OCEN THERMAL ENERGY CONVERSION (OTEC)

→ OTEC is a new technology, needed to be harenessed in India where the coastline is about 6000km.

→ OTEC is a process or technology for producing energy by harnessing the temperature difference (thermal gradient) between ocean surface waters and deep ocean waters.

→ Power from the OTEC is renewable and eco-friendly.

→ An OTEC plant can operate in remote ~~area~~ islands and sea-shore continuously.

→ It is very low grade solar thermal energy, so the efficiency of energy recovery is quite low.

→ According to MNRE, the overall potetial of ocean energy in the country may be in excess of 50,000MW.

The OTEC plant are of 3 types
- → open cycle or Claude cycle
- → closed cycle or
- → hybrid

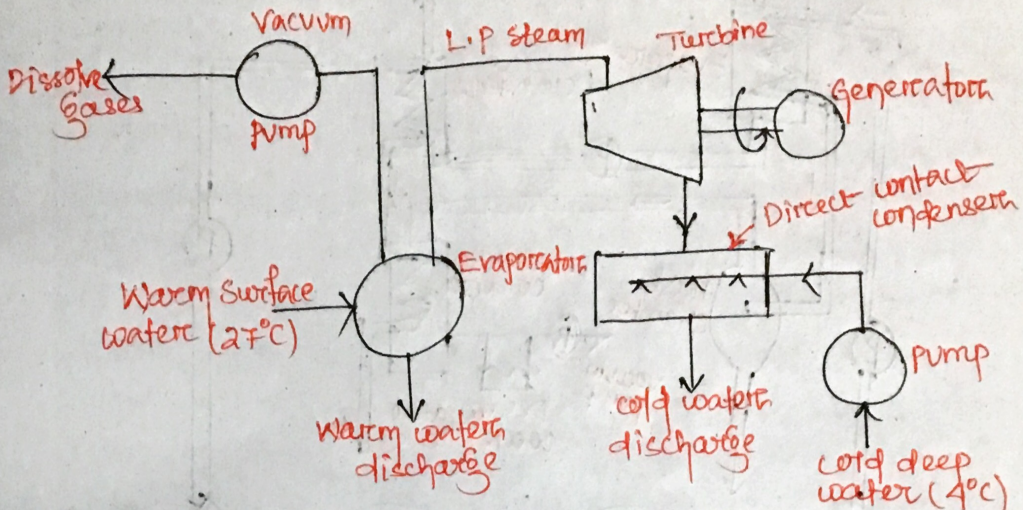
→ The ocen and seas constitute about 70% of the earth surface area and hence they represent a large storage reservoir of the solar energy.

→ In tropical waters, the surface water temp. is about 27°C and 1 km directly below, the temp is about 4°C.

→ The reservoir of surface water may be considered a heat source and the reseervoir of cold water (1 km below) is considered a heat sink.

→ The concept of ocean thermal energy conversion is based on the utilization of temp. difference bet^n the heat source and the heat sink in a heat engine to generate power.

Open Cycle OTEC Claude Cycle :-



→ In this cycle, the seawater play a multiple role of a heat source, working fluid, coolant and heat sink.

→ Warm surface water enters an evaporator where the water is flash evaporated to steam under particle vacuum.

→ Low pressure is maintained in the evaporator by a vacuum pump.

→ The low pressure is maintained to removes the non-condensable gases from the evaporators.

→ The steam and water mixture from evaporator then enters a turbine, driving it thus generating electricity.

→ The exhaust ~~steam~~ from the turbine is mixed with cold water from deep ocean in a direct contact condenser and is discharge to the ocean.

→ The cycle is then repeated.

