Decrease in Oil Cooler Pressure of Counter Flow with Variation Static Twisted Tape Length

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Abstract

One way for increasing the rate of heat transfer is by creating a simple wake in a fluid flow by placing a barrier on or screw -shaped fluid flow is called the static twisted tape . The use of twisted tape static tube mounted in the heat exchanger is to increase the speed of the working fluid . With the increasing speed of the working fluid will greater of reynold numbers , so that the rate of heat transfer and more effectiveness . This research aims to determine the effect of variations in the length of twisted tape static pressure drop in counter flow type oil cooler . The method used is an experimental research . The data was done using a thermocouple temperature and the value displayed by a digital thermometer . This research uses independent variable discharge of hot oil (8 l / min ; 9 l / min , 10 l / min , 11 l / min ; 12 l / min) , uncontrolled variable is static length twisted tape (1000 mm , 800 mm , 600 mm) and the dependent variable the rate of heat transfer , pressure drop and effectiveness .

1. Introduction

Heat exchanger or heat exchanger is a tool that is widely used in the industrial world. This tool is used to increase or decrease temperature of the fluid that is used for various purposes and various processes that occur in the industrial world. In planning requires knowledge of the science of heat transfer in order to do the engineering to a heat exchanger to obtain a heat exchanger designs that have high efficacy and relatively smaller dimensions ahirnya that can save energy and reduce production costs.

There are various ways to increase the effectiveness of a heat exchanger such as by increasing the convective heat transfer coefficient, increasing the surface area of the heat exchanger, and increase the temperature difference, the heat exchanger applications are usually planned to move the work to heat up to temperatures that have been determined so that the business to do is increase the convective heat transfer coefficient and increase surface area of heat exchanger.

Usage twisted tape static tube mounted in the heat exchanger is to increase the speed of the working fluid. With the increasing speed of the working fluid will greater of reynold numbers, so that the rate of heat transfer and greater effectiveness.

2. Literature

Watcharin, Smith and Pongjet (2006) conducted an experimental research on the effect of installation the twisted tape insert and flow friction characteristics in the two concentric pipes on the Heat Exchanger. The results of the experiments showed an increase in heat transfer rate of the twisted-tape inserts was found to be greatly increased because it is influenced by the vortex.

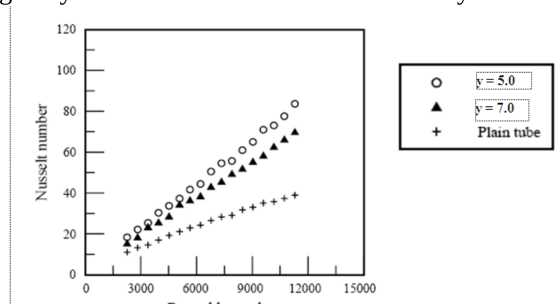

Figure 2.1 The relationship twist ratio on Nusselt number at the twisted tape insertion on heat transfers.

Arifin, Mechanical Engineering, of brawijaya university (2008) conducted a research of the effect of variation in wire helical turbulator on the rate of heat

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transfer and pressure drop (pressure drop) at counterflow heat exchanger, the research carried out by varying the wire of 0.5 mm helical turbulator, 1 mm and 1.4 mm, the tool is in the attach to the walls of the inner tube of the heat exchanger in the hot water flow.
The results of these studies that the presence of helical turbulator cause the rate of heat transfer that occurs tends to increase compared to without turbulator, the larger the wire diameter helical turbulator mounted the heat transfer rate will increase. Besides, the increase in pressure drop is directly proportional to the large helical turbulator wire and flow rate.

2.1 Heat Energy

Heat energy is a form of energy that can moved from one system to another system as a result of differences in temperature at steady state of fluid flow in a channel where there is one inlet and one outlet then the mass flow rate incoming fluid will be equal to the mass flow rate of fluid out, if the fluid does not do nothing then the amount of heat energy that is transferred will be equal to the change in the energy contained in the system.

