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Experimental Investigation of the Ag-Nano Lubricant Effect on Air Conditioning Performance

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ABSTRACT

The use of nanotechnology has expanded in recent years and has entered the fields of heat transfer. The most important fields are cooling and the air conditioning system. present work conducted with the energy consumption and the coefficient of performance for air conditioning to indicate the influence of the adding Ag Nanoparticles to mineral Oil (MO4E) on the COP. Five concentration of Ag/MO 4E mixed in two steps which are kept the mixture in ultrasonic and then in mixing devices. The energy consumption was decreased with concentration until reach to 0.1% and 0.15% which acted minimum then increase while the COP increase with adding Ag nanoparticles and the optimum enhancement was 144.74% at the concentration 0.15%Ag. So that, it may be increase the performance of the system by mixing the nanoparticles with the lubricant oil.

Keywords:
Energy consumption; coefficient of performance (COP); Ag nanoparticles; air conditioning.

1. Introduction

Nano lubricant is developed lubrication kind which reduce the friction losses and enhance the heat transfer. The literature studies on thermal properties of Nano lubricant are found. Nano lubricant is developed lubrication type which reduce the friction losses and enhance the heat transfer. Nano lubricant made from adding Nanoparticles to oil that is use in a compressor of air conditioning system.

The literature studies on thermal properties of Nano lubricant are found. An experimental study by Kedzierski [1] was presented for the concentration of oil with CuO nanoparticles with the temperature gauge 288 K - 318 K and atmospheric pressure. The results show that increase the density and viscosity of Nano oil with increasing of the mass fraction of nanoparticles. As well as his other experimental study [2] for the concentration and kinematic viscosity concentration of the oil with Al_2O_3 nanoparticles at atmospheric pressure of the temperature 288- 318 K. Results showed that the decreasing and increasing in the viscosity of oil-Al_2O_3 related with the mass fraction and

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temperature while the density was decreased with temperature and increased concentration of Al_2O_3 nanoparticles. The thermal conductivity and viscosity of (0.1 - 2%v) Al_2O_3 with R141b nano-refrigerant were investigated by Mahbubul *et al.,* [3] Of the effects show that increasing the viscosity with increase the volume concentrations of the nanoparticles for the temperature 5 to 20 °C and decreases with rising the temperature. An experimental study by Zhelezny, VP *et al.,* [4] was investigated on the density, viscosity, and solubility for R600a-mineral oil-Al_2O_3/TiO_2. The results showed that increase the solubility, viscosity and density when adding the nano particles to lubricant oil, while reduce the surface tension. Peng *et al.,* [5] investigated the the pressure drop when adding CuO nanoparticles to R113 for a horizontal tube. The results showed that the maximum increased value of pressure drop was 20.8% for Nano fluid. Abdel-Hadi *et al.,* [6] studied influence of adding CuO nanoparticles to R134a pure refrigerant on heat transfer in vapor-compression system where the maximum enhancement value was 0.55%. Kumar and Elansezhian [7] investigated freeze capacity and energy consumption by adding Al_2O_3 to PAG oil / R134a in a vapor-compression refrigeration system. Kasni *et al.,* [8] carried out the subcooling effects on system COP for a residential air conditioning using R410A as working fluid, with a compressor capacity of about 0.75 kW. Their results showed that the use of condensate water reduces the refrigerant temperature in the condenser outlet by 2.7 ^{o}C.

This work focuses on the investigation of enhancing the coefficient of performance and reducing the energy consumption of the air conditioning process. The objective of this research is for studying the effect of utilizing (Ag-R22) Nano fluid as a heat transfer agent in the performance of the air conditioning system. From results, the maximum enhancement in the COP with the adding (Ag) nanoparticles to the refrigerant R22 by 0.15% wt. and increased by (144.71) %.

2. Methodology

The division of the heat acquired from evaporator (q_L) to the energy consumption in compressor (w_{in}) result in the coefficient of performance COP for the suit, that one is used to express the system activity. All these parameters can be found from the p-h diagram, which is shown in the Figure 1, and they are used to ability started from the next equations [9].

$$q_L = h_1 - h_4 \tag{1}$$

$$w_{in} = h_2 - h_1 \tag{2}$$

The enthalpy established of the limited temperature for using cooling system R22 table, so the coefficient of performance may be studied for [9]

$$\text{coefficient of performance} = \frac{q_L}{w_{in}} = \frac{h_1 - h_4}{h_2 - h_1} \tag{3}$$

