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"AN EXPERIMENTAL ANALYSIS OF THE PERFORMANCE OF REFRIGERATION SYSTEM BASED ON (R134a + SiO_2) REFRIGERANT"

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ABSTRACT

In this paper , study deals with the experimental investigations of the performance of a vapour compression refrigeration system based on (R134a + SiO_2) nanorefrigerant. The experimental setup is build up as per the national standards of India, and made to function under varying conditions. Throughout the research work, an effort is made for analysing the effect of that of the nanoparticles on the performance of that of the refrigeration system. R134a is used as the base refrigerant which is one of the refrigerants used commonly . Silicon oxide (SiO_2) nanoparticles of size (60-70) nm were being employed in that of the refrigeration system. Two concentrations of the nanoparticles were used. Observations revealed that there was an improvement in that of the thermo-physical properties of refrierant and also in the performance of the refrigeration system by the addition of silicon oxide nanoparticles into the refrigerant. The COP of the system was also seen to be improved during that of the investigations (15.9%).

KEYWORDS : *Silicon oxide nanoparticles, Nanorefrigerant, Thermal conductivity, The COP of the system, Energy consumption.*

I. INTRODUCTION

In cooling and heating applications, thermo–physical properties of matter play a great role. Various properties are there which are supposed to affect the performance of any system like, specific heat, viscosity, thermal conductivity and density of gasses and liquids which are used in the system. The Conventional fluids have low capacity to transfer heat and less thermal conductivity that limits its performance. . Small solid additives usually in micrometer are good option for the enhancement of the thermal properties of the fluids, but it is also seen that these small solid additives posses number of problems like particle sedimentation, particle clogging etc. It is possible to bring down the limit of the conventionally used solid particles suspension by taking up the point of nanoparticle fluids suspensions. These suspensions which are of nanoparticle-fluid are known as nanofluids, which are produced by mixing the particles that have size in the order of the nanometers into the base fluids like, water, oil etc. Nanoparticles like those of metallic oxides (Al_2O_3, CuO, SiO2), ceramics of nitrides (SiN, AlN), semiconductors (TiO2, SiC), carbides (TiC, SiC), metals like (Cu, Ag), carbon nanotubes having single, double or multi

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walls are used. The performance and the thermal conductivity is seen to be improved even at the quiet small concentrations of that of the nanofluids. They show large improvement if their temperature and concentrations are increased.

II. EXPERIMENTAL SETUP

This topic deals mainly with the description in detail of the techniques present and investigated for conducting the experimental research on that of the domestic refrigerator. The techniques used for charging the nanoparticles and also the discussion of the techniques for the evacuation of the system is done here.

2.1 Layout of the Vapor Compression System

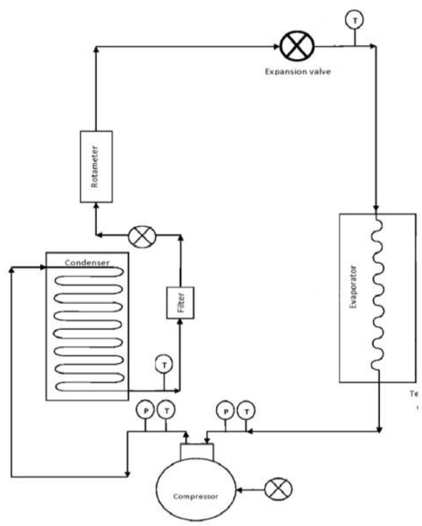

Fig 1.Schematic diagram of the Vapor Compression System

Table 1.Experimental Setup & Components

S.No.	Component	Specification
1	Compressor (R134a)	165 liter
2	Expansion device (Manual)	as per compressor
3	Condenser	as per compressor
4	Evaporator	as per compressor
5	Heating element	230 W
6	Pressure gauge	1low,1high pressure

7	Rotameter	6.5-76 LPH
8	Refrigerant	99.9% pure R134a
9	Volt meter	0-300 Volt
10	Ampere meter	0-5Amp.
11	Temperature gauge (Thermometer)	Digital thermometer
12	Flexible charging Line	--

