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Applying a heat superconductor with high efficiency thermoelectric generator of ORRA modules to geothermal power industry

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ABSTRACT

A heat superconductor, multi-inorganic materials, with conducting rate and efficiency at 2960000 ft/sec, 102%, respectively was applied to the temperature about -50℃ to 3,000℃. There are two advantages to employee the high efficiency thermoelectric generator (TEG) of ORRA. One is it can work on at least 60℃ of temperature difference with 0.3026W power generation; the other one is that TEG of ORRA may provide has higher electrical energy and higher temperature difference than any other existing ones. This study attempts to integrate a heat superconductor with the high efficiency thermoelectric generator of ORRA module on geothermal power plant to provide higher efficiency power generation in geothermal generator field in the future.

1. INTRODUCTION

It is a well-known fact that heat superconductor can deliver heat quickly and efficiently and thermoelectric generator (TEG) can be a great agent for heat transfer. Even heat superconductor has been developing since 1987. Yet, the application is limited when it is less than 35cm. This limitation has been lifted by heat superconductor of ORRA which has been successfully test up to 5m in laboratory scale. The TEG of ORRA currently test results in the laboratory show that $1m^2$ TEG of ORRA can generate about 529W of electricity at a temperature difference of 150 ℃ which is equivalent to 5 times of $1m^2$ solar photovoltaic panel generation, about 100W.

Therefore, this study will attempt to integrate heat superconductor and thermoelectric generator for the first time. It is expected that this module design concept will be applied to geothermal power generation.

2. THE HEAT SUPERCONDUCTOR OF ORRA

The heat superconductor of ORRA is made of any kind of temperature-conducting material, and the tube wall is cleaned and purified. Then the hot super-duct is vacuumed (-9torr~-10torr), and the micro-inorganic medium is dripped into the hot super-catheter. When the heat energy supplied is received, these tiny inorganic media collide with each other in the vacuum state to generate heat transfer effect. Because the thermal conductivity of heat superconductor of ORRA is extremely high (Table 1), the heat generated by these inorganic media under vacuum is not dissipated due (Luo, 2004).

Table 1: Comparison of thermal conductivity between the hear superconductor of ORRA and other materials:

Material	thermal conductivity (w/m · ℃)	Material	thermal conductivity (w/m · ℃)
air	0.0267	copper	401
water	0.61	silver	418
stainless	16.51	ORRA	2,926,000
aluminum	218.		

3. THE THERMOELECTRIC GENERATOR OF ORRA

The thermoelectric generator of ORRA uses material made of bismuth telluride, which is firstly formed into a wafer rod at nano-sized. Furthermore, the wafer rod is cut into sheets, strips and cubes. Then, the P-doped and the N-doped integrated together, one side render heat and the other side render cold and it will generate electric automatically (Luo, 2004).

The thermoelectric generator of ORRA has been proven the temperature different can be generated up to 60°C in the lab under the same heat dissipation conditions (Figure 1). Moreover, the thermoelectric generator of ORRA can generate 130°C of the temperature difference by the area of $0.24m^2$ with 120W generation efficiency (Figure 2) (Wu and Fan, 2008).

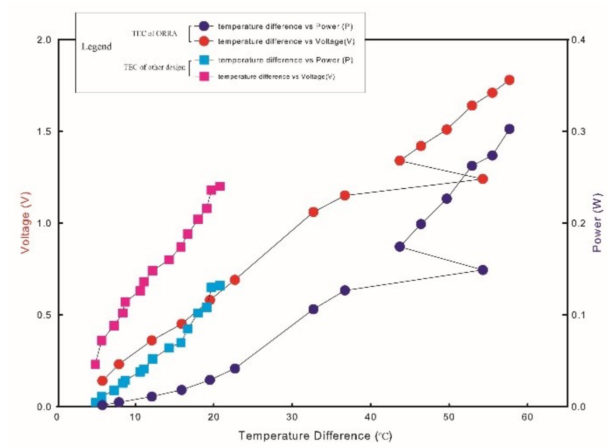

Figure 1: The thermoelectric generator of ORRA can generate 0.3026W at a temperature difference of 60 °C while others can only produce 0.132 W at a 20 °C temperature difference.

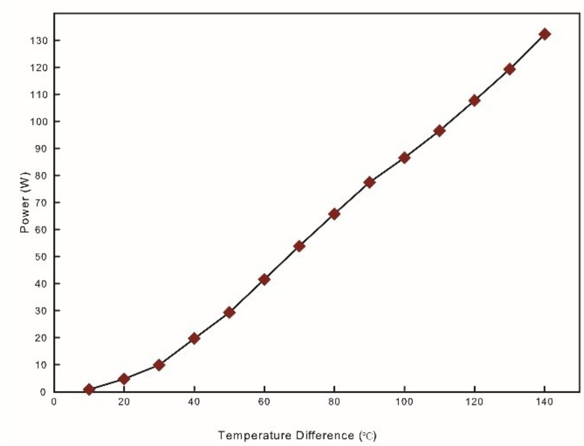

Figure 2: Power (W) dependence on temperature difference (°C) under the loading resistence of 100Ω.

