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Use of Geothermal Electric System for Remote Powering: A Case Study of Puga Geothermal Field.

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ABSTRACT

India has a good geothermal potential and it can produce about 10,600 MW of power. It will make an essential contribution to India's long-term energy supply and to reduce greenhouse emission of our nation. Puga Geothermal Field in Ladakh region of Jammu and Kashmir is one of the areas that show significant potential for geothermal energy. It has the most promising hydrothermal system of the Indian subcontinent. Puga geothermal field can sustain 20 MW power plants. The geothermal fluid is obtained from a well that is similar to an oil well. If this well is not self-flowing then it is fitted with a down holes pump to increase the flow rate of the pump and to make sure that the pressure of the water is high enough to keep it from flashing into steam as it rises up the well and is piped to the power plant. To produce electricity, geothermal power plant uses steam which comes from the reservoirs of hot water. This steam rotates the turbine and produce electricity. In India, by the year 2030 the energy need may be increase to 3, 00,000 MW. The overall outcome of this paper is to see how the remote areas near Puga Geothermal Field can get proper electricity.

1. INTRODUCTION

Geothermal energy is the thermal energy that is obtained and collected in the Earth. It can also be used for cooling or heating purpose or also for producing electricity. The use of geothermal energy first occurred more than ten thousand years ago. In late 18th century, near Pisa, Italy the 1st industrial use of geothermal energy were started, where the steam from holes that were drilled or natural orifice was used to draw out boric acid from hot reservoir known as Larderello Fields. Power that is generated by the use of geothermal energy is known as geothermal power and it is considered as a renewable energy source. Steam from hot reservoirs build few or more miles below the earth's surface, is used by geothermal power plant to generate electricity. This steam drives a turbine that turn on the generator that generates electricity. Three types of geothermal power plants are there i.e. dry steam plant, flash steam plant and binary cycle plant. In dry steam power plant the steam from underground wells is directly drawn to the power plant where it is used to generate turbine to produce electricity. Flash steam power plant use geothermal water which has a temperature higher than 182˚C i.e. 360˚F, while binary cycle power plant use geothermal water having less temperature of 225 to 360˚F i.e. 107 to 182˚C. From hot water reservoir binary cycle power plant uses the heat to boil a working fluid (an organic compound having low boiling point). In the development of geothermal energy this power plant plays a major role.

Puga geothermal field is located in the North-Western part of Himalayas; it is the most favourable area among different geothermal zones. It makes a division of Himalayan geothermal belt that is situated in the south-eastern part of Ladakh district in Jammu and Kashmir State in India. In the eastern part of the valley, sulphur and borax are found which are genetically attached with thermal fluids. Direct steam power plant is used to generate electricity for remote areas and it is used at dry steam i.e. vapour-dominated reservoirs. From wells; saturated, dry or little superheated steam is produced that take away non-condensable gases having varying concentration and compositions and this steam is carried by pipelines to powerhouse where it is used to rotate turbine to generate electricity. Liquid-dominated geothermal reservoir is the most common reservoir. The mixture quality is a function of the fluid conditions of reservoir, dimensions of wells, and the pressure of wellhead which is managed by a valve at wellhead and orifice plate. In this paper we are discussing about the performance, condition and costs involves for remote powering or how geothermal system is useful for producing electricity for remote areas.

2. STUDY AREA

Various locations in India are popular for the geothermal energy production. Puga geothermal field is situated at an altitude of about 4400 meters in the Ladakh region of Jammu and Kashmir states having more than hundred hot springs having temperature of about 84˚C. It contains fresh sublimate of eolian sand, clay, and glacial moraines. Geothermal abnormal areas are spread over 5 kilometres across Puga stream and it has a largest width of about 1 km. Around Puga Geothermal Field rocks are garnet-mica, volcanic, kyanite schist, gravestones, limestone and carbonaceous phyllite. Hot water from geothermal reservoir provides energy to geothermal power system. From a well, geothermal fluid is obtained and this fluid flows through a tubes in one direction while the working fluid flows from opposite direction that absorb heat and vaporize the working fluid. This vaporised working fluid is used to drive the turbine to generate electricity for remote areas. Geothermal fluid is transported back into the ground from the heat exchanger through injection wells. As the vapour pressure which is low comes out of the turbine, in the condenser it gets liquefied and by the hydrocarbon pump it is again pressurized to return back to heat exchanger. Through the condenser waste heat is released to the atmosphere. A broad range of temperature of about 100 to 150˚C of geothermal reservoir is collected by binary power plant. In the form of hot springs, mud pools, sulphur and borax Puga Geothermal Field exhibits vigorous geothermal activity covering an area of 15 km^2. At Puga it was found that

around 5,000 kWh of geothermal energy is available. There is about 90 percent probability that Puga Geothermal Field can handle 20 MW Power Plant.

