

Experiment study investigation compare temperature series circuit and the parallel circuit of thermoelectric and variable water, electrical of thermoelectric for heat exchanger

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ABSTRACT

This paper presents the comparison temperature of thermoelectric (Tec1-12708) between the series circuit and parallel circuit by adjusting of water flow rate pump and electrical supplying to thermoelectric, the electrical voltage at 8,10 and 12 V, water flow rate in reservoir was 0.015 kg/s and 0.025 kg/s. Experiments perform were 6 hours. The result from the researches, thermoelectric with parallel circuit high temperature more than thermoelectric with series circuit. The parallel circuit of thermoelectric can work better than the series circuit in hot side. The different temperature hot side of parallel circuit with the electrical voltage at 8, 10 and 12 V water flow rate in reservoir was 0.015 kg/s temperature average is 22.44 °C, 22.90 °C, 29.86 °C, and water flow rate in reservoir was 0.025 kg/s temperature average is 20.67 °C, 26.66 °C, 27.69 °C. Thermoelectric with parallel circuit makes the higher temperature more than thermoelectric with series circuit about 33 %, 37 %, 44 % water flow rate in reservoir was 0.015 kg/s and 30 %, 40 %, 41 % water flow rate in reservoir was 0.025 kg/s.

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1. INTRODUCTION

Since Thailand uses a lot of electrical energy, cold energy, and thermal power that are also essential in the household and industrial sectors and necessary for the daily life of the population in the country, so the trend of energy consumption is increased accordingly. The team has been looking for equipment that can produce both cold energy and thermal power which is Thermoelectric. These energies are still used in the household and the team focuses on the households that use these various energy sources but not much, and using of alternative energy is also reduce the environmental impact. The Alternative Energy Development Plan: AEDP 2015 was developed and focused on promoting energy production within the full potential of domestic renewable energy resources. Develop appropriate renewable energy production with considered to the appropriate and benefit in social and environmental dimensions of the community. The Alternative Energy Development Plan: AEDP 2015 [1] consist of The Power Development Plan, The Energy Efficiency Development Plan, The Alternative Energy development Plan, The Oil Development Plan and The Gas Development Plan. The researcher emphasized and tested the heat and cooling energy production for responding and promoting renewable energy and alternative energy. Therefore, the researcher selected a device that can produce the energy to become alternative energy. There is thermoelectric which can produce electrical, heating and cooling; these energies are used in households. The researcher focused on the

household sector that uses not much energy; moreover, using alternative energy also reduce the environmental impact and reply energy plan too.

Thermoelectric can produce electricity. The thermodynamic phenomenon occurs in materials that can change the different in temperature [2] of the material, heat, and cold and can be reversed. The material that uses hotness to make electricity is Thermoelectric Power (TEP) [3] and material that uses coolness to make electricity is Thermoelectric Cooling (TEC) [4] and can bring electricity that is produced by Thermoelectric [5] to use. Most of the Thermoelectric is applied to systems that produce energy in various forms.

So, this research uses the Thermoelectric that can produce cold energy and thermal power by joining the circuit of Thermoelectric in series and parallel for test efficiency. The experiment is the adjustment to make electricity and the flow rate with Thermoelectric to be appropriate to get a high temperature from Thermoelectric to make energy.

This research is just a comparison temperature of the thermoelectric series circuit and parallel circuit. By adjusting the power supply voltage from the power supply to the thermostat and adjusting the flow rate of the water exchanger heating and cooling. And the results will be applied to other applications.

Thermoelectric Module [6] is made by using the principle of heat pump of semiconductor materials. When the direct electric current is turned on the power to the thermocouple module that use a P-N type semiconductor, and when the current flowing through the semiconductor material is different that will make the electric potential different cause a different in temperature between the two terminals. When the electromotive force flows through a N type semiconductor that will make the electrons flowing from the negative side of the power supply to the positive side of the power supply and the heat absorbing from another side of the power for release heat out at the end of the semiconductor on the other side.

The hole flowing style of P-type semiconductor is opposite with the flowing style of P-type semiconductor's electrons that means when the electric current flows into the P-type semiconductor cause the flow of hole from the anode to the cathode and the heat absorbing from the anode of P-type semiconductor for release heat out at the cathode then we choose the advantage of both semiconductor to use together in a series of thermoelectric module.

