Review on Analysis of Vapour Compression Refrigeration System Charge with Varied Concentration of SiO_2 Nano Lubricant in Domestic Refrigerator with Varied Length of Capillary Tube

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ABSTRACT This article review of varied mass charges of Liquid Petroleum Gas (LPG) in place of R134a, with varied concentration of SiO_2 nano lubricant and making the refrigerator better by using the varied length of the capillary tube. Thereby increasing of all types of properties of refrigerator enhanced with varied concentration of SiO_2 nanoparticle with mineral oil in a R134a compressor of a domestic refrigerator. It is assumed that with the use of SiO_2 nano particle refrigerant the perform of system like pull down time, power consumption through refrigerator is reduced, compressor power input, cooling capacity and coefficient of performance (COP). Analysis was based on temperature and pressure readings obtained from appropriate gauges attached to the test rig. In conclusion, LPG-SiO_2 nanolubricant mixture works safely and efficiently in domestic refrigerators with modification of capillary tube length. Using this mixer can reduce the system's irreversible process.

Keyword: Refrigeration Effect, COP, Power consumption, Refrigerant, Capillary Tube, Nano Lubricants,

1.0 INTRODUCTION

In this paper the application of nanoparticles as lubricant with varied concentration as lubricant additives has been investigated in many fields. Nano lubricant, which was prepared by dispersing nanoparticals in lubricant, performed better than base fluid when using in refrigeration compressor. With or without change of refrigeration system without replacement of refrigeration equipments like evaporator, compressor, condenser and some changes of capillary tube length. Several works have applied nanolubricant in vapour-compression refrigeration systems and found that it is an effective way to reduce refrigerator ir-reversibility, enhance energy efficiency ratio of domestic refrigerator and residential air conditioners, as well as increase the coefficient of performance of the refrigeration system. In a domestic refrigerator, lubricant plays roles of lubricating internal parts, cooling the compressor during working, cleaning the system, and circulating with refrigerant as working fluid. Therefore, there were two main causations for the improving performance of refrigeration system using nanolubricant. On one hand, adding of nanoparticles should change tribological properties of the lubricant, which could improve the energy efficiency of refrigerating compressor [2]. Energy performance analyses can be used to increase utilization proficiency of energy resources of various thermodynamic system. Besides , substantial advancements has been witnessed in numerous applications that employed these analyses recently [1]. Damola S Adelekan[3] found that TiO_2 nanoparticles increased the density and viscosity of base lubricant (synthetic polyolester) and mineral oil, while discovered the same tendency by dispersing Si nanoparticles into mineral oil [3]. Jatinder Gill[1] investigated the friction and antiwear characteristics of TiO_2, SiO_2 ,Al_2O_3 added nanolubricant mix with mineral oil in scroll compressors. The result indicated that the fullerene nanoparticles improved the lubrication property of base lubricant by coating the friction surfaces. And higher volume concentration of these nanoparticles resulted in the lower friction coefficient and less wear. Further more, the viscosity of lubricant played a major role in the wear behavior of sliding contacting surfaces experiencing extreme contact pressure conditions [5]. The nanoparticle is used in chillers for increasing system performance. The increasing concentration of nanoparticles (TiO2) in refrigerant increases the performances of the system due. decreasing compressor work done and enhance heat transfer rate [6]. For hot and dry climate condition, performances of air-cooled condenser minimize, and C.O.P. decreases extensively in chillers due to heat transfer rate decreases in the condenser. In the condenser, nano-refrigerants are not cool at the desired level, and the system was faulty. These drawbacks of the nano-particles mixed refrigerator have promoted the research and improving heat rejection rate in the condenser. In this article, vapour compression refrigeration system coupled with evaporative cooling pad, and nano-refrigerant, for improving the performance of the system in hot & dry weather is proposed and compared experimentally [7]. Combined evaporative cooling system and ice plant test rig have been proposed for the appropriate heat rejection offered in the condenser due to a faulty system run at high pressure. The experimental investigations revealed that the performance characteristics of the evaporatively-cooled condenser are significantly enhanced. Maximum COP [8]. lubricant selected for a refrigeration system must be suitable for lubricating the type of compressor used in the refrigeration system have the appropriate miscibility and solubility characteristics with the refrigerant fluid. This work is a performance study that investigated the nanorefrigerant CuO/Al_2O_3-R22 used in a refrigerator without any remodeling of the system. The refrigerator performance was then investigated using energy consumption test and enhancing heat transfer rate. The heat transfer enhancement was investigated on the surface of a refrigerator by using the nanorefrigerant Al_2O_3/CuO. The results indicate that CuO-R22 works normally and safely in a refrigerator and has better power consumption and heat transfer rate. Thus, using CuO-R22 as nanorefrigerant in domestic