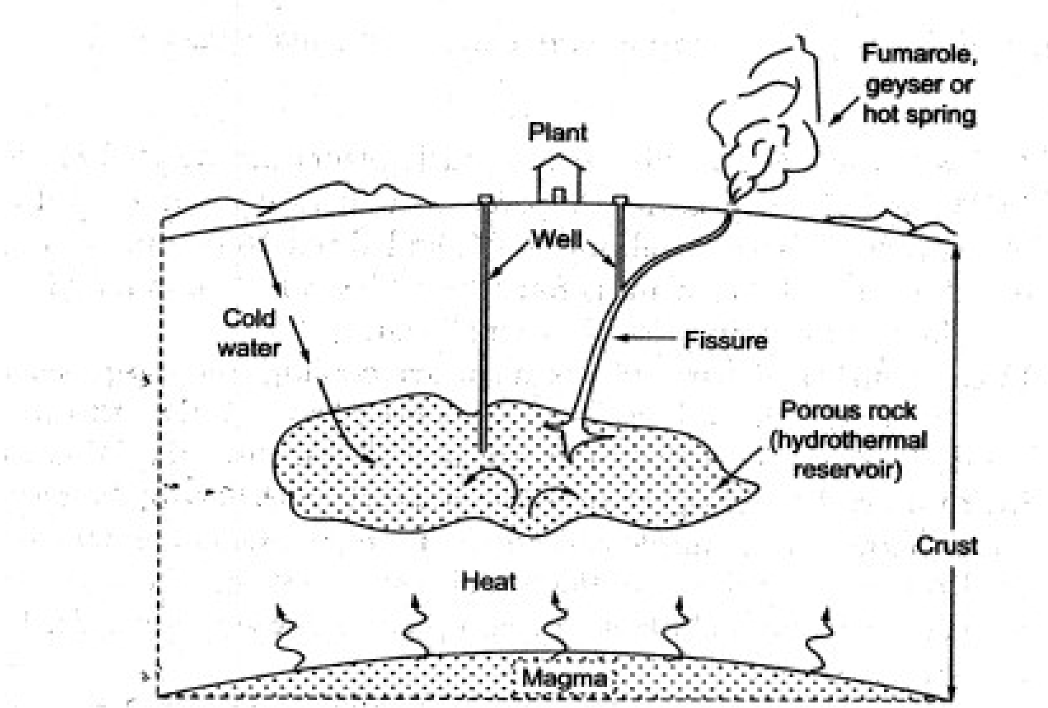
Geothermal energy originates from the earth's interior in the form of heat. Volcanoes, geysers, hot springs and boiling mud pots are visible evidence of the great reservoirs of heat that lie beneath the earth.

Low temperature resources, i.e., 'geysers' have been used from time immemorial for applications such as therapeutic hot baths, cooking, space and water heating. Most geothermal resources produce low-grade heat at about 50–70°C, which can be used directly for thermal applications. Occasionally, geothermal heat is available at temperatures above about 90°C, and so electrical power production from turbines can be contemplated. The

TYPES OF GEOTHERMAL RESOURCES

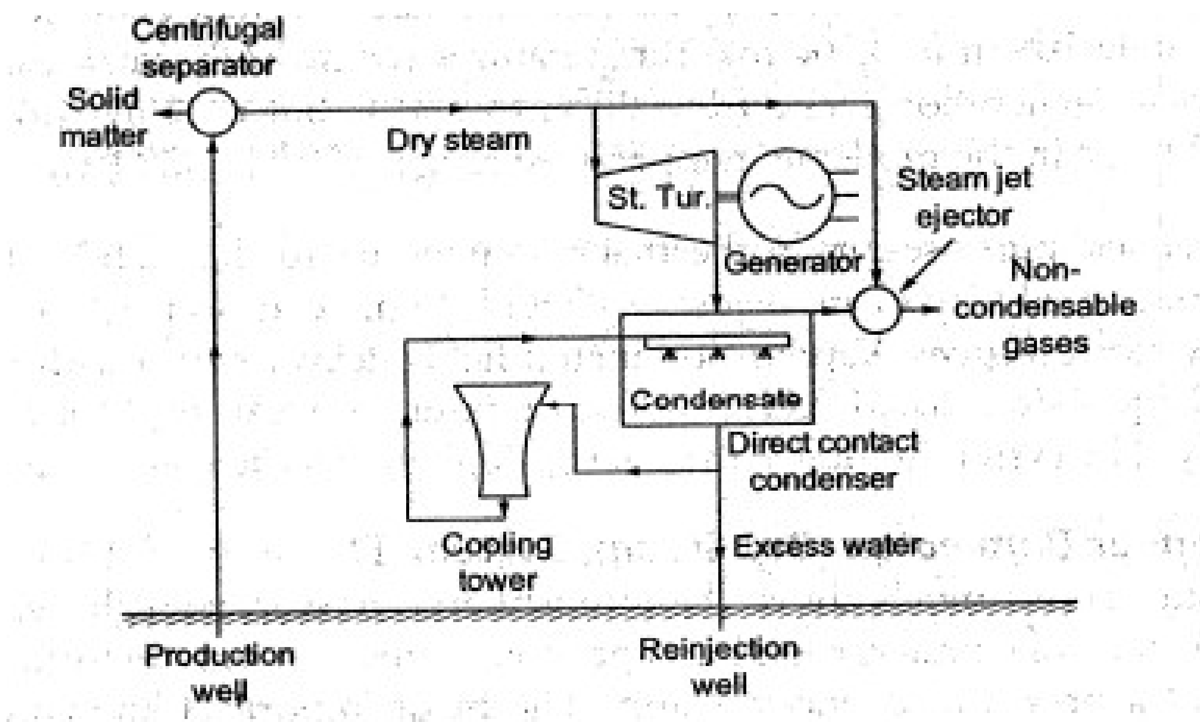
There are four types of geothermal resources: (i) hydrothermal, (ii) geopressured, (iii) hot dry rock (HDR), and (iv) magma. At present, the technology for economic recovery of energy is available for hydrothermal resources only. Thus, this is the only commercially used resource at present. Other resources are going through a development phase and have not become commercial so far.