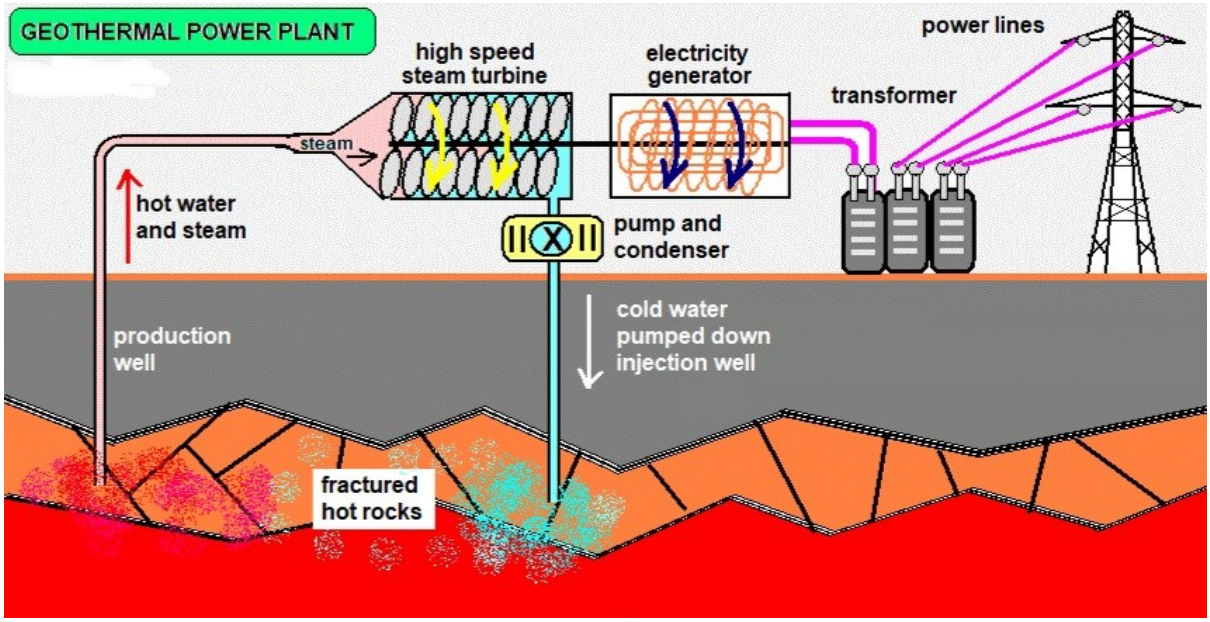

Figure 1 Geothermal Energy Power Plant

3. METHODOLOGY

To understand the electrical resistivity of the subsurface, a geophysical technique known as Magnetotelluric Method (MT) was used. In the subsurface, useful information about the variation in the vertical and lateral resistivity is provided by the use of electromagnetic fields as a source, is obtained naturally from the earth. A subsurface resistivity variation model is provided by the electrical and electromagnetic methods as the electrical resistivity is more affected by the temperature and permeability changes. Most of the geothermal plant is developed near the geothermal resources as it is not possible to carry steam having very high temperature to a long distance with the help of pipelines as it cause a loss of heat. A single geothermal well has a capacity of 4 to 10 megawatt and the range of geothermal power plant is about 20 to 60 MW. In a binary power plant 500 to 3000 kW is the most common range.

To generate electricity different types of geothermal power plant are used i.e. direct steam plant, flash and double flash plant, and binary plant. At dry steam (vapour-dominated) reservoir, direct-steam power plant is used. Hydrothermal fluids are used by direct-steam power plant. From wells; dry, saturated and little superheated steam is obtained and it carries gases that are non-condensable which is having changeable composition and concentrations. This steam directly goes to the turbine that generates electricity by operating generator. Centrifugal cyclone separator is situated between each well heads and the plant, that are used to remove rocks and dust that get stucked in the pipelines which is formed during transmission and at the entrance of the powerhouse one can found a moisture removal.

