

B.Sc. Computer Science/Physical Science(SEC)
Renewable Energy and Energy Harvesting
Sem :- VI

Geothermal Energy

Introduction

The Geothermal energy is enormous and last for several millions of years. Hence it is called renewable energy. There is the large amount of heat lying in earth's interior in the form of Volcanoes, geysers and hot springs. This thermal energy contained in the interior of the earth is called geothermal energy.

Magma is the molten rock within the earth is pushed up towards the surface where the heat of the magma is being conducted upward through an overlying rock layer. The hot magma near the surface solidifies into igneous rock. The heat of the magma is conducted upward to this igneous rock. Ground water which finds its way down to this rock through cracks is heated by the heat of the rock or by mixing with hot gases and steam coming from magma. The heated water convectively rise upward and into a porous and permeable reservoir above the igneous rock.

Geothermal Resources

- **Hydrothermal source**

- ▶ Vapour dominated or dry steam fields
- ▶ Liquid dominated system
- ▶ Hot-water fields

It contains superheated water, steam or both in fractures or porous rock but further trapped by a layer of impermeable rock. It may give dry and pure steam with the temperature above 240°C . The majority of these resources have moderate temperature ranging from 100°C to 180°C while few resources have moderate temperature ranging from 150°C to 200°C .

- **Geopressured reservoirs**

It is hot water trapped underground at the depth of about 4 km to 9.1 km with temperature about 150°C stored under pressure of about 1000 bar from the weight of overlying rock. It is used for heat and natural gas having great heat potential for power generation but uneconomical.

- **Hot dry rock or Petrothermal**

It consist of high temperature rocks ranging from $90C$ to $650C$.The rocks can be fractured and water may be circulated through the rocks to extract thermal energy.

- **Magma Resources**

The molten rock or magma present in the volcanic vents at a temperature ranging from $700C$ to $1600C$.

- **Volcanoes**

Direct usage of Geothermal Energy

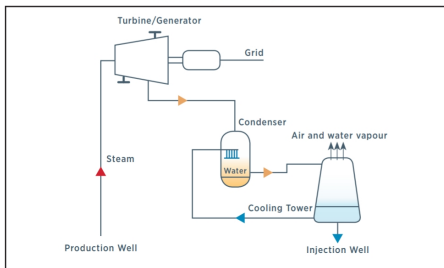
- Space heating
- Air conditioning
- Industrial processes
- Drying
- Greenhouses
- Aquaculture
- Hot water
- Resorts and pull
- Melting snow

Working principle of direct usage

- Direct sources function by sending water down a well to be heated by the Earth's surface.
- A heat pump is used to take the heat from the underground water to the substance that heats the house.
- Cold water is injected back into the Earth.

GEOHERMAL POWER PLANT

- Dry Steam Plants

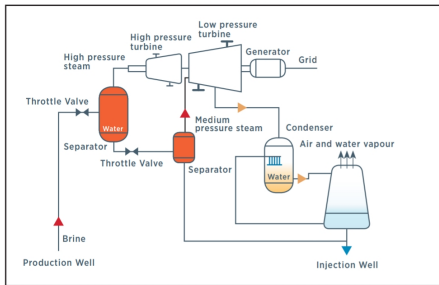


Source: IRENA, 2017c

Figure: 1. Dry Steam Plant

In this system the conversion device is the steam turbine which use directly the low pressure ,high-volume fluid produced in the steam field.This plant commonly use condensing turbine and the condensate is re-injected in wet cooling towers.It uses steam of 150C.fig(1).

● Flash Plant

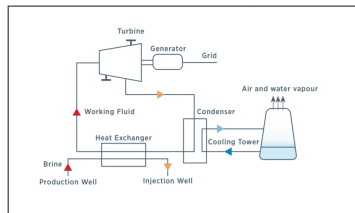


Source: IRENA, 2017c

Figure: 2. Flash Steam Plant

This power plant is similar to dry stream plant. The steam is obtained from separation process and then directed to the turbines after that the re-injection takes place at lower pressure. Flash plants vary in size depending on whether they are single, double or triple-flash. fig.(2)

● Binary Plants

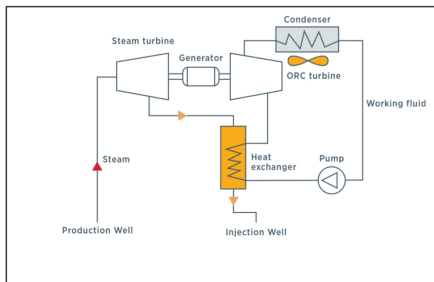


Source: IRENA, 2017c

Figure: 3. Binary Plant

It is basically a Rankine cycle with organic working fluid. To transfer a fraction of the brine enthalpy to vaporize the secondary working fluid. These plants are usually applied to low or medium enthalpy geothermal fields where the resource fluid is used, via heat exchanger, to heat a process fluid in a closed loop having boiling and condensation points that match the geothermal resource temperature. Binary plants range in size from less than 1MW to 50MW. fig.(3).

• Combined Cycle or Hybrid Plant



Adapted from: ORMAT, 2017

Figure: 4. Combined Cycle Plant

This type of power plants use combined cycle which adds a traditional Rankine cycle to produce electricity from what otherwise would become waste heat from a binary cycle. Using two cycle provides relatively high electric efficiency. fig.(4). The same basics are used by the Hybrid geothermal power plant as a stand alone geothermal power plant but combine a different heat production source into the process.

Advantages

- It is versatile in its use and reliable source of energy.
- It delivers a greater amount of net energy from its system.
- Require little land area.
- Its availability is independent of weather.
- No extra storage systems are necessary.
- It leads a minimum pollution.

Disadvantages

- Drilling operation is noisy.
- Continuous extraction of heated ground water may lead to subsidence of land.
- Geothermal fluid reduces the life of plants.
- Overall efficiency is low about 15 percent comparing fossil fuel.

Reference;

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By Dr.G.K.Vijayaraghavan,Dr. R. Rajappan and Dr. S. Sundarvalli
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