THE EFFECT OF BAFFLE SPIRAL
ON THE PERFORMANCE OF HEAT EXCHANGER

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Abstract. The application of heat exchanger still causes many problems. Research on the performance improvement of the heat exchanger is also conducted by adding baffle. This research is aimed at finding out the influence of spiral baffle on the performance of heat exchanger. Research is conducted by doing experiment. The heat exchanger used is the opposite flow type. The independent variable includes round and triangular springs with gap spacing of 1, 2 and 3 cm which are installed in the heat pipe. The flow rate of the water is varied by 100, 150, 200 and 250 ml / sec. The dependent variable includes the temperature of hot water (in and out) and the temperature of cold water (in and out). Temperature measurement is done by using a K type thermocouple every minute for 5 minutes. Discharge measurement is done by using flow meter and stopwatch. The results showed that there were effects of the spiral and water discharge variation on the rate of heat transfer. The phenomenon of water discharge is inversely proportional to the rate of temperature change. Maximum heat temperature displacement occurred at a variation of 1.5 cm with a flow rate of 31.25 was 1.44°. The minimum heat transfer temperature occurred at a variation of 0.5 cm with a flow rate of 38.46 was 0.82°. The maximum cold temperature heat transfer occurred at a variation of 1.5 cm with a flow rate of 31.25 was 0.52° and the minimum occurred at variation of 0.5 cm with a flow discharge of 38.46 was 0.14°.

Keywords : heat exchanger, baffle spiral, temperature difference, performance

1. INTRODUCTION

Heat exchanger is a means of transferring heat between fluid and other fluids through a separation wall [1]. Heat exchanger is an equipment used to exchange energy in the form of heat between fluids of different temperatures. Energy exchange can occur through direct or indirect contact. Fluid that exchanges energy can be a fluid with the same phase (liquid to liquid or gas to gas) or two different fluid phases [2]. Heat exchangers are very widely used in the world of industries such as power plants, oil refineries, chemical plants and petrochemicals, natural gas industry, refrigeration, etc. [3]. Pyrolysis technology in mahogany waste treatment [4].

In the application of heat exchanger, many of the problems were still arising, for example, the heat transferred has not been maximum yet, the occurrence of pressure decrease so that the pump becomes heavy in performance [5]. One of the characteristics of the heat exchanger performance is its effectiveness [2]. The efficiency increase of energy transfer needs a change of parameters, such as the changes the parameters of the fluid flow (turbulence), the changes energy receptor area, and the temperature conditioning of the working fluid [6].

Researches on heat exchanger have been conducted for various types, they are shell and tube types [7] [8] [2] [9], plate and frame types [10], and the opposite flow type [11] [6]. Researches on the performance increase of heat exchanger are also conducted by adding delta wing fin-shaped baffle [5], static angle [12] and fins in pipe [13] [12] [14] [6].

The main function of baffle is to direct the flow of fluid to the pipe evenly to gain the efficiency of greater heat transfer. Baffle types, cut sizes, and tilt angles affect the coefficient of heat transfer from a heat exchanger [14]. This is done as an effort to engineer the flow of the working fluid through the addition of heat transfer surface area [6].

Researches on heat exchanger that study about the effect of baffle have been conducted many times. Baffle angle also affects the distribution of temperature [15]. Shinde S, Pancha MH (2012) conducted research about performance comparison of heat exchangers with partial and complete baffle along the pipe. Shinde SK, et al (2012) conducted research about the performance increase of heat exchanger with baffle helix change. Vishwakarma M, Jain KK (2013) researched the performance of heat exchanger with helix baffle. Gu X, et al (2016) researched the heat transfer and flow resistance caused by baffles spreading along the pipe. Based on the background above, it can be conducted research on the addition of flow inhibitor to increase the performance of pipe type heat exchanger. This research will be conducted with a variation of inhibitors such as spring wire mounted in the middle of pipe axis.
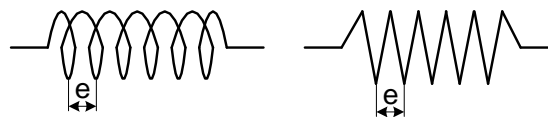
2. METHODS
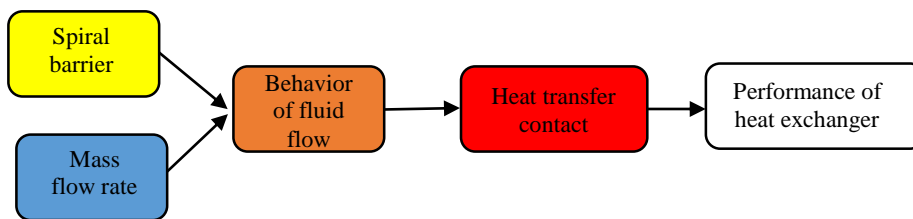
Picture 1. Mindset

Research variables
1) Independent variable:
   a. 3 variations of round spiral based on distance between the spirals (e): 1, 2, and 3 cm.
   b. 3 variations of triangle spiral based on peak distance (e): 1, 2, and 3 cm.
   c. Water discharge: 100, 150, 200, and 250 ml/sec.

