Performance Study Of 2 Pk Split AC Through Variation Of Capillary Tube For 0.070 Inch And 0.080 Inch Diameter With R22 And R290 Refrigerants

Jhon Arnoldos Wabang, Edwin P.D. Hattu, Nasaruddin, Aris Samule, Marselinus Doreng, Fransisko P. Niron, Amirudin Abdullah, Duran Hore, Jufra D.J. Abanat, Antonius Pangalinan

State Polytechnics of Kupang Adisucipto Street, Kupang, Indonesia
jnhonarwabang@mail.com

Abstract. The capillary tube is one of the most important components in the air cooling system (AC), whose function is to reduce the pressure and temperature of the refrigerant in the AC system. The dimensions of the capillary tube influence the performance of an air cooling system, therefore this research was carried out by varying the dimensions of the capillary tube in the form of varying the diameter of the capillary pipe in a 2 PK split AC to determine the performance of the AC. The refrigerant material used is refrigerant (R22 and R290/hydrocarbon (MC22). The results showed that the performance of the The the capillary tube for a diameter of 0.070 inches with refrigerant R22, Coefficient of Performance (COP) was 7.41 Refrigeration Efficiency 57.11%, cooling capacity 5.08 kW, and refrigeration effect 175.01 kJ/kg and then for capillary tube for a diameter of 0.080 inches with refrigerant R290, Coefficient of Performance (COP) was 6.76, Refrigeration Efficiency 52.15%, cooling capacity 8.89 kW, and refrigeration effect 306.57 kJ/kg.

Keywords: Air Conditioning System, Capillary Tube, Hydrocarbon (MC 22).

1 Introduction

The refrigeration and air conditioning system is a system that continues to be a concern because this system is needed in almost all fields, therefore efforts to improve system performance continue to be made in order to get a more effective and efficient work system within the system. One component that plays a role in supporting the efficiency and effectiveness of the work of the system is the size of the capillary tube both for its diameter and the length of the capillary tube.The capillary tube has the function of lowering pressure and temperature so that the right capillary tube size is needed to be applied to the system. On the other hand, refrigerant is one of the filling materials for the system because the refrigerant used can cause damage to the ozone layer and disrupt human health. These Ozone Depleting Substances (BPO) include chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs).

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In Indonesia, to eliminate the use of ODS (Ozone Depleting Substances), the Minister of Industry issued Minister of Industry Regulation No. 41 of 2014 and Minister of Trade Regulation No. 55 of 2014 regarding the same prohibition.
The regulation states that starting January 1, 2015 HCFC types HCFC 22 and HCFC 141b are prohibited from being used in: "Filling in the production process of machines and air conditioners (AC), air conditioning machines, and refrigeration tools/machines, rigid foam production processes for goods freezer, domestic, refrigenerator, boardstock/laminated, refrigerated trucks, and skin integral production process for use in the automotive and furniture sectors. Then it was emphasized again that "starting December 1, 2030 HCFCs are prohibited from being used for the maintenance of goods".

The capillary tube is a component that plays an important role in determining the performance of the air conditioner. The test results [7] show that the performance of a split AC that uses refrigerant (R22) has a better COP and cooling capacity than R290 while R290 has the smallest compressor work. However, this study has not shown the performance of split AC through variations in the dimensions of the capillary tube. Mufty Luay Salsabilla Alfa1, conducted research on [8] Experimental Study of the Effect of Variations in Capillary Pipe Diameter on Coolbox Performance with refrigerant R134a, the test results showed that the larger the capillary tube, the COP and efficiency were better.

In this study, variations of capillary tubes were carried out for diameters of 0.070 inches and 0.080 inches and the refrigerant used was R22 and hydrocarbon refrigerant (MC 22). The purpose of using a hydrocarbon refrigerant (MC 22) is a hydrocarbon refrigerant (MC 22) which has properties that can lighten the work of the compressor, so that the service life of the AC compressor becomes longer and is environmentally friendly, and does not damage the Ozone layer and does not cause a Greenhouse Effect/Global Warming. Using Musicool means that you can contribute to preserving the environment There are variations in the diameter of the capillary tube and refrigerant type R22 as well as the characteristics of the refrigerant hydrocarbon (MC 22) in the performance test of this 2 pk split AC, it is hoped that the performance of the 2 pk split AC which has better performance in this test can be obtained or known to be applied in this system.

