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# "INVESTIGATION ON PERFORMANCE ENHANCEMENT OF DOMESTIC REFRIGERATOR USING NANOREFRIGERANT/NANOLUBRICANT"- A REVIEW

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**Abstract-**Domestic Refrigerator is the essential equipment for people. Nearly there is no home without refrigerator. Thermal systems like refrigerators and air conditioners consume large amount of electric power. So avenues of developing energy efficient refrigeration and air conditioning systems with nature friendly refrigerants need to be explored. The rapid advances in nanotechnology have led to emerging of new generation heat transfer fluids called Nano fluids. Nano fluids are prepared by suspending nano sized particles (1-100nm) in conventional fluids and have higher thermal conductivity than the base fluids. The researchers continuously working on increasing cooling capacity and developing a cooling system that is energy efficient. The use of nanorefrigerant in small amount in vapor compression refrigeration system aided in improving system performance. This paper focuses on extensive literature review on thermal performance of the VCRs system used in a residential refrigerator using nanorefrigerant and nanolubricant.

**Keywords-**Vapor Compression Cycle, Performance Enhance of VCC, Nanoparticles, Nanofluids,

**1. Introduction-** Refrigeration is the necessity of today. In today's fast life we can't spare time daily for the purchase of daily needs. Hence we purchase in bulk once in a week and store it. The needs are perishable and need to take care for its preservation. Hence we always need a device to keep the perishables in good condition. Hence the refrigerator is essential and used equipment in every house for preservation of food. The refrigerator is working on simple vapor compression cycle. Type of compressor used in domestic refrigerator is the hermetically sealed compressor A hermetic or sealed compressor is one in which both compressor and motor are confined in a single outer welded steel shell. The motor and compressor are directly coupled on the same shaft, with the motor inside the refrigeration circuit. The compressor shell is constructed from a steel sheet with the top cover welded together with the bottom housing. That connection is hermetically sealed, ensuring that refrigerant cannot leak to the outside. In the bottom housing oil is stored for cooling refrigerant and lubrication purpose. There are three main purposes of the oil. They are used for lubrication, removal of heat and for sealing. The many researchers tried to improve the performance of domestic refrigeration system using various methods have been summarized through extensive literature below. In a vapor compression refrigeration system the nanoparticles can be added to the lubricant (compressor oil) and the lubricant nanoparticles mixture is known as Nano lubricant. When the refrigerant is circulated through the compressor it will carry traces Nano lubricants so that the other parts of the system will have Nano lubricant-refrigerant mixture. The advantages of adding nanoparticles to the refrigeration system are manifold (i) addition of nanoparticles to the lubricant improve tribological characteristics of the lubricant, so that there are improvements in the performance of the compressor. (ii) Addition of nanoparticles to the refrigerants improves the thermo physical and heat transfer characteristics of the refrigerant which in turn results in the enhancement in the

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refrigerating effect (iii) presence of nanoparticles in the refrigeration system enhances the solubility between the lubricant and refrigerant and returns more lubricant oil back to the compressor Many tried to increase performance of vapor compression cycles. Choi and Eastman (1995) first proposed the use of NPs instead of millimeter and micrometer size particles to enhance thermal conductivity of fluids while avoiding clogging and stability problems. Therefore, researches about convective heat transfer in Nano fluids have been increasing for various applications such as electronics, air conditioning and refrigeration system.

Based on the application nanoparticles are currently made out of a very wide variety of materials, the most common of the new generation of nanoparticles being ceramics, which are best split into metal oxide ceramics, such as titanium, zinc, aluminum, copper and iron oxides, to name a prominent few and silicate nanoparticles, generally in the form of Nano scale flakes of clay. Nanoparticles can be used in refrigeration systems because of its remarkable improvement in thermo physical and heat transfer capabilities to enhance the performance of refrigeration systems.

