## 5.7 OCEAN THERMAL ENERGY CONVERSION

Ocean thermal energy conversion (OTEC) is a method to produce electricity by using the temperature differences between warm ocean surface and cool deep ocean water to run a heat engine. If temperature difference is greater,then more energy will be produced. About 70% of the earth‟s surface is covered by oceans, which are continuously heated by the sun. Extracting the solar energy stored in an ocean is carried out by exploiting the temperature difference between warm surface water and cold deep sea water.

OTEC sites that are located between the Tropic of Cancer and Tropic of Capricorn (23.5°N and 23.5°S of equator) found to be best locations. Ocean water with temperature gradient of 5°C and more is known as ocean thermal energy. However, significant amount of electric power can be generated in the location where a temperature difference of 20°C and above exists between warm surface water and cold deep water. In many regions, ocean surface water is generally maintained at 25°C or above and more than 1,000 metres below the surface is generally at about 5°C.Since average temperature in Baltic Sea is about 10°C, setting up of OTEC electrical power plant is not Profitable

Therefore, OTEC is an energy technology that converts solar radiation to electric power through heat of ocean water. These systems use ocean‟s natural thermal gradient. As long as the temperature difference between the warm surface water and the cold deep water below 600 metres by about 20°C, an OTEC system can produce a significant amount of power.

Thus, oceans are vast renewable resources with the potential to produce thousands of kW of electric power. The cold deep sea water used in the OTEC system is also rich in nutrients, and it can be used to cultivate plant and marine organism near the shore or on land.

### 5.7.1 PRINCIPLE OF OCEAN THERMAL ENERGY CONVERSION

The basic principle of ocean thermal energy conversion (OTEC) is explained as follows:

- The warm water from the ocean surface is collected and pumped through the heat exchanger to heat and vaporize a working fluid, and it develops pressure in a secondary cycle. Then, the vaporized working fluid expands through a heat engine (similar to a turbine) coupled to an electric generator that generates electrical power. Working fluid

vapour coming out of heat engine is condensed back into liquid by a condenser. Cold deep ocean water is pumped through condenser ere the vapour is cooled and returns to liquid state. The liquid (working fluid) is pumped again through heat exchanger and cycle repeats. It is known as closed-cycle OTEC.

- If ocean surface water is high, enough propane or similar material is used as working fluid; otherwise, for low-temperature surface water, fluid such as ammonia with low boiling point is used.
- In an open-cycle OETC, warm ocean surface water is pumped into a low pressure boiler to boil and produce steam. Then, the steam is used in steam turbine to drive an electrical generator for producing electrical power.
- The cold deep sea water is used in condenser to condense steam. Some fractions of electrical power generated by OTEC plants are used for operating and controlling equipment's involved in power plants, and high electrical power is used for feeding to several other energy consumers.

## 5.3.2 OCEAN THERMAL ENERGY CONVERSION PLANTS

There are two different kinds of OTEC power plants, namely land-based Power plant and floating power plant.

### 5.3.2.1 Land-based Power Plant

- The land-based power plant will consist of a building as shown in Figure 5.3.1. It is constructed on shore and accommodates all parts of OTEC plants. It requires laying down long pipes from plant site on shore to two extreme points of necessary temperature gradient.
- One pipe is used to collect warm ocean surface water through screened enclosure near the shore. Another long pipe lay down on the slope deep into the ocean to collect cold water.
- A third pipe is used as outlet to discharge used water again in ocean via marine culture ponds deep down the ocean. Cost of pipe installation and maintenance is very expensive, and land based plant is also very expensive.
- Since large electricity is used to pump water through long pipes, the net electricity reduces considerably. Land-based OTEC plant has the advantage of savings on electrical transmission line and connectivity to electrical power grid.