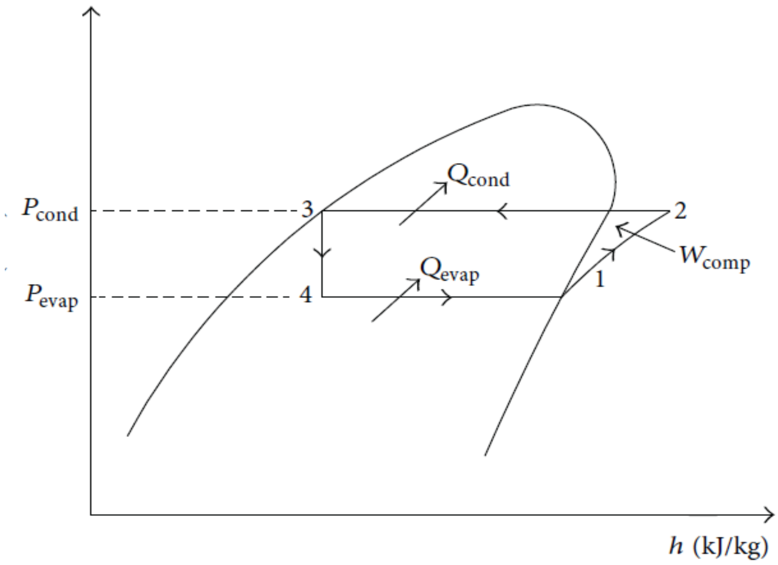
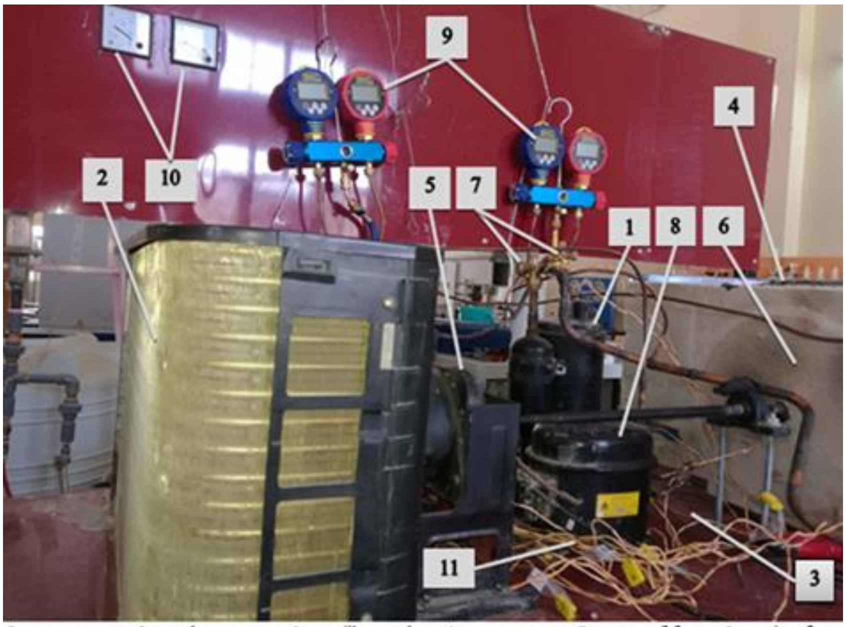


Fig. 1. The (p-h) graph in the refrigerant R22 in cooling rotation

3. Experimental Part

Windows in the air conditioning suit is utilized for experimental test which is include evaporator, compressor, condenser, and capillary tube as well as fans, vacuum pump, thermometer, voltmeter, gages pressure electronic weight, ammeter, thermocouples type K and gage pressure as Shown in Figure 2 and the Figure 3 is indicated The schematic diagram of air conditioning in close system with main components. The system air is discharged from inner air before charging the refrigerant R22 gas by vacuum pomp. The Nano-lubricant is charging to compressor after separating from rig and discharging the firstly oil as shown Figure 4. And The experimental rig was built to study the effect adding of the two types of Nano-refrigerant in different concentrations on the efficiency of the air conditioning, the consumption energy and the refrigeration effect with the constant mass of refrigerant R22[10].



