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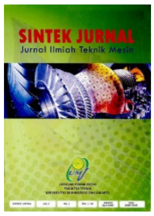

OPTIMIZATION OF COMPRESSOR WORK, POWER AND HEAT ON EFFICIENCY REFRIGERANT R290 ON SPLIT AC

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ABSTRACT

The vapor compression cycle refrigeration machine is the type of refrigeration machine that is most widely used today, generally the medium used as a working fluid that transfers heat from the product being cooled to its environment is a synthetic refrigerant. The working fluid is called refrigerant. Refrigerant is the main working fluid used in air conditioning systems to absorb heat and convert it in the refrigeration system. This then encourages countries in the world including Indonesia to then jointly carry out prevention and improvement by making agreements. Then this agreement was known as the Vienna Convention in 1985 followed by the Montreal agreement in 1987. In order to reduce the impact of ODS (Ozone Depleting Substances), in 1992 Indonesia signed the Montreal protocol. At that time, Indonesia also launched the "Indonesian Country for the phase Out of Ozone Depleting Substances (ODS) under the Montreal Protocol". This study aims to compare the work of compression, heat absorbed, and the electric power used by the split type refrigeration machine between refrigerant R-22 and refrigerant R-290. These results and analysis show that R-290 has a higher value than R-22 in compression performance. R22 power consumption is 0.30 kw and R290 is 0.26. R290 this is influenced by the light work of the compressor so that it will have an impact on electric power consumption. The power consumption of R290 is 42% less than R22. The heat absorbed by R 22 is smaller than that using hydrocarbons. The results of the optimization of compressor work, power and heat variables show an effect on efficiency.

Keywords: compression work; electric power, heat absorbed, R22, R290.

1. INTRODUCTION

The vapor compression cycle refrigeration machine is the type of refrigeration machine that is most widely used today, generally the medium used as a working fluid that transfers heat from the product being cooled to its environment is a synthetic refrigerant. Since it was discovered around 1930 until the mid-1970s, the impact of using synthetic refrigerants such as chlorofluoro carbon (CFC) refrigerants and hydro chloro fluoro carbon (HCFC) has not caused an environmental problem [1].

In the process of refrigeration or air conditioning, a substance that is useful as a working fluid is needed to transfer heat from a space to the environment. The working fluid is called refrigerant [3]. Refrigerant is the main working fluid used in air conditioning systems to absorb heat and convert it in the refrigeration system. Refrigerant absorbs heat at low temperature and low pressure and releases it at higher temperature and pressure. The refrigerant undergoes a phase change during the process of heat absorption, evaporation, heat release and condensation [4].

This then encourages countries in the world including Indonesia to then jointly carry out prevention and improvement by making agreements. Then this agreement was known as the Vienna Convention in 1985 followed by the Montreal agreement in 1987. In order to reduce the impact of ODS (Ozone Depleting Substances), in 1992 Indonesia signed the Montreal protocol [5]. At that time, Indonesia also launched the "Indonesian Country for the phase Out of Ozone Depleting Substances (ODS) under the Montreal Protocol". So that starting in early 2020 until 2030, refrigerant refrigerants of the HCFC type will be removed and their use will be discontinued. To avoid depletion of the ozone layer due to the use of refrigerants of the halocarbon type, alternative refrigerants are sought that are better without having a major impact on the environment. Several previous studies have tried to develop refrigerants that do not contain chlorine and do not damage the ozone layer [6]. Alternative refrigerants that are starting to be widely used are refrigerants in the HFC (Hydrofluorocarbon) group such as R-134a which are considered to be able to compensate for the performance of the previous refrigerants CFC and HCFC [7].

Currently, the refrigeration system with a compression system is more widely used than an absorption refrigeration system because it is considered more practical. But on the other hand, the use of electrical energy for compressor work is relatively higher than the absorption refrigeration system [8,13]. In the absorption system, the increase in pressure and temperature before entering the condenser is to use a heating system, heat exchange that can take advantage of solar heat. Thus, it is expected to reduce the burden of electrical energy consumption [9]. This research focuses on the isenthalpic expansion section along the capillary tube that connects the condenser output and the evaporator input. The system under study has a capacity of 1 PK with an inlet temperature of 300C and an outlet temperature of -150C. The mass flow rate of refrigerant R717 which is operated is 0.0031 kg/s [10].

