Utilization of Geothermal Energy for Power Generation

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Abstract— A standardized arrangement of a geothermal system is represented here. In this paper, a prototype of geothermal energy power plant is accomplished and analyzed in which region it will be much more effective. Geothermal process totally depends on underground heating, so it is important to find a suitable place where it will get more underground heat. The production and application of this examine are mainly based on the perspective of our country, Bangladesh. Geothermal energy is highly forceful and able to extract a renewable energy from the earth through natural processes. By using this process, it is possible to produce a large amount of electrical energy without providing any fuel. So, it would be a helpful program for a developing country like Bangladesh because this design is cost effective and environmentally friendly. So, this paper offers a utilization of geothermal system for power origination in Bangladesh by making a model of the power plant that is related to steam-engine plants where heat from a subsistence origin is obtained to heat water or hot liquid. This type of liquid is then operated to adjust a turbine of a generator, and execute electricity. After then the hot liquid cooled and backed to the heat source.

Index Terms— Geothermal Energy, Steam turbine, Renewable energy, Underground heat, Geothermal Power plant, Brushless DC motor, Working fluid (NaHCO3)

1 Introduction

Increasing the amount of global warming, it is very important to finding green energy source. Geothermal energy is the part of renewable energy. It is the multidimensional process which has the growing improvement. It is also a continuous process because heat is continuously produced inside the Earth. The decay of radioactive minerals deep in the ground such as uranium which is caused to produced geothermal energy. This type of power plant is produced electricity from magma where steam is generated. This system also works in reserved hot water found below the Earth's surface. So, it would be said that steam power plant and geothermal power plant almost same. The process of generating electricity and the basic working principal is almost similar. Fossil fuels are used in the steam power plant but underground boil water is used in the geothermal power system [1-4].

In the underground level of the earth is carried a mixer of carbon dioxide gas, hydrogen sulfide, methane, ammonia radon this type of dangerous gas. If these gases are released, global warming, acid rain, radiation and noxious smells are increased. On the other hand, a lot of acids and volatile chemicals have emitted this type of stations or power plants. Geothermal stations infuse these gases back into the deep of the earth, as a form of carbon capture and storage. Again, dissolved gases and hot water from geothermal source contains a toxic chemical. If this chemical comes out, it can be caused environmental risk. Geothermal power plant minimizes the environmental damage [5,6].

Above 24 countries using a geothermal system to generate electricity. It is safe and environment-friendly. Once it was believed that geothermal plant can place where volcanoes are situated. But now scientists have developed this system in a low-temperature area also. So, we can choose binary steam power plant as our geothermal power plant. It is easy to install and require a lower temperature. It will help to level up our energy generation. It has a lower maintenance cost and doesn't need any fuel to operate because of that it has the high rate of efficiency. As a developing country, it will add a new dimension to our energy development and also effect economically [7-9].

As a result, Bangladesh should continue to run the geothermal power plant in future. This work is difficult to find possibilities to develop the geothermal system in perspective of Bangladesh. So, the main work to observe which type of geothermal plant is suitable for this country and design a prototype of this power plant.

2 Designed Prototype

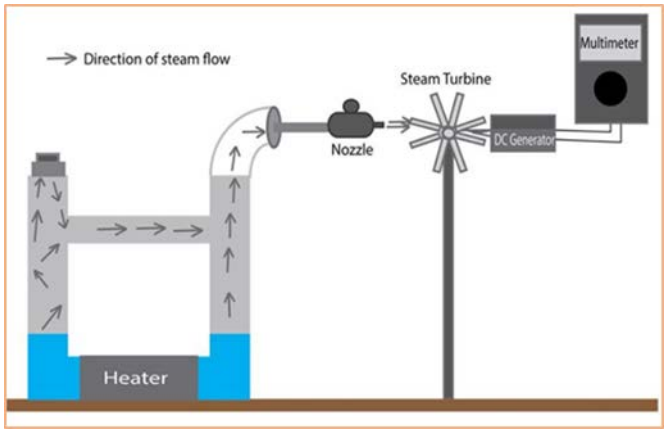

Fig. 1. Geothermal power plant

A simplified and effective diagram of Geothermal Power plant has been shown in Figure 1. The goal of this system is to design a both cost effective power plant prototype which can be used as an alternative power source in particular areas of Bangladesh where sufficient geothermal energy is gained and shows the basic functionality of the proposed system.

