Performance Test Study of Car Cooling System (Air Conditioning/AC) Using Block and Elder Type Expansion Valve

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Keywords: Air Cooling, Expansion Valve, Block Valve.

Abstract: Air cooling in cars is an absolute necessity in cars because it can provide comfort for drivers and passengers. There are a series of main components to support the working system, namely the compressor, condenser, filter drayer, expansion valve and evaporator. The five components that are of concern in this study are the expansion valves because in all cooling systems there are different types of expansion valves, but have the same function of these types of expansion valves, namely to lower the pressure and lower the temperature of the system. The types of expansion valves in question are elbow type expansion valves (TXV) sensing and box or block type expansion valves These two types of expansion valves were tested using the car's air conditioning cooling system. The refrigerant material used is refrigerant (R134a. The results showed that the performance of the expansion valve (TXV), Coeficient of Performance (COP) was 3.79, Refrigeration Efficiency 64,45%, cooling capacity 3.26 kW, and refrigeration effect 160.06 kJ/kg. For valve block Coeficient of Performance (COP) is 3.90, Refrigeration Efficiency 70.28%, cooling capacity 2.89 kW, and refrigeration effect 115.75 kJ/kg.

1 INTRODUCTION

Technology to provide comfort for passengers in driving is a necessary requirement in a vehicle. Comfort in question is the need for cool air for passengers. Coolness can be obtained with a technology called air conditioning (Air Conditioning / AC) in cars. In this technology there is a series of interrelated components of the system to produce cool air while driving, therefore the use and application of components that can work effectively and efficiently continue to be researched in order to get an AC working system that can provide comfort for users in their daily activities (Handbook-Fundamentals, 2009); (Wardika, 2018).

In the cooling system (AC), there are a series of main components to support the working system, namely the compressor, condenser, filter drayer, expansion valve and evaporator. The five components that are of concern in this study are the block and elbow type expansion valves, because in all cooling systems there are different types of expansion valves, but have the same function of these types of expansion valves, namely to lower the pressure and lower the temperature of the system. The types of expansion valves in question are elbow-type (TXV) sensing expansion valves and box or block-type expansion valves (Muslih, 2020); (Jamaludin, 2018).

This type of expansion valve will be tested using the car's air conditioning cooling system. The refrigerant material used is refrigerant (R234a). The basis for choosing this material is because the car air conditioner compressor is only suitable for using R134a (Wang et al., 2016).

The test model used is to vary the two types of valves to determine the performance of the system in the form of Coeficient of Performance (COP), cooling capacity (Cooling Capacity), refrigeration effect and system efficiency.

2 RESEARCH METHODOLOGY

The method used in this research is the experimental method and it was conducted in the Refrigeration Engineering laboratory, with the set up as figure 1.

The implementation of this research followed the flow chart as shown below in fig.2. From this set up of experiments, a system test is performed with steps such as the following flow chart (Stubblefield et al., 2009); (Prabakaran et al., 2021).

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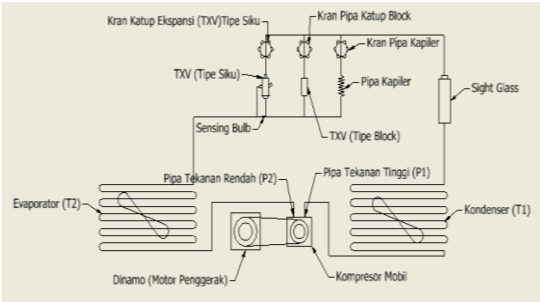

Figure 1: Set Up Experimental.