This R717 isenthalpic expansion process operates at an input temperature of 300C and an output temperature of -150C with an enthalpy value of 339.04 kJ/kg. The input pressure value is 1166.93 kPa and the output pressure is 236.20 kPa. The mass flow rate of refrigerant R717 which is operated is 0.0031 kg/s. This study aims to calculate the length of the capillary tube with variations in diameter of 0.026 inches, 0.031 inches, and 0.042 inches and to find out how the temperature, pressure and vapor fraction changes along the capillary tube with these diameter variations. The calculation results show that the larger the diameter of the capillary pipe, the longer the pipe requirement [11].

Capillary tubes with diameters of 0.026 inches, 0.031 inches, and 0.042 inches require a capillary tube length of 0.249 m, 0.368 m and 0.959 m, respectively. The decrease in temperature and pressure of refrigerant R717 along the capillary tube in all the diameter variations is not linear with the increase in pipe length. There is a steep drop in temperature and pressure at the end of the flow. The increase in the refrigerant vapor fraction of R717 along the capillary tube in all the diameter variations is not linear with the increase in pipe length. There is an exponential increase in the vapor fraction at the end of the flow until it reaches the output fraction at -150C, which is 0.158 [12].

In tropical countries, cooling machines play a very important role, especially in urban areas where economic activity is running very fast. This is different from subtropical countries and cold temperatures which require more heating.

2. METHODS

The test was carried out for 2 hours and data was collected every 5 minutes. Observations were made on the measured parameters which were then analyzed to determine the performance of the system. Figure 8.1 Parameters measured include compressor inlet pressure, compressor outlet pressure, expansion valve inlet pressure, capillary tube outlet pressure, compressor inlet temperature, compressor outlet temperature, capillary tube inlet temperature, expansion valve outlet temperature, wet bulb temperature and dry bulb air entering the evaporator. , the temperature of the wet bulb and dry bulb of the air leaving the compressor, the electric current and the velocity of the air leaving the evaporator.

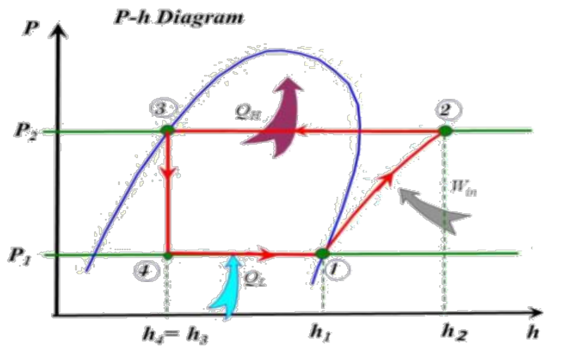

Figure 1. P-h diagram and measuring instrument placement

Comparison of the performance of refrigerants R-22 and R-290 performed an analysis of the performance of the two refrigerants. The performance includes compressor work, electric power, refrigeration effect.

2.1 Compressor Working

Compressor work is the power used by energy per unit mass (kj/kg). The power consumed by the compressor system to be able to move the fluid into the engine cooling system (watts). refrigeration effect the amount of heat absorbed in energy per unit mass (kJ/kg). Compressor working equation:

$$Wc = h2 - h1 \text{ (kj/kg)} \quad (1)$$

Where:
Wc= compressor work
h1= enthalpy entering compressor
h2= enthalpy out of compressor

2.2 Equation of power consumed by the air conditioning system:

$$\text{Power} : P.I.\cos\varphi \text{ (watts)} \quad (2)$$

Where:
P = voltage
I = Load electric current
Cos φ = power factor

2.3 Equation of heat absorbed by the evaporator:

$$Qe = h1 - h4 \text{ (kj/kg)} \quad (3)$$

Where:
Qe : heat absorbed (kj/kg)
h1: enthalpy entering compressor (kj/kg)
h2: enthalpy out expansion (kj/kg)

3. RESULTS AND DISCUSSION

Table 1 shows the enthalpy results obtained from the test results so that it can be continued to obtain the value / value to be sought.