4. THE GEOTHERMAL CHARACTERISTICS IN TAIWAN

Most of the geothermal prospects in Taiwan are located in the low-grade metamorphic rock area (Figure 3). The geothermal power plant of Chingshui geothermal field, once the 14th geothermal power plant built of the world, is located in the low-grade metamorphic rock area (Bertani, 2012; Chen and Liu, 2013). That geothermal power plant was shut down majorly due to serious scaling and insufficient water in the operation and partly because base on volcanic rocks mindset to design for the low metamorphic rocks nature. (Figure 4) (Lin, 2000)

Taiwan has resumed to conduct geothermal exploration and basic studies of geological and rock characteristics for low-grade metamorphic rocks since 2009 in light of the new development of geothermal energy. Some preliminary studies regarding the low graded metamorphic geothermal exploration has been published (Liu et al., 2017; Kuo et al., 2017).

Due to most the geothermal fluid in low-grade metamorphic rock of Taiwan will pose no rust corrosion but the issue of scaling. The ORRA system will be a perfect heat conversion system for the future geothermal develop in Taiwan because it only transfers heat from the geothermal potential region and cause no scaling.

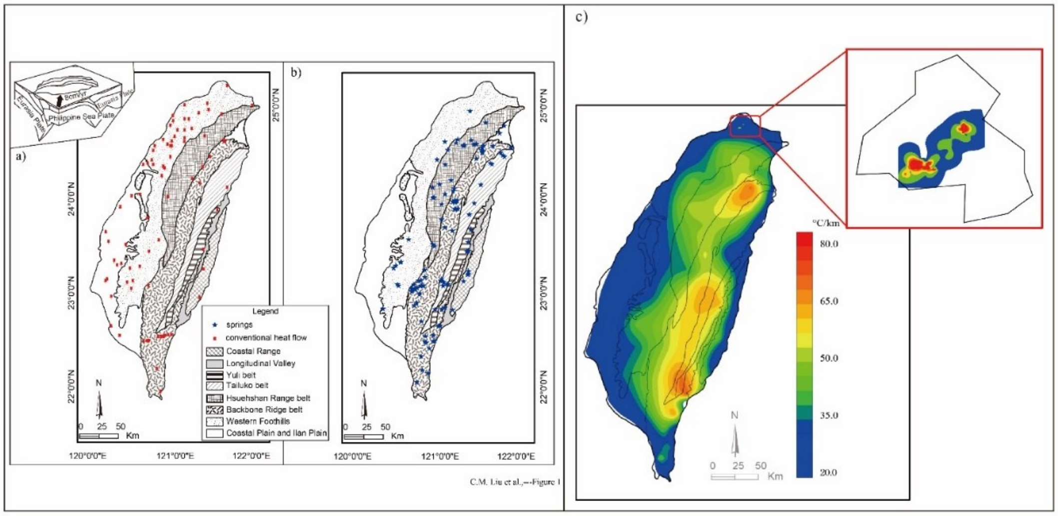

Figure 3: The potential geothermal area of Taiwan (modified Liu et al., 2015).

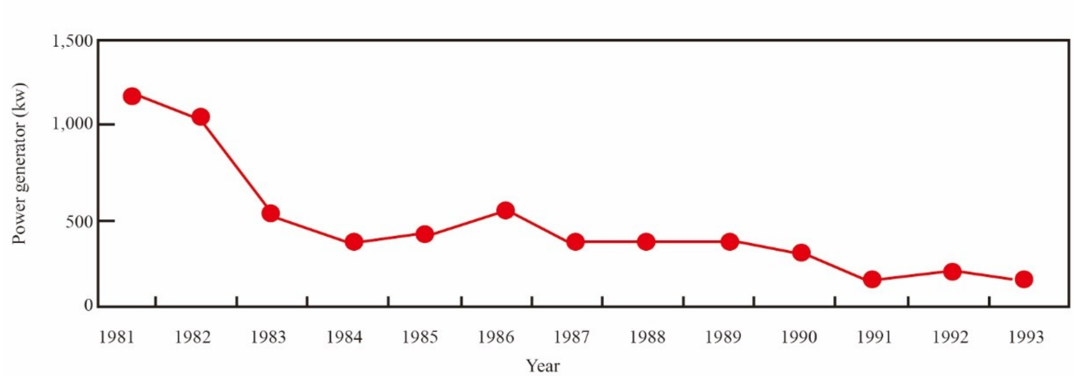

Figure 4: The power generation of the Chingshui Geothermal Field between 1981 and 1993 (modified Lin, 2000).

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