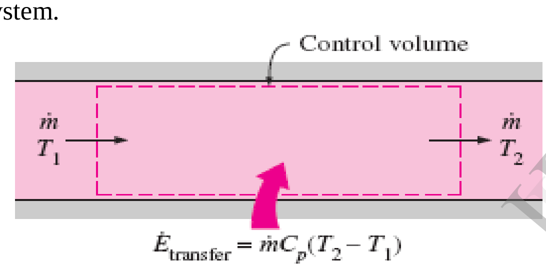

Figure 2.2 Transfers of heat energy at a system with volume control

The magnitude of the rate of heat energy at the system can be expressed as follows

$$\dot{Q} = \dot{m}C_p \Delta T \quad (2\text{-}1)$$

2.2 Heat Transfers

Heat transfer can be defined as the transfer of energy from one system to another as a result of differences in temperature, this energy transfer always occurs from a high-temperature system to another system at a lower temperature and will stop after the two systems reach the same temperature, the temperature difference is the main requirement for the transfer of heat, if both systems have the same temperature then there will be no heat transfer at both systems.
Conduction heat transfer is defined as a process of heat transfer through layers of solid objects. Conduction heat transfer can occur either at solids, liquids or gases, liquids and gases In heat transfer conduction occurs because of the collision (collision) as well as the diffusion of at molecules during undergo random motion due to increase in temperature.

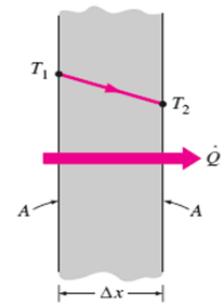

Figure 2.3 The conduction transfer of heat

The rate of heat transfer by conduction proposed JBJ Fourier in 1822ie the magnitude of the rate of conduction heat transfer surface area proporsioanal passed against heat, temperature differences and thermal conductivity of the material, but inversely proportional to the thickness of the surface traversed by the heat.

$$\dot{Q}_{cond} = -kA\frac{(T_2 - T_1)}{\Delta x} \quad (2\text{-}2)$$

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Convection heat transfer is a mechanism of heat transfer through a fluid layer , either liquid or gas fluid . The faster the fluid motion , the greater the rate of heat transfer, On the basis of a process of cooling the hot beams of cold air is blown then the convection heat transfer process will take place in several stages , the first heat energy will flow by conduction from the surface of the solid particles to adjacent fluid layer , then this energy will be carried from the solid surface through convection mechanism , there are two processes that occur simultaneously , namely a combination of conduction effects in the fluid due to the random movement of particles inter -occurring microscopic fluid so that the fluid particles has a higher energy will transfer some of its energy to the fluid particles that have a lower energy , and the presence of macroscopic fluid motion that will replace the fluid that has been hot around the solid surface with cold fluid.

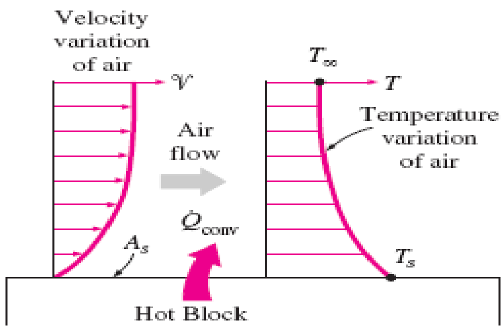

Figure 2.4 The convection transfer of heat from a hot surface cold air blown

2.3 The Flow analysis.

Laminar is a flow that moves in layers with regular movement (highly-ordered motion), each fluid particle moves follow a certain path and remain in each layer with a regular order without mutual precede that laminar flow has streamlined are not intermingled, the fluid velocity can vary from streamlined with each other.

Heat transfer and momentum occurs in the molecular conduction between the fluid and the fluid to the wall, there is no mixing currents that transport the energy stored in the fluid particles crossing the lines flow, laminar to turbulent flow tendencies can still be muted by viscous forces which provide constraints on the relative motion of fluid layers.