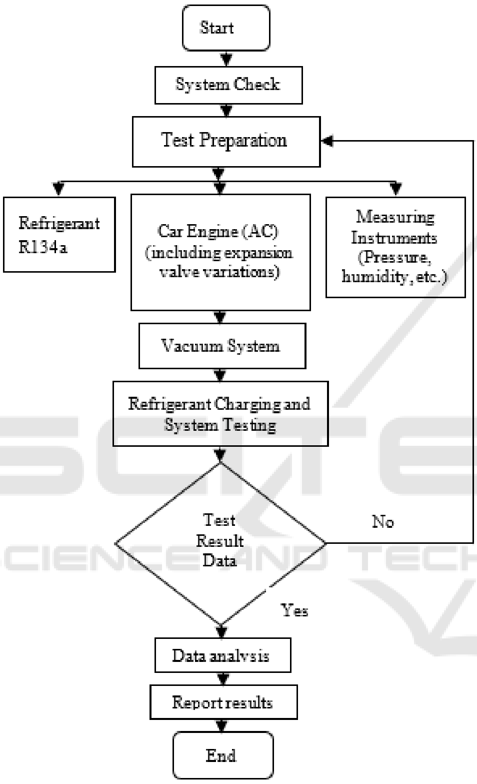

Figure 2: Flow Charts.

3 RESULT AND DISCUSSION

3.1 Result

This test is carried out on a cars AC with the following specifications:

1. The mass of refrigerant = 250gr
2. Testing time = 100 Minutes

Based on the planned system design and the research flow, the test results of the two valves can be seen in the following table below :

Table 1: Test Results for Expansion Valve (TXV).

No	Time (Menute)	Massa Refrigeran (gr)	Temperature (^{0}C)			Low Pressure (Psi)
			Evaporator	Condenser	Enviroment	
1	20	50	30,1	35	30,6	2
2	40	100	29,1	43,3	30,3	5
3	60	150	25,1	56,2	30,1	7
4	80	200	22,4	61,2	29,6	10
5	100	250	18,4	68	29,8	14

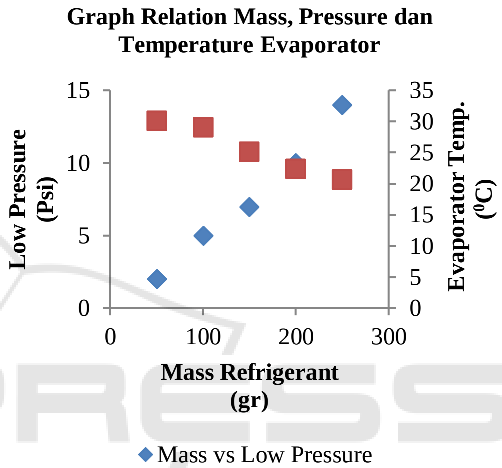

Figure 3: Graph of relationship between Mass, Pressure and Evap. Temperaure.

Table 2: Test Results for Block Valve.

No	**Time Menute)**	**Mass Refrigerat (gr)**	Temperature (^{0}C)			Low Pressure (Psi)
			Evaporator	Condenser	Environment	
1	20	50	29,3	41,4	30,6	17
2	40	100	27,4	59,3	30,6	21
3	60	150	24,8	60,6	29,5	25
4	80	200	20,8	69,4	29,5	30
5	100	250	16,5	64,8	29,5	35

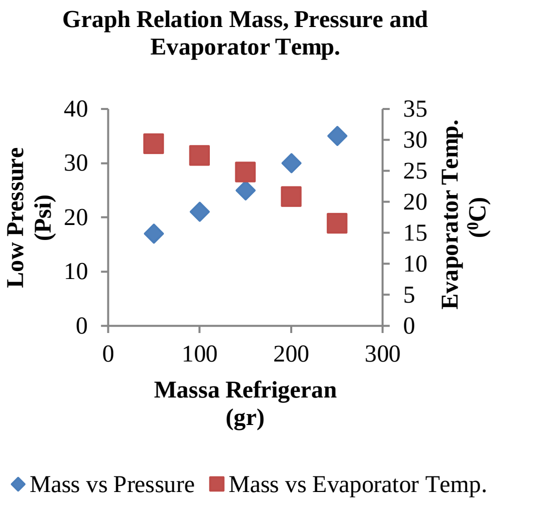

Figure 4: Graph of relationship between Mass, Pressure and Evap. Temperaure.