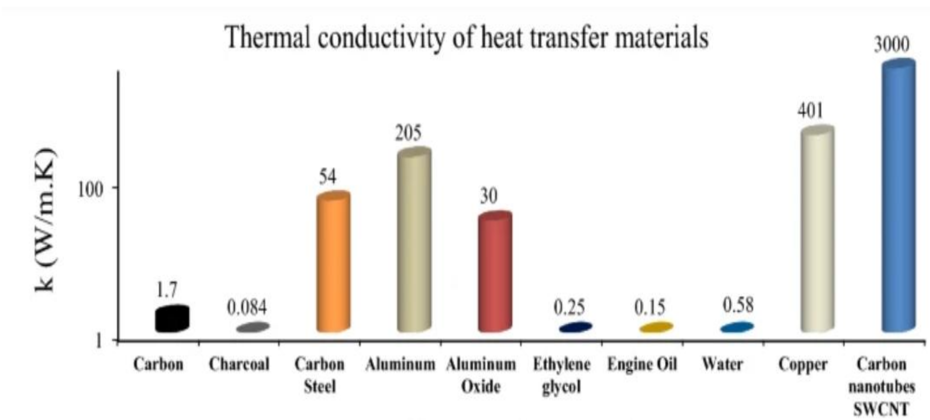


Fig 1 Thermal conductivity of different types of materials
(Abdul Kaggwa, 2019)

## 2. Literature review

Begin with a comprehensive review of existing literature related to refrigeration, domestic refrigerator technology, Nano fluids, and their applications. This will help you understand the state of the field and identify gaps for your research. Most of the refrigeration and air-conditioning systems work on the vapor compression cycle, the expansion in most practical real vapor compression cycles occurring in an expansion valve is an irreversible throttling process. This causes a reduced cooling capacity and an increased work requirement in comparison with the Carnot cycle. Many Researchers tried performance enhancement of Simple Vapor compression system by using the Following different way such as

1. By using the different type's compressors/expanders, flash chamber, accumulator or pre-cooler, economizer, ejector or diffuser, different type's refrigerants etc.
2. By using the sub cooling methods such as
   a) By sub cooling the liquid Refrigerant by using vapor refrigerant or using liquid refrigerant that is using Liquid line suction heat exchanger (LLS-HX).

b) By sub cooling the liquid Refrigerant by external cooling source such as Condenser sub cooling by supplying more amount coolant water in a condenser, using sub cooler IHX between Condenser and expansion device, mechanical sub cooling, using Auxiliary Cooling system etc.

**3.** By Using Multistage compression.

**4.** By Using the Nano fluids such as Nano refrigerant and Nano lubricants is the recent trend.

In this paper only performance enhancement of vapor compression system using Nano fluids Presented. In literature, several applications of Nano fluids in HVAC&R have been studied, both as primary or secondary fluids. In particular, some very recent papers suggested their use as lubricants in the compressors, promising improvement in the total system efficiency, due to better thermal dissipation, lower wearing and improved lubrication properties. For refrigeration applications, scientists usually investigated the use of NPs as additives with conventional refrigerants and oils in order to make refrigeration systems more efficient.

