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Experimental Study of Performance AC Split R32 Retrofited with R1270 on 50% Mass

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***Abstract* - This study examines the performance of split-type air conditioning with a cooling capacity of 1 PK after replacing a less environmentally friendly refrigerant with a more environmentally friendly one, ranging from R32 to R1270. R1270 has a mass of 50%. The evaporator's inlet temperatures are 23°C, 25°C, and 27°C, while the condenser's inlet temperatures are 30°C and 35°C. The results showed that there was a 41.47 percent decrease in power consumption from R32 to R1270 for cooling capacity, and a 45.46 percent decrease from R32 to R1270 for heating capacity. From R32 to R1270, the COP value decreased by 19.04 percent. R32 still outperforms R1270 in terms of performance, but R1270 has lower power consumption, making electricity consumption more efficient.**

Keywords: Energy Conversion, Air Conditioning, R32, R1270.

I. INTRODUCTION

Refrigeration and air conditioning require substances that can act as a working fluid in transferring heat from a space to the environment. The working fluid is refrigerant, which is used in the air conditioning system to absorb heat and convert it into cool air in the refrigeration system. Refrigerators absorb heat at low temperatures and pressures and release it at higher temperatures and pressures. The refrigerant undergoes a phase change during the heat absorption, evaporation, heating, and condensation processes[1].

Air conditioning (AC) is now widely used in hotels, homes, office buildings, hospitals, and industries. Air conditioners are used in capacities ranging from small to medium to large. The fields of refrigeration and air conditioning are related, but each has a distinct scope. In order to function, the refrigeration system requires a fluid that can easily absorb and release heat. Refrigerant is a working fluid that circulates in the refrigeration cycle and is the most important component of the refrigeration cycle because it causes cooling and heating effects in the refrigeration machine[2,3].

The development of refrigerants is primarily driven by two the development of refrigerants is primarily motivated by two environmental issues: the ozone layer and global warming. The impact of ozone depletion is that ultraviolet rays from the sun will be emitted directly onto the earth. Directly emitted ultraviolet rays from the sun can cause disease, raise the earth's temperature, and provide no protection from falling objects from the sky. GWP and ODP contribute to global warming by trapping heat in the atmosphere, which causes global warming.

HFC (R410A, R407C, and R404A) was initially considered as a long-term substitute for HCFC 22 (R22). However, this HFC mixture has a high global warming potential (GWP). One of the points stated in the Montreal and Kyoto Protocols (1897 & 1997) was the elimination of the refrigerant R-22 (HCFC-22) in favor of a more environmentally friendly refrigerant[4].

A hydrocarbon refrigerant is an alternative refrigerant. Hydrocarbon refrigerant is a refrigerant that is currently being researched because it is environmentally friendly, non-toxic, cheaper, does not cause ozone depletion with an Ozone Depletion Potential (ODP) of 0, and does not cause global warming with a Global Warming Potential (GWP) of less than 3[5,6].

R1270, or propylene, is a hydrocarbon refrigerant. Because of its properties, it can be used to replace synthetic refrigeration systems in domestic cooling systems. R-1270's thermodynamic properties make it a viable energy source. It is air-conditioning component compatible, has a low initial cost, and has good thermal conductivity. R1270 offers the following benefits: It has no ozone layer effect (ODP-0) and has a mild global warming effect of 2. R-1270's thermodynamic properties make it a viable energy source. It is compatible with air-conditioning components, has a low initial cost, and has good thermal conductivity.R1270, a refrigerant with thermal diffusivity similar to HCFC22, has been suggested as a promising replacement for HCFC22[7–9].

