Lecture Notes

for

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(Electrical Engg.)

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Subject: Power Station Practices

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Unit- 5 (Geothermal and Ocean Thermal Energy Conversion)

Advantages and disadvantages of geothermal energy

The geothermal energy have following advantages and disadvantages.

Advantages :

1. It is renewable. Since geothermal energy comes from the heat of the earth, it is considered to be a renewable resource. This means that you can use and reuse it over and over again. In fact, it can be considered as a lifetime energy source since the earth itself is the one that gives off this heat. You can be assured that have a continuous source of energy.
2. It is clean. Geothermal energy is classified as one of the clean sources of energy because it does not burn fossil fuel in producing electricity. And since it does not burn fossil fuels, carbon dioxide in the air is greatly reduced.
3. High heat source. The energy coming from beneath the earth is really powerful, allowing geothermal plants to generate much electricity.
4. Geothermal energy works 24 hours a day, 7 days a week, regardless of the weather or temperature above the earth.
5. Low running cost. Unlike other energy sources that utilize fossil fuel, geothermal energy saves about 80% of the fossil fuel cost.
6. No fuel needed. This would not need to use fuel in order to generate power.
7. Renewable. Since geothermal energy comes naturally from the earth, it becomes renewable and does not get depleted. So you can be assured of an energy source for a long time.
8. It does not wreak havoc to the environment. Because this energy source is renewable, it does not harm the environment in the process.
9. It helps in decreasing the country's dependence on fossil fuel, which are mostly imported from other oil-producing countries.

Disadvantages :

1. Not all areas are suitable for geothermal energy. You need to find a good spot where there is substantial and continuous amount of heat that could be tapped into. The geothermal heat source is one of the primary considerations when trying to build a geothermal plant.
2. Huge startup costs. When trying to build a geothermal plant, there is a great deal of capitalization needed especially at the start. Drilling and testing whether a certain area is suitable for a geothermal plant costs a lot of money.
3. High initial installation cost. One of the things that deter different government agencies, as well as private capitalists to invest on geothermal energy is the high installation cost.
4. Viable areas for construction are only few. The area where geothermal plants are built must have a good heat source.
5. Carries with it the risk of releasing harmful gases trapped beneath the earth's surface.

Types of Geothermal power plants

All geothermal power plants use steam to turn large turbines, which run electrical generators. In the Geysers Geothermal area, dry steam from below ground is used directly in the steam turbines. In other areas of the state, super-hot water is "flashed" into steam within the power plant, and that steam turns the turbine.

Direct Dry Steam :

Steam plants use hydrothermal fluids that are primarily steam. The steam goes directly to a turbine, which drives a generator that produces electricity. The steam eliminates the need to burn fossil fuels to run the turbine. (Also eliminating the need to transport and store fuels!)

This is the oldest type of geothermal power plant. It was first used at Lardarello in Italy in 1904. Steam technology is used today at The Geysers in northern California, the world's largest single source of geothermal electricity. These plants emit only excess steam and very minor amounts of gases.

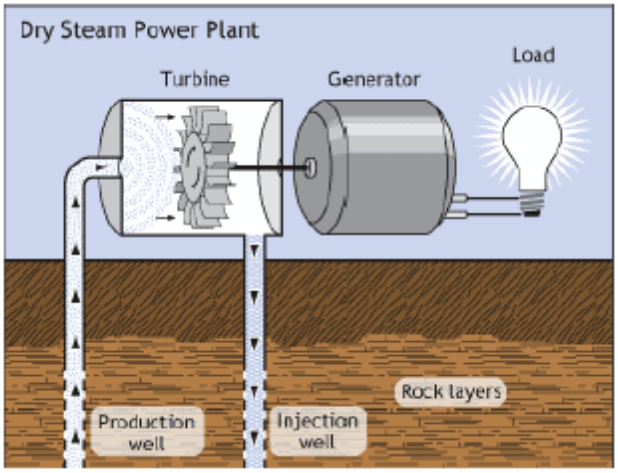

Figure : Direct Dry steam power plant

Flash and Double Flash Cycle :

- Hydrothermal fluids above 360°F (182°C) can be used in flash plants to make electricity.
- Fluid is sprayed into a tank held at a much lower pressure than the fluid, causing some of the fluid to rapidly vaporize, or "flash." The vapour then drives a turbine, which drives a generator.
- If any liquid remains in the tank, it can be flashed again in a second tank (double flash) to extract even more energy.