The prototype consists of pipe, water heater, nozzle, and turbine, brushless DC motor and motor stand. Water heater resembles underground heat in this project. In Figure 2, a U-shaped pipe is shown which is used for the designing purpose of this prototype. At one end, a nozzle is connected. At the other end of the pipe is sealed with a screw which is made by the screw.

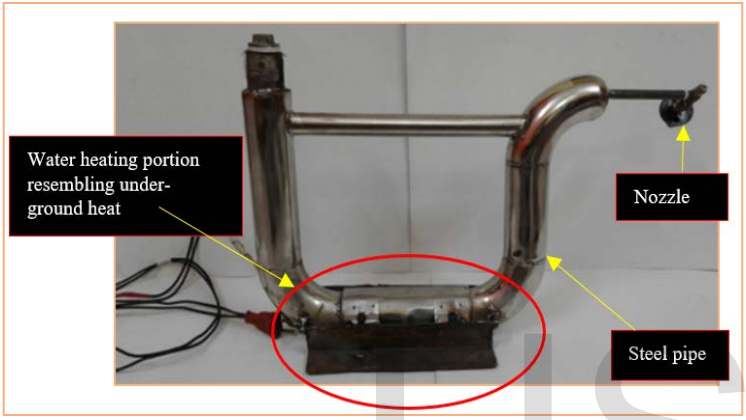

Fig. 2. U-shaped stainless-steel pipe along with water heater

The screw is opened when the pipe is filled with water. These two ends are connected by another pipe. So that the nozzle gets the pressure of steam from both side of the pipe. The pipe is made of stainless steel and liquefies point is 1400-1450°C. Pipe diameter is 5cm, vertical length 32cm, horizontal length 35cm with thickness 1.5mm and the gate diameter is 2.5cm. The heater is used to heat the water inside the pipe. The heater is clipped around the pipe. The heater is made of Nichrome wire. (80% nickel, 20% chromium) and melting point is 2030°C. Welding of stainless steel and steel is not strong so the nozzle is screwed with a stainless steel.

Fig. 3. Steam turbine consisted of 18 blades

Normally the nozzle is kept off by Poly-valve. The Poly-valve kept off until enough pressure is created inside the pipe by steam. Then the Poly-valve turned on so the steam can pass through the nozzle. In figure 2, there are 18 blades in this turbine. Each blade is 4.5cm long and 40° bent. These blades are made of Tin (Sn). The melting point of this material is 231.9°C. Turbine stand is 23cm long stand which is carrying a brushless DC motor and a turbine is attached to it. Turbine stand is made of Iron (Fe) which Melting point is 1,538 °C.

3 METHODOLOGY

At first, the pipe was filled up with a 700ml solution of water, salt and soda (NaHCO3). The solution was helped the water to vaporize quicker than normal water and produce more steam. One of the ends of the pipe was connected to a nozzle. And the other end of the pipe was sealed by a gate. The gate was opened and the Pipe was filled with the solution. Perfect separation of the steam from the internal environment of the pipe and the external environment was ensured by closing the gate. The nozzle was made of Brass. A Poly-valve was attached with the nozzle to open it. The output hole of the nozzle was very small to ensure a forceful steam flow. A heater was attached to the pipe which can heat up the water solution inside the pipe. This heater was capable of producing sufficient amount of steam within 30mins after it was powered. At the beginning, the gate and Poly-Valve of the nozzle were in a turned off state. Then the heater was heated up. After 30 to 40mins of continuous heating the solution was started to vaporize and inside the pipe, the pressure was increased. The pipe was capable enough to tolerate even more pressure. So there was hardly any chance to occur any accident. After that, the Poly-valve of the nozzle was turned on then the steam started flowing out of the pipe through the nozzle. A turbine of 18 blades was kept in front of the nozzle and the turbine started rotating. The turbine was connected with the DC generator. So, the generator was produced energy. The voltage and current was measured by a Multi-meter. The motor speed was measured in rpm by a Tachometer. The prototype can produce up to 1.62V, 59.7mA and 1727 rpm from 300ml of water.

