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Heating System Performance in Oil Cooler Capacity Testing Design

Handini Novita Sari[1,*] I Made Arsana[1] Tri Darma Setiawan[1]

Novi Sukma Drastiawati[1] Mochamad Cholik[1] Soeryanto[1]

[1] *Mechanical Engineering Department, Universitas Negeri Surabaya, Surabaya, Indonesia*
[*] *Corresponding author. Email: handinisari@unesa.ac.id*

ABSTRACT
Cooling a vehicle is a very important thing, the goal is not to overheat the engine. Along with advances in vehicle engine cooling technology, there are several types such as radiators and oil coolers, but studies that explain engine cooling, especially on oil coolers, are still lacking. In this study, we will discuss the planning of the heating system in the design of the oil cooler capacity tester. The testing process is carried out by measuring using temperatures of 40˚C, 50˚C, 60˚C, 70˚C, 80˚C, 90˚C and an outside temperature (room temperature) of T∞ = 300C with a pressure of 1 atm and a heating system that using 2 heaters with 600 watts of power, taking 3 times with a time lag of 1 day. Based on the results of testing the heating system on the oil cooler capacity tester, it can increase the temperature and takes time with the following data: the first 40˚ temperature increase takes 4 minutes 48 seconds, the second 50˚ temperature increase takes 3 minutes 18 seconds, the third temperature rise to 60˚ takes 3 minutes 40 seconds, the fourth temperature rise to 70˚ takes 3 minutes 25 seconds, the fifth temperature rise to 80˚ takes 3 minutes 02 seconds, the sixth temperature rise to 90˚ takes 3 minute 04 seconds. The results that have been achieved in terms of heating the fluid in the tank can heat well up to a temperature of 90˚ and there are no problems whatsoever.

Keywords: *Heater, Heating System, Oilcooler, Temperature, Capacity.*

1. INTRODUCTION

The development of Science and Technology is growing rapidly at this time, both in terms of technological progress and the diversity of products produced. In the development of motor vehicles requires a better cooling system to cool the engine so that overheating does not occur, along with advances in vehicle engine cooling technology of several types such as radiators and oil coolers. Oil cooler is one component or engine parts that has a function to cool hot oil because the oil circulates in the lubrication or lubrication system to lubricate rotating or moving workpieces [3]. This oil cooler serves to support engine cooling performance on the engine to be maintained [2]. However, in this case studies that explain engine cooling, especially the oil cooler, are still lacking.

Based on these conditions and a survey that has been conducted at the Laboratory of Mechanical Engineering Heat Transfer, State University of Surabaya, the learning process in the Heat Transfer course has not been effective because the current learning media is not yet complete. Learning media is a device that can provide easy learning for students so that students can understand the material in the course. Therefore, learning media is needed that can support student learning to achieve a perfect and acceptable level of understanding in the course, namely by designing a heating system in the design of the oil cooler capacity tester.

This oil cooler cooling system is an engine cooling system that functions to reduce the temperature of the lubricating oil contained in the cylinder and lower the engine temperature to working temperature [1]. The design of the heating system on the oil cooler which is planned in this study aims to help the process of heating the fluid used to reach the set temperature which will be used as a factor in the oil cooler capacity test trainer. Where the heating system in the motor engine is initially heated by when it rotates, while in this design it uses a heater with a temperature that can be adjusted easily so that it can be understood by all students or readers in using oil coolers and can make it easier for lecturers to explain to students. Students about this oil cooler.

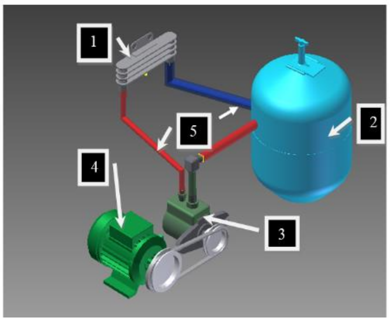

Figure 1 Flow schematic in design build oil cooler capacity tester.