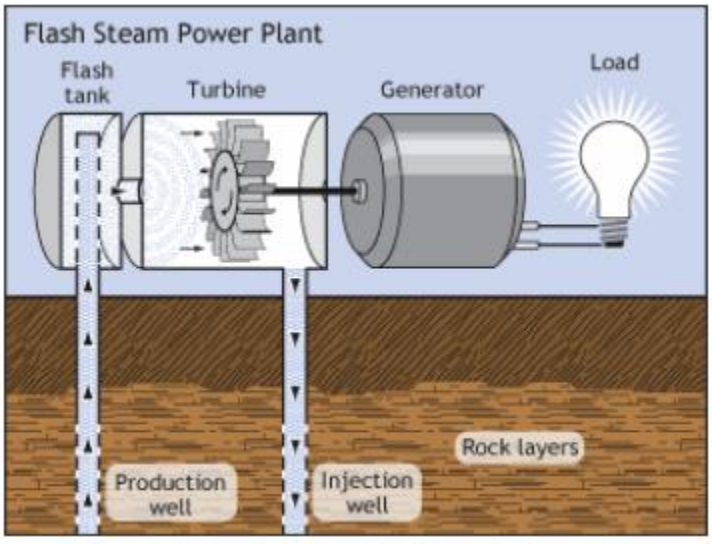

Figure : Flash steam power plant

Binary Cycle :

- Most geothermal areas contain moderate-temperature water (below 400°F). Energy is extracted from these fluids in binary-cycle power plants.
- Hot geothermal fluid and a secondary (hence, "binary") fluid with a much lower boiling point than water pass through a heat exchanger.
- Heat from the geothermal fluid causes the secondary fluid to flash to vapor, which then drives the turbines.
- Because this is a closed-loop system, virtually nothing is emitted to the atmosphere. Moderate-temperature water is by far the more common geothermal resource, and most geothermal power plants in the future will be binary-cycle plants.

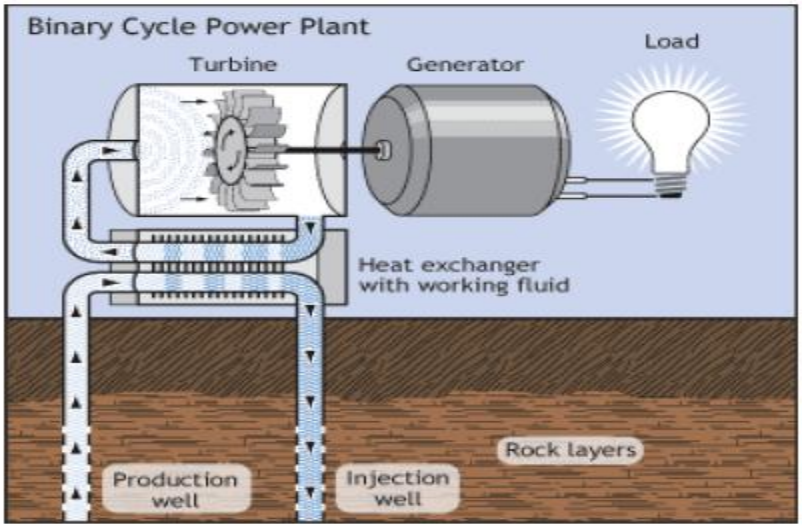

Figure : Binary cycle power plant

Ocean Thermal Energy Conversion (OTEC)

OTEC, Ocean Thermal Energy Conversion is an energy technology that converts solar radiation to electric power.

The Earth's oceans are continually heated by the sun, and cover nearly 70% of the earth's surface. The secret to harvesting the ocean's stored solar energy lies in exploiting the difference in temperature between the warmer water at the surface, and the colder water at greater depth.

If the extraction could be made cost-effective, it could provide two to three times more energy than other ocean-energy options, such as wave power. But the small magnitude of the temperature difference makes energy extraction, so far, relatively difficult and expensive.

How Does Ocean Thermal Energy Conversion Create Electrical Energy :

Perhaps the easiest way to understand ocean thermal energy conversion (OTEC) is by looking at the three primary types of OTEC plant:

(1) open-cycle, (2) closed-cycle, and (3) hybrid.

All three plants make use of a "heat engine" – a device placed between deep, cold ocean water and shallow, warmer water. As heat flows from the warm water to the cold water, the heat engine uses the energy of the transfer to drive a generator that creates electricity.