2 Research Methodology

The method used in completing this research can be seen in the following reasoning sketch:

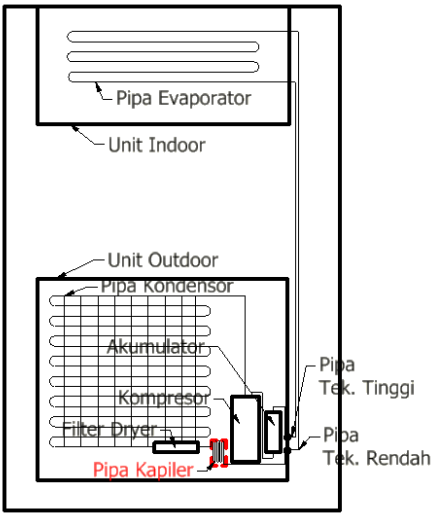

Fig. 1. Set Up Experimental

Based on the research sketch above in fig. 1, the sequence of research implementation can also be seen in the following flowchart:

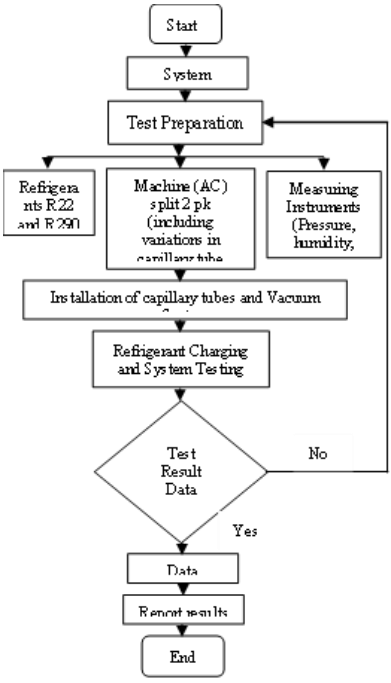

Fig. 2. Flow Charts

3 Result and Discussion

3.1 Result

This research was conducted on split air conditioners as research objects with the following test specifications :

1. AC Split = 2 PK
2. The mass of refrigerant 290 = 400gr
3. The mass of refrigerant 22 = 1000gr
4. Testing time = 4 hours

Based on test data for variations in capillary tubes on refrigerant 22 and refrigerant 290, the results are as shown in the following table:

Table 1. Split AC performance test results using capillary tube diameters of 0.064 inches, 0.070 inches and 0.080 inches for a length of 100 cm with refrigerant (R22)

No	Diameter of Capil-lary Tube (Inch)	Temperature (^{0}C)				
		Evaporators		Condenser		Environ ment
		Evapo rating	Super heat	Conden sation	Sub cooling	
1	0.064	9.6	15.2	31.2	25.2	17.2
2	0.070	8.4	14.8	30.1	24.5	17.5
3	0.080	10.2	15.8	35.9	27.2	16.5

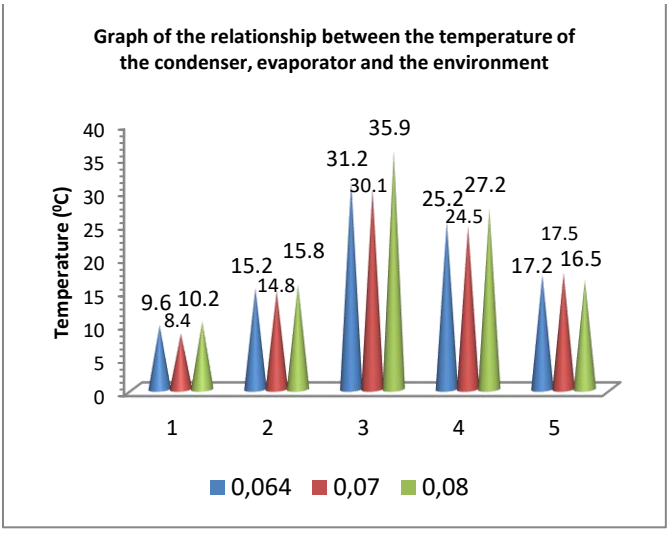

Fig. 3. Graph of temperature for refrigerant R22

Table 2. Split AC performance test results using capillary tube diameters of 0.064 inches, 0.070 inches and 0.080 inches for a length of 100 cm with refrigerant (R290)

No	Diameter of Capil-lary Tube (Inch)	Temperature (^{0}C)				
		Evaporators		Condenser		Environ ment
		Evapo rating	Super heat	Conden sation	Sub cooling	
1	0.064	9.2	14.8	29.2	21.2	15.2
2	0.07	10.8	15.1	35	27.5	18.6
3	0.08	7.9	13.5	31.9	22.5	18.6