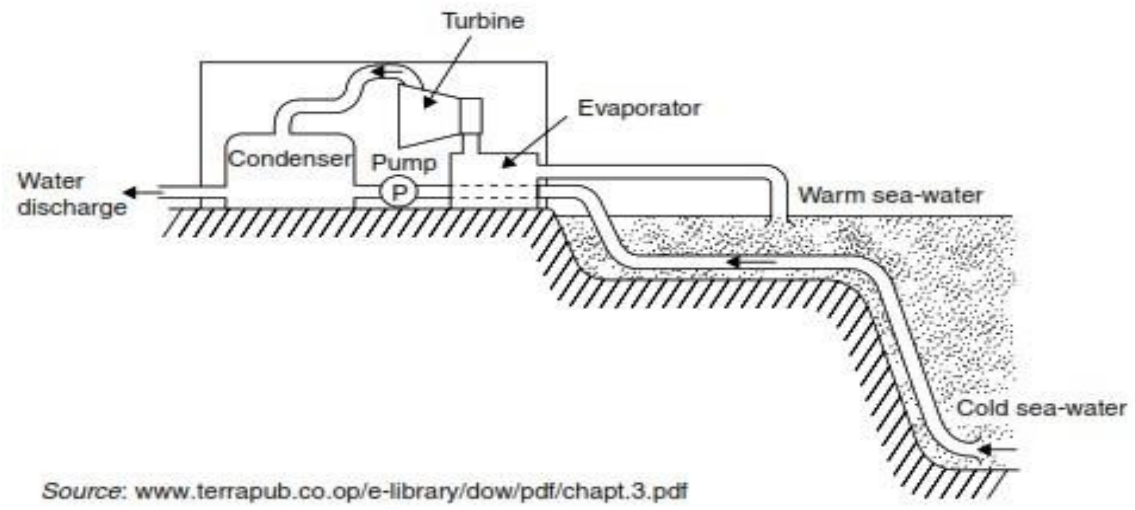


Fig 5.3.1. Land Based OTEC power Plant

### 5.3.2.2 Floating Power Plant

- Floating power plant is built on a ship platform exactly where required temperature gradient sufficient for OTEC plant is available. The working principle of ocean Thermal energy conversion.(OTEC) is same as that of land-based power plant. Undoubtedly, the cost savings exist on piping system, but long transmission line is required to transmit electrical power from plant to sea shore.
- Owing to high installation cost of long Underwater power cables and its inefficiency and Many other associated problems, floating OTEC plants are considered for the production of fuels, such as hydrogen, on the platform itself by the electrolysis of water.
- Cold water pipe is the largest single item in the land-based plant design, as the slopes are seldom larger than 15° or more. If 1,000-metres-long vertical pipe with 10 to 15 m diameter used in floating plant, the length of land-based plant considering slope will be about three times.

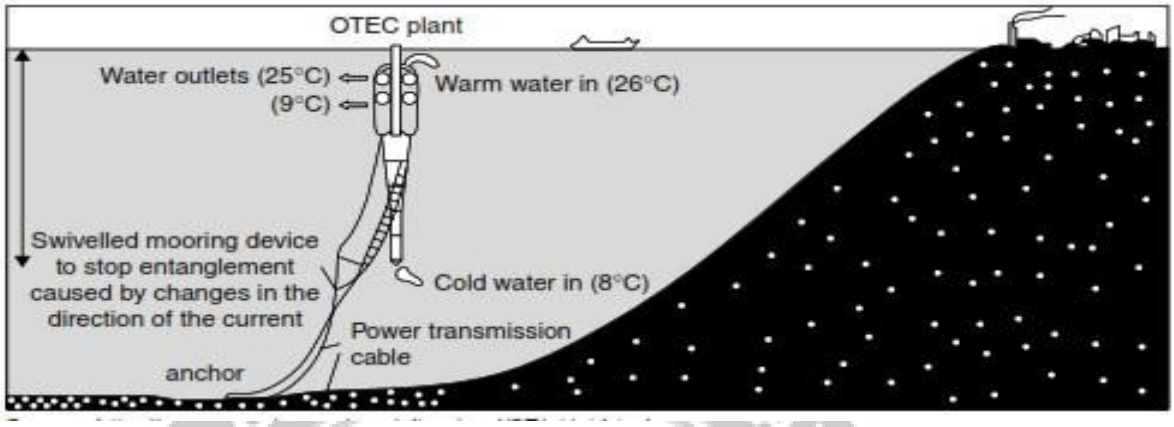


Fig 5.3.2 Floating power Plant

*[Source: "Renewable Energy Sources and Emerging Technologies" by D.P.Kothari, K.C Singal, Rakesh Ranjan, Page: 385]*