Table 1. Enthalpi R22 dan R290

R290			
h1	h2	h3	h4
597.05	647.71	278.19	278.19
R22			
h1	h2	h3	h4
418.9	438.1	236.7	236.7

The results of data analysis show that the compression work of R22 is 19.2 and for R290 is 50.7. R290 it is 67% lighter. The power consumption of R22 is 0.30 kw and R290 is 0.26. R290 this is influenced by the light work of the compressor so that it will have an impact on electric power consumption. The power consumption of R290 is 42% more efficient than R22. The heat absorbed by R22 is smaller than that of using hydrocarbons. Based on the three experimental variables, optimization of the interaction of the three variables of compression work, power and heat required on the efficiency response was carried out. Variable optimization was carried out by statistical methods, namely the Response Surface Methodology RSM, using the Statistica 6 software. The optimization results were in the form of an equation model that produced the optimum crust mass. Figure 2 shows the optimization when the research results with response efficiency (%).

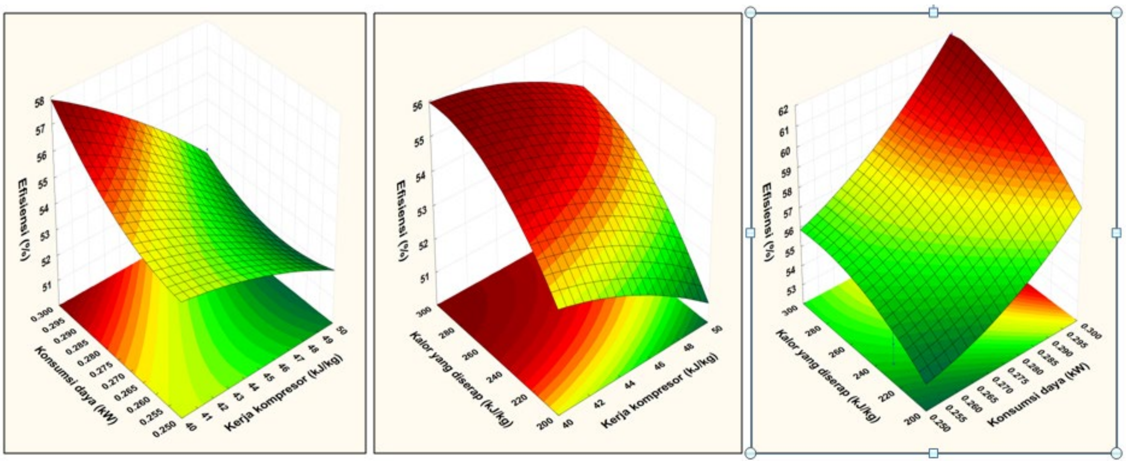

Figure 2. Optimization of Variables with Efficiency Response

Variable optimization was carried out by statistical methods, namely the Response Surface Methodology RSM, using the Statistica 6 software. The results of the optimization of compressor work, power and heat variables showed an influence on efficiency. The most influential factors on efficiency are power consumption and heat absorbed. While the work of the compressor is enough to affect the efficiency.

The optimization graph shows the greater power consumption and decreasing compressor work has an effect on efficiency. Efficiency increases with increasing power consumption and decreases with increasing compressor work. The variables of heat absorbed and compressor work are also shown in the optimization graph. Based on the graph above, the effect of heat absorbed and compressor work affects the value of efficiency. The greater the heat absorbed, the higher the efficiency value, while the greater the compressor work value, the lower the efficiency value. The graph of the effect of the variable between the heat absorbed and the power consumption on the efficiency value is also shown in the graph above. The graph shows that the absorbed heat and power consumption have the same effect on the efficiency value. The greater the power consumption and the heat absorbed, it will affect the increase in efficiency. Based on the three graphs above, the variables that affect the efficiency increase are power consumption and absorbed heat, while those that reduce efficiency are the compressor work variable.

CONCLUSION

Based on the results of the study, it can be concluded that the compression work of R22 is 19.2 and for R290 is 50.7.R290 is 67% lighter. The power consumption of R22 is 0.30 kw and R290 is 0.26. R290 this is influenced by the light work of the compressor so that it will have an impact on electric power consumption. The power consumption of R290 is 42% more efficient than R22. The heat absorbed by R22 is smaller than that of using hydrocarbons. The results of the optimization of compressor work, power and heat variables show an effect on efficiency. Based on the three graphs, the variables that affect the efficiency increase are power consumption and absorbed heat, while those that decrease efficiency are the compressor work variable.

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