2. METHOD

This research method uses descriptive analysis method, which is a way to formulate and interpret existing data so that it has a clear picture. The type of research is experimental research, where the researcher intentionally gives treatment (certain behavior) to research subjects in order to get an event or situation to be studied in this study, namely an oil cooler capacity tester to find out some of the data in the study. The following is a schematic of the experimental test equipment used in this study.

Information:

1. Oil cooler
2. Fluid Tank
3. Pump
4. Electric Motor
5. Pipe

The heating system is a system that converts energy that comes from electricity as in into a heat energy as out. The fluid tank design:

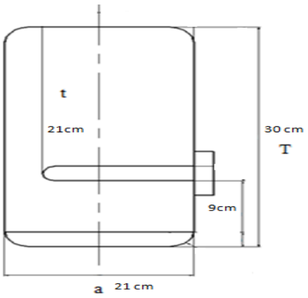

Figure 2 Fluid tank design.

Information:

1. Height (H) = 30 cm
2. Oil capacity = 7 liters
3. Height between heater to top surface (t) = 21 cm
4. Base diameter (a) 21 cm

Heater is an electric device that can heat water easily and quickly. The element's heat source is obtained from a wire that has a high electrical resistance (Resistance Wire), so that the wire does not melt or burn when it is hot.

Figure 3 Heater element (17).

Specification:

1. Power = 600 watts
2. Input voltage = 220 V
3. Brand = lasco
4. Made = Germany

Thermocontrol is an electrical component or spare part that can disconnect and connect electric current automatically by detecting the temperature on a medium to keep it at the set temperature.

Figure 4 Thermocontrol.

Specification:

1. Type = Digital thermocontrol type PXR9
2. Brand = Fuji, Japan
3. Range = 0 to 10000C
4. Supply Voltage= AC 100/240V

3. RESULTS AND DISCUSSIONS

3.1. Design Results

This heating system aims to heat the fluid in the fluid tank by using a heater as a heater which will be given orders by the thermocontrol as an information provider and can also prevent overheating of the heater in the tank. To find out the amount of heat released by the heater, it will be read by a thermocouple whose function is to determine the value of the working temperature carried out by the thermocontrol to the heater. The following is an overview of the oil cooler capacity tester:

3.2. Testing Results

The test was carried out by measuring the ambient room temperature of 30˚C and adjusting the valve on the flowmeter for a fluid flow rate of 0.6 L/m and with the help of wind (forced convection) of 32 Km/h, and the temperature of the test was carried out with various variations. namely 40˚C, 50˚C, 60˚C, 70˚C, 80˚C, 90˚C with a pressure of 1 atm, data collection was carried out 3 times with a data collection interval of 1 day so that the components in it can work properly. In the next data collection, here are the results when taking data with different temperature variations, the results of which are test data in the form of a table list.

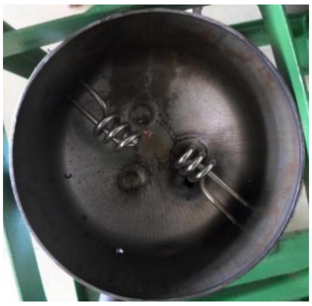

Figure 5 Design of the heating system.

Figure 6 Oil cooler capacity test.

Table 1 Fluid temperature at 40˚C in the tank.

Temp (0C)	Time (mins)
30˚	0
31˚	1
32˚	0.55
33˚	0.48
34˚	1.02
35˚	0.4
36˚	0.3
37˚	0.4
38˚	0.3
39˚	0.35
40˚	0.46
41˚	0.3
42˚	0.35
43˚	0.38
40˚	5.4
Total time	12.39

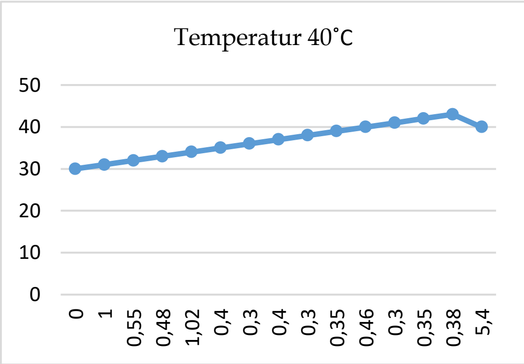

Figure 7 Relationship of time to temperature when installing thermocontrol temperature 40˚C.