1-compressor 2-condenser 3- capillary tube 4-eavaporator 5-motor of fans 6-suction fan
7-net valves 8-air compressor 9-gage pressure 10-ameter and voltmeter 11-thermocouple

Fig. 2. The experimental system of the air conditioner

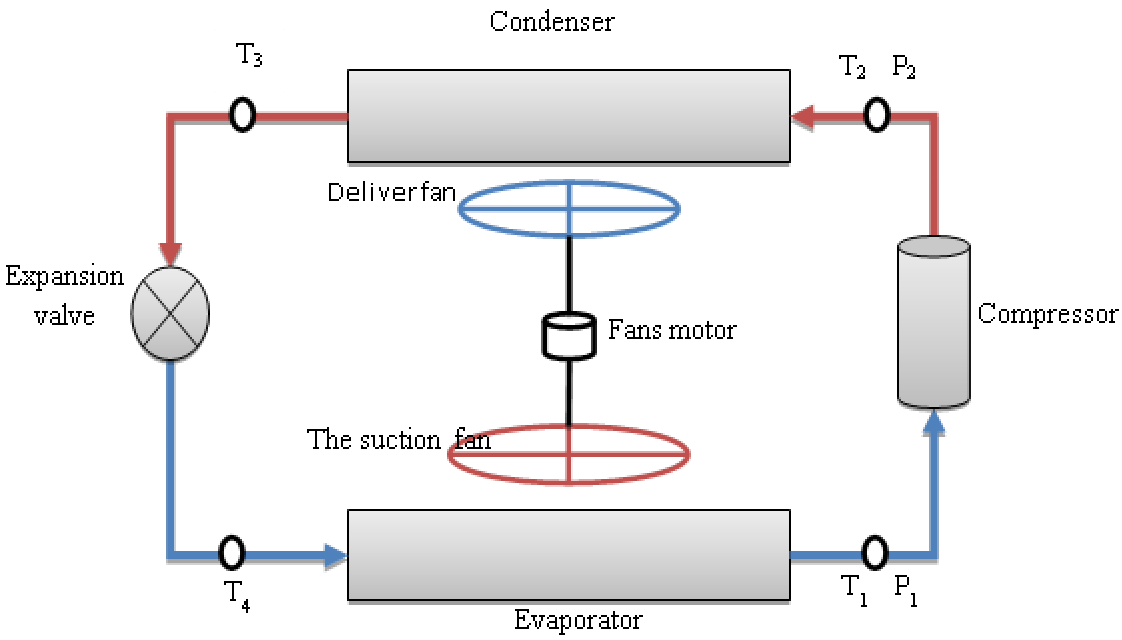


Fig. 3. The outline of air condition system

Fig. 4. The steps for the loading oil into the compressor

4. Preparation Nano Lubricant

The nanoparticles Ag at 20nm are added to the mineral oil 4E as a lubricant oil to make the mixture of Nano lubricant with used in this study. The mass fraction is determined for the Eq. (4) [11]. Table 1 mention the possession of the nanotechnology.

$$\emptyset = \frac{m_n}{m_o + m_n} \tag{4}$$

Specific heat of the Nano lubricant oil and Nano-oil refrigerant are calculated from below equations [12].

$$Cp,n,o = (1-\emptyset n)\ Cpo + \emptyset n\ Cpn \quad (5)$$

Table 1
The possession of Ag

Nanoparticle	Density Kg/m3	Size nm	Morphology	Purity	Color
basic-Ag	10500	20	Nearly spherical	99+%	black

For preparation of the Nano lubricant, two steps are done after weighting the amount of Nanoparticles Ag as shown in Figure 5(a), in the first step, the mixture kept in the ultrasonic device at 40°C and 10 min, as shown in Figure 5(b). while electrical mixture device is used for 30min in the second step as shown in the Figure 5(c). The same of making ready of Nano fluids when using Nano refrigrent R134a with CuO nanoparticles [13] and investigation of COP for Air-Conditioner system through addition TiO2 nanoparticles to a mineral oil as a base fluid while the refrigerant R22 [14]. For the results showed that COP enhancement with adding Nanoparticles and R600a / Al_2O_3 [15].

(a) (b) (c)

Fig. 5. The making ready of Nano fluids

5. Results and Discussion

The comparison between different concentrations of the Ag nanoparticles in MO4E is done in this study to indicate effect of adding nanoparticles to lubricant oil on the heat transfer and the saving energy. When the comparing results to another search for analysis of performance Nano fluid in pipe was investigated by Nanoparticles increase the heat transfer rate by increasing the thermal conductivity for the standard liquid. The results showed the heat transfer raise through Ag/Heg via out of k-ε turbulence model as Nusselt number raise for the Reynold number [16].

In this compression, five mass fractions which are (0.01, 0.05, 0.1, 0.15 and 0.2) %Ag used in experimental test the outlet temperature of the compressor with these concentration show in Figure 6. So, the 0.1% Ag was better one which is equal to 77.5°C.