Berkah et al. analyzed split air conditioners with R410A refrigerant interchanged by hydrocarbon refrigerant in three different mass fractions: 33.88%, 38.12%, and 42.35%. The compressor power consumption is 1.93 kJ/s and 0.32 kJ/s, respectively. This means that the power consumption of hydrocarbon refrigerants is lower, and the conversion of a comparatively tiny air conditioner from HCFC22 to HC was investigated. According to the findings, the greatest increase in AC performance was obtained when the mass of HC was 50% that of HCFC22. Thermal performance decreased by 2.8 % while EER (energy efficiency ratio) increased by 12.6 % at this optimal charge[10–12].

However, the use of refrigerant R1270 has issues due to its high fire resistance, which can be dangerous if mishandled, so special configuration and proper handling are required[13]. As a result, analysis of the use of refrigerant R1270 in the refrigeration system is needed.

II. EXPERIMENTAL DEVICE

2.1 Model Test

A split-type air conditioning unit with a cooling load of 9,000 BTU is used in the laboratory exercise. The compressor, condenser, evaporator, and capillary tube are the air conditioner's primary parts. A duck is used to house the condenser and evaporator. The component provides a link to the refrigerant pipe to measure temperature and pressure, making it simple to obtain compressor, condenser, and evaporator performance measures.

The mass flow rate of the refrigerant in the system is calculated by measuring the refrigerant flowing in the capillary tube. Electric current, voltage, and power factor are used to measure compressor power. Desktops, data acquisition (DAQ NI), temperature sensors (LM35), pressure gauges, and digital scales are used as data acquisition devices and measurement instruments. The universal testing machine and measuring instruments used in the experiment are depicted in Figure 1.

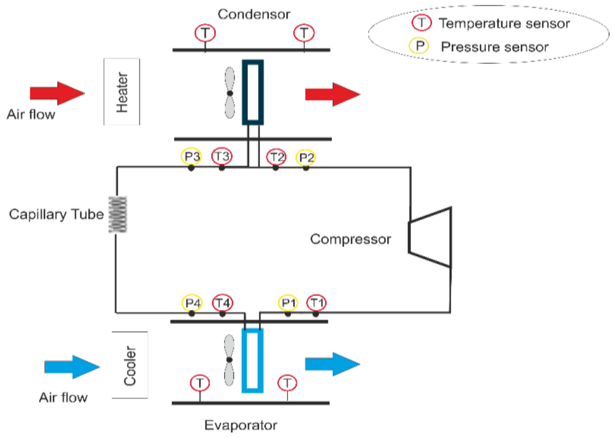

Figure 1: Schematic diagram

2.2 The Procedure for the Experiment

This analysis was conducted through direct testing in the field and analysis of data. The following is the testing procedure used in this study:

The test involves filling the mass of 430 grams of refrigerant according to the specifications on the name plate. The tests were conducted at evaporator inlet air temperatures of 23°C, 25°C, and 27°C, as well as condenser inlet air temperatures of 30°C and 35°C. Adjusting the evaporator and condenser inlet temperatures with the assistance of supporting air conditioners and heaters. After steady state, data is collected every five minutes for one hour. The second test utilizes the refrigerant R1270.

Meanwhile, R1270 is filled with 50% (215 grams) of the total mass of R32 according to the hydrocarbon filling reference (MC22/R1270). System testing was performed with a mass variation of 50%, respectively. The temperature of the air entering the evaporator and the temperature of the air entering the condenser are both the same as in the R32 test. adjusting the evaporator and condenser inlet temperatures with the assistance of supporting air conditioners and heaters. After steady state, data is collected every five minutes for one hour.

III. RESULTS AND DISCUSSIONS

3.1 Cooling Capacity

Figure 2 compares the cooling capacity of R32 to that of R1270. Cooling capacity is a measurement of a cooling system's ability to dissipate heat or the air conditioners predicted output. The faster the room temperature rises to the desired temperature, the better its cooling capacity. Figure 3 shows that R1270 has a lower cooling capacity than R32 due to a reduction in compression effort caused by the use of R32 components in the equipment.

