Performance Investigation of Vapour Compression Refrigeration System Using R 134a-Tio$_2$

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Abstract- *In this work, an experimental work was investigated vapour compression refrigeration system.R134a-TiO$_2$ refrigerant was used in domestic refrigerant without any reconstruction of the system. The system performance was investigated using energy consumption test and co-efficient of performance test. The result denoted R134a-TiO$_2$ is give better performance while compare with R134a.The results indicate that R134a-TiO$_2$ refrigerant works normally and safely in the refrigeration system. That R134a-TiO$_2$ system 8.1% of less energy consumption used with 80% R134a and 20% TiO$_2$. Thus blended mixture can be used in domestic refrigerators to considerably reduce energy consumption.*

Keywords- 1,1,1,2-Tetrafluoroethane, Titanium dioxide, COP, Energy Consumption Test

I. INTRODUCTION

The HFC134a is the most widely used alternative refrigerant in refrigeration equipment such as domestic refrigerators, chillers and automobile air conditioners. Though the greenhouse warming potential (GWP) of R134a is relatively high and this also long term alternative fuel. Wrag and xie [1] found that TiO$_2$ particles could be used as additives to enhance the solubility between mineral oil and hydrocarbon refrigerant. The refrigeration systems using the mixture of R134a and mineral oil appended with particles TiO2, appeared to give better performance by returning more lubricant oil back to the compressor, and had the similar performance compared to the systems using polyol-ester (POE) and R134a. Titanium dioxide particles suspended in lubricant of the compressor is found to be increasing the system efficiency and also the system works without any choking. Eedet al.[2] investigated the titanium dioxide have good evaporating heat transfer co-efficient and heat flux in a domestic refrigerator. Peng et al. [3] found that the heat transfer coefficient of CuO-R113 was larger than that of pure refrigerant R113, and the maximum enhancement of heat transfer coefficient was 29.7%.Jwo et al. [4] carried out the performance experiment of a domestic refrigerator using hydrocarbon refrigerant and 0.1 wt.% Al2O3-mineral oil as working fluid, the results indicated that the power consumption was reduced by about 2.4%, and the coefficient of performance was increased by 4.4%.Li et al. [5] investigated the pool boiling heat transfer characteristics of R11 refrigerant with TiO$_2$ nanoparticles and showed that the heat transfer enhancement reached 20% at a particle loading of 0.01 g/L.Park [6] investigate the effects of carbon nanotube (CNTs) on the nucleate boiling heat transfer of R123 and HFC134a refrigerants. Their test results showed that CNTs increase the nucleate boiling heat transfer coefficients for these refrigerants. Large enhancements of up to 36.6% were observed at low heat Fluxes of less than 30 kW/m^2.Peng et al. [7] studied the heat transfer characteristics of refrigerant-based nanofluid flow boiling inside a horizontal smooth tube and obtained a maximum heat transfer coefficient enhancement of 29.7%. They then proposed a heat transfer correlation, and found that the deviation between the predicted and experimental data is 20%.Bi et al. [8] studied the performance of a domestic refrigerator using TiO2-R600a nano refrigerant. They found that the performance of refrigerator with 0.5 g L^{-1} TiO2-R600a nano refrigerant was better than that of pure R600a system with 9.6% less energy used. The presence of refrigerant R134a improved the evaporating heat transfer co-efficient.

This paper is to investigated the use of nanoparticles in refrigeration systems is a new, innovative way to enhance the efficiency and reliability of refrigerators. This study analyzes the use of oil particles in domestic refrigerators by measuring the refrigeration performance of a domestic refrigerator charged with HFC134a and mineral oil mixed with titanium dioxide particles.