Marcucci Pico et.al (2023), Nanolubricant, dispersions of nanometer-scale particles in a conventional lubricant, have been one of the main subjects of recent studies aimed at increasing energy efficiency and durability of refrigeration systems. Zafar Said et.al (2023), Key operational factors such as nanoparticle concentration, temperature, and particle characteristics like migration, degradation, and aggregation, has a considerable impact on the performance of these nano-fluids. Notably, the thermal conductivity and viscosity of nanofluids are dependent on nanoparticle concentration and temperature, thus affecting the heat transfer performance. T.O. Babarinde, D.M. Madyira (2023), the use of nanolubricant in vapor compression systems has the potential to improve thermal performance and increase energy efficiency.Baskaran N. et.al (2022), analyzed thermo physical properties for the various volume fractions of nanoparticles & investigated the performance of nanorefrigerant (R134a-ZrO2) in a domestic refrigerator at a concentration of 0.2 g/l, they observed that the pull downtime, energy consumption, and discharge temperature are reduced with increased COP. Mustafa W. Hamdallah et.al (2021),carried out experimental investigation using CuO nanoparticles (0.003 mass fractions) in compressor oil and in R22 refrigerant. The results showed that the increasing of density ratio, COP and viscosity ratio are 3%, 50% and 1.8% respectively while the decreasing of electrical consumption is 51.2%. Marcucci Pico et. al (2020),substituted R32/diamond Nano mixture for R410A in a VCRS. The refrigeration effect and COP were raised by 0.5% and 5.0%, respectively, with 0.1% and 0.5% diamond nanoparticles, and the compressor discharge temperature was dramatically decreased. Nish et.al (2020), conducted experiments using CuO/Al2O3/ZnO nanoparticles in an R22 refrigeration system, they found, addition of 0.05% nanoparticles raised the COP by 0.62, as well as refrigeration capacity and reduced compressor power consumption. As per Senthilkumar et.al (2020),the dispersion of various nanoparticles in the compressor oils and refrigerants of vapor compression refrigeration system are considered to be prospective method to enhance the efficiency of the system. Niraj N. Raja (2020), The investigations show that nano refrigerant (R134a+ Al2O3 0.5gm/L Concentration & 50-60nm size) with evaporative condenser recorded the highest coefficient of performance.Adelekan et al. (2019), experimentally investigated energy consumption and heat transmission performance of home refrigerator using TiO2 nanoparticles 0.2 g/l, 0.4 g/l, and 0.6 g/l and they observed to reduce average power consumption. Marcucci Pico et.al (2019), tested and analyzed R410a refrigerator's performance using 0.1% and 0.5% diamond nanolubricant they found that COP increased by 4% and by 8% respectively. The refrigeration capacity increased by 7% as diamond nanoparticles concentrations increased.VitalyZhelezny et.al (2019) found adding additive fullerenes C60 with compressor oil increase the energy efficiency of the compression refrigeration machine. Imaduddin (2018) found that the COP increased by 22.5 percent when compared to R134a VCRS with and without nanoparticle in POE oil (300 ml) suspended with TiO2 nanoparticles (2.5 g).Santhana Krishnan et.al (2018),tested functionality of an $Al_2O_3$, $SiO_2$, $ZrO_2$, and CNTs nanoparticle based R134a VCRS. Veera Raghavalu & GovindhaRasu (2018) Nano-particles mixed with mineral PAG oil gives enhanced