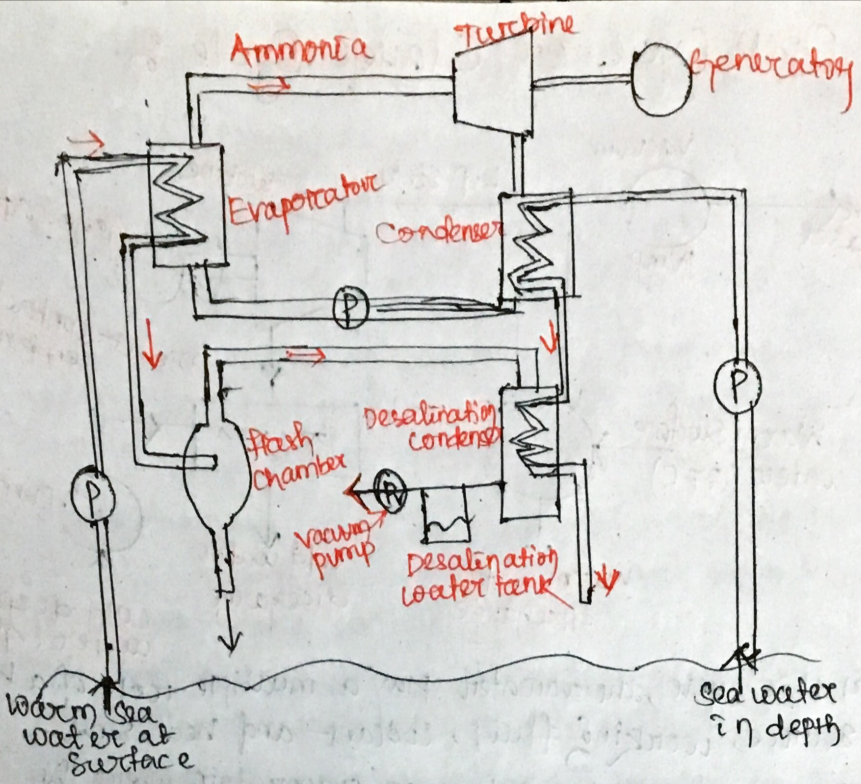
→ Since the condensate is discharge to the ocen, the cycle is called open.

Hybrid - Cycle :-

→ A hybrid cycle combine the features of both the closed-cycle and open-cycle system.

→ In a hybrid OTEC system, warm seawater enters a vacuum chamber where it is flash-evaporated into steam, which is similar to the open cycle evaporation process.

→ The ammonia is then mixed with the warm sea water and the mixed vapours are used to drive the turbine producing energy.



→ The evaporated ammonia is then separated from the steam/water and re-condensed with cold temp. and reintroduce back into the closed loop cycle.

→ The steam condensed within the condenser and provide desalinated water.

→ The advantage of hybrid system is that it improves the efficiency of the system.

Advantages of OTEC :—

→ Energy is freely available.

→ Provides air-conditioning for building.

→ Produces desalinated water for industrial, agricultural and residential uses.

→ Eco-friendly.

→ It provide clean, cost-effective electricity for the future.

Disadvantages of OTEC :-

→ Capital cost is very high.

→ Efficiency is very low, about 2.5%, as compared to 30-40% efficiency for conventional power plant.

It may be seen that the temperature at the surface changes slowly, then remains constant at a depth of about 200 m. Subsequently, the temperature decreases asymptotically and approaches a low value of about 4°C at a depth of 1000 metres. The difference in temperature between the surface and the deeper parts of the ocean is utilised to generate electrical energy. The basic process of OTEC is to bring the warm surface water and the cold water from a certain depth of the sea through pipes so as to act as 'heat source' and 'heat sink' for operating a heat engine. It will form the same system as that of conventional thermal power station with nil fuel consumption.

The OTEC plants are of three types, namely 'closed', 'open', and thermoelectric. The important broad features of these plants are as follows:

11.30 CLOSED RANKINE CYCLE OR ANDERSON CLOSED CYCLE OTEC SYSTEM

The closed cycle system using a low boiling point working fluid like ammonia or propane is shown in Figure 11.29.