Electromagnetic method are one of the method which is used for investigation and monitoring Enhanced Geothermal System. In the context of geo-technology project it is more appropriate for detecting the underground geothermal energy or carbon-dioxide (CO2) separation. In this, the design of survey greatly depends on the specific procedure that is used and the location is to be monitored properly. This will assist us to understand the particular behavior of electromagnetic fields and its complications in a three dimensional geological atmosphere. The hydrological perspective, geological characteristics and thermal resource is narrated by this method. In this the development of the current technique strongly depends on the rock electrical resistivity. It is seen that using a technique of time-lapse this method can keep an eye on the zone of stimulated fractured for deep geothermal energy. It is proved that for enhanced exploration, planning and monitoring assessment this realistic effective experiment is strong and cost effective. To most sites, framework and geophysical techniques this methodology is strongly applicable.

In a flash steam power plant to produce electricity there is a use of geothermal fluids having temperature more than 182˚C i.e. 360˚F; and in the tank which is having less pressure this fluid is pumped (the fluid pressure is more than the pressure in the tank) which causes some of this fluid to get vaporize or “flash”. This flash steam or vapour goes to the turbine and operates the generator to produce electricity that is used to light up remote areas. This is called a Flash Steam Power Plant. It used the sources that occurred naturally like hot water and steam from underground. Single flash steam plant is the one which only uses primary high pressure steam. The power plant which uses low as well as high pressure is called double steam power plant. In Double-Steam Power Plant if the liquid remains in the tank then again in a second tank it get vaporized or flashed i.e. to produce even more amount of energy flash is done twice. By the use of Double-Steam Power Plant, from the same geothermal fluid near 20 to 23 percent more power can be produce.

Binary cycle power plant uses geothermal water at a lower temperature of 107 to 182˚C i.e. 225 to 360˚F. Here in the binary cycle plant via a heat exchanger, geothermal fluid's thermal energy is transferred to a secondary working fluid. Areas having a potential of geothermal energy have a geothermal water of a temperature below 400˚F. Binary cycle power plant generates energy from this fluid. With a very less boiling point, binary fluid i.e. secondary fluid and a hot geothermal fluid flow from a heat exchanger. Binary fluids get flashed to vapour due to the heat that is produced from the geo-fluid and that vapour is used to produce electricity by driving a turbine. Binary power plant is a close loop system and during the process nothing is released to the atmosphere. Under a various conditions like a geothermal fluid having temperature of about 150˚C i.e. 300˚F or with a high gases that is dissolved or greater corrosion, etc. this type of power plant is more beneficial.