II. EXPERIMENTAL SETUP

2.1 Components

The experimental consists of compressor, fan cooled condenser, expansion device and an evaporator section. Capillary tube is used as an expansion device. The Evaporator is of coil type which is loaded with water. Service ports are provided at the inlet of expansion device and compressor for charging the refrigerant [4]. The mass flow rate is measured with the help of flow meter fitted in the line between expansion device and drier unit. The experimental setup was placed on a platform in a constant room temperature. The ambient temperature was ±1.5°C. The air flow velocity was found tobe less than 0.35m/s. Table1. Shows the specification of the refrigeration system

Table1.

Refrigerant	R134a
Charged mass	150g
Compressor type	Reciprocating
Gross capacity	5L

Fig.1 Experimental setup

2.2 Instruments

The temperatures at different parts of the experimental setup are measured using digital thermometer. The three resistance thermocouples were used for the experimentation. The pressure at compressor suction, discharge, condenser outlet and at evaporator outlet is measured with the help of pressure gauges. The power consumption of the system was measures by Watt-hr meter. A wattmeter is also connected with the experimental setup.

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2.4 Blended Refrigerant Concentration

Blended refrigerant with 0.1% concentration of TiO2 in the refrigerant R134a is prepared and tested in the setup.

2.5 Charging of the set up

The fabricated experimental setup was filled with N2gas at a pressure of 5 bar to 7bar and this pressure is maintained for 45 minutes. Thus the system was ensured for no leakages. The system was evacuated by removing N2 gas. A vacuum pump was connected to the port provided in the compressor and the system was completely evacuated for the removal of any impurities. Through the service ports blended refrigerant was carefully added to the system to charge a mass of 150 gm. into the system.

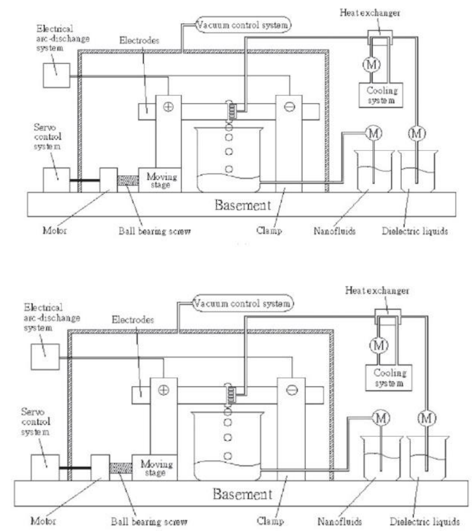

Fig 2. Experimental set up of titanium dioxide preparation flow chart

III. PERFORMANCE TEST

A performance test is made for 150 gm. of pure R134a system which is treated as the basis for comparison with other results. Blended R134a-TiO_2 with 0.1% concentration was feed to the experimental setup and the tests were conducted under the same conditions. In order to obtain repeatability each test was run for 3 to 4 times.

3.1 Factors affecting Refrigeration System

The important factors affect the performance of refrigeration system is Coefficient of Performance (COP) and Energy Factor (EF).

a) Coefficient of Performance

COP = Heat Removal / Work Input

b) Energy Factor

EF = Cooling capacity / Power consumption

IV. RESULT AND DISCUSSION

The refrigerator performance test included energy consumption test and COP test. The test requirements are that the average temperature of fresh food storage compartments is less than 5˚c. The test was carried out every 5mintues gap of each interval. Initially 3.5kg of water is taking into test for cooling. At that time the atmospheric temperature and water initial temperature is note downed as 35˚c and 30˚c respectively. The amount of blended mixture and pressure at inlet and outlet of condenser, compressors are noted. The 1/8hp reciprocating compressor is used for circulate refrigerant in entire circuit tube.

V. CONCLUSION

1. The advantages of the use of nanoparticles in a domestic refrigerator was investigated experimentally. The main conclusions are listed as follow:
2. (1) The HFC134a refrigerant and titanium dioxide blended mixture worked normally and efficiently in the domestic refrigerator.
3. (2) The energy consumption of the HFC134a refrigerant with titanium dioxide blended mixture as was saved with 8.1% less energy consumption used with 0.1% mass fraction of 80% R143a +20% TiO_2.

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