

**CAI335 SOLAR AND WIND ENERGY SYSTEM**

**UNIT V NOTES**



## 5.4 Geothermal energy

Geothermal energy is primarily heat energy from earth's own interior.

It is classified as renewable because the earth's interior is and will continue in the process of cooling for the indefinite future. Hence, geothermal energy from the earth's interior is almost inexhaustible as solar or wind energy, so long as its sources are actively sought and economically tapped.

As we travel down earth's surface radially, there exists a temperature gradient of  $0.03^{\circ}\text{C}$  per metre. Thus a  $30^{\circ}\text{C}$  increase in temperature can be obtained per kilometre depth from the earth crust. There are many local hot spots just below the surface where the temperatures are much higher than expected. Ground water, when comes into contact with hot spots, either dry or wet steam is formed. By drilling holes to these locations, hot water and steam can be tapped and these can be used for power generation or space heating.

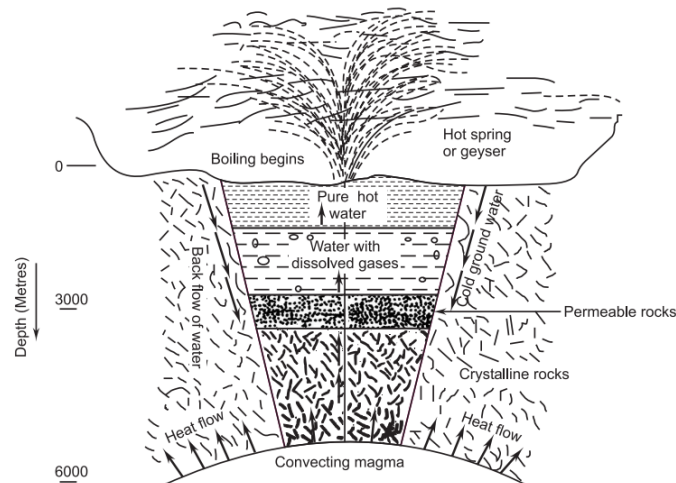
Geothermal energy is present over the entire earth's surface except that it is nearer to the surface in the 'volcanic areas'.

Heat transfer from the earth's interior is by three primary means

1. Direct heat conduction,
2. Rapid injection of ballastic magma along natural rifts penetrating deep into earth's mantles.
3. Bubble-like magma that buoys upwards towards the surface.

### 5.4.1 Geothermal system – hot spring structure

Figure shows a schematic diagram depicting how "hot springs (geysers)" are produced through hot magma (molten mass), the fractured crystalline rocks, the permeable rocks and percolating ground water.

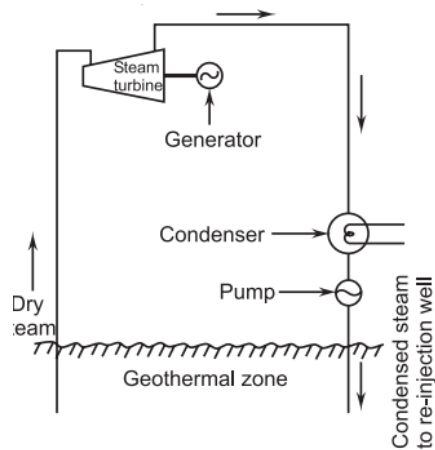


At a depth of 5000 m or so lies an impermeable magma. Above the magma are the ‘impermeable rocks’ which are overlain by localised pockets of ‘permeable rocks’. One such localised pocket is shown in this figure. The localised pockets are bounded by fracture zones or faults along which some relative motion of rocks has occurred. Water circulates along the fault lines. As it goes down and moves in earth’s interior it is heated by the permeable layer which is in turn heated by conduction of heat from the magma. The hot water comes out through another fault and forms a hot spring.

#### 5.4.2 classification and types of geothermal power plants.

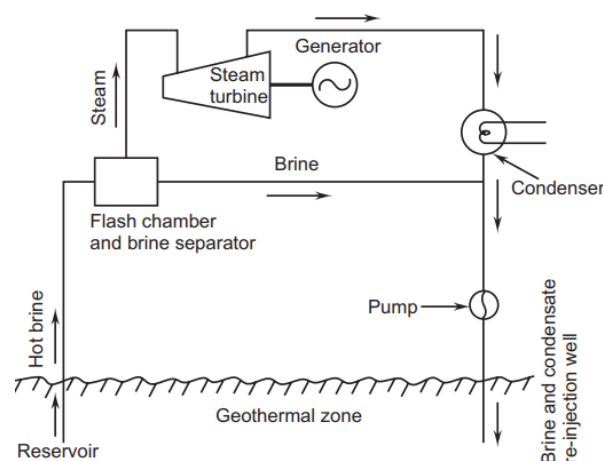
##### Vapour-dominated or dry steam fields:

The vapour-dominated reservoirs produce dry saturated steam of pressure above atmosphere and at high temperature about 350°C



Steam extracted from the well is cleaned in centrifugal separator which removes solid matters. The cleaned steam is then supplied directly into the 'steam turbine'. The exhaust steam from steam turbine is wet steam, (i.e., mixture of water and steam) which passes through the condenser. The condenser condenses wet steam into water (through a cooling tower). The non-condensable gases present in wet steam are removed by 'steam jet injection method'

### The flash steam open system:



Hot brine from the reservoir reaches the well head at lower pressure by throttling process.

This low quality mixture is then throttled in flash separator which improves the quality of

mixture. Now steam is separated as a dry saturated steam and supplied to the 'steam turbine', which produces electric power through a 'generator'. The 'power generation' from such system can be made more economical by associating chemical industry with power plant to make use of brine and gases effluent.

### **5.4.3 ADVANTAGES**

. Geothermal energy is cheaper. 2. It is versatile in its use. 3. It is the least polluting as compared to other conventional energy sources. 4. It is amenable for multiple uses from a single resource. 5. Geothermal power plants have the highest annual load factors of 85 per cent to 90 per cent compared to 45 per cent to 50 per cent for fossil fuel plants. 6. It delivers greater amount of net energy from its system as compared to other alternative or conventional systems.

### **Disadvantages:**

1. Low overall power production efficiency (about 15% as compared to 35 to 40% for fossil fuel plants). 2. Drilling operation is noisy. 3. Large areas are needed for exploitation of geothermal energy. 4. The withdrawal of large amounts of steam or water from a hydro-thermal reservoir may result in surface subsidence or settlement