III. .EXPERIMENTAL PROCEDURE

The experimental setup consists of compressor ,expansion device and an evaporato section .Capillary tube is used as an expansion device. The test rig is placed in a constant room temperature with proper insulation. 500 gm water which is at 45 ^{0}C is kept into the Evaporator for 1 hour. All readings are noted down for the unit volume flow rate (25 LPH). First collection of the data is done for the pure refrigerant R134a and then nanorefrigerant is introduced with two mass fractions 0.30% (wt.) of refrigerant charged mass and again 0.50% (wt.) of the refrigerant charged mass. The charged mass of the gas is 200 gm. Using the nanoparticles which ranges between 60-70 nm size, the experiments are performed. Tests are done for the investigation of the consumption of the power, COP of the system, gain of temperature in the evaporator, drop in the temperature in the condenser, temperatures at every salient points within the system. The temperature which is observed for the refrigerant at the inlet section and at the outlet sections for each of the component is measured with digital themometer.Firstly refrigerant is extracted from the system which was previously present into the system. After the charging of the system with that of the refrigerant R134a and which weighs 200gm. Now the system made to run and is switched on and system is allowed to attain steady state in approximately one hour. After the achievement of the steady state, readings of the pressures at the compressor's suction and discharge sections and temperature's readings at the inlet and outlet points of the evaporator and the condenser were taken at the interval of 10 minutes. Observation and recording of the surrounding temperature is done regularly. At the start and at the end of the experiment readings for voltmeter and ammeter are also noted. For finding the COP of the system data collection is done. Same procedure is adopted for nanorefrigerant R134a + SiO_2 (60-70 nm) 0.30% mass fraction, nanorefrigerant R134a + SiO_2 (60-70 nm) 0.50% mass fraction. After analyzing various parameters, evaluation of the performance of the refrigeration system is done.

3.1.Charging of nanoparticles

Measured & required quantity of SiO_2 is taken and weighed in digital weighing machine. After this with the help of vacuum pump old refrigerant which is present there in the system is removed. Nanoparticles are placed in charging line. Then R134a refrigerant which carries the nanoparticles along with it is made to charge the refrigeration system through the charging line. Thus the system is now said to be charged with the nanorefrigerant.

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3.2.Important Specifications

Refrigerant charged mass – *200 gm*

Concentration of the nanoparticles – *0.60gm (0.30%) and 0.100(0.50%) gm*

Size of nanoparticles – SiO_2 (60-70nm)

IV. RESULTS AND DISCUSSION

After the experiment was conducted using R134a refrigerant in its basic form, refrigerant R134a + 0.30% SiO_2 and with refrigerant R134a + 050% SiO_2 readings were recorded for the temperature, pressure, power at 25 LPH volume flow rate, for the temperature-time analysis of the cooling load. Graphs are drawn for the coefficient of performance (COP) of the refrigeration system, drop of temperature in the condenser and gain in the temperature in the evaporator. All the parametes are summarized in graphs below.

