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Measuring Coefisien of Air Condition Hydrocarbon Refrigerant Performance with Inlet Diameter Modification of Centrifugal Compressors

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***Abstract**--The backgrounds of this research were the ozone depletion is becoming the world concern and contributes in causing skin cancer to people and other health disorders caused by synthetic refrigerant leaks (CFC). Besides, denoting regulations from ministry of energy and mineral resources of Republic Indonesia no. 14 /2012 about energy management and government regulation no.70/ 2009 about energy conservations.*

The aim of this research is to overcome previous issues of using hydrocarbon refrigerant which proven more environment friendly but requires few modifications on the diameter of the compressor's inlet on air conditioning (A/C) system that previously using CFC refrigerant. This is caused by the difference of viscosity in which synthetic refrigerant owns less than synthetic ones. The brand of the hydrocarbon refrigerant used for this research is MUSIcool fabricated by PT PERTAMINA.

The methodology of research is on laboratory research scale by the following research steps: first is measuring the COP of existing and unmodified A/C using synthetic refrigerant, the second steps is operating and measuring the COP of modified A/C which modified on centrifugal compressor's intake diameter and then compared it with unmodified one. The type of A/C being used in this research is cold room type with the following specification : 4 kW, 380 V, 3 Phs, 50 Hz. The third step is compiling the data to represent them on graphical form.

The result of this research shows significant COP of cold room type A/C with 4 kW power consumption 380 V, 3 phase 50 Hz, R22 refrigerant, and 5 kg of refrigerant mass specification between the use of synthetic refrigerant and the hydrocarbon one. The following datas were acquired from this reseach: electrical power consumption 2.725 KWh, while Hydrocarbon refrigerant consumes 2.312 kW, 6.2 A. Which saves 1,1 A or 15% of electrical consumptio for 24 hours and 30 days of usage.

***Keywords**: efficiency, redesign, MUSIcool, COP.*

I. INTRODUCTION

1. Backgrounds

The backgrounds of this research were the ozone depletion is becoming the world concern and contributes in causing skin cancer to people and other health disorders caused by synthetic refrigerant leaks (CFC). Besides, denoting regulations from ministry of energy and mineral resources of Republic Indonesia no. 14 /2012 about energy management and Goverment regulation no.70/ 2009 about energy conservations**.**

Scientists worries when they found out that chemical substances such as Chloro Fluoro Carbon (CFC) is implemented for daily human needs especially for cooling media since CFC is proven to be hazardous to ozone layer which causing depletion. The depletions of ozone caused by CFC will exposing people to ecessive ultra violet (UV) radiation that might causing skin cancer and catarract to human. Every single molecules of CFC will damage 100.000 molecules of ozones. This effect will harmful to human, so it requires actions to overcomes this issue. So people must aware about using and choosing the right environmental safety equipment to diminish global warming effect for good and sustainable future of the world (Permendag. No.24/M-DAG/PER/6/2006). The aims of the research are: a) to achieve A/C's COP that environmentally and energy save b) implifying MUSIcool on centrifugal blower A/C type c) modifying inlet diameter of centrifugal compressor type A/C.

I. NOMENCLATURE

1. The principle of A/C system

The principle of A/C working system is known as vapor compression cycle which illustrated as follow:

