

SEC-B: Renewable Energy and Energy Harvesting Renewable Energy and Energy Harvesting - (Theory) Paper: PHS-A-SEC-B-TH

5. Geothermal Energy (a) Geothermal Resources, Geothermal Technologies.

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Introduction

Among different planets discovered in the universe, existence of life in Earth is a distinguished phenomenon. This is possible for the ideal position of the Earth from the Sun. Another important component that makes the Earth so unique in our Galaxy is that the presence of ozone shield around Earth in the stratosphere. It protects UV rays to enter and as well as allows ~70% of incoming solar radiation to enter the atmosphere. This amount of heat and light is appropriate to make Earth perfectly hot/cold to support the existence of life.

The ozone layer consists of Greenhouse gases like methane, CO₂, nitrous oxide, water vapour, ozone, chlorofluorocarbons, hydrofluorocarbons. Occurrence of natural greenhouse effect from millions of years maintains the temperature level on Earth's atmosphere preventing it from becoming too cold. However, increasing amount of greenhouse gases has negative effect. Thicker layer leads to more heat trapping and hence rising the temperature over the time.

The factors behind the increase in greenhouse gas concentration level are burning of fossil fuels like coal and gas to generate electricity and deforestation and tree cleaning for urban and infrastructure development, farming or to sell tree products. Since industrial revolution the percentage of greenhouse gases increasing surprisingly. In 2013 CO₂ level in atmosphere reached 400 parts per million, much higher than pre-existing normal 200 ppm level. It is reported in April 2019, the average monthly level of CO₂ exceeded 413 ppm in the atmosphere of our planet. Plantation of more and more trees throughout the world is probably the best cure we can do for the harm created to the world by human being. However the prevention of emission of greenhouse gases also very crucial.

Generation of electricity from alternative sources like: wind energy, solar energy, tide energy, geothermal energy can reduce the production to many extents.

Geothermal energy

It is thermal energy stored in the Earth. Since the creation of the Earth it is cooling, radiating thermal energy and also due to the radioactive decay of some material within Earth thermal energy is generated. There is a temperature difference between the core and the surface of the planet. Due to this geothermal gradient heat energy flows continuously from the core to the surface through the process of conduction and convection of heat energy. In the Earth's interior core-mantle boundary temperature may reach over 4000°C (7200°F). At this high temperature and due to high interior pressure some solid rocks melt and mantle behaves plastically. Thus they may be pushed upward and heats the rock and water in the crust upto temperature 370°C. Thus hot springs are created.

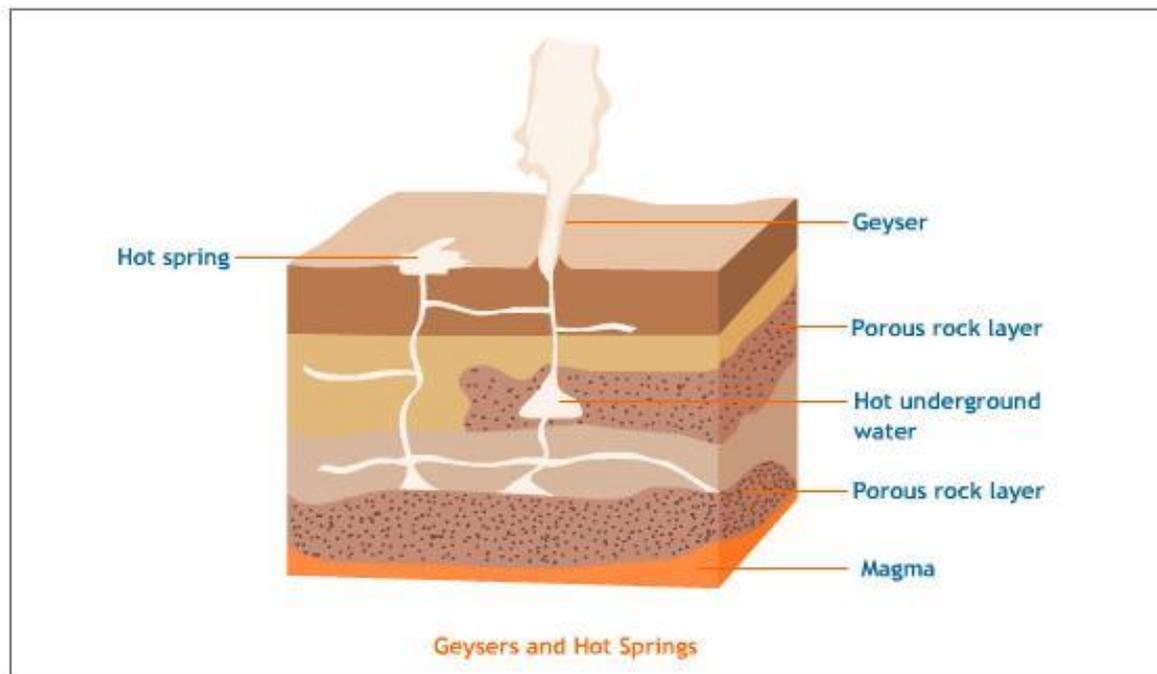


Fig 1. Formation of hot spring

Thermal energy of hot springs are used for bathing since Paleolithic times and for space heating during Roman empire. Now importance is given in generating power from the geothermal energy. Geothermal power plant is environment friendly, cost-effective, sustainable, reliable. Historically they were limited to the region of tectonic plate boundary area. However with the progression of modern technology range and size of viable sources have been extended. Though geothermal wells release greenhouse gases trapped inside the Earth but these are negligible per unit energy production, compared to the fossil fuel generated electricity. Geothermal energy is stored even under the coldest part of Earth's crust but at deep enough. For most of the places it is trapped below 20 miles from the surface. For geological hotspots like: geysers, hot springs, volcanic eruptions thermal energy is near

Earth's surface. Theoretically geothermal energy resources are enormous and adequate to supply the electrical energy required to humanity worldwide. But only very few fractions are profitably exploitable.