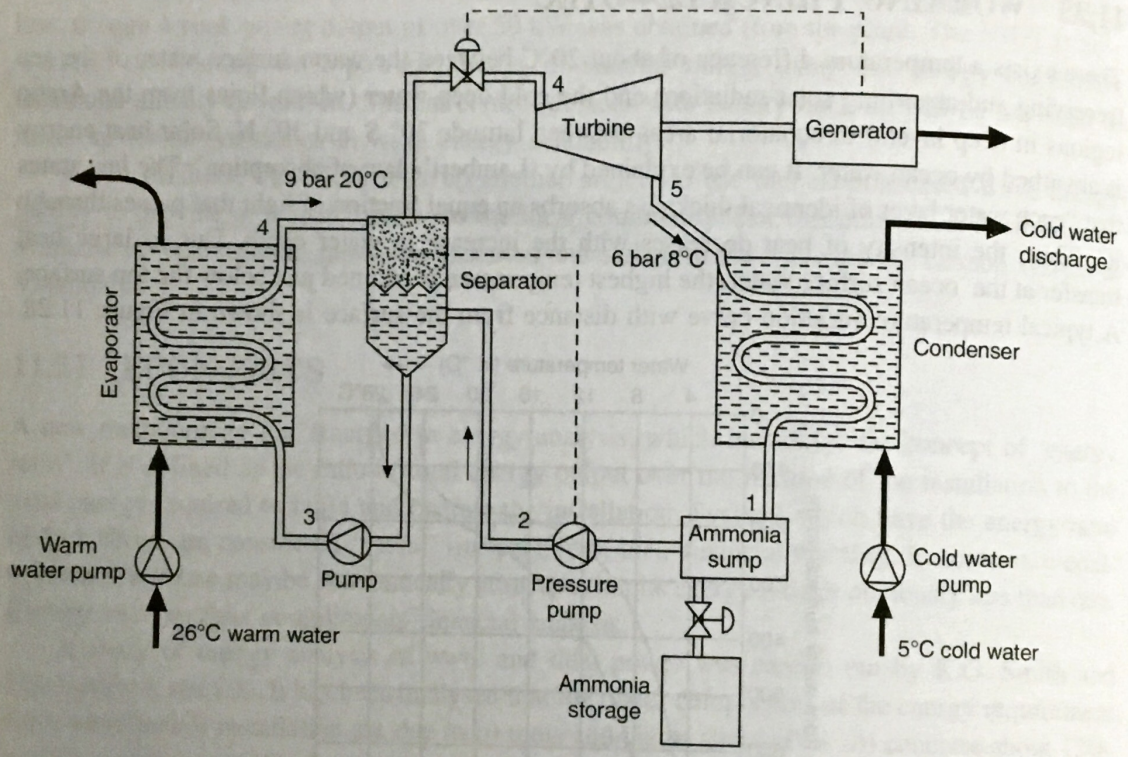


Figure 11.29 Schematic diagram of a closed Rankine Cycle OTEC system.

It may be seen that warm water from the surface which is at a temperature of about 26°C is brought in one pipe, and cold water at a temperature of around 5°C is brought in another pipe from a depth of about 1000 metres. In OTEC plants two water pipes are used in conjunction with a working fluid to generate electric power. Different operational activities of the plant are:

(a) The warm sea water evaporates the liquid ammonia into vapour in a unit called an evaporator. This can be done because ammonia exists in the form of gas at the temperature corresponding to the surface sea water.

(b) The liquid ammonia which is not evaporated collects in a unit known as separator, which again recirculates through the evaporator.

(c) The evaporated ammonia in the form of high pressure vapour is made to pass through a turbine where its pressure and temperature make the turbine to rotate, thus converting thermal energy into mechanical energy. The rotating turbine if coupled to an electric generator produces electric power.

(d) The ammonia vapour coming out of the turbine, which is now at the lower pressure than when it entered the turbine is condensed back into liquid ammonia by cooling it with the colder sea water brought up from the deep part.

(e) The liquified ammonia collects in an ammonia sump. After a few hours of operation, the make-up quantity of ammonia is added from the ammonia storage to make up for the operational loss.

(f) The liquified ammonia is then pumped back to the evaporator, thus completing the cycle. The cycle repeats to run the plant continuously.