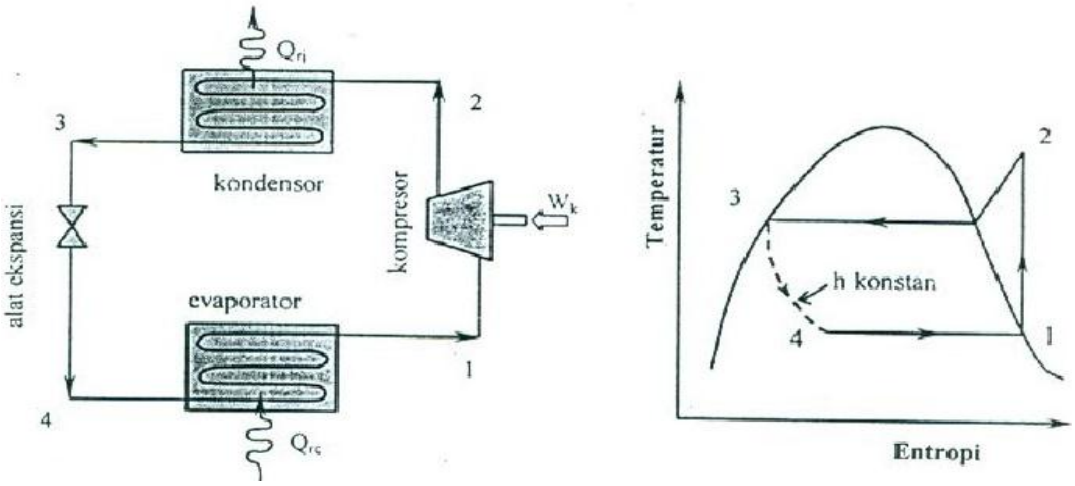

Figure 2.1. vapor compression cycle

Low pressure refrigerant compressed and circulated to absorb heat and then condensed in the condenser to discard the heat. When he heat discarded, the refrigerant turns into liquid and then expanded on the expansion valve to decrease the pressure. Then the refrigerant process continued to evaporator which evaporate the refrigerant and absorbing heat and then the cycle continues.

2. Centrifugal Compressor

Centrifugal Compressor classified in dynamic compressors which convert velocity of working fluids (compressible fluids) into potential energy by using mechanical impeller (Munandar,2009).

Impeller takes improtant roles in producing pressure and gas flows required for the operation of the system. By density, natural gas are bigger than CFC (Yeni,2009), so in refrigeration, hydrocarbon as a product of natural gas has more density than R-22 which is synthetic refrigerant and illustrated by figure 2.2.

MUSIcool is a product of PT. PERTAMINA which prepared to replace synthetic refrigerant that less enviromentally friendly and saves more energy (Inpres No.10/2005 and policy of ministery of mineral and energy resorces no. No. 2 /2007). MUSIcool which consist of hydrocarbon is a product of natural gas fabrication which has similiar properties to Refrigerant R- 12, R-22 dan R-134a.

The one-dimensional continuity equation

$$\boldsymbol{P_1 - P_2 = \frac{1}{2}\rho\left(V_2^2 - V_1^2\right)\ and\ A_1V_1 = A_2V_2}$$

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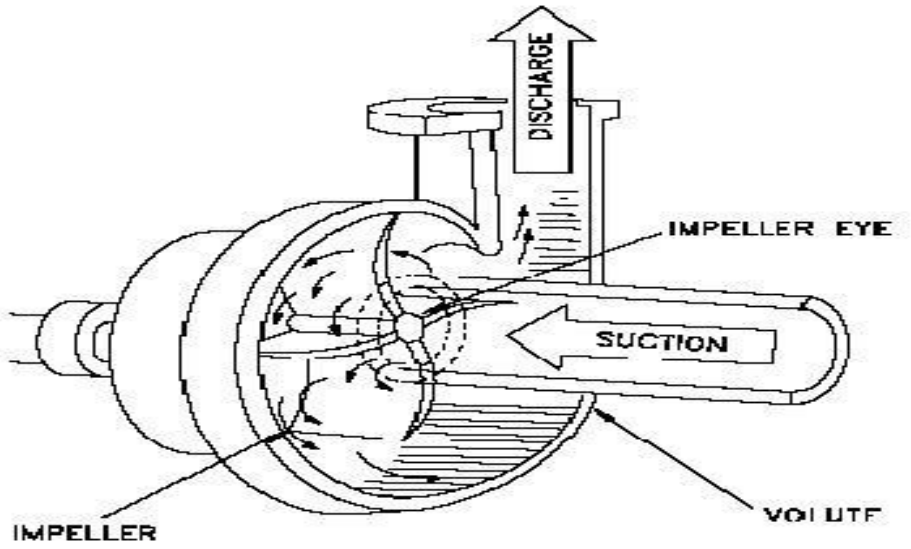