Hydrothermal resources occur when underground water has access to high temperature porous rocks, capped by a layer of solid impervious rock. Thus, water is trapped in the underground reservoir (aquifers) and is heated by surrounding rocks. Heat is supplied by magma by upward conduction through solid rocks below the reservoir. Thus, it forms a giant underground boiler.

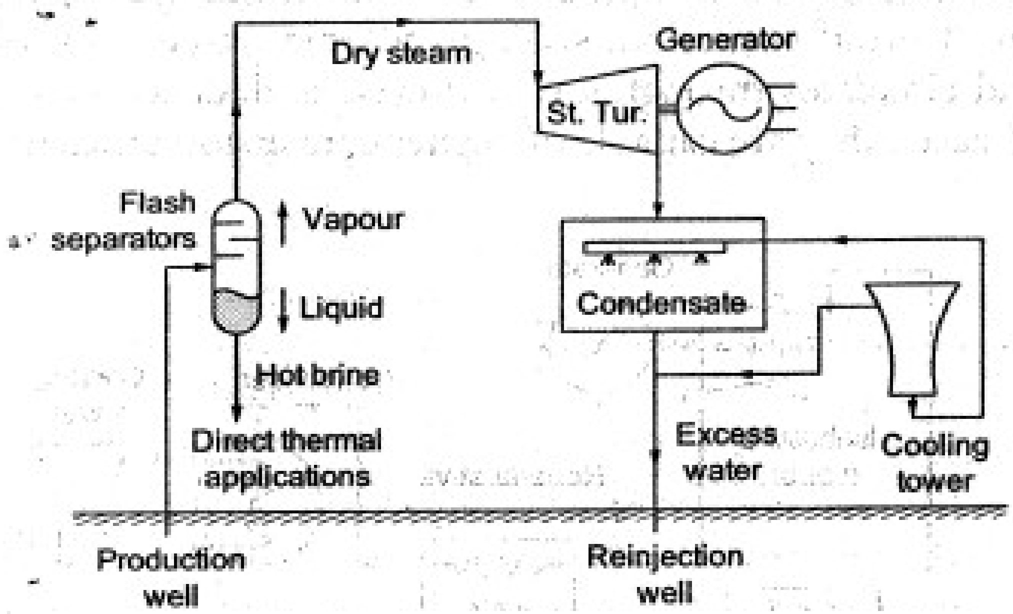

Fumarole,
geyser or
hot spring
Plant
Well
Cold
water
Fissure
Porous rock
(hydrothermal
reservoir)
Crust
Heat
Magma

(i) Vapour-Dominated (Dry Steam) System

(i) Vapour-Dominated (Dry Steam) System Dry steam fields occur when the pressure is not much above the atmospheric pressure and the temperature is high. Water boils underground and generates steam at temperatures of about 165°C and a pressure of about 7 atm.



(ii) Liquid-Dominated (Wet Steam) System



(a) Liquid Dominated—High–Temperature System In a high-temperature, liquid-dominated reservoir, the water temperature is above 175°C. However it is under high pressure and remains in liquid state. The most developed such system is found at the Wairakei fields in New Zealand, where the reservoir temperature and pressures are 230°C and 40 atm respectively, and depths are 600 m to

1400 m. When water is brought to the surface and pressure is reduced, rapid boiling occurs and it 'flashes' into steam and hot water. The steam is separated and used to generate electrical power in the usual manner. The remaining highly saline hot water (known as brine) can be used for direct heat and then reinjected into the ground.