Fig. 4. Designed prototype

4 Experimental Results

The V-I curve represents the decrement of voltage and current along with increasing time. The reason behind the decrement of voltage and current is the decrement of speed along with the increasing time.

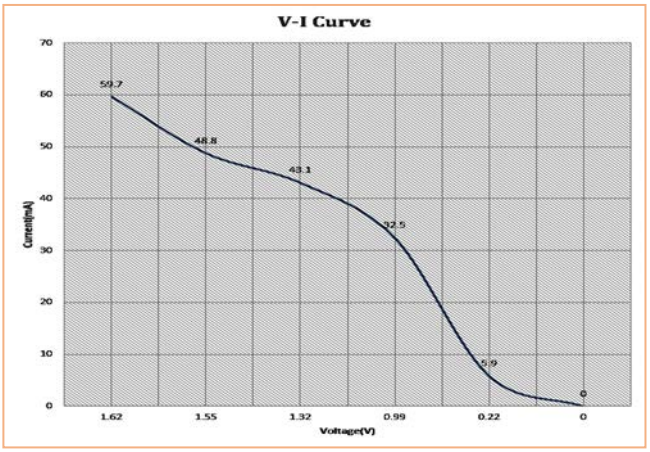

Fig. 5. V-I characteristics curve of designed prototype

Time vs. speed curve represents the decreasing speed along with increasing time. In this curve we can see, at first 15 sec, the speed is approximately 1723 RPM, at 20 sec the speed all of a sudden, falls at 28.4 RPM after that the speed keeps on decreasing. The sudden decrement of speed takes place due to lack of pressurized steam inside the U-shaped pipe.

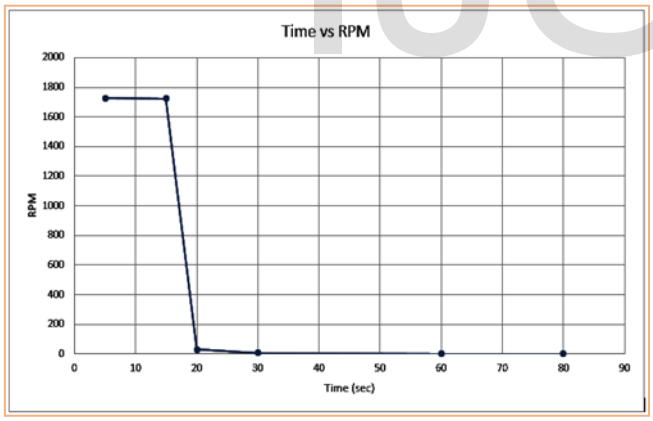

Fig. 6. Time vs. speed characteristics curve of designed prototype

TABLE 1
OUTCOMES

Time (sec)	Voltage(v)	Current(mA)	Speed(RPM)	Power(W)
5	1.62	59.7	1727	0.0967
15	1.55	48.8	1723	0.0744
20	1.32	43.1	28.4	0.0567
30	0.99	32.5	5.2	0.0321
60	0.22	5.9	1.8	0.0012
80	0	0	0	0

5 Conclusion

The goal was to propose a prototype which can be implemented in selected areas of Bangladesh which are suitable for power generation using geothermal heat. To achieve the goal a prototype was designed which represents the Binary steam geothermal system. From the prototype voltage, current, rpm and power were measured. Voltage vs. current and time vs. rpm characteristics curve was built. As it is not possible to implement a geothermal power plant for research purpose, So the prototype was designed to show the basic working principle of the power plant.

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