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Performance Analysis of Air Conditioning System Using Freon R22 and Musicool (Mc 22) Based on Speed of Variation of Air Conditioning Condensers

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***Abstract*—Air conditioning system is a cooling system whose function is to condition the air according to the desired needs. Air conditioning can be done in workspaces, foodstuffs, or industrial products that are desirable in accordance with the needs. The cooling system used is a steam compression system. The problems faced so far are the amount / weight of the refrigerant (cooling material) and the rotational speed of the condenser fan to the cooling capacity of the cooling system. The refrigerant that used in this research is R22 refrigerant and hydrocarbon refrigerant (Musucool / MC 22). The purpose of using these two refrigerants is to find out the performance of the air conditioning system by using R22 refrigerant and hydrocarbon refrigerant (MC 22) through variations in fan rotation speed on the condenser. The method used in this research is an experimental method with an existing refrigeration machine, which is a refrigerant machine 22 (R22). The testing is carried out in stages, namely vacuuming the system, charging refrigerant in the form of Freon R22 and also hydrocarbon refrigerant (MC 22) which is carried out on the basis of the weight / mass of the two types of refrigerant, then the air velocity varies in the condenser. Furthermore, the system working pressure measurements are measured either low pressure (LP) and high pressure (HP) of the system as well as performance measurement in the form of the Coefficient Of Performance (COP) system and current consumption that occurs. The test results show that at low rotation (200 rpm), the system pressure is higher, namely 100 psi for R22 and 95 for R290, while at high rotation (750 rpm), the system pressure is 91 psi for R22 and 90 for R290. Likewise, the consumption of electric current from 2.9 A to 2.2 A on R22 and 2.2 to 2.0 on R290.**

Keywords—air conditioning system, freon, hydrocarbon (MC 22)

I. INTRODUCTION

The use of technology in the field of cooling and air conditioning continues to be a concern because this system is very much needed in almost all fields, but performance and refrigerants are used to be a serious concern because refrigerants can cause damage to the coating ozone and interfere with human health. Ozone depleting substances (BPO) are for example chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs).

Efforts to minimize the use of BPO (Ozone Depleting Substances), the Government through the Minister of Industry issued a Regulation of the Minister of Industry No. 41 of 2014 and Regulation of the Minister of Trade 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: "Charging 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, refrigerator, board stock / laminated, refrigerated trucks, and integral skin production processes for use in the automotive and furniture sectors. Then it was emphasized again that "starting December 1, 2030 HCFC is prohibited from being used for maintenance of goods" [1].

Currently, a number of manufacturers are busy switching to more environmentally friendly AC technology. One of them is by using the Freon R-32. However, the problem is that the air conditioner or other cooling material that still uses R22 and is still in good condition (proper function) must be destroyed or replaced. Then to replace the Freon R22 to Freon R32 is usually constrained by the form of Freon packaging (Freon holder). This is often an obstacle for some companies who want to replace the types of freon found in air conditioners or other cooling machines [2].

One of the materials that can be used as a coolant in an air conditioner system is hydrocarbon refrigerant (MC 22) or R290. The purpose of using hydrocarbon refrigerants (MC 22) is hydrocarbon refrigerants (MC 22) which have properties that can lighten the work of the compressor, so that the service life of the AC compressor is longer and is environmentally friendly, because it does not damage the Ozone layer and does not cause a Greenhouse Effect / Global Warming. By using Musicool means that you can contribute to preserving the

environment. Due to the characteristics of the hydrocarbon refrigerant (MC 22), in this study I conducted a research on the performance of AC Split using hydrocarbon refrigerants (MC 22)/R290 [3].

Air conditioning performance for the two different types of refrigerants (R22 and Musicool, MC 22) given different air conditioning speeds on the condenser will affect the performance of the air conditioner, for this reason, this research wants to know the performance of the air conditioner through variations in speed. cooling air in the condenser.

II. METHODS

This research was conducted in the Refrigeration Engineering laboratory, with the set up as follows Figure 1:

Fig. 1. Set Up Experimental.