2. RESEARCH METHOD

The research of comparing thermoelectric's temperature between the parallel circuit and series have the ventilation of hot and cold by water with the appropriate flowing rate for making high thermoelectric's temperature. The research steps are as follows, making the parallel circuit and series circuit by using the thermoelectric (tec1-12708) (Table. 1) that size is 4x4 cm. Measure the temperature between the hot side and cold side of water block [7], and measure the water's temperature in the tank of hot and cold water by using the thermocouple type k. The heat exchanger uses water to make the drainage of hot side and cold side, water flow rate in reservoir was 0.015 kg/s and 0.025 kg/s and collect experimental results by data logger every 10 seconds experiments perform were 6 hours. Figure 1. Schematic of the measurement of hot side and cold side water block [8], Figure 2. Motor pump water dc, Figure 3. Schematic of this experimental setup thermoelectric series circuit, Figure 4. Schematic of this experimental setup thermoelectric parallel circuit.

Table 1 Specifications of thermoelectric module TEC1-12708 [9]

Parameter	Cooling modules
Thermoelectric	TEC1-12708
Size (mm)	40x40
Module hight (mm)	3.46
No.of couple (number)	127
Maximum voltage (volts)	15.0
Maximum current (amps)	8.5
Maximum power (watts)	127.5
Maximum hot side temperature (°C)	160-170
Maximum different temperature (°C)	68
Module cost (US\$)	8

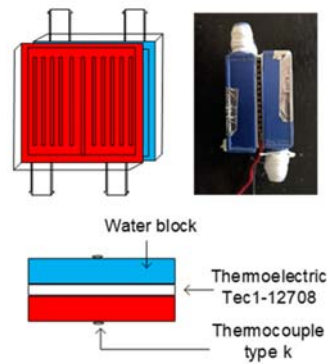


Figure 1. Schematic of the measurement hot side and cold side water block [10]



Figure 2. Motor pump water dc
Water flow rate in reservoir was 0.015 kg/s (3V)
Water flow rate in reservoir was 0.025 kg/s (4V)

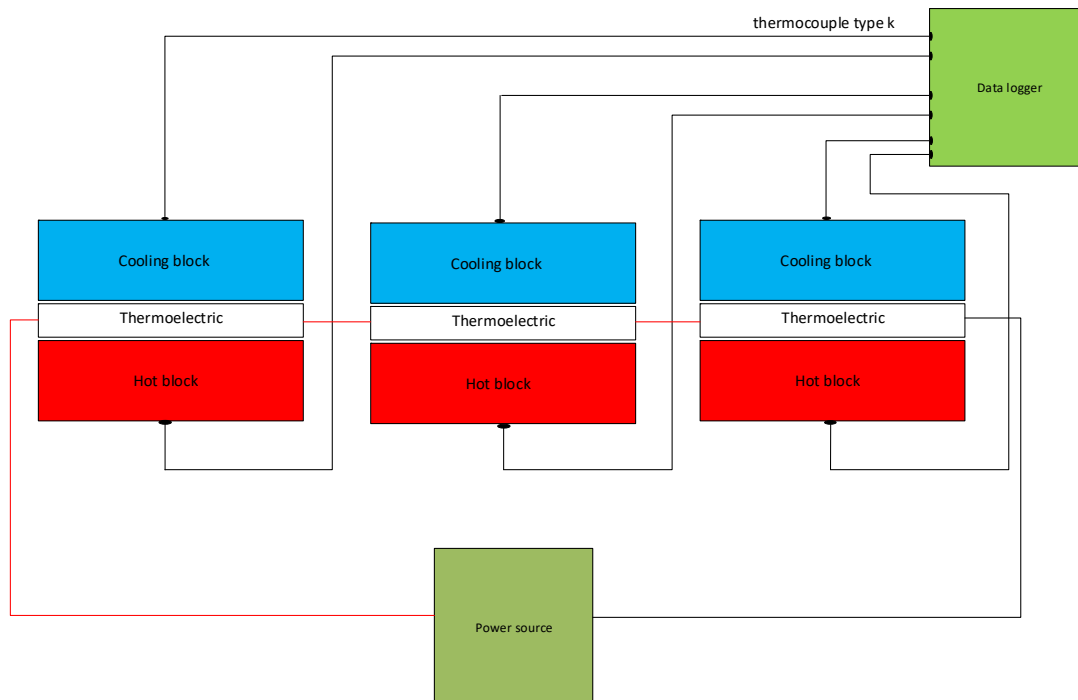


Figure 3. Front view of the thermoelectric series circuit.