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results than polyester (POE) oil. G. Jatinder et al. (2018), studied behavior of household cooler using different lubricant, such as R134a and LPG coolants, polyol-ester, mineral oils (MO), and TiO2, SiO2, and Al2O3 nanoparticles distributed in mineral oil. The refrigerator with a 40 g charge of LPG/TiO2–MO lubrication (0.2 g/L TiO2) had the highest COP efficiency and 2nd efficiency, with the minimum compressor energy usage and 100% irreversibility. Zawawi et.al (2017),they found the viscosity of the Al2O3-TiO2/PAG oil rose by 20%, and the thermal conductivity of the Al2O3-SiO2/PAG oil increased by 2.4%., with hydride nanoparticles (Al2O3- TiO2, Al2O3-SiO2, and TiO2-SiO2) in a rheological test. According to W.H. Azmia et.al (2017), Nanofluids show extraordinary potential in upgrading the thermodynamic and mechanical performance of the refrigeration system.Krishnan et al. (2017) analyzed the performance of nano coolant (Al2O3–R290/R600a) in a programme based simulation of VCRS. They found that heat rejection and compressor power are slightly lower in the nano coolant mix. Baskar and Karikalan (2017), with ZrO2 nanoparticle concentrations of 0.1%, 0.2%, and 0.3% (by a mass fraction) in the compressor oil, did the study to investigate cooling of the functioning of a VCRs system. The study demonstrates that using nano-oil instead of pure oil enhanced the system's COP by 7.61 percent, 14.05 percent, and 11.90 percent, respectively. Singh and Ansari (2017), carried out experimental work on the cooling system using nano refrigerant (R600a/R290), with different volumetric concentrations of CuO particles of size 20-30 nm (0.15, 0.25, and 35 g). They observed improved performance coefficient during the study (3.18%-11.57%). According to Murshed et.al(2017)&Babarinde et.al(2020b), dispersing nanoparticles into compressor oil uniformly is preferable, also studied rheological characteristics of Nanofluids, Kushwaha et.al (2016),experimentally investigated performance of refrigeration system with a nano refrigerant (R134a+Al2O3). They found that the COP increases with the usage of nano-Al2O3. Veera et.al (2016), they found that with a nanorefrigerant (Al2O3-ethylene glycol oil and TiO2-ethylene glycol oil) in an R134a VCRs, the heat transfer coefficient increases& their use in refrigeration systems is feasible. M.E. Haque et.al (2016), studied the performance of a household refrigerator by using nanolubricant (POE Oil/ Al2O3) at nanoparticle conc. of 0.05 and 0.1%., they found energy consumption reduced and freezer capacity increased. Kumar et al. (2016) investigated the performance of a VCRS with ZrO2 nanoparticle in the working liquid with conc. of 0.01% to 0.06% & particle size of 20 nm ranging with R134a and R152a. Mahbubul et.al (2013) &Mahbubul et.al (2015)used 5% Al2O3 nanoparticles in an R134a-filled refrigerator they found that COP increased to 15%, and the thermal and physical properties of the refrigerant improved. Desai and Patil& Subramanian et al. (2015) investigated experimentally performance of domestic refrigerator with SiO2 nano-oil as a viable lubricant in domestic refrigerator with different nano refrigerant. M.D. Suziyana et.al (2015)found that with 0.2% Al2O3 nanoparticles in POE oil energy consumption reduced by 2.1% and COP (improved by 2.67-3.21).V. M. Jamadar and A. M. Patil (2014)was used compressor cooling for improvement of COP of VCRs and save power consumption of compressor. R. Reji Kumar et.al (2014), their experimental studies indicate that the refrigeration system with nano-refrigerant works normally. It is found that the freezing capacity is higher and the power consumption reduces by 11.5 % when POE oil is replaced by a mixture of mineral oil and aluminum oxide nanoparticles.T. Coumaressin and K. Palaniradja (2014) carried out performance analysis using CuO-R134a nanofluids in thevapor compression system. Heat transfer coefficients were evaluated using FLUENT for heat fluxranged from 10 to 40 KW/m$^2$, using nano CuO concentrations ranged from 0.05 to 1% and particle size from 10 to 70 nm. The experimental studies indicate that the refrigeration system with nano refrigerant works normally. The results indicate that evaporator heat transfer coefficient increases with the usage of nano CuO. Laura et.al (2014) tested the applicability of nanofluids as lubricants in the compressors of heat pump systems, with the purpose to experimentally detect the possible positive effects of nanolubricant. Several nanolubricant, formed by Polyester (POE) or mineral oil as base fluid, and titanium oxide (TiO2) or single wall carbon nano-horns (SWCNH) as nanoparticles, were studied in a dedicated test rig. In contrast with