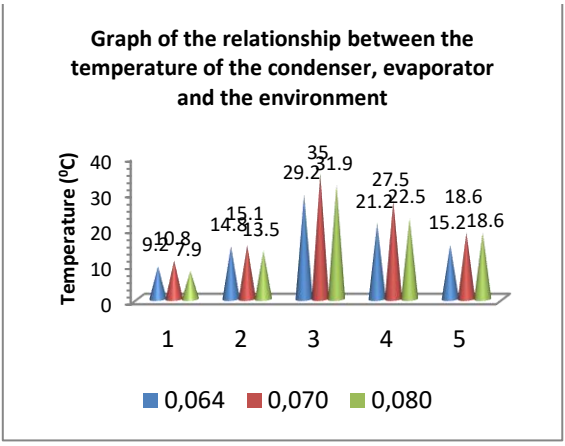

Fig. 4. Graph of temperature for refrigerant R290

3.2 Discussion

The test results in the table graph above can be calculated the performance of split AC with R22 refrigerant and R290 refrigerant as follows:

a. Capillary tube for a diameter of 0.070 inches with refrigerant R22 :

In this test, the results are for the evaporation and codenser temperatures respectively of 8.4^{0}C and 30.1^{0}C with an environmental temperature of 17.5^{0}C.

The data above, after being processed using the coolpack application, the following graphs and enthalpies are obtained:

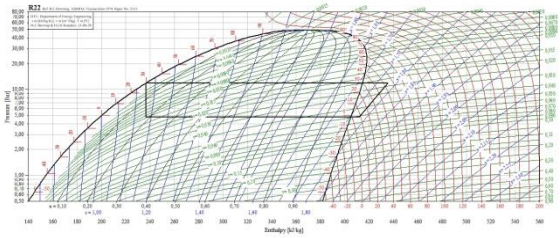

Fig. 5. Graph of p-h diagram for R22

h_1 = 411.79 kJ/kg h_2= 435.42 kJ/kg
h_3 = 236.78 kJ/kg h_4 = 236.78 kJ/kg

1. Specific work by the Compressor (Q_w).
   23.63 kJ/kg
2. The heat is released by the condenser (q_k)
   198.64 kJ/kg
3. Refrigeration Effect (q_e)
   175.01 kJ/kg
4. Coeffisient Of Performance(COP)
   a. COP_{aktual} = 7.41
   b. COP_{carnot} = 12.7
5. Refrigeration Efficiency (η)
   57.11%
6. Cooling Capacity (Q_e) :
   5.08 kW.

b. Capillarry tube for a diameter of 0,080 inches with refrigerant R290

As in the R22 test, results for R290 for evaporation and codenser temperatures respectively of 7.9^{0}C and 31.9^{0}C with an environmental temperature of 18.6^{0}C.

The data above, after being processed using the coolpack application, the following graphs and enthalpies are obtained:

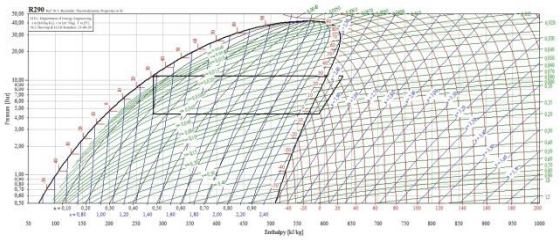

Fig. 6. Graph of p-h diagram for R290

h_1 = 588.99 kJ/kg h_2= 634.32 kJ/kg

h_3 = 282.42 kJ/kg h_4 = 282.42 kJ/kg

1. Specific work by the Compressor (Q_w).
   45.33 kJ/kg
2. The heat is released by the condenser (q_k)
   351.19 kJ/kg
3. Refrigeration Effect (q_e)
   306.57 kJ/kg
4. Coeffisient Of Performance(COP)
   c. COP_{aktual} = 6.76
   d. COP_{carnot} = 12.97
5. Refrigeration Efficiency (η)
   52.15%
6. Cooling Capacity (Q_e) :
   8.89 kW.

4 Conclusions

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

1. The results showed that the performance of the capillary tube for a diameter of 0.070 inches with refrigerant R22, Coeficient of Performance (COP) was 7.41 Refrigeration Efficiency 57.11%, cooling capacity 5.08 kW, and refrigeration effect 175.01 kJ/kg.
2. For capillary tube for a diameter of 0.080 inches with refrigerant R290, Coeficient of Performance (COP) was 6.76, Refrigeration Efficiency 52.15%, cooling capacity 8.89 kW, and refrigeration effect 306.57 kJ/kg.

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