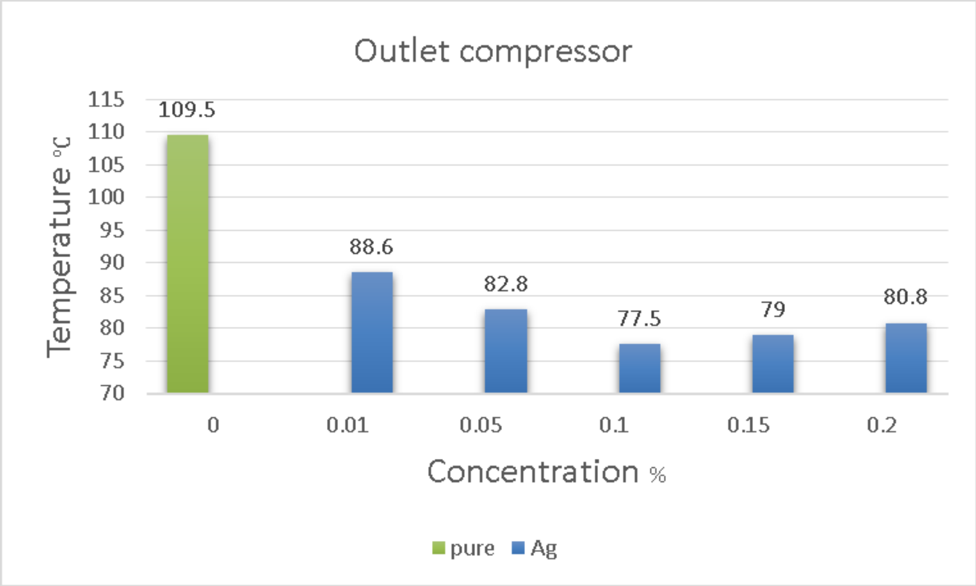


Fig. 6. The making ready of Nano fluids

Effect of Nano fluids on the energy consumption is shown in Figure 7 where they are lower at two concentrations 0.1% and 0.15% Ag-MO4E mass fraction which is equal 25 KJ/Kg.

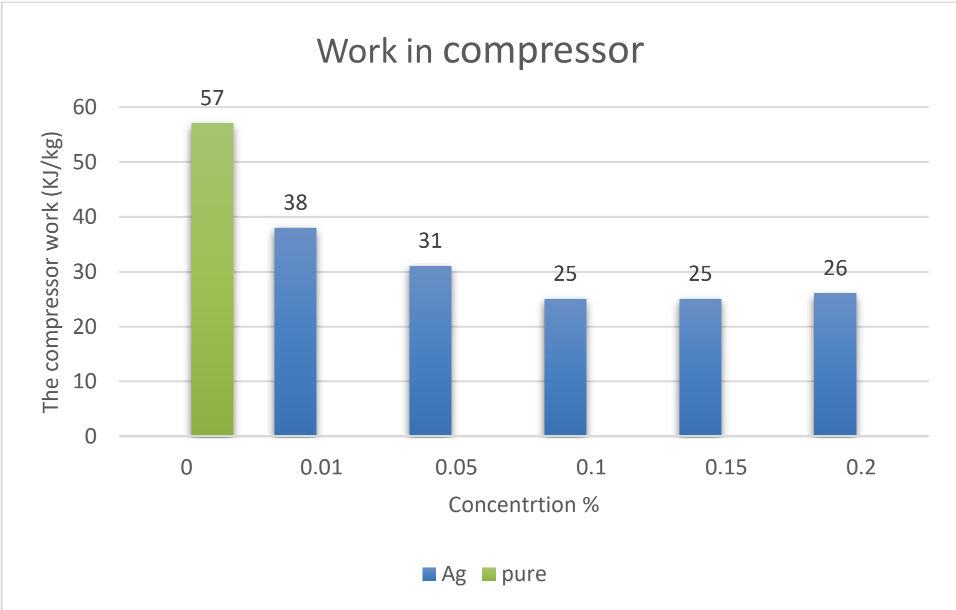


Fig. 7. The compressor work and concentration

Figure 8 show the rising with Coefficient of performance and it found that the best performance was at 0.15% Ag which is 9.064.