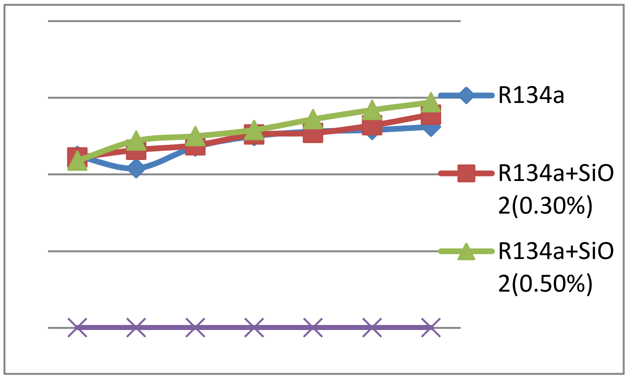

Fig. 2.Temperature drop in condenser for nanorefrigerants

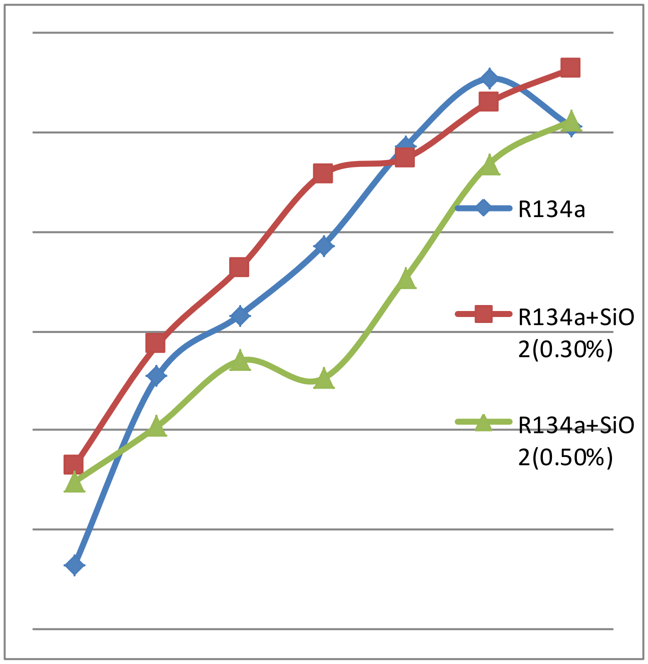

Fig. 3. Gain in temperature across the evaporator for nanorefrigerants

4.1.The Coefficient of performance (COP)

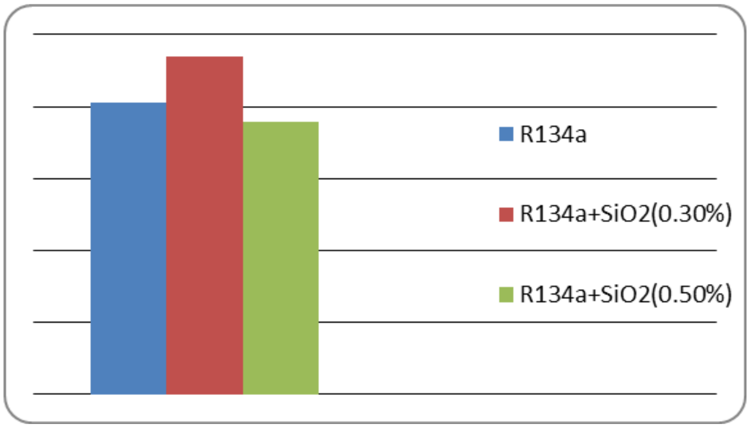

Fig. 4. Comparison of the COP for the Nanorefrigerants

V. CALCULATION

1. All readings were noted dowm at 25 LPH rate of volume flow.
2. A study for the nanoparticles at both the concentrations was done for analyzing the drop in the temperature across the condenser, the gain in the temperature along the evaporator, COP for the system and the temperature-time chart.
3. The thermo physical properties and the heat transfer characteristics of the refrigeration system are seen to be improved when Silicon Oxide nanoparticles were added to the pure refrigerant.
4. Observations have also revealed that the temperature drop across the condenser is higher for the nanorefrigerant (7.43%) as in comparison to that of the pure refrigerant R134a. Similarly, a cumulative gain of 10.67% was obtained for the evaporator temperature. During the investigations it is seen that COP has been improved (15.9%).
5. It was also seen that if the nanoparticles are added more than certain amount it shows reverse effect as the drop in the temperature across the condenser id higher for the nanorefrigerant (7.43%) as in comparison to pure refrigerant R134a. But instead of gain, lose of 13.95% was obtained for evaporator temperature. An also decrement in COP was also observed during the investigations (6.53%).

There is an indication based upon study that the operation of the refrigeration system is normal and usual with nanorefrigerant like that of any conventional refrigeration system.

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