The work of the heater in heating the fluid at a temperature of 30˚ to a temperature of 40 takes as much as 4 minutes 48 seconds then for the steady temperature time (back to the set temperature) from a temperature of 43˚ to a temperature of 40˚ it takes 5 minutes 40 seconds. In the oil cooler there are conditions of hot behavior and the results can be seen in the following table:

Table 2 Fluid temperature at 40˚ in the oil cooler.

T_{in}	T_{out}	∆ T	P_{in}	P_{out}	M
40˚	27˚	23˚	0	0	0.6 LPM

Table 3 Fluid temperature at 50˚C in the tank.

Temp (⁰C)	Time (mins)
40˚	0
41˚	0.2
42˚	0.33
43˚	0.38
44˚	0.34
45˚	0.39
46˚	0.4
47˚	0.44
48˚	0.42
49˚	0.4
50˚	0.44
51˚	0.45
52˚	0.43
53˚	0.39
50˚	5.8
Total time	10.81

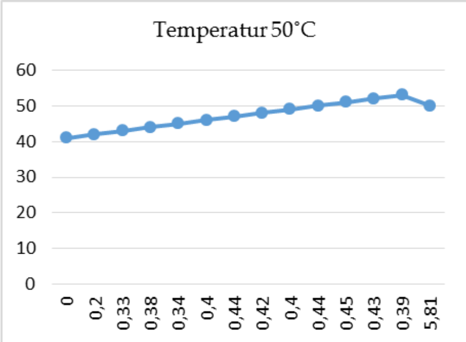

Figure 8 Relationship of time to temperature when installing thermocontrol temperature 50˚C.

A temperature rise of 50˚ which comes from a temperature of 40˚ takes as much as 3 minutes 18 seconds for the process of heating the fluid in the tank. Then for the steady time back from 53˚ to 50˚ it takes 5 minutes 8 seconds. The oil cooler gets the heat behavior in the table as follows:

Table 4 Fluid temperature at 50˚ in the oil cooler.

T_{in}	T_{out}	∆ T	P_{in}	P_{out}	M
50˚	37˚	13˚	0	0	0.6 LPM

Table 5 Fluid temperature at 60˚C in the tank.

Temp (^{0}C)	Time (mins)
50˚	0
51˚	0.4
52˚	0.43
53˚	0.42
54˚	0.45
55˚	0.49
56˚	0.45
57˚	0.47
58˚	0.5
59˚	0.52
60˚	0.45
61˚	0.5
62˚	0.54
63˚	0.55
60˚	6.4
Total time	12.03

The increase in temperature of 60˚ which comes from a temperature of 50˚ takes 3 minutes 40 seconds for the process of heating the fluid in the tank. Then for the steady time back from 63˚ to 60˚ it takes 6 minutes 4 seconds.

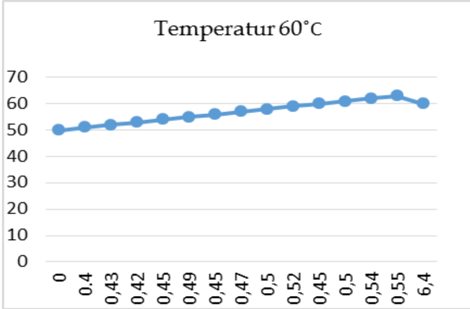

Figure 9 Relationship of time to temperature when installing thermocontrol temperature 60˚C.

The oil cooler gets the heat behavior in the table as follows:

Table 6 Fluid temperature at 60˚ in the oil cooler.