Figure 2. Centrifugal compressor

3. Coefficient of Performance (COP) of air conditioner (A/C)

Coefficient of Performance (COP) of air conditioner (A/C) is defined as the ratio of work or useful output to the amount of work or energy input, used generally as a measure of the energy-efficiency of air conditioners, space heaters and other cooling and heating devices. COP equals heat delivered (output) in British thermal units (Btu) per hour divided by the heat equivalent of the electric energy input (one watt = 3.413 Btu/hour) or, alternatively, energy efficiency ratio divided by 3.413. Higher the COP, higher the efficiency of the equipment (www.business dictionary.com)

II. RESEARCH METHODOLOGY

The first step for this research is to measure cold room type A/C 4 kW, 380 V, 3 phase, 50 Hz performance with the following data acquired: using R-22, mass of refrigerant 5 kg, electrical power consumption 3.780 kW, 7.3 A that measured using multitester, weight scale and ampere meter. The second step is modification by attaching tapper on 1 mm thick copper pipe on the pump inlet. The third step is measuring the performance of A/C and replacing the existing refrigerant with MUSIcool with equal mass and measuring the COP.

III. RESULT AND DISCUSSION

Figure 3. shows the data comparison of COP of cold room type A/C 4 kW with R-22 and with MUSICool with ambient temperatures assumed to be 35^{o}C.

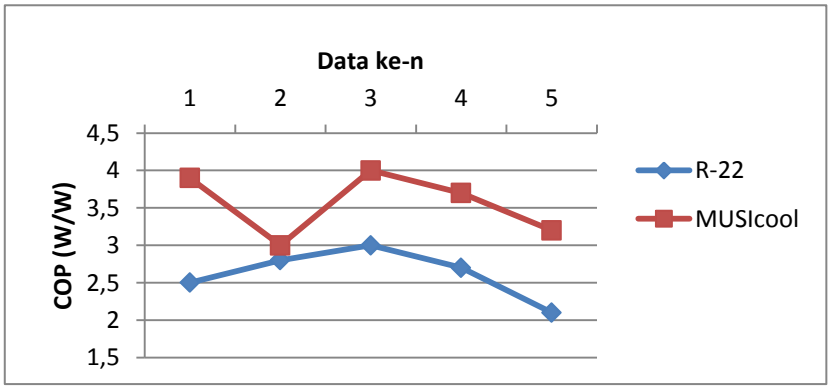

Figure 3. Comparison COP data of cold room type A/C 4 kW with R-22 and with MUSIcool at assumed ambient temperatures of 35°C.

Figure 4. shows the comparison of COP between unmodified and modified inlet diameter of centrifugal compressor with MUSIcool refrigerant and assumed ambient temperature 35°C.

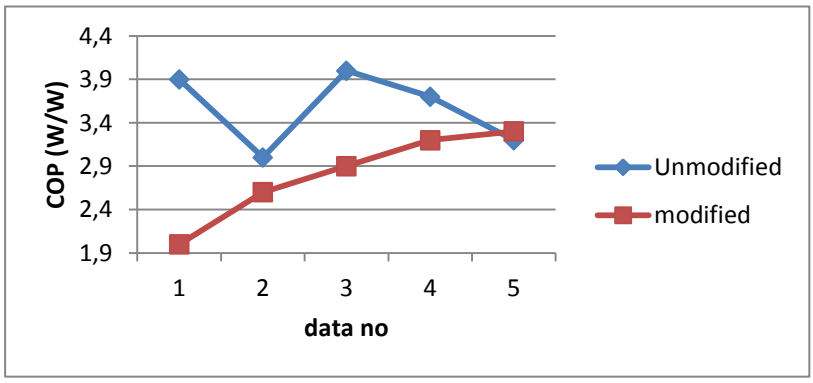

Figure 4. Comparison of COP between unmodified and modified inlet diameter of centrifugal compressor with MUSIcool refrigerant and assumed ambient temperature 35°C.

IV. CONCLUSION

1. Compares to synthetic, hydrocarbon (MUSIcool) refrigerant producing higher COP which means saves more energy in the forms of electrical consumption.
2. Same cooling effect could achieved by hydrocarbon (MUSIcool) at 30% less weight than synthetic refrigerant
3. Saves 1,1 A or 15% of electrical consumptio for 24 hours and 30 days of usage.

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