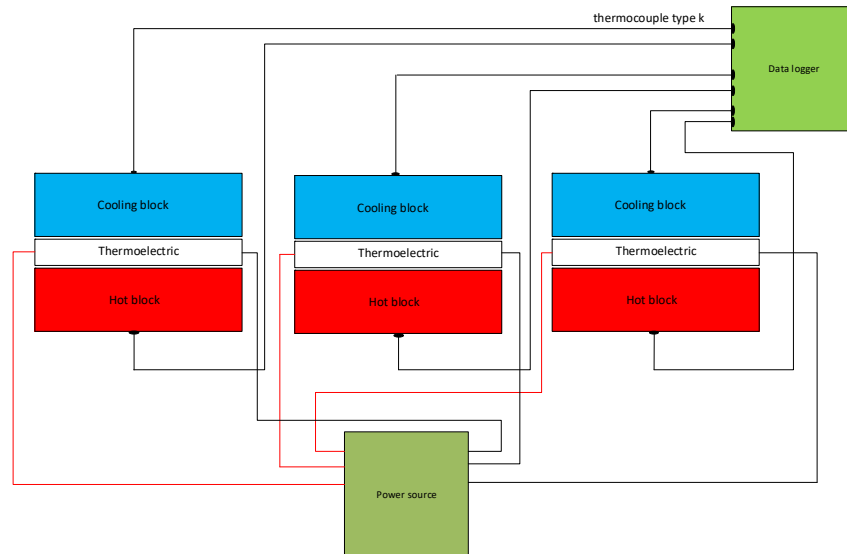


Figure 4. Front view of the thermoelectric parallel circuit.

3. RESULTS AND ANALYSIS

This research comparing thermoelectric's temperature between the series circuit and parallel circuit. The electrical voltage at 8,10 and 12 V, and the heat exchanger between the hot side and cold side of thermoelectric by using water. The water flow rate in reservoir was 0.015 and 0.025 kg/s, and these value is average of temperature from the start research to finished.

3.1. Compare series circuit and parallel circuit 8 V, water flow rate in reservoir was 0.015 and 0.025 kg/s

This research comparing thermoelectric's temperature between series circuit and parallel circuit by using the power supply the electricity to thermoelectric with 8 V water flow rate in reservoir was 0.015 kg/s (3V) as shown in Figure 5, the thermoelectric's circuit of parallel is higher temperature than the series circuit, which the highest temperature of parallel circuit is 65.96 oC and the lowest is 20.87 oC, and the highest temperature of series circuit is 41.28 oC and the lowest is 24.68 oC, so the different of hot side temperature is 24.68 oC.

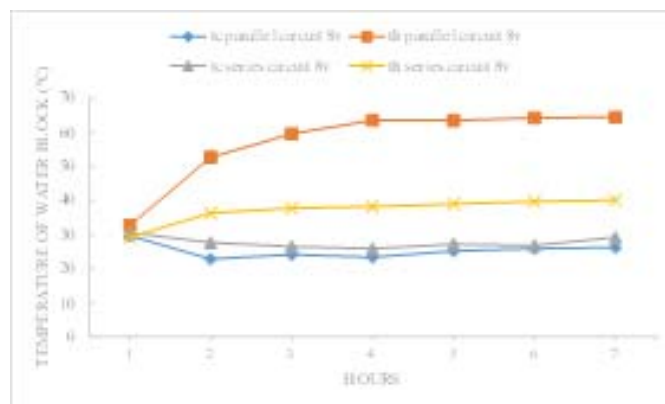


Figure 5. Temperature compare series circuit and parallel circuit the electrical voltage at 8 V, water flow rate in reservoir was 0.015 kg/s

The thermoelectric's circuit of parallel is higher temperature than the series circuit, which the highest temperature of parallel circuit is 65.26 °C and the lowest is 21.24 °C, and the highest temperature of series circuit is 43.01 °C and the lowest is 24.91 °C, so the different of hot side temperature is 22.25°C, water flow rate of 0.025 kg/s as shown in Figure 6.