T_{in}	T_{out}	∆ T	P_{in}	P_{out}	M
60˚	46.6˚	13,4˚	0	0	0.6 LPM

Table 7. Fluid temperature at 70˚c in the tank

Temp (^{0}C)	Time (mins)
60˚	0
61˚	0.3
62˚	0.32
63˚	0.35
64˚	0.38
65˚	0.38
66˚	0.4
67˚	0.41
68˚	0.43
69˚	0.45
70˚	0.39
71˚	0.4
72˚	0.42
73˚	0.4
70˚	7.6
Total time	12.63

The temperature increase of 70˚ which comes from a temperature of 60˚ takes as much as 3 minutes 25 seconds for the process of heating the fluid in the tank. Then for the steady time back from 73˚ to 70˚ it takes 7 minutes 6 seconds.

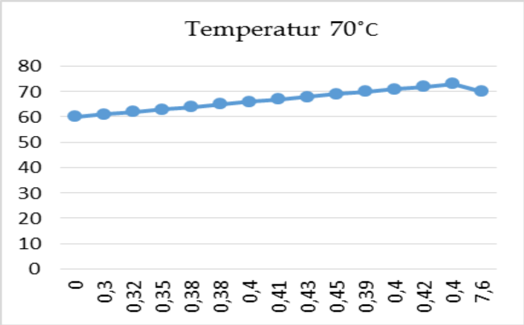

Figure 10 Relationship of time to temperature when installing thermocontrol temperature 70˚C.

The oil cooler gets the heat behavior in the table as follows:

Table 8 Fluid temperature at 70˚ in the oil cooler.

T_{in}	T_{out}	∆ T	P_{in}	P_{out}	M
70˚	52˚	18˚	0	0	0,6 LPM

Table 9 Fluid temperature at 80˚c in the tank.

Temp (^{0}C)	Time (mins)
70˚	0
71˚	0.27
72˚	0.29
73˚	0.35
74˚	0.32
75˚	0.35
76˚	0.35
77˚	0.36
78˚	0.36
79˚	0.38
80˚	0.37
81˚	0.4
82˚	0.44
83˚	0.45
80˚	8.8
Total time	13.5

Temperature rise of 80˚ which comes from a temperature of 70˚ takes 3 minutes 02 seconds for the process of heating the fluid in the tank. Then for the steady time back from 83˚ to 80˚ it takes 8 minutes and 8 seconds.

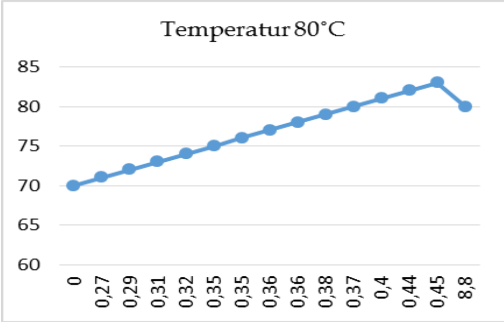

Figure 11 Relationship of time to temperature when installing thermocontrol temperature 80˚C.

The oil cooler gets the heat behavior in the table as follows:

Table 10. Fluid temperature at 80˚ in the oil cooler.

T_{in}	T_{out}	∆ T	P_{in}	P_{out}	M
80˚	63˚	17˚	0	0	0.6L/m

Table 11 Fluid temperature at 80˚c in the tank.

Temp (^{0}C)	Time (mins)
80˚	0
81˚	0.29
82˚	0.3
83˚	0.32
84˚	0.33
85˚	0.35
86˚	0.34
87˚	0.37
88˚	0.38
89˚	0.38
90˚	0.42
91˚	0.42
92˚	0.41
93˚	0.4
90˚	10.5
Total time	15.21

An increase in temperature of 90˚ which comes from a temperature of 80˚ takes 3 minutes 04 seconds for the process of heating the fluid in the tank. Then for the steady time back from 93˚ to 90˚ it takes 10 minutes 5 seconds.