refrigerators is feasible for better heat transfer rate [15]. In this work, the thermodynamic performance of a domestic refrigerator was experimentally studied by simultaneously varying the refrigerant charge (mr) and the capillary tube length (L). The potential of replacing R12 by R600a was also investigated [9].The effects of L and mr on the performance parameters were analyzed for both R600a and R134a, with the objective of obtaining the best values of L and mr and to study the feasibility of using R600a in a VCRS designed for R134a. the effect of L on the system COP; the COP increases with increase in L for all values of mr. Instantaneous power consumption is the main criterion to choose a right quantity of mass charge [10].Performance tests were performed with different evaporator temperatures under controlled ambient conditions. The results showed that the R134a/LPG mixture has a higher coefficient of performance (COP) than R134a by the studied range. The applicability of adaptive neuro-fuzzy inference system (ANFIS) to predict the COP of R134a/LPG system was also investigated. An ANFIS model for the system was developed. The comparison of statistical analysis of mathematical and ANFIS models predictions respectively in terms of the absolute fraction of variance , the root mean square error and the mean absolute percentage error showed that ANFIS model gave the better statistical prediction [11]. In this paper, experimental results on the performance of liquefied petroleum gas (LPG) as a possible substitute for refrigerant R-12 in domestic refrigerators are presented. LPG is obtained from the local market with the composition of about 30% propane, 55% n-butane and 15% iso-butane by mass fraction. The domestic refrigerator used was designed to work on R-12. Various mass charges of 50, 80 and 100 g of LPG were used during this study [12]. In this work, the experimental examination was carried out using a mixture of R134a and LPG refrigerant (consisting of R134a and LPG in a proportion of 28:72 by weight) as a replacement for R134a in a vapor compression refrigeration system. Exergy and energy tests were carried out at different evaporator and condenser temperatures with controlled environmental conditions. The results showed that the exergy destruction in the compressor, condenser, evaporator, and a capillary tube of the R134a / LPG refrigeration system was found lower by approximately 11.13–3.41%, 2.24–3.43%, 12.02–13.47% and 1.54–5.61% respectively. The compressor exhibits the highest level of destruction, accompanied by a condenser, an evaporator and a capillary tube in refrigeration systems. The refrigeration capacity, COP and power consumption of the compressor of the R134a /LPG refrigeration system were detected higher and lower compared to the R134a refrigeration system by about 7.04–11.41%, 15.1–17.82%, and 3.83–8.08% respectively. Also, the miscibility of R134a and LPG blend with mineral oil discovered good. The R134a and LPG refrigerant mixture proposed in this study perform superior to R134a from component-wise exergy and energy analyses under similar experimental conditions [14]. This paper experimentally investigated and also modeled using artificial neural networks (ANN) approach the energy analysis of a domestic refrigerator using selected charges of LPG refrigerants (40, 50, 60 and 70 g) and different concentrations (0, 0.2, 0.4 and 0.6 gL^{-1}) of TiO_2-based nanolubricants as replacement for R134a refrigerant. The parameters for energy analysis include: compressor power consumption, cooling capacity, COP, compressor discharge temperature and pressure ratio. The findings showed that cooling capacity and COP of the domestic refrigerator using LPG refrigerant with TiO_2 nanoparticles dispersed in a mineral oil lubricant was found to be higher than that of R134a by around 18.74–32.72 and 10.15–61.49%, respectively. Furthermore, compressor power consumption and pressure ratio of the domestic refrigerator using LPG refrigerant with TiO_2–mineral oil lubricant were also found to be lower than that of R134a by about 3.20–18.1 and 2.33–8.45%, respectively, under similar conditions. The compressor discharge temperature was also found to be lower using LPG refrigerant with lubricant TiO_2–mineral oil than R134a [16]. This article present an experimental investigation of varied mass charges of Liquefied Petroleum Gas (40 g, 50 g, 60 g and 70 g) enhanced with varied TiO_2 nanoparticle/mineral oil concentrations (0.2 g/L, 0.4 g/L and 0.6 g/L nano-lubricants) in a R134a compressor of a domestic refrigerator. Performance tests investigated at steady state included: pull down time, power consumption, compressor power input, cooling capacity and coefficient of performance (COP). Analysis was based on temperature and pressure readings obtained from appropriate gauges attached to the test rig. Refrigerant property characteristics were obtained using Ref-Prop NIST 9.0 software. Results obtained showed almost equal evaporator air temperatures and reduction in power consumption for all tested nano-lubricant concentrations except at 70 g charge of LPG using 0.6 g/L nano-lubricant. Furthermore, the lowest compressor power input was found to be 21 W and obtained using 70 g of LPG with either of 0.2 g/L or 0.4 g/L nano-lubricants. At 70 g of LPG using 0.6 g/L concentration of nano-lubricant, highest cooling capacity index of 65 W was obtained while the highest COP of 2.8 was obtained with 40 g charge of LPG using 0.4 g/L concentration of nanolubricant. In conclusion, LPG-TiO2 nano-lubricant mixture works safely and efficiently in domestic refrigerators without modification of capillary tube length, but requires adequate optimization[21].