The steps for implementing this research are as follows:

- Prepare material (R22 and MC 22)
- Prepare equipment such as 1 split AC unit, clamp ampere, rotary control, tachometer etc.
- Vacuum system
- Charging of refrigerant (R22 and MC 22) into the system
- Check for system leaks
- Testing the system with variations in the condenser fan speed
- Collecting and analyzing data

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:

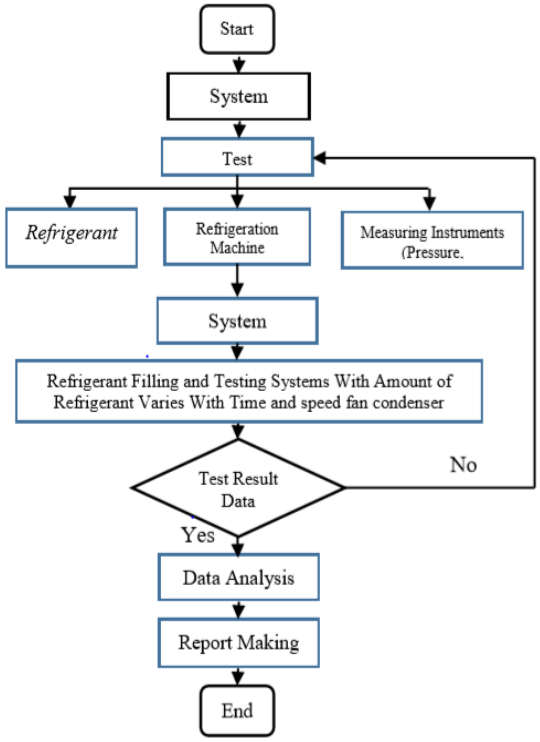

Fig. 2. Flow chart diagrams.

III. RESULTS AND DISCUSSION

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

- The mass of refrigerant = 560gr
- Electric current = 1,5 A
- Cooling capacity = 1.5 kW
- Max.discharge pressure = 2,8 Mpa
- Max.suction pressure = 0,8 Mpa

Based on the planned system design and the research flow, the tests are carried out and the results obtained are presented as in the following table 1 and table 2.

TABLE I. TEST DATA FOR REFRIGERANT R 22

No	Temperature (^{0}C)		Variation of Condenser Fan Rotations (rpm)	Low Pressure (psi)	Currents (A)
	Evaporator	*Condenser*			
1	17,7	40,5	200	100	2,9
2	18,1	40,4	400	95	2,3
3	16,7	35,5	600	91	2,3
4	16,7	35,5	750	91	2,2

TABLE II. TEST DATA FOR REFRIGERANT R 22

No	Temperature (^{0}C)		Variation of Condenser Fan Rotations (rpm)	Low Pressure (psi)	Currents (A)
	Evaporator	*Condenser*			
1	18,3	41,2	200	95	2,1
2	17,4	35,6	400	91	2,1
3	17,2	35,7	600	90	2,0
4	17,1	33,8	750	90	2,0

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

A. Variation of Condenser Rotation with Pressure and Electric Current Consumption for Refrigerant R22

In this test, the mass of the refrigerant is filled according to the design specification, which is 560gr, then the condenser fan rotation is varied. The variation of the condenser fan rotation shows that the higher the condenser fan rotation (750 rpm), the lower the pressure (91 psi), as well as the electric current consumption (2.2A) as shown in the figure 1 below

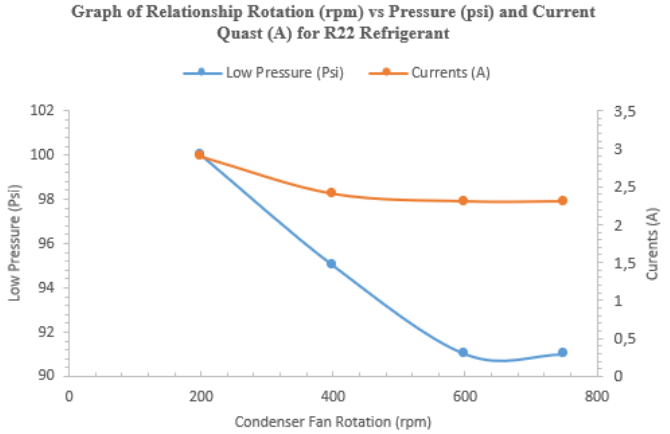

Fig. 3. Graph of relationship rotation (rpm) vs pressure (psi) and current consumption (A) for R22 refrigerant.

B. Variation of condenser rotation with pressure and electric current consumption for refrigerant R290

The mass of the refrigerant R290 used in this system is less than that of the R22 refrigerant, which is 300gr. This mass amount does not match its design specification of 560gr, but the system has shown constant work. Furthermore, the condenser fan rotation is carried out. The variation of the condenser fan rotation shows that the higher the condenser fan rotation (750 rpm), the lower the pressure (90 psi), as well as the electric current consumption (2.0A) as shown in the figure 2 below.