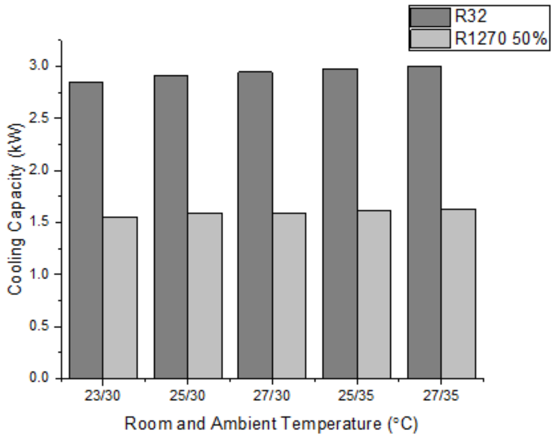

Figure 2: Cooling capacity

3.2 Power Consumption

Figure 3 shows that the compressor power consumption of the refrigerant R1270 is lower at all room temperature and incoming ambient temperature conditions when compared to the R32 refrigerant power consumption. This is due to the fact that R1270 contains less mass than R32. Because the compressor work becomes lighter, less power is required.

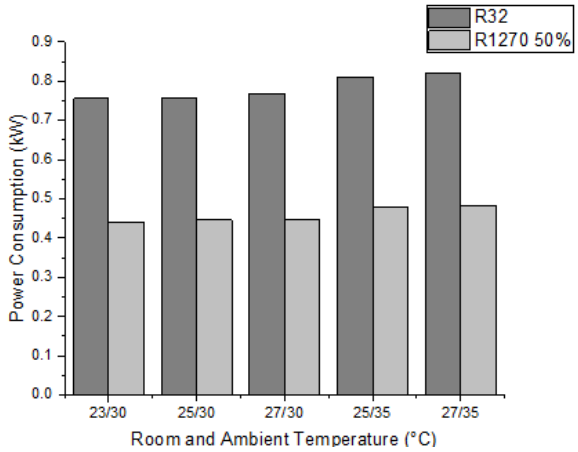

Figure 3: Power consumption

3.3 Coefficient of Performance

Figure 4 depicts the performance coefficients of the refrigerants R32 and R1270. The results show that the COP of refrigerant R1270 is lower than that of refrigerant R32 for all room and ambient temperature settings. Because R32 has a higher cooling capacity and uses more energy than R1270, the COP value of each refrigerant is affected.

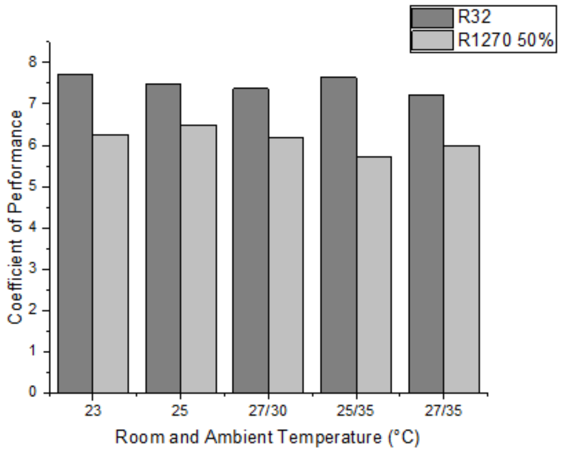

Figure 4: Coefficient of performance

IV. CONCLUSION

Based on the results of the research that has been done, some conclusions can be drawn as follows:

1. According to the study's findings, the use of R1270 retrofitted R32 with a mass of 50% and variations in room and ambient temperature resulted in a 41.47 % decrease in power consumption from R32 to R1270.
2. The cooling capacity of R1270 is 45.46 % lower than that of R32 due to the lower cooling capacity, which affects the compressor's lower power consumption.
3. The COP decreased by 19.04 % from R32 to R1270. Overall, the performance of using refrigerant R1270 to replace refrigerant R32 has not been optimized.

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