2.0 DIFFERENT PARTS USED IN VAOOUR COMPRESSON REFRIGERATION SYSTEM

2.1 Evaporator

One kind of evaporator is a kind of radiator coil used in a closed compressor driven circulation of a liquid coolant. That is called a refrigeration system to allow a compressed cooling chemical, such as R-22 (Freon) or R-410A, to evaporate/vaporize from liquid to gas within the system while absorbing heat from the enclosed cooled area, for example a refrigerator or rooms indoors, in the process. This works in the closed refrigeration system with a condenser radiator coil that exchanges the heat from the coolant, such as into the ambient environment.

2.2 Expansion Device

Expansion device is also known as throttling device is an important device that divides the high pressure side and the low pressure side of a refrigerating system. It is connected between the receiver and the evaporator containing liquid refrigerant at high pressure and liquid refrigerant at low pressure). The expansion device performs the following function. It reduces the high pressure liquid refrigerant to low pressure liquid refrigerant before being fed to the evaporator. It maintains the desired pressure difference between the high and low pressure side of the system, so that the liquid refrigerant vaporizes at the designed pressure in the evaporator. It controls the flow of refrigerant according to the load evaporator.

2.2.1 Capillary tubes

Capillary tube is one of the commonly used throttling devices in the refrigeration and the air conditioning systems.The capillary tube is a tube whose diameter is less than 1 cm. This tube is used to reduce pressure and temperature. We want to use the length of the capillary tube in this experiment by changing it. So that the result of our project is good.

2.3 Compressors

A compressor is the most important and often the costliest component (typically 30 to 40 percent of total cost) of any vapour compression refrigeration system (VCRS). The function of a compressor in a VCRS is to continuously draw the refrigerant vapour from the evaporator, so that a low pressure and low temperature can be maintained in the evaporator at which the refrigerant can boil extracting heat from the refrigerated space. The compressor then has to raise the pressure of the refrigerant to a level at which it can condense by rejecting heat to the cooling medium in the condenser.