3.2 Discussion

All of the test results in the table and graph above can be calculated the performance of cars AC with R134a refrigerant as follows:

3.2.1 Expansion Valve (TXV)

In this expansion valve, based on the test results in the table 1 above, it appears that in the 100th minute with a refrigerant mass of 250 g, the evaporator temperature reaches a temperature of 18.40C at a low pressure of 14 Psi.

Test result data through coolpack software are as follows :

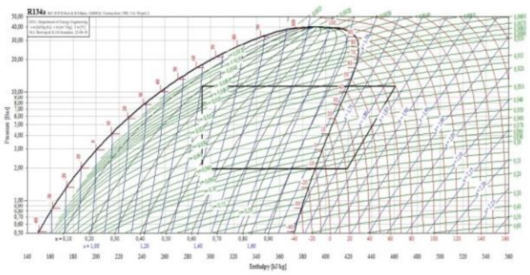

Figure 5: Graph of p-h diagram for Expansion Valve.

The graph in this figure shows the enthalpy values as follows:

h_1 = 418,47 kJ/kg h_3 = 292,35kJ/kg
h_2 = 460,74 kJ/kg h_4 = 292,35kJ/kg

Refrigerator performance based on enthalpy values are as follows:

1. Specific work by the Compressor (Q_w).
   42,27 kJ/kg
2. The heat is released by the condenser (q_k)
   168,39 kJ/kg
3. Refrigeration Effect (q_e)
   160,06 kJ/kg
4. Coefficient Of Performance(COP)
   a. COP_{aktual} = 3,79
   b. COP_{carnot} = 5.88
5. Refrigeration Efficiency (η)
   64,45%
6. Pressure Ratio :
   5,79.

3.2.2 Block Valves

In block valves, based on the test results in table 2 above, it appears that in the 100th minute with a refrigerant mass of 250 gr, the evaporator temperature reaches a temperature of 14.10C at a low pressure of 35 Psi

Test result data through coolpack software are as follows :

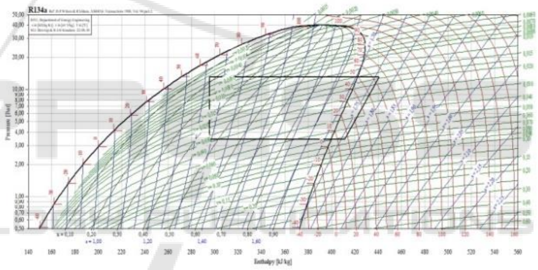

Figure 6: Graph of p-h diagram for Block Valve.

The graph in this figure shows the enthalpy values as follows:

h_1 = 411,12 kJ/kg h_3 = 295,37 kJ/kg
h_2 = 440,78 kJ/kg h_4 = 295,37 kJ/kg

1. Specific work by the Compressor (Q_w).
   29,66 kJ/kg
2. The heat is released by the condenser (q_k)
   145,41 kJ/kg
3. Refrigeration Effect (q_e)
   115,75 kJ/kg
4. Coefficient Of Performance(COP)
   c. COP_{aktual} = 3,90
   d. COP_{carnot} = 5,53
5. Refrigeration Efficiency (η)
   70,28%
6. Pressure Ratio :
   3,83.

4 CONCLUSIONS

Based on the results of data analysis, it can be concluded as follows:

1. In expansion valve (TXV), Coeficient of Performance (COP) was 3.79, Refrigeration Efficiency 64.45%, pressure ratio 5,79 and refrigeration effect 160.06 kJ/kg.
2. For valve block, Coeficient of Performance (COP) is 3.90, Refrigeration Efficiency 70.28%, pressure ratio 3,83 and refrigeration effect 115.75 kJ/kg.
3. The result of COP, efficiency and pressure ratio of block valve is more than expansion valve.

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