Fundamentals of Renewable Energy and Applications

Chaiyat et al., J Fundam Renewable Energy Appl 2014, 4:2
http://dx.doi.org/10.4172/2090-4541.1000138

Research Article | Open Access

Geothermal Energy Potentials and Technologies in Thailand

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Abstract

This paper presents a concept for using the geothermal energy in Thailand. The geophysical properties and the suitable technologies are considered; moreover the prototypes of the suitable technology have been constructed and tested the system performances. The potential of 97 hot springs in Thailand are classified into three groups as high, moderate and low potential. Organic rankine cycle is selected for 12 high potential hot springs to generate electricity 3,909 kWe. Absorption chiller and 8 moderate potential hot springs could be produced the total cooling capacity 304 kW and the payback period is 22 months. Central drying room and 8 moderate potential hot springs could be used in the heating process at 406 kW and the payback period is 15 months. Drying room integrated with vapor compression heat pump is represented for boosting 26 low potential hot springs. The upgrading heat around 2,002 kW could be used for drying the agricultural products 200 Ton/d which the payback period is 29 months. It could be found that the geothermal energy potential in Thailand could be developed from 46 hot springs to be used for heat and power at around 6.6 MW.

Keywords: Geothermal energy; Organic rankine cycle; Heat pump system; Drying room; Absorption chiller.

Introduction

Geothermal energy is one type of renewable energy which the Thailand government sets a geothermal policy to increase the power generation to be 1 MW in 2021. Department of Mineral Resources of Thailand [1] reports 112 hot springs in Thailand. In 2008, Chiang Mai University (CMU) [2] also reported 97 potential of hot springs in Thailand and classified them into three groups as high, moderate and low potential which is shown in Figure 1. For high potential hot spring, the surface water temperature is higher than 80°C. Moderate potential hot spring refers the surface water temperature between 60-80°C and low potential hot springs represents the surface water temperature is lower than 60°C. Thus, the aim of this research is to study the appropriate technologies for using geothermal energy in Thailand.

For technology to generate electricity, the various literatures are presented such as Chaiyat and Chaichana [3] reported using high temperature hot spring at higher than 90°C to generate the electricity by using a binary system and a thermoelectric module. Combs et al. [4] studied the small geothermal power plant in America and Japan at capacity around 100-1,000 kW. The technologies of the slim hole and binary-cycle technology were selected to use for the off-grid area. And, the environment affect from the geothermal power plant was lower than the fossil power plant which was similarly Brophy [5], Kose [6] and Dagdas [7]. For the simulation studies, the selection of suitable working fluids for the organic rankine cycle (ORC) system was the hot issue which had many reports to study this topic such as Hettiarachchi et al. [8], Schuster et al. [9], Guo [10], Sauret et al. [11], Liu et al. [12], Edrisi et al. [13], Li et al. [14], and Rodriguez et al. [15]. It was found that the suitable working fluid of those results were different because the system conditions of each study were different. But the most suitable working fluid of those studies introduced R-134a and R-245fa. In generating electricity process, the ORC system was compared with a Kalina cycle in term of efficiency. Guzovic et al. [16] studied the geothermal energy to power plant in Croatia. The high temperature hot spring at 175°C was supplied to binary system which of organic rankine cycle and kalina cycle. The simulated results shown the ORC cycle had a higher thermal efficiency and energy efficiency compared with the kalina cycle. Moreover, a low potential geothermal at hot water temperature around 61-80°C in China had studied by Aneke [17]. R-134a ORC system was chosen to produce electricity and the system efficiency was around 8.8%.

For the cooling technology, an absorption chiller is presented by various literatures. Kanoglu and Cengel [18] reported economic evaluation of geothermal power generation, heating, and cooling. It found that geothermal heating and geothermal absorption cooling were revenue higher than geothermal power generation about 3.1 times and 2.9 times, respectively. Kececiler et al. [19] simulated the absorption refrigeration cycle by using hot spring in Sivas, Turkey as heat source. The simulation results also shown that hot spring in Sivas did not be used efficiently in electricity generation. Kairouani and Nehdi [20] presented a novel combined refrigeration system which was absorption system cascaded with conventional compression system. The modified system increased the efficiency around 37-54% which was similarly the research of Ayala et al. [21], Seara et al. [22] and Kairouani and Nehdi [23].

For technique for drying process, Chaiyat and Chaichana [24] presented 2 types of drying processes which are a central drying room and a geothermal heat pump for drying room. The central drying room used hot spring to direct supplied into the drying room. For geothermal heat pump, a R-290 vapor compression heat pump for upgrading hot spring temperature around 40-50°C to be hot water around 70°C for using in the drying room. Heat pump dryer was found to be an effective equipment with low energy consumption as reported by Singharajwarapan and Chaiyat [25] which used low potential hot spring at temperature around 50°C to generate hot water temperature around 70°C for the drying room. Pendyala et al. [26], Chou et al. [27],

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Received August 01, 2014; **Accepted** September 23, 2014; **Published** September 30, 2014

Citation: Chaiyat N, Chaichana C, Singharajwarapan FS (2014) Geothermal Energy Potentials and Technologies in Thailand. J Fundam Renewable Energy Appl 4: 139. doi: 10.4172/2090-4541.1000139