2.4 Condenser

It is ultimately in the condenser that heat is rejected in a VCRS refrigeration machine. The vapour at discharge from the compressor is super heated. Desirer heating of the vapour takes place in the discharge line and in the first few coils of condenser. It is followed by the condensation of the vapour at the saturated discharge temperature. In some condensers, subcooling may also takes place near the bottom where there is only liquid. However ,the sensible heat of the latent heat of the condensation process.

3.0 NANO LUBRICANTS

The tribological properties of surface modified SiO_2 nanoparticles suspension in water-based lubricant have been studied. SiO_2 (5-15 nm) nanoparticles were dispersed through surface modification with mineral oil. Transmission electron microscope (TEM) and infrared (IR) spectroscopy show that SiO_2 nanoparticles disperse well and stably in the water-based lubricant. The diameter of the nanoparticles is about 30-40 nm. Tribological properties of the water-based lubricant were evaluated using four-ball wear test machine and pin-on-disk tester under different loads and different concentrations of SiO_2 nanoparticles. Wear surface morphology, element chemistry configuration of steel balls and steel rings were studied by means of X-ray photoelectron spectroscopy (XPS) and scanning electron microscopy (SEM). Results show that the tribological properties of the water-based fluid have been improved by addition of nanoparticles ranging from 0.1% to 0.3% concentrations. SiO_2 nanoparticles deposited onto the wear surface during the sliding, which helped to reduce the friction coefficients and increase the anti-wear properties due to the miniature ball bearing effect and self-repairing performance of nanoparticles between the friction pairs. With the increase of test load, the friction coefficients decrease but the wear of the surface increase.

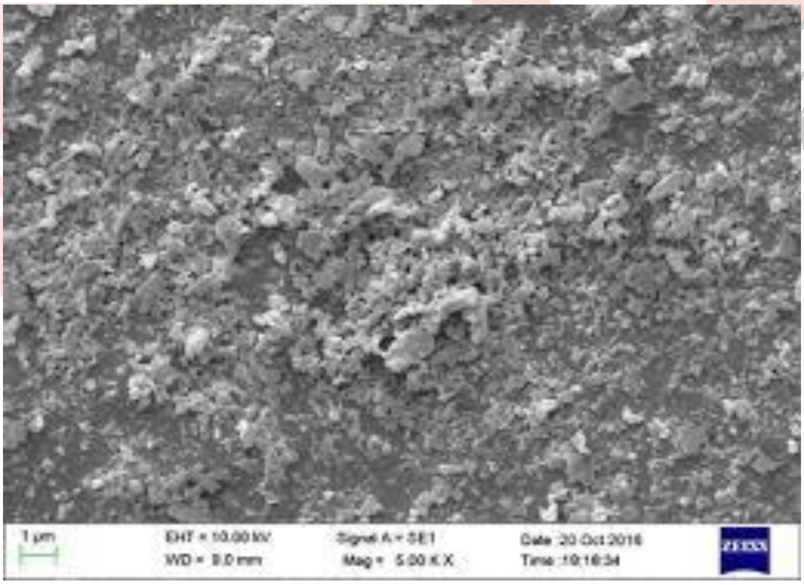

Fig.1- SiO2 (5–15 nm), Nano particals [1]

4.0 REFRIGERANTS

A refrigerant is a substance or mixture, usually a fluid, used in a heat pump and refrigeration cycle. In most cycles it undergoes phase transitions from a liquid to a gas and back again. Many working fluids have been used for such purposes. Fluorocarbons, especially chlorofluorocarbons, became commonplace in the 20th century, but they are being phased out because of their ozone depletion effects. Other common refrigerants used in various applications are ammonia, sulfur dioxide, and non-halogenated hydrocarbons such as propane.