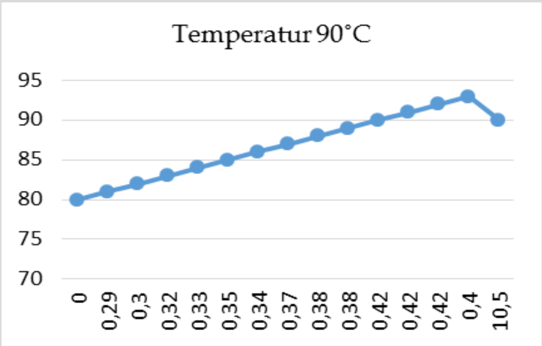

Figure 12 Relationship of time to temperature when installing thermocontrol temperature 90˚C.

The oil cooler gets the heat behavior in the table as follows:

Table 12 Fluid temperature behavior at 80˚ in the oil cooler.

T_{in}	T_{out}	∆ T	P_{in}	P_{out}	M
90˚	75˚	15˚	0	0	0.6 LPM

Based on several tests, it can be seen from the data table that it is noted that the temperature change increases with time to get to the SV (Setting Value) point that has been done on the thermocontrol.

3.3. Discussion

In increasing the temperature it will take time as a process to raise the temperature and maintain the temperature so that the increase in temperature greatly affects the time required in the process of increasing the temperature.

In the table that has been entered, the heat required during the test can be calculated starting from temperatures of 40˚, 50˚, 60˚, 70˚, 80˚, 90˚ as follows formula:

$$Q = m \times Cp \times \Delta T \quad (4)$$

Information:

Q = The amount of heat that (J/s)

m = Mass of substance (Kg)

Cp = specific heat of substance (J/ Kg .°C))

∆T = Increase in temperature (˚C)

Calculation:

The volume of fluid in the fluid tank is 7 liters, the fluid used is thermo oil 22 which has a specific heat of substance of 2000 J⁄kg.°C, a temperature starting from 30˚ (room temperature) to 90˚. The density of thermo oil 22 is 0.8724 kg⁄liter and the heater power of 300 watts, and there are two heater. How much time needed?

Answer :

ρ = m/v

m = 0,8724 kg/liter x 7 liter = 6,1068 kg

So it is known that the mass of the substance is 6.1068 Kg and the value of Q is the heater power of 600 J/s (1 J/s = 1 watt), the amount of time can be found

$Q = m^o \text{ x } C_p \text{ x } \Delta T$

$Q = \frac{m}{t} \text{ x } C_p \text{ x } (t_{akhir} - t_{awal})$

$600 \text{ Joule} = \frac{6,1068\ Kg}{t} \text{ x } 2000 \text{ J/kg oC x } (90 - 30)^\circ C$

$$t = \frac{6,1068\ Kg\ x\ 2000\ {}^{J}/_{Kg\ .\ ^\circ C}\ x\ 60\ ^\circ C}{600\ Joule}$$

= 1221.36 s

The time required from a temperature of 30˚ to 90˚ takes 1221.36 seconds according to the theory and formula but when testing the longest temperature is 1250 seconds, so this oil cooler capacity tester has exceeded the temperature calculated using the formula.

4. CONCLUSION

1. The results of the heating system design on the oil cooler capacity tester trainer consisting of the following heating system components, the first fluid tank with a base diameter of 71 cm, and a height of 30 cm and uses a fluid capacity of 7 liters, then the second heating element uses two heaters with a capacity of 600 watts brand from Germany and the third thermocontrol type PXR 9 Fuji.
2. The test results of the heating system on the oil cooler capacity tester, it can increase the temperature and takes time with the following data: the first 40˚ temperature increase takes 4 minutes 48 seconds, the second 50˚ temperature increase takes 3 minutes 18 seconds , the third 60˚ temperature rise takes 3 minutes 40 seconds, the fourth 70˚ temperature rise takes 3 minutes 25 seconds, the fifth 80˚ temperature rise takes 3 minutes 02 seconds, the sixth 90˚ temperature rise takes 3 minutes 04 seconds. The results that have been achieved in terms of heating the fluid in the tank can heat well up to a temperature of 90˚.

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