Picture 2. Spiral scheme (mounted inside hot pipes)

2) Dependent variable: in and out water temperature (flow of heat and cold)
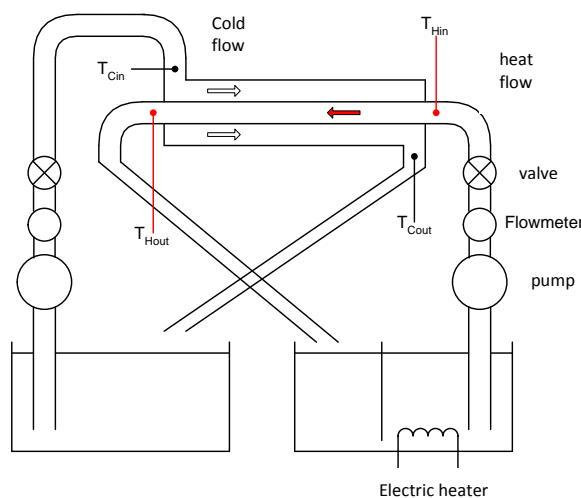
Picture 3. Device scheme

The average value of the data obtained was calculated. Temperature data was used to calculate the temperature difference occurred. Then, it was calculated the heat exchanger performance including range, the rate of heat transfer, and efficiency. The calculation results were showed in form of tables and graphics and analyzed based on the theory concerned.

3. RESULTS AND DISCUSSION

Picture 4. Device

The data obtained from the research through observation and experiment still needs to be processed. The processed data results in the average value and then it is tabulated in table.

Table 1. Temperature difference

| Debit (cm3/dt) | Δt | Spiral Barrier Variations | | | | | |
| | | 0,5 cm | | 1 cm | | 1,5 cm | |
		Δ H	Δ C	Δ H	Δ C	Δ H	Δ C
31.25	1	1.3	0.5	1.0	0.5	0.9	0.6
	2	0.9	0.3	1.4	0.6	1.3	0.5
	3	1.2	0.5	1.4	0.5	1.4	0.4
	4	1.2	0.5	1.5	0.5	1.7	0.5
	5	1.5	0.5	1.7	0.3	1.9	0.6
35.71	1	1.6	0.4	1.4	0.3	1.6	0.5
	2	1.1	0.2	1.2	0.4	1.0	0.2
	3	0.9	0.2	1.2	0.1	1.1	0.3
	4	0.9	0.3	1.2	0.4	1.4	0.4
	5	0.9	0.3	1.4	0.3	1.5	0.5
38.46	1	0.6	0.2	0.5	0.2	1.0	0.3
	2	0.9	0.1	0.9	0.2	0.8	0.2
	3	0.8	0.1	1.0	0.1	1.1	0.1
	4	1.0	0.1	1.0	0.2	1.0	0.3
	5	0.8	0.2	1.2	0.2	1.2	0.2

Table 2. Temperature average

| Debit (cm3/dt) | Spiral Barrier Variations | | | | | |
| | 0,5 cm | | 1 cm | | 1,5 cm | |
	Δ H	Δ C	Δ H	Δ C	Δ H	Δ C
31.25	1.22	0.46	1.40	0.48	1.44	0.52
35.71	1.08	0.28	1.28	0.30	1.32	0.38
38.46	0.82	0.14	0.92	0.18	1.02	0.22

Table 3. Heat transfer

| Debit (cm3/dt)	Spiral Barrier			Heat transfer, q (watt)		
	0,5 cm	1 cm	1,5 cm	0,5 cm	1 cm	1,5 cm
31.25	0.78	0.86	0.90	24.35	26.86	28.23
35.71	0.59	0.68	0.75	21.17	24.12	26.96
38.46	0.38	0.45	0.52	14.01	17.45	20.06