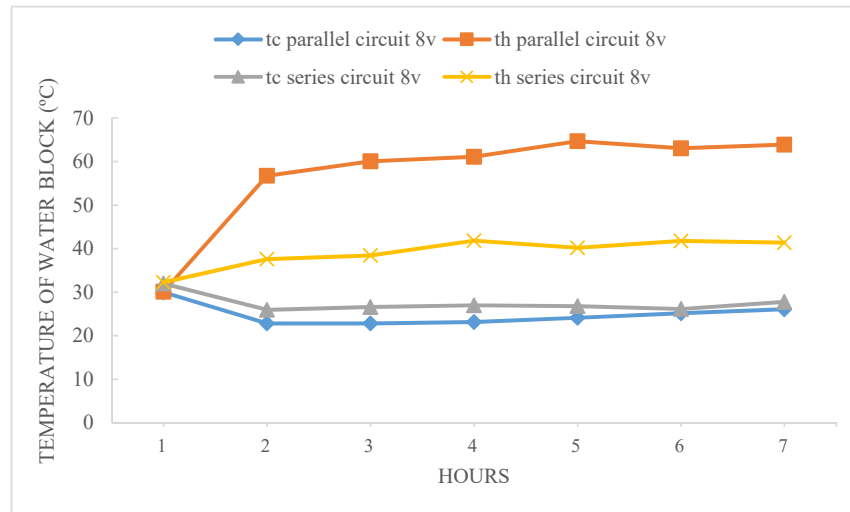


Figure 6. Temperature compare series circuit and parallel circuit the electrical voltage at 8 V, water flow rate in reservoir was 0.025 kg

3.2. Compare series circuit and parallel circuit 10v, water flow rate in reservoir was 0.015 and 0.025 kg/s

This research comparing thermoelectric's temperature between series circuit and parallel circuit by using the power supply the electricity to thermoelectric with 10 V and water flow rate pumps 3v is shown in Figure 7, the thermoelectric's circuit of parallel is higher temperature than the series circuit, which the highest temperature of parallel circuit is 75.88 oC and the lowest is 22.36 oC, and the highest temperature of series circuit is 43.96 oC and the lowest is 22.43 oC, so the different of hot side temperature is 31.92oC.

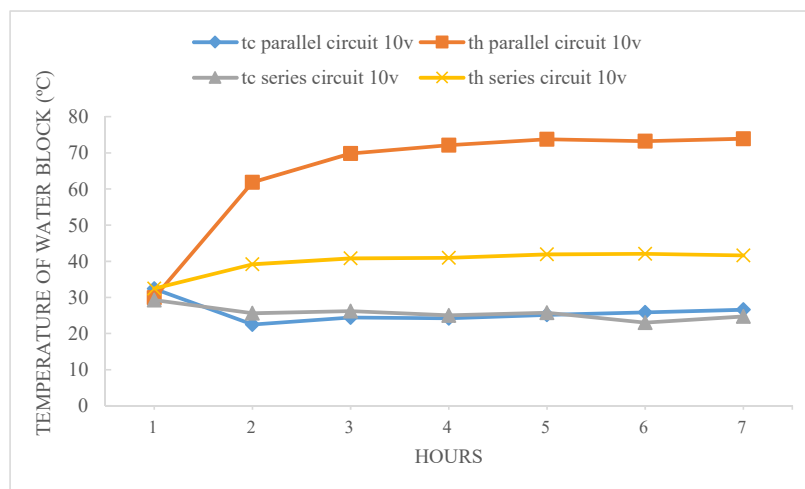


Figure 7. Temperature compare series circuit and parallel circuit the electrical voltage at 10 V, water flow rate in reservoir was 0.015 kg/s

The thermoelectric's circuit of parallel is higher temperature than the series circuit, which the highest temperature of parallel circuit is 73.74 °C and the lowest is 22.84 °C, and the highest temperature of series circuit is 45.91°C and the lowest is 24.15 °C, so the different of hot side temperature is 27.83 °C, the water flow rate 0.025 kg/s is shown in Figure 8.

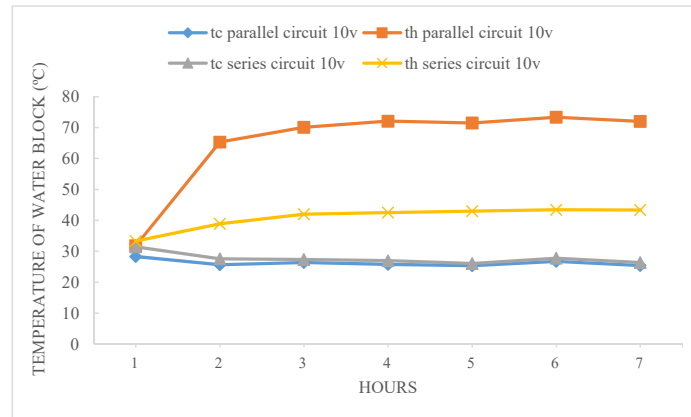


Figure 8. Temperature compare series circuit and parallel circuit the electrical voltage at 10 V, water flow rate in reservoir was 0.025 kg/s

3.3. Compare series circuit and parallel circuit the electrical voltage at 12 V, water flow rate in reservoir was 0.015 and 0.025 kg/s

This research comparing thermoelectric's temperature between the series circuit and parallel circuit by using the power to supply the electricity to thermoelectric with 12 V and water flow rate of 0.015 kg/s is shown in Figure 9. The thermoelectric's circuit of parallel is the higher temperature than the series circuit, which the highest temperature of the parallel circuit is 88.08 oC and the lowest is 22.75 oC, and the highest temperature of the series circuit is 47.17 oC and the lowest is 21.56 oC, so the different of hot side temperature is 40.91oC.