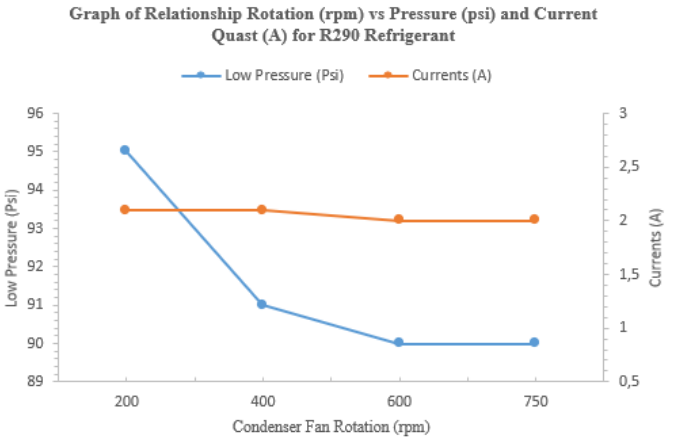

Fig. 4. Graph of relationship rotation (rpm) vs pressure (psi) and current consumption (A) for R290 refrigerant.

C. Test Result Data through Coolpack Software

1) For R22

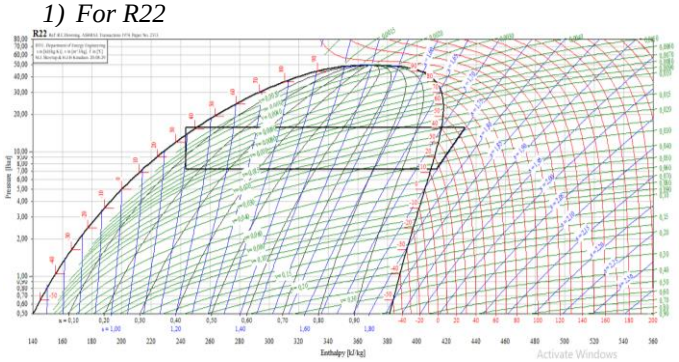

Fig. 5. Graph oGraph of p-h diagram for R22

- h1 = 413,76 kJ/kg
- h2= 432,82 kJ/kg
- h3 = 243,96 kJ/kg
- h4 = 243,96kJ/kg

- Specific work by the Compressor (Qw): 19,06 kJ/kg.
- The heat is released by the condenser (qk): 188,86 kJ/kg
- Refrigeration Effect (qe): 169,80 kJ/kg
- Coeffisient Of Performance (COP)
  COPaktual = 7,45

COPcarnot = 8,73

- Refrigeration Efficiency (η): 85,34%
- Cooling Capacity (Qe): 1,5 kW.

2) For R290

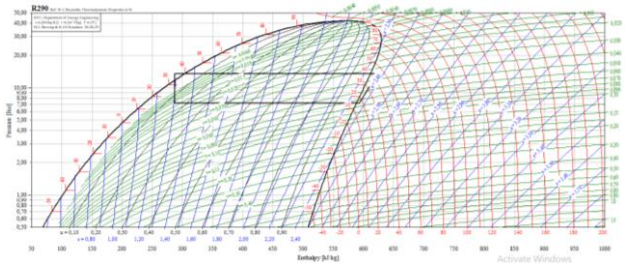

Fig. 6. Graph oGraph of p-h diagram for R290.

- h1 = 594,76 kJ/kg
- h2 = 624,55 kJ/kg
- h3 = 288,28 kJ/kg
- h4 = 288,28 kJ/kg

- Specific work by the Compressor (Qw): 29,79 kJ/kg
- The heat is released by the condenser (qk): 336,27 kJ/kg
- Refrigeration Effect (qe): 306,48 kJ/kg
- Coeffisient Of Performance (COP)
  COP_{aktual} : 6,73
  COP_{carnot} : 10,32
- Refrigeration Efficiency (η): 65,21%
- Cooling Capacity (Q_e): 1,5 kW.

IV. Conclusion

The variation of condenser fan rotation affects the rate of temperature change for both the condenser and the evaporator, both for refrigerant R22 and R290, which at R22 the temperature decreases from 17.7°C to 16.7°C from 200 rpm to 750 rpm. Whereas at R290 the temperature decreased from 18.3°C to 17.1°C from 200 rpm to 750 rpm.

The variation of condenser fan rotation also affects the rate of pressure change and the consumption of electric current for refrigerant materials R22 and R290, where at R22, the pressure changes from 100 psi to 91 psi and the current consumption from 2.9 A to 2.2A. Whereas in R290, the pressure changes from 95 psi to 90 psi and the electric current consumption from 2.1 A to 2.0A.

Acknowledgments

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