The Graphic of the Research Result
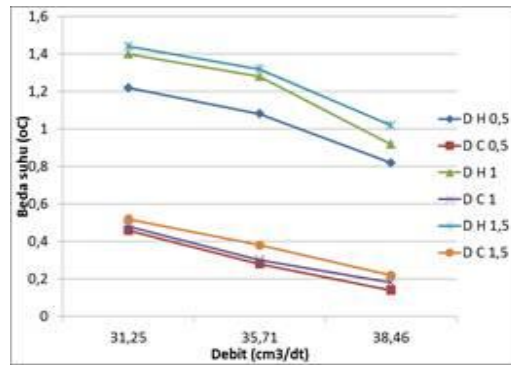
Picture 5. Graphic of temperature difference

The graphic above shows that the temperature differences tend to decrease with the increasing discharge variation. This is caused by the heat transfer that occurred when the fluids flowed through the spiral groove; the longer the spiral groove distance, the greater the heat transfer. If the transfer is greater, the effectiveness of the transfer will be greater. The maximum temperature difference occurred in a variation of hot temperature difference in discharge of 31,25 cm^3/sec and variation of spiral baffle of 1,5 cm was 1,44^{0}C, meanwhile the minimum temperature difference occurred in cold temperature difference, discharge variation of 38,46 cm^3/sec, variation of spiral baffle 0,5 cm was 0,14^{0}C

Graphic of heat transfer
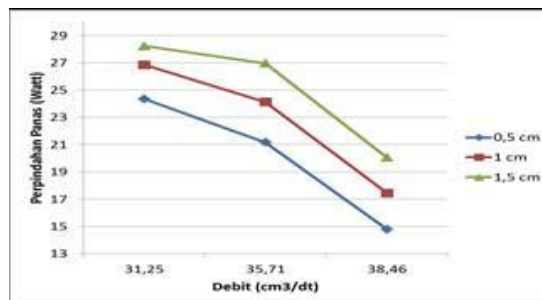
Picture 6. Graphic of heat transfer

The graphic above shows that the temperature difference tends to decrease if the discharge becomes greater. It also shows that the heat transfer of 1,5 cm spiral variation tends to be greater than the 1 and 0,5 cm spiral variations. This is because in 1,5 cm spiral, the flow of the fluid through the pipe tend to consume longer time and becomes longer, which means that the heat transfer through spiral becomes better. The minimum transfer occurred in 0,5 cm variation with the heat transfer of 14,01 watt, this is because in 0,5 cm spiral, it is the fluid touch time with the short spiral so the heat transfer tends to decrease compared to 1,5 and 1 cm variations. Hot temperature difference is 1,9 degree with the discharge of 31,25 and spiral baffle variant of 1,5 cm. Minimum temperature difference occurred in the cold temperature difference of 0,1 degree, with discharge of 38,46 and spiral baffle variant of 0,5 cm.

Temperature difference

The graphics of the result show that the temperature difference tends to decrease if the discharge is greater. This is because when the discharge is greater, the water flow will be greater as well, which means that the hat transfer from hot to cold fluid and vice versa will be shorter, thus the temperature difference becomes small. The graphics show that the temperature difference tends to increase if the discharge gets weaker, this is because in the discharge with low flow, the water flow becomes weak and it means that the fluid movement becomes laminate so the fluid touch time with the spiral might become longer, the heat transfer becomes greater, and the temperature difference becomes higher as well.

The biggest comparison of hot temperature difference in spiral variants is 1,5 cm. This is because the fluid touch time between hot and cold fluid is longer. The temperature comparison based on spiral variants shows that the longer the spiral distance, the greater the heat transfer rate. It means that then temperature difference becomes higher, this is because the touch time between fluid and spiral is longer.

Heat transfer

The graphics of the result show that the heat transfer tends to decrease if the discharge is greater. This is because water discharge with the large flow is very fast so the heat transfer becomes smaller. Meanwhile the graphics also show that the heat transfer for the 1,5 cm spiral variant tends to be bigger than the 1 and 0,5 cm variants. This is because for the variants of 0,5 cm and 1 cm, the distance between the spirals is too tight so the resistance becomes small, so the flow of the fluid is not really affected by those two variants. Unlike the 1,5 cm spiral, for these variants, the fluid has big resistance so relatively large heat transfer occurs in case of these variants.

4. CONCLUSION

Based on the description of the results and discussion above, it can be concluded that the variation of the 1.5 cm spiral barrier affects the heat transfer performance of the heat exchanger, the spiral length and the amount of discharge also influence the heat transfer rate. Heat transfer is said to be good when the temperature difference resulting from the displacement is high.

5. ACKNOWLEDGEMENT

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