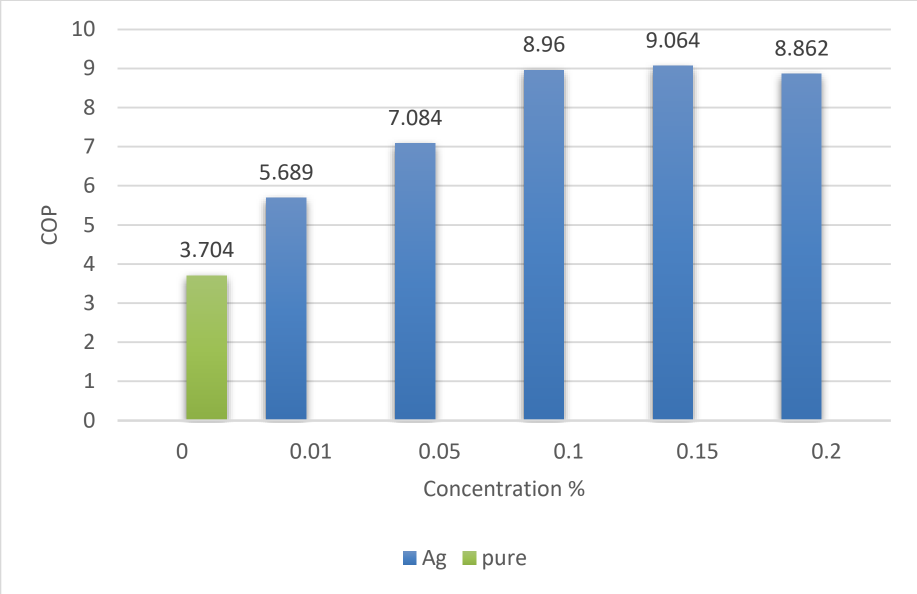


Fig. 8. Coefficient of performance

The increasing in COP for Nano lubricant has been investigated as shown in Figure 9 where the optimum concentration was 0.15%Ag. It is equal 144.9%.

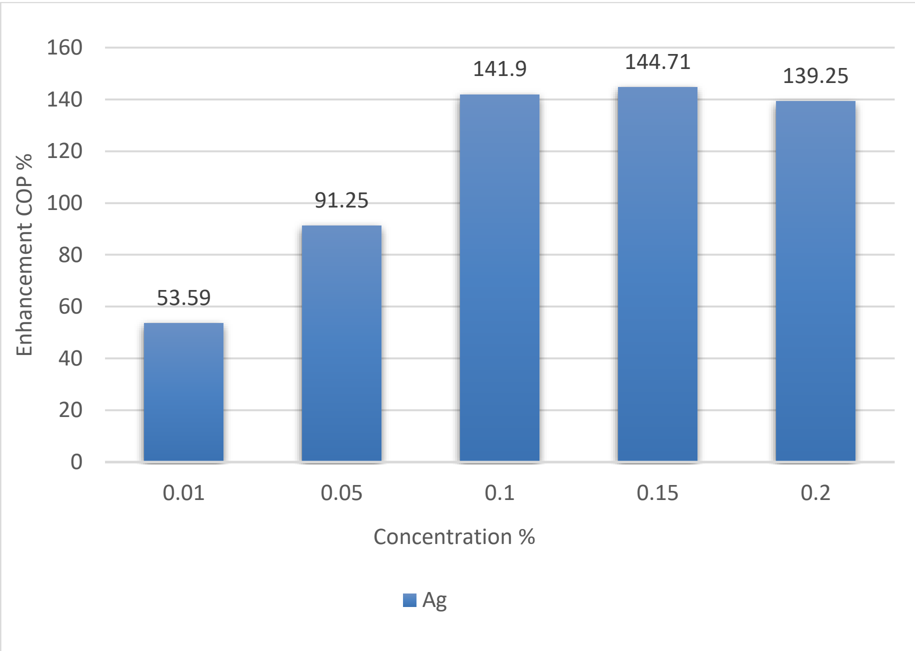


Fig. 9. The rising of cop and concentration

6. Conclusions

In this study investigation experimentally by utilizing rig test and numerically by designing 3D models through utilizing Computational Fluid Dynamics (CFD). The energy consumption is decreased with the Nano lubricant but for specified amount and the lower value was 25 kJ/kg at both concentration 0.1% Ag and 0.15% Ag. The heat transfer enhanced when using Nano lubricant where the thermal properties of R22 in evaporator were improved. The COP increased with adding nanoparticles and the optimum value was 9.064 at 0.15%Ag mass fraction. The maximum enhancement in the consumption work of the critical point was 56.14% for Ag nanoparticles. The temperature of the working fluid at the inlet compressor and outlet evaporator increase with increase mass fraction of nanoparticles. The temperature of the working fluid at the outlet compressor and inlet evaporator decrease with increase mass fraction of nanoparticles. And The temperature of the room air at the outlet decrease with increase mass fraction of nanoparticles. The pressure of working fluid decrease with increase mass fraction of nanoparticles at all location. And the pressure ratio increase with increase mass fraction of nanoparticles at all location.

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