the published literature, no improvement was detected using nanofluids instead of commercial oil. Krishna Kant Dwivedi& R.C. Gupta (2014) carried out experimental work for performance enhancement of the household refrigerator by cooling of compressor they found that 20 to 25% global savings in energy consumption by remove heat released during running of Compressor. FatouToutieNdoye et.al (2014)studied numerically energy performance secondary loops of refrigeration Systems using nanofluids for various types of nanoparticles (Al2O3, Co, CuO, Fe, SiO2 and TiO2) and a wide range of volume fraction they found that heat transfer coefficients improvement significantly and pumping power also increased with the increase of nanoparticles concentration whatever the flow regime.Sendil et.al (2013)found greater COP of 3.5 & power consumption reduced 10.32% in test Al2O3 in PAG oil in an R134a refrigerator. Kumar et al (2013) investigated performance of VCRs system using refrigerant R134a and PAG oil (150, 180, and 200 ml) suspended with Al2O3 nanoparticles (0.2 percent concentration by volume) and found that the COP increased by 3.5 percent. & power consumption decreased by 10.32. Sreejith (2013) investigated & compared performance of the refrigerator with air and a water-cooled condenser with a 0.06 percent mass fraction of CuO mixture and various compressor oils, with the HFC134a/POE oil system, the energy consumption was reduced between 12% and 19% with SUNISO 3GS mineral oil system.Jubin V Jose et.al (2013)&GobinathNatarajan(2012) carried out performance analysis of a hermetically sealed compressor, in a refrigeration system working with both conventional mineral oil lubricantsTiO2 nanoparticles as additive. They found reduction in power consumption and use of nanoparticles as additives is economical and aids in better performance compared to mineral oil lubricant. R. Reji Kumar, K. Sridhar, & M. Narasimha (2013) investigated heat transfer enhancement numerically using Al2O3 Nano lubricant and R600a/mineral oil/nano-Al2O3 as working fluid in domestic refrigerator they found that Freezing capacity of the refrigeration system is higher with mineral oil + alumina nanoparticles oil mixture compared the system with POE oil,the power consumption reduces by 11.5 % & COP also increase by 19.6 %. Subramani et.al (2013) investigated performance of a vapor compression refrigeration system using nano-lubricant with mineral oil and mineral oil with different nanoparticles added to it. The results indicate that refrigeration system with Nano lubricant works normally and safely. It is found that power consumption reduces by 15.4% and the coefficient of performance increases by 20%when TiO2 nanolubricant is used instead of SUNISO 3GS. Rashmi G. Walvekar et.al (2013) carried out experimental analysis of air conditioning unit with a conc. of 0.01-0.1wt% of CNT polyester oil along with R134a. Results show that CNT nanoparticles concentration of 0.1wt% is optimal and gives highest heat transfer enhancement and improve the COP by 4.2%. Javadi et.al (2013) used TiO2 nanoparticles in the oil of the R134a refrigeration system at a concentration of 0.1%. The system's technique saved about 25% of the energy while also lowering greenhouse gas emissions. Kumar and Elansezhian (2012) observed that with Al2O3-PAG oil, the performance of the cooling system was better than the pure lubricant of working fluid R134a, and energy consumption was reduced by 10.32% at 0.2% volumetric. Subramani and Prakash (2011), they employed Al2O3 nanoparticles at 0.06% by weight in mineral oil instead of POE in the cycle compressor, with about 25% reduction of power consumption. Ahamedet.al (2011) published a review on energy analysis of vapor compression system, finding a reduction in the energy losses when nanofluids are used as Nano lubricants instead of base lubricants.M.S.Hossain et.al (2010) carried out experimental investigation of domestic refrigeration system using HFC134a and mineral oil with TiO2 nanoparticles. The results indicate that refrigerator works normally and safely in the refrigerator with better performance with energy saving 26.1% with 0.1% mass fraction. Kristen Henderson et.al (2010)& Sergio Bobbo et.al (2010)studied tribological properties of POE oil & influence of dispersion of CuO, SWCNH& TiO2 nanoparticles resp.Jwo et.al (2009)their studies show that the 60% R-134a and 0.1 wt % Al2O3 nanoparticles were optimal. Under these conditions, the power consumption was reduced by about 2.4%, and the coefficient of performance was increased by 4.4%. In Bi et.al (2008)the operation of a domestic refrigerator, working with R134a and a mineral oil added with TiO2 and aluminum oxide (Al2O3) nanoparticles, instead of POE