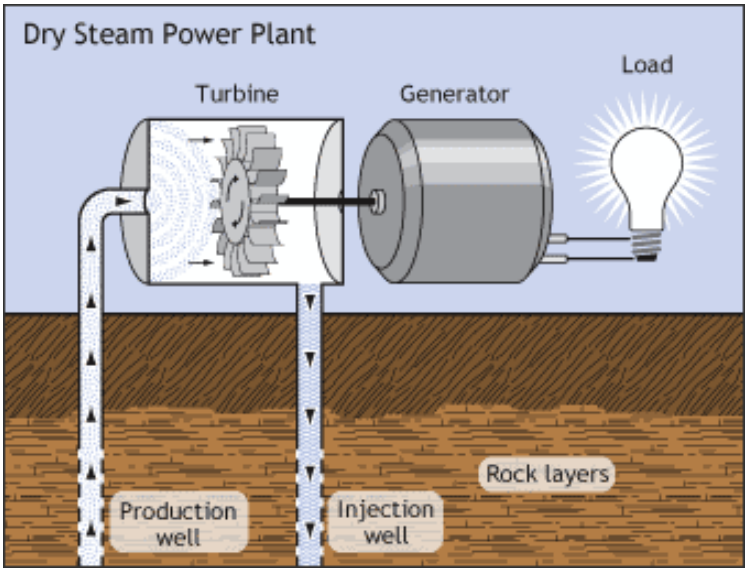

Figure 2 Dry Steam Power Plant

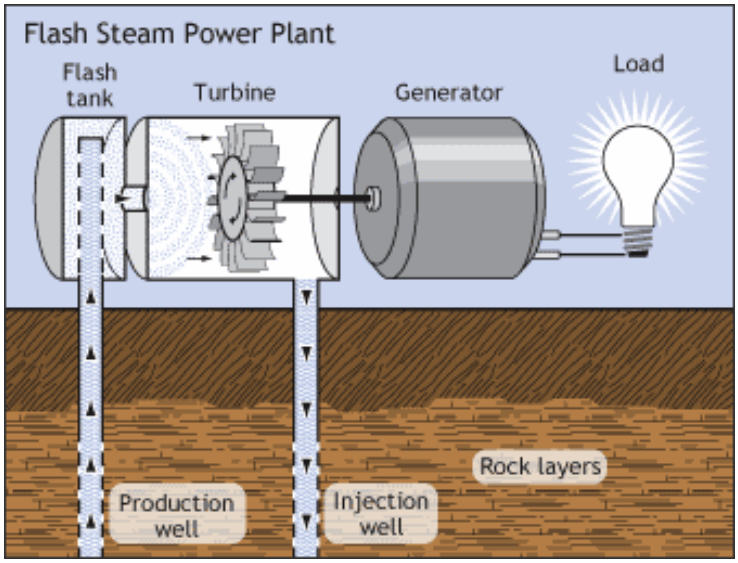

Figure 3 Flash Steam Power Plant

4. CHALLENGES AND FUTURE SCOPE

Geothermal energy is a renewable energy but there are some challenges that are faced during its usage. On the electrical industry the effect of deregulation can also cause a negative impact on geothermal power plant. To the earth surface the development of geothermal power plant on a large scale is very dangerous. It is very hard (very difficult) to repair the underground loops if it get damaged and it is very expensive. Geothermal power plant is very costly. To run heat pump a very large amount of electricity is needed. Various constrains of geothermal energy is that there is a shortage of exploitable area, there is an unacceptable emission of gases and from the load centres remote areas are often very far. Challenges that can be faced for the production of geothermal electricity like the lack of advance technologies, problem of funding and for conventional power plant the period of development is too long of about 5 to 10 years. In the production and growth of geothermal resources, drilling is a most complex process and it is costly, that's why the development of geographical procedure to solve this problem is needed as it can decrease the cost of development of geothermal energy,

hence advance technology is to be made that can decrease cost and development risk. Geothermal energy give a solution to a great concern of global warming that is caused due to the use of other resource to produce electricity but the rate of geothermal resources is too low with a very large evolution period and it can involve a huge cost. So it is necessary to identify and understand the problems and there is a need to find a solution to enable the faster growth of geothermal electricity, to reduce cost and to accelerate the growth and efficiency.

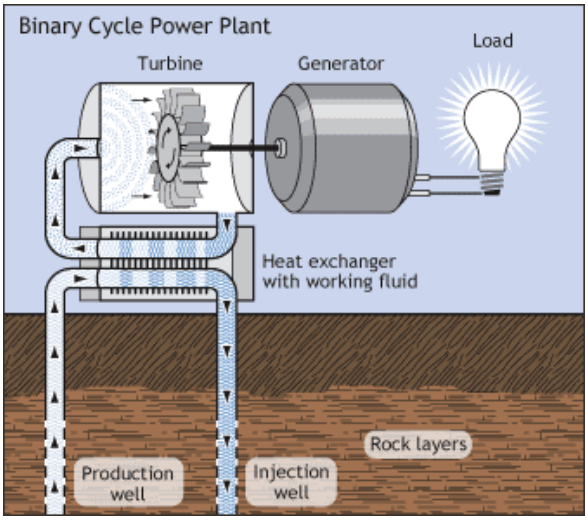

Figure 4 Binary Cycle Power Plant

5. CONCLUSION

The energy services can become better if geothermal energy is used to generate electricity or for any other indirect applications. The rate of electricity in remote areas and the aim of growth in production of electricity for the areas near Puga geothermal field can increase the growth of market. Recent sources for production of energy are available for generation of power in a large scale but the use of geothermal energy for the production of electricity is most suitable as it will not cause many environment related problems. Other energy sources causes a great impact on environment then the geothermal energy and also in geothermal power plant the emission of gasses are very less that is near to zero as compared to that of the oil and coal plants. It was found that the concentration of a compound is changeable in a geothermal fluid and they may vary with time. Geothermal power plant compared to all conventional thermal power plants has the lower conversion efficiency.

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