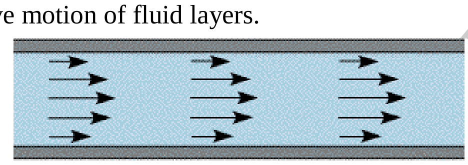

Figure 2.5 The Laminar Flows

Turbulent is the flow of the fluid particles move randomly with very fast (highly-disordered motion) with a fluctuating velocity.

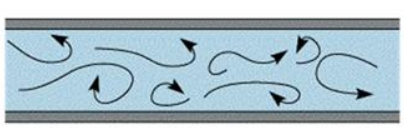

Figure 2.6 The Turbulance flows

2.4 Heat Exchanger

is a tool that serve to transfer heat between two fluids have different temperatures and can keep the two fluids do not mix. Under the direction of flow heat exchanger can be divided into three, ie the parallel flow, counter flow and cross flow.

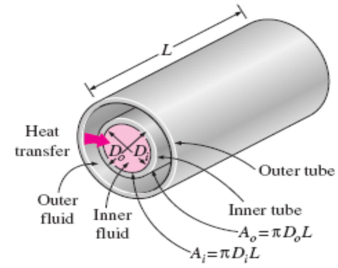

Figure 2.7 Concentric double tube heat exchanger

Magnitude of the rate of heat transfer in a heat exchanger can be determined through the following equation:

$$\dot{Q} = U.A.\Delta T_m \qquad (2\text{-}3)$$

2.5 Static Twisted Tape

Static single twisted tape mounted in line with the pipe axis (inner tube) where the point coincides with the center of the pipe in center point of the Static twisted tape. This tool is a barrier to fluid flow in a pipe that is used to change the direction of orientation into a swirling fluid flow (vortex) as well as if more and more directed towards the pipe wall due to the centrifugal force of fluid flow along the cross-section of the tool, causing wake that changed the flow of fluid into the random (turbulent) in order to make the most of the fluid particles can be mixed with each other and interact with the pipe wall (the inner tube) to transfered heat.

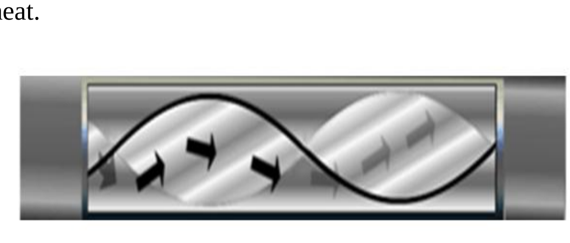

Figure 2.7 Static Twisted Tape

3. Method of Research

Three kinds of variables that used are :

1. The independent variable is a variable whose value is determined freely by researchers prior to conducting research. In this research the independent variables used are, discharge of hot fluid (oil) on the pipe varied from 8 liters / min up to 12 litter / min with each increment 1 litter / min.
2. The dependent variable is the outcome variable that magnitude can not be determined by the researcher, the value of this variable depends on the value of the independent variable. Dependent variables were observed

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in this research are, the rate of heat transfer, the pressure drop, and effectiveness.

3. Controlled variable is a variable that is determined by the researcher, and conditioned its constant value, there are static length twisted tape of 600mm, 800mm, and 1000mm.

4. Data And Analysis

The results of testing the effect of the static length of twisted tape on the pressure drop in the heat exchanger counter flow type.