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oil, was analyzed. Results highlight about 26% increase of refrigerator performance compared to the use of R134a with POE oil, with a nanoparticles concentration around 0.1% in mass. Shengshan Bi, Lin Shi &Lili Zhang (2007) &Wang et al. (2003) conducted studies on a domestic refrigerator using Nano refrigerant R134a and a mixture of mineral oil TiO2 was used as the lubricant. They found that the refrigeration system worked normally and efficiently and the energy consumption reduces by 21.2%. When compared with R134a/POE oil system & larger return of lubricant to the compressor was observed.

**2.1 Literature Summary:** From the literature reviews, it has been found that using nanofluids the heat transfer coefficient enhances performance and there is considerable saving in power consumption. Many researchers have been investigated effect of use nanoparticles in refrigerant and lubricant of compressor in last decade to enhance the heat transfer rate, to improve performance of the systems. Use of nanoparticles in lubricants is the recent idea, to improve thermo physical and heat transfer capabilities of the system, nanoparticles are either suspended in the refrigerant or lubricating oil.

**Table 1- Comparison of various nanorefrigerants for the performance enhancement of VCRS.**

| Author | Ref type &Oil in compressor | NPs type & Conc | Weight in g per ml of oil | COP | Power Consumption | Other findings |
|---|---|---|---|---|---|---|
| A. Baskaran et.al (2022) | R134a, PAG (poly alkylene glycol) | $ZrO_2$ | 0.2 g/L | 2.1% higher | - | Refrigeration capacity increased by 38.7% Pull downtime decreased by 23.3% |
| M. Anish et.al (2020) | R22, Sanden SP-10 lubricant | CuO, ZnO& $AL_2O_3$ | 250 ml/ 0.05%v | COPrinceasedfrom 0.58-0.62 | Reduced | CuO Better |
| Marcucci Pico et.al (2020). | R132 PAG Oil | Diamond | 0.1 % & O.5 % | Improved | Reduced | Dramatically decrease in Comp discharge temp |
| Marcucci Pico et.al (2019) | R410a PAG Oil | Diamond | 0.1 % & O.5 % | Increase in 4% & 5% resp. | - | - |
| Adelekan et al. (2019) | R134a, POE oil | TiO2 | 0.2 g/l, 0.4 g/l, &0.6 g/l | Improved | Reduced | - |
| Adelekan et.al. (2019) | R600a, POE oil | Graphene | 0, 0.2, 0.4 and 0.6 g/L | Max COP 0.76 | Reduced | - |
| ShaikImaduddin et.al (2018) | R134a, POE | $TiO_2$ | (2..5 g/300 ml ) | 22.5% higher | - | - |
| G. Jatinder et.al (2018) | R134a, polyol-ester, mineral oils | TiO2, SiO2, and Al2O3 | 0.2 g/L | Increased | Reduced | 100% irreversibility |
| Wang et.al (2017) | R134a, Fullerene (70) | silicon dioxide, NiFe2O4 | 0.60 g | Increased by 1.73 & 23% | - | - |
| B.P. Krishnan et.al (2017) | R290/R600a | Al2O3 | - | Increased | Reduced | Mathematical modeling & |