Closed-cycle Ocean Thermal Energy Conversion :

Warm seawater is placed in a low-pressure container, where it boils. The expanding steam drives a turbine attached to an electrical generator. When the ocean water turns to steam, it

leaves behind its salt and other contaminants. The steam is then exposed to cold ocean water, condensing it into fresh water for drinking or irrigation.

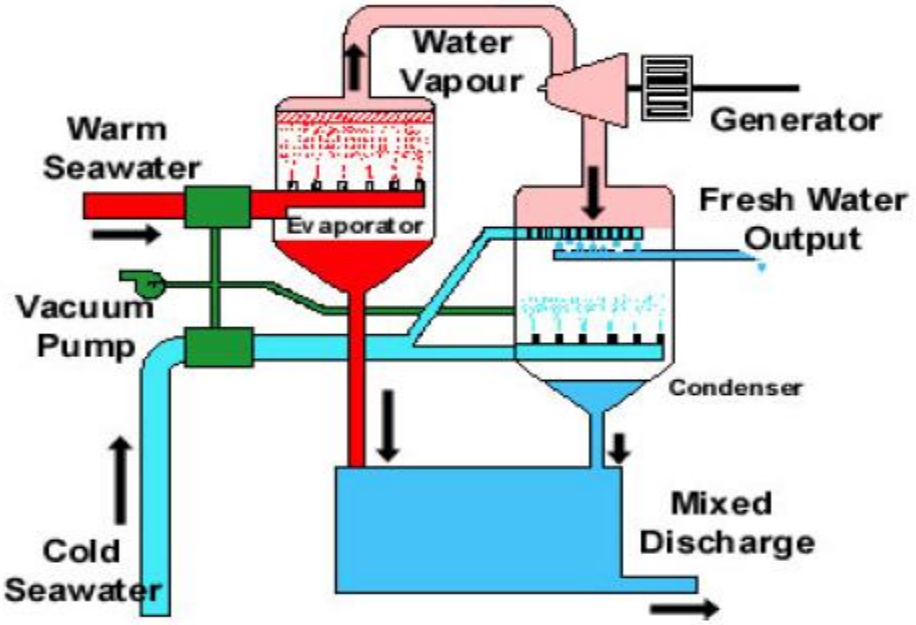

Figure : Closed cycle OTEC

Open-cycle Ocean Thermal Energy Conversion :

Warm seawater is placed in a low-pressure container, where it boils. The expanding steam drives a turbine attached to an electrical generator. When the ocean water turns to steam, it leaves behind its salt and other contaminants. The steam is then exposed to cold ocean water, condensing it into fresh water for drinking or irrigation.

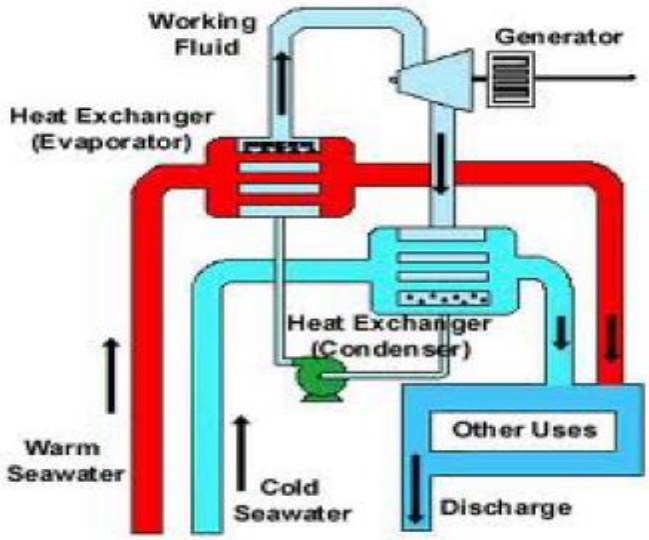

Figure : Open-cycle OTEC

Hybrid Ocean Thermal Energy Conversion :

Warm seawater enters a vacuum chamber, where it is flash-evaporated into steam (similar to the open-cycle process). The heat of the steam vaporizes ammonia in a separate container, and the vaporized ammonia drives a turbine to produce electricity (similar to the closed-cycle process). Vaporizing the seawater removes its salt and other impurities. When the steam condenses in the heat exchanger, it emerges as fresh, pure water for drinking or agriculture.