As of 2010, 28 GW of direct geothermal heating capacity has been installed for space heating, spas, industrial process, agriculture application. Beside this 11,700 MW geothermal power was available in 2013.

Geothermal technologies: Conversion of geothermal energy to electrical energy

Electrical power generated using geothermal energy called geothermal power. Basically, three types of technologies are used in generating power from geothermal energy. These are: i) dry steam power stations, ii) flash steam power station and iii) binary cycle power station.

All geothermal plants draw the thermal energy from Earth's interior through the so-called production wells which are drilled up-to the depth ranging from 500 ft to 2 miles. Steam or hot water come out through the wells under their own pressure and used to rotate turbine generator, which converts the mechanical energy to electrical energy. The waste water in this process are then captured and returned to underground through rejection wells.

Most common technology used today is dry-steam geothermal plant, where underground steam is directly passed to electricity generating turbines. This process is pretty straight forward.

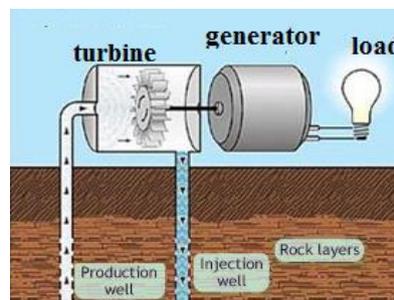


Fig 2. Dry steam power plant

Another geothermal technology is flash-steam power plant. There a pump pushes the hot fluid to a tank where it cools. As the fluid cools it flashes vapour which in turn rotates a turbine and power is generated.

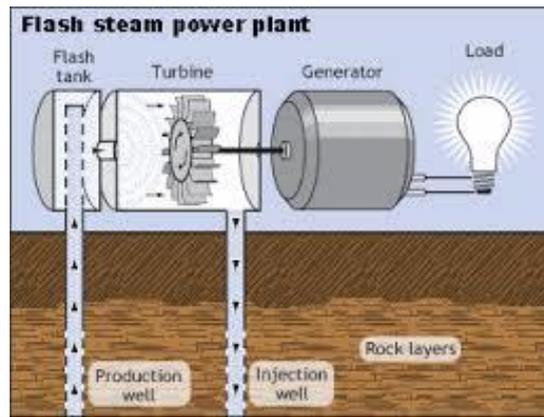


Fig 3. Flash steam power plant

The third type of geothermal power plant technology uses two fluid channels. In this binary cycle plant hot fluid from underground heats a second fluid, at a giant heat exchanger. The second fluid has a much lower boiling point than the first fluid. So it flashes into vapour at a relatively lower temperature. This vapour spins a turbine to generate electricity.

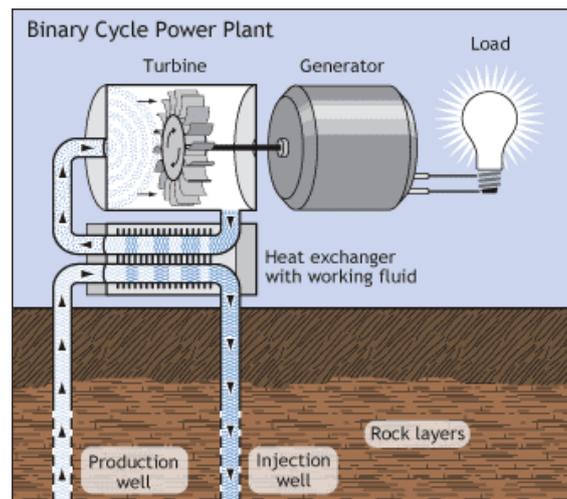


Fig 4. Binary cycle power plant

Geothermal Resources: geothermal power plants through the globe

Currently, in 26 countries geothermal electric energy is used and in 70 countries geothermal heating is in use. Geothermal power plants in these countries have capacity of 10.7 GW. However, 88% of it is generated in just 7 countries: US, Philippines, Indonesia, Mexico, Italy, New Zealand and Iceland. 10% of US electricity consumption comes from geothermal plant.

India has reasonably good potential for geothermal power plants with potential capacity of 10,600 MW of power. But no geothermal plant yet has been installed. One chief reason is the availability of coal as fuel at cheap for thermal power generation. However, taking the environmental aspect in

account in future India will start depending upon eco-friendly energy sources one of which could be geothermal.

Barriers in the field

Though according to Glassley geothermal power plants are cost-effective than other renewable energy sources like: wind, hydro power, solar power it faces some barriers in practical instalments, like:

- ◆ Finding the appropriate build location.
- ◆ Drilling the hard and hot rocks up-to the source is an high-risk and tough process and also extremely capital intensive.
- ◆ Some areas of Earth's surface have sufficiently hot rocks to provide hot waters. However, mostly they are at harsh areas of the world: near the poles or high up the mountains.
- ◆ During drilling and after harmful gases can escape from interior places through production well. The plant must be able to contain the gases and dispose them trickily safely.

Conclusion

To keep our planet Earth green and to save the existence of life in it we must rein in the sources of environment polluting agents and causes. Much emphasis should be given on tree plantation. Enhanced use of renewable energy sources will decrease the pollution to considerable amount. In spite of the barriers geothermal energy is always a good alternative source of light to fight the climate change.