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| | | | | | | programmed based simulation |
| Baskar and Karikalan (2017) | R134a, POE oil | ZrO2 | 0.1%, 0.2%, 0.3% mass fraction | Enhanced by 7.61%, 14.05 % & 11.90% resp. | - | - |
| B. K. Singh and M. S. Ansari (2017) | R600a/R290 | CuO | 0.15, 0.25, & 35 g | Increased to 3.18%-11.57% | - | - |
| Sanukrishna et.al (2017) | R134a, PAG (poly alkylene glycol) | CuO | 0.06%, 0.08%, 0.1% by vol. | Increased | Reduced by 6.25% | - |
| Kushwaha et.al (2016) | R134a | Al2O3 | 0.2% | Increased | - | System work satisfactory |
| K. Veera et.al. (2016) | R134a, (nanorefrigerant ) | Al2O3 | 0.1 to 0.3 % | Increased | - | their use in refrigeration systems is feasible |
| M. E. Haque et.al (2016) | R134a, POE oil | Al2O3 | 0.05 and 0.1% | - | Reduced | Cooling capacity increased |
| Kumar et.al (2016) | R134a and R152a. | ZrO2 | 0.01% to 0.06% | Increased | Reduced | Works satisfactorily |
| M. Suziyanaet.al (2015) | R134a,Polyester oil | Al2O3 | 0.2% | Increased by 3.21 % | Reduced by 2.1 | - |
| O.A. Alawi, et.al (2015) | R134a, POE | TiO4 | 0.25 wt% | Increased | Reduced | - |
| Coumaressin et.al (2014) | R134a, POE | CuO | 0.05 to 1 Wt. % | Increased | - | system with nanorefrigerant works normally |
| R. Reji Kumar et.al (2014) | R134a, POE(mineral oil) | $Al_2O_3$ | 0.1%V, 0.3%V, 0.5%V | Increased | Reduced by 11.5 % | - |
| Rashmi G. Walvekar et.al (2013) | R134a, Polyester Oil | CNT | 0.01-0.1wt% | Maximum 4.2%. | - | - |
| Subramani et.al (2013) | R134a, mineral oil (SUNISO 3GS. | TiO2 | 0.1%, 0.2%, and 0.3% mass fraction | Increased by 20% | Reduced 15.4% | - |
| R. Reji Kumar, K. Sridhar, & M. Narasimha (2013) | R600a mineral oil | Al2O3 | 0.06%. Mass fraction | Increased by 19.6 % | Reduces by 11.5 % | - |
| Sreejith (2013) | HFC134a/POE oil (SUNISO 3GS) | CuO | 0.06% mass fraction | - | Reduced 12%-19% | - |

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| Kumar and Elansezhian (2012) | R134a, PAG Oil | $Al_2O_3$ | 0.2%V | Increased 3.5 | 10.32% reduced | - |
| Sendil Kumar et.al(2012) | R152a, POE Oil | ZnO | 0.1%V, 0.3%V, 0.5%V | - | 21% less@ 0.5%V | - |
| Bi et.al (2008) | R134a, POE(mineral oil) | $Al_2O_3$ &TiO2 | 0.06%– 0.1% | - | Reduced | - |
| Subramani et.al (2012) | R134a, POE(mineral oil) | TiO2 | 300g | | - | More effective Heat transfer |
| Elansezhian et.al (2012) | R134a,POE(mineral oil) | CuO | 0.55% to 1.5% | COP Improved | - | - |
| D.S. Kumar, R. Elansezhian (2012) | R124A, POE(mineral oil) | TiO2 | 0.1% to 0.55 | Improved | Decreased | - |
| Tashtoush et.al (2012) | R134a, R123, R290, R141b, POE(mineral oil) | CuO, Al2O3 | 0-4 wt.% | 24.7% with R134a-CuO for 2 wt. %. | - | - |

**Conclusion-** From the literature, it has been observed that nano-particles mixed with mineral oil gives enhanced results than polyester (POE) oil or base lubricant, use of nanolubricant feasible in vapor compression system. There is need identify best combination of refrigerant, lubricant, nanoparticles type & concentration of nanoparticles having better performance, reduced energy consumption & feasibility.

**Proposed Work-** literature shows that there is need more studies on investigation on effect of use of different nanoparticles in base fluid (refrigerant & lubricant) on performance & reliability of refrigeration system. With this perspective it's decided to investigate effect of use of Al2O3 & CuO nanoparticles with different concentration in lubricant of hermetically sealed compressor of domestic refrigerator.

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