4.1 R12

Dichlorodifluoromethane (R-12) is a colorless gas usually sold under the brand name Freon-12, and a chlorofluorocarbonhalomethane (CFC) used as a refrigerant and aerosol spray propellant. Complying with the Montreal Protocol, its manufacture was banned in developed countries (non-article 5 countries) in 1996, and developing countries (article 5 countries) in 2010 due to concerns about its damaging impact to the ozone layer. Its only allowed usage is as fire retardant in submarines and aircraft. It is soluble in many organic solvents. Dichlorodifluoromethane was one of the original propellants for Silly String. R-12 cylinders are colored white.

4.2 R22

Chlorodifluoromethane or difluoromonochloromethane is a hydrochlorofluorocarbon (HCFC). This colorless gas is better known as HCFC-22, or R-22. It is commonly used as a propellant and refrigerant. These applications are being phased out in developed countriesdue to the compound's ozone depletion potential (ODP) and high global warming potential (GWP), although global use of R-22 continues to increase because of high demand in developing countries. R-22 is a versatile intermediate in industrial organ fluorine chemistry, e.g. as a precursor to tetrafluoroethylene. R-22 cylinders are colored light green.

4.3 R134a

R134a is also known as Tetrafluoroethane (CF3CH2F) from the family of HFC refrigerant. With the discovery of the damaging effect of CFCs and HCFCs refrigerants to the ozone layer, the HFC family of refrigerant has been widely used as their replacement. It is now being used as a replacement for R-12 CFC refrigerant in the area of centrifugal, rotary screw, scroll and reciprocating compresssors. It is safe for normal handling as it is non-toxic, non-flammable and non-corrosive.

4.4 Liquid Petroleum Gas (LPG)

LPG is instrumental in providing off-the-grid refrigeration, usually by means of a gas absorption refrigerator. Blended of pure, dry propane (refrigerant designator R-290) and isobutane (R-600a) the blend "R-290a" has negligible ozone depletion potential and very low global warming potential and can serve asa functional replacement for R-12, R-22, R-134a andother chlorofluorocarbon or hydrofluorocarbon refrigerants in conventional stationary refrigeration and air conditioning systems. Such substitution is widely prohibited or discouraged in motor vehicle air conditioning systems, on the grounds that using flammable hydrocarbons in systems originally designed to carry non-flammable refrigerant presents a significant risk of fire or explosion. Vendors and advocates of hydrocarbon refrigerants argue against such bans on the grounds that there have been very few such incidents relative to the number of vehicle air conditioning systems filled with hydrocarbons.One particular test, conducted by a professor at the University of New South Wales, unintentionally tested the worst-case scenario of a sudden and complete refrigerant expulsion into the passenger compartment followed by subsequent ignition. He and several others in the car sustained minor burns to their face, ears, and hands, and several observers received lacerations from the burst glass of the front passenger window. No one was seriously injured.Table-1 shows properties of refrigerants.

Table-1. Properties of Refrigerants

No.	Properties	R12	R22	R134a	LPG
1.	Boiling point	-29.8^{0}C	-40.7^{0}C	-26.7^{0}C	42^{0}C
2.	Ozone depletion level	.055(CCl_3F)=1	.055(CCl_3F)=1	0	0
3.	Critical Temperature	96.2^{0}C	96.2°C	122°C	104°C
4.	Global Warming Potential (GWP)	10900	1890	1200	0

5.0 CONCLUSION

The selection of nanolubricant with addition of refrigerant like Liquid Petroleum Gas with the replacement of R134a. Refrigeration lubricant is use to the type of compressor, application parameters, and, most important of refrigeration system is refrigerant fluid(LPG) and nano lubricant oil(SiO_2 with mineral oil). We have used a wide range of synthetic and mineral oil based refrigeratig oil, and suitable for domestic refrigeration applications. Our main objective is to work without any maintenance of the refrigerator for a long time and without any atmospheric pollution or green house effect. To improve COP, and refrigeration effect, and reduce irreversibility and improve the working of refrigeration system and power consumption is less compression other refrigeration system.

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