1. Data flow testing of heat exchanger without mounting opposite static twisted tape shown in Table 4.1

Table 4.1 Data flow test results without barrier

No	acted fluid (oli)				acting fluid (air)				ΔP (Pa)	ε (%)	q (Watt)	U (W/m2oC)
	Q (L/mnt)	Tin (oC)	Tout (oC)	q (Watt)	Q (L/mnt)	Tin (oC)	Tout (oC)	q (Watt)				
1	8	50	45,33	794,31	16	24,17	24,83	740,28	217,36	20,93	767,29	788,06
2	9	50	45,33	893,60	16	24,00	24,83	925,37	222,86	20,79	909,48	907,16
3	10	50	45,00	1062,96	16	24,00	25,00	1110,42	231,14	22,28	1086,69	1076,21
4	11	50	44,50	1284,65	16	24,17	25,33	1295,39	244,95	24,67	1290,02	1287,34
5	12	50	44,17	1485,19	16	24,33	25,67	1480,34	253,23	26,34	1482,77	1485,21

2. Data flow testing of heat exchanger opposite the mounting length 600 mm static twisted tape shown in table 4.2

Table 4.2 Data from the test with a length of 600 mm

No	acted fluid (oli)				acting fluid (air)				ΔP (Pa)	ε (%)	q (Watt)	U (W/m2oC)
	Q (L/mnt)	Tin (ºC)	Tout (ºC)	q (Watt)	Q (L/mnt)	Tin (ºC)	Tout (ºC)	q (Watt)				
1	8	50	41,17	1488,59	16	24,00	25,33	1467,69	507,01	39,43	1478,14	1557,3066
2	9	50	40,83	1736,46	16	24,17	25,67	1651,44	567,69	41,19	1693,95	1804,6808
3	10	50	40,83	1929,40	16	24,17	25,83	1835,84	622,81	41,19	1882,62	2153,0342
4	11	50	40,33	2235,40	16	24,33	26,33	2203,85	667,02	43,73	2219,63	2635,1863
5	12	50	40,17	2479,67	16	24,50	26,67	2387,43	713,92	44,77	2433,55	2976,3344

3. Data flow testing of heat exchanger opposite the mounting length 800 mm static twisted tape shown in Table 4.3

Table 4.3 Data from the test with a length of 800 mm

No	acted fluid (oli)				acting fluid (air)				ΔP (Pa)	ε (%)	q (Watt)	U (W/m2oC)
	Q (L/mnt)	Tin (ºC)	Tout (ºC)	q (Watt)	Q (L/mnt)	Tin (ºC)	Tout (ºC)	q (Watt)				
1	8	50	40,33	1704,31	16	24,00	25,50	1652,12	609,14	45,87	1678,21	1728,8485
2	9	50	39,83	2013,06	16	24,00	25,83	2020,93	741,57	48,26	2016,99	2085,6307
3	10	50	39,17	2377,94	16	24,17	26,33	2388,93	799,66	51,79	2383,43	2511,0901
4	11	50	39,17	2615,73	16	24,33	26,67	2572,51	810,69	52,12	2594,12	2763,9572
5	12	50	38,83	2937,94	16	24,50	27,17	2940,30	835,60	54,10	2939,12	3180,1811

4. Data flow testing of heat exchanger as opposed to the installation of a static length 1000 mm twisted tape are shown in Table 4.4

Table 4.4 Data from the test with a length of 1000 mm

No	acted fluid (oli)				acting fluid (air)				ΔP (Pa)	ε (%)	q (Watt)	U (W/m2oC)
	Q (L/mnt)	Tin (ºC)	Tout (ºC)	q (Watt)	Q (L/mnt)	Tin (ºC)	Tout (ºC)	q (Watt)				
1	8	50	37,83	2126,65	16	24,17	26,17	2204,58	979,35	58,23	2165,62	2281,6077
2	9	50	37,83	2392,49	16	24,17	26,33	2388,93	995,91	58,23	2390,71	2546,9879
3	10	50	37,67	2693,17	16	25,00	27,50	2753,63	1015,28	61,01	2723,40	3114,5892
4	11	50	36,83	3153,51	16	25,17	28,00	3121,23	1076,29	65,62	3137,37	3724,7473
5	12	50	36,00	3647,30	16	24,83	28,17	3675,49	1106,98	68,90	3661,40	4478,0439