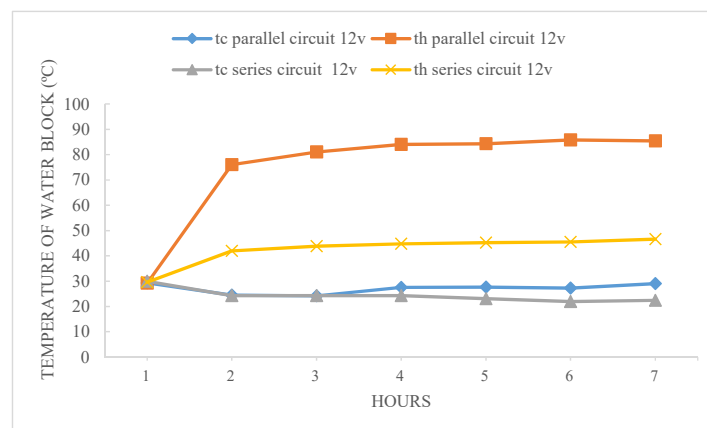


Figure 9. Temperature compare series circuit and parallel circuit the electrical voltage at 12 V, water flow rate in reservoir was 0.015 kg/s

The thermoelectric's circuit of parallel is higher temperature than the series circuit, which the highest temperature of parallel circuit is 81.84 oC and the lowest is 22.62 oC, and the highest temperature of series circuit is 47.87 oC and the lowest is 23.57 oC, so the different of hot side temperature is 33.97 oC, the water flow rate of 0.025 kg/s is shown in Figure 10.

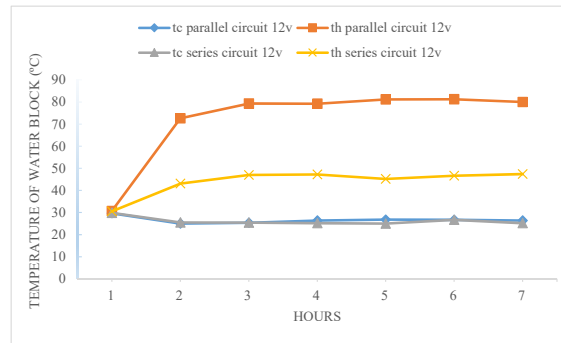


Figure 10. Temperature compare series circuit and parallel circuit the electrical voltage at 12 V, water flow rate in reservoir was 0.025 kg/s

4. CONCLUSION

The research, taking the electrical voltage at 8, 10 and 12 V to the series circuit of thermoelectric, and taking the electric from power supply to pumps, hot side with water flow rate in reservoir was 0.015 kg/s have the maximum temperature is 41.28 °C, 43.96 °C, 47.17 °C, and cold side the minimum temperature is 21.82 °C, 22.43 °C, 21.56 °C and water flow rate in reservoir was 0.025 kg/s have hot side the maximum temperature is 43.01 °C, 45.91 °C, 47.87 °C and cold side the minimum temperature is 24.91 °C, 24.15 °C, 23.57 °C.

The research, taking the electrical voltage at 12 V 8, 10 and 12 V to the parallel circuit of thermoelectric, and taking the electric from power supply to pumps, hot side with water flow rate in reservoir was 0.015 kg/s have the maximum temperature is 65.96 °C, 75.88 °C, 88.08 °C, and cold side the minimum temperature is 20.87 °C, 22.36 °C, 22.75 °C and water flow rate in reservoir was 0.025 kg/s have hot side the maximum temperature is 65.26 °C, 73.74 °C, 81.84 °C and cold side the minimum temperature is 21.24 °C, 22.84 °C, 22.62 °C.

So, the parallel circuit of thermoelectric can work better than the series circuit in hot side. The different temperature hot side of parallel circuit with the electrical voltage at 12 V 8v, 10v and 12 V, water flow rate in reservoir was 0.015 kg/s temperature average is 22.44 °C, 22.90 °C, 29.86 °C, and water flow rate in reservoir was 0.025 kg/s temperature average is 20.67 °C, 26.66 °C, 27.69 °C.

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