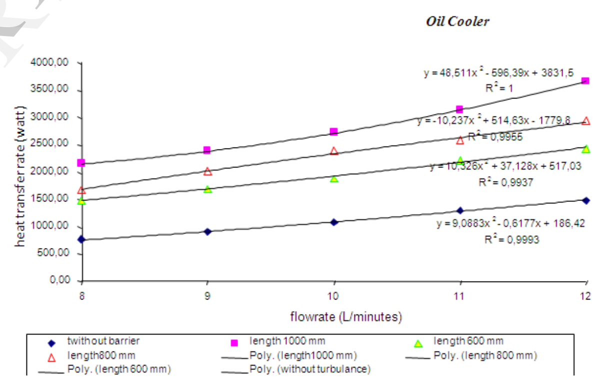

Figure 4.1 Graph of term effects variation static twisted tape and flows fluid pressure decline against oil heat

relationships between the variation in the length of twisted tape to static pressure drop (pressure drop) in the pipe (inner tube) caused by the presence of twisted tape static and without static twisted mounting tape in each variation of hot fluid discharge. In figure 4.1 it can be seen that the pressure drop is directly proportional to the length of the growing static discharge increases the twisted tape and hot oil.

The decrease in pressure (pressure drop) always occurs at the smallest heat exchanger testing without twisted tape static installation, this occurs because of the pressure drop generated only due to major losses. As a result, the value will always be smaller than the test installation of a heat exchanger with twisted tape static pressure losses dropnya influenced by minor and major losses.

While the growing influence of the length of the twisted tape to static pressure drop caused by increasing the loss coefficient in the pipe wall. With increasing length of twisted tape resulting static fluid flow rate thus increasing friction with the pipe walls as well as the static twisted tape will also increase, the pressure drop that occurs in the channel will also increase.

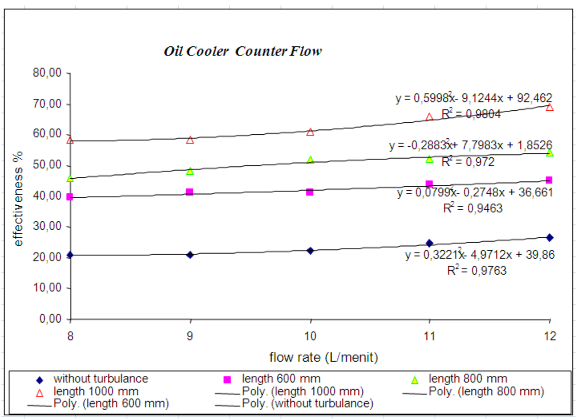

Figure 4.2 Graph term effects of variation twisted tape and fluid oil heta against flow rate effectiveness

relationships between the variation of the static length of twisted tape on the effectiveness of each variation on fluid flow of hot oil. At the same flowrate variation with static mounting twisted tape causes an increase in the effectiveness of a heat exchanger as compared to non-installation of static twisted tape.

Greater fluid flowrate resulted in increasing the effectiveness of each test with a variety of static length twisted tape. It is caused by an increase in the fluid flow fluid motion and random movement toward radial fluid will result in most of the fluid particles will be able to mix and interact with each other to further energy to transfer heat to the fluid particles on the surface of the other and the media. Based on these low temperatures causing heat more effectively in a fluid to transfer heat. The increasing difference in the effectiveness of the hot fluid temperature heat exchanger will increase.

5. Conclusion

Based on the graph shows that the variation of the static length of twisted tape and hot oil fluid flow variations have a significant effect on the pressure drop (pressure drop) in the counter flow type oil cooler can be concluded that it:

1. The greater static length twisted tape is mounted on the inner tube of heat exchanger and by the increasing flow of hot fluid flow, in each test with a variation of fluid flow heat the same oil will increase the pressure drop, and effectiveness.
2. Static length twisted tape is best obtained in the static length of twisted tape 1000 mm, where the heat transfer rate of 3661.40 watts and cause a decrease in pressure of 1106.98 Pa.

6. References

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