A review on the impact on thermal conductivity of refrigerants of nano sized powders.

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Abstract

The combination of nano-particle with a conventional refrigerant is recognized as a nano-refrigerant. The nano-particles are being used with refrigerants due to its capability to change the properties of refrigerant. The major requirement of a refrigerant is to absorb the heat from a place or object, through the evaporator. When the refrigerants are mixed with nano-particles, its thermal properties are enhanced. It has been found that the application of different nano-particles with various refrigerants provides the good results in terms of thermal conductivity and deduction in energy consumption. It has shown its effectiveness in domestic as well as in industrial refrigeration system. The excessive addition of these nono-particles also rises the viscosity which in turn raises the pump work sometimes. So, an optimum ratio of refrigerant with nano-particles should be used to achieve the better results of refrigeration system.

Key words: Nano-refrigerants, Thermal conductivity, Efficiency.

1. Introduction

As the human being cannot work without the blood, in the same manner a refrigeration system cannot work without a refrigerant. The refrigerant runs through all the parts of a refrigeration system. It starts its journey from compressor to expansion tube by following the condenser. Finally it enters to evaporator where it absorbs the heat from a perishable material. After absorbing heat, it again reaches to compressor as shown in figure 1 [12] and hence the cycle is repeated till the requirement. The thermal conductivity, viscosity, specific heat, density etc. are the major properties of a refrigerant. To achieve the better performance of refrigeration system the thermal conductivity of a refrigerant should be high.

1.1 Nano-Particles

The particles are generally divided into three frames depending on their diameter. It is classified as coarse particles (2500-10,000 nm), fine particles (100-2500 nm) and ultra-fine particles (1-100 nm). For the preparation of nano-refrigerants, ultra-fine sized particles are considered. These nano-particles are formed from different metal oxides, carbon nanotubes and carbides also.

1.2 Nano-Refrigerants

The homogeneous or colloidal solution of nano-particle with a selected refrigerant forms a nano-refrigerant. To prepare this solution either magnetic stirring or ultra sonication process is recommended. The solution should be prepared very carefully otherwise the particles may get settled down in the solution.

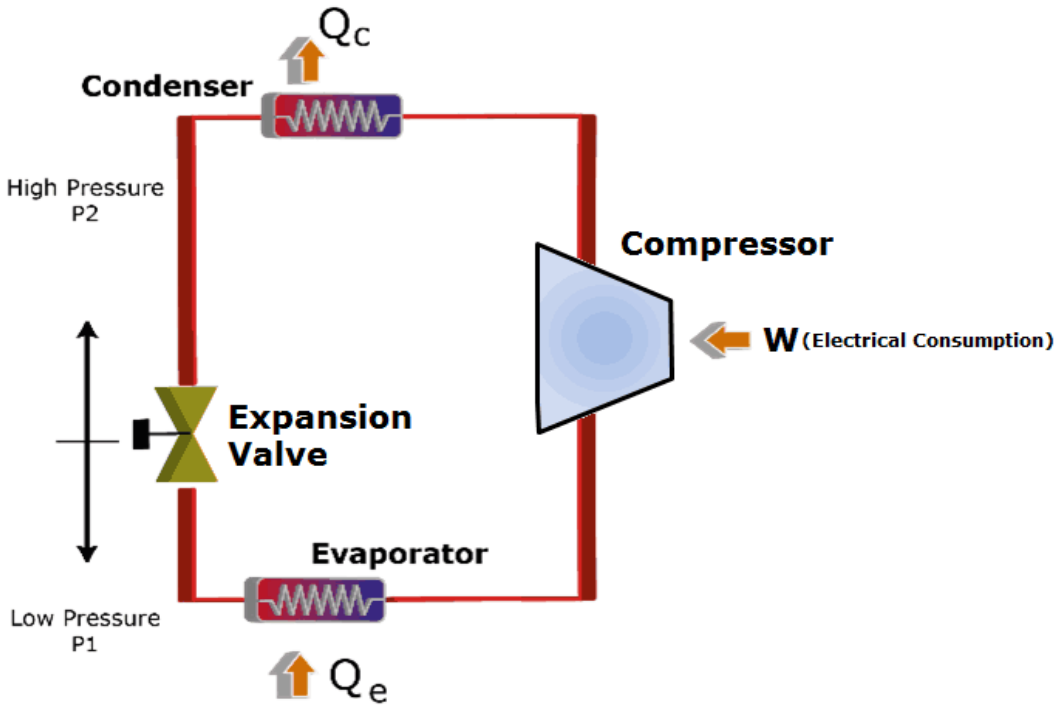

Fig.1. A schematic diagram of a refrigeration system

2. *Literature Review*

In the field of nano-refrigeration system, it has been observed that these refrigerants are very effective to use. It has more capability to work efficiently as compare to conventional refrigerants. The various results which are achieved by different researches are highlighted in this review.

Stephen et al. [1] studied the low thermal conductivity of fluids which causes the more power consumption to run the system. To improve this property, different metal oxides are introduced in refrigerants. The deduction in pumping power of heat exchanger is also observed. Sunder et al. [2] conducted experiment with ethelene glycol in water (20:80) by adding 2% of nano-particles and resulted the improvement in thermal conductivity of fluid by 46%. The variation in temperature also affects the thermal conductivity of fluid. A change in temperature from 20°C to 60°C, gives the improvement of 21% in thermal conductivity. Mahbubul et al. [3] found that the rise in temperature and concentration of particle by volume, increases the thermal conductivity and further rise in concentration causes the pressure drop which causes the more pumping work. The thermal conductivity also decreases by increasing the size of particles. Cheng and Liu 2013 [4] found that the addition of carbon nano-tubes (CNT) in R113 based refrigerants gives the good results in terms of thermal conductivity. Also increase in convective heat transfer is noticed. Kole et al.

[5] noticed that the copper nano-particle increases the thermal conductivity by 24%. It is used with gear oil with 2% of volume concentration. The fluid also obtained the Non-Newtonian behaviour from Newtonian. Murshed et al. [6] examined that variation in thermal conductivity depends on change in temperature. It also affected by shape as well as size of nano-particles. Cylindrical shape particles are more affective as compare the spherical shared particles. Sun and Yang 2013 [7] investigated that by increasing the mass fraction of nano-particles in refrigerant improves the co-efficient of heat transfer. Mahbubul et al. [8] noticed that thermal conductivity is affected by vapour quality and concentration of particles. Also pressure drop is observed due to increase in concentration of alumina particles. Mahbubul et al. [9,10] examined that with the increase in temperature and concentration of particles thermal conductivity improved. The viscosity is increased and falls with rise in temperature. Zhang et al. [11] noticed that size and concentration of particles also affects the heat transfer properties. It also decreases the co-efficient of friction which improves the efficiency and reliability of compressor.

3. Conclusions

It is concluded the application of metal oxides with conventional refrigerants found as better. For the better performance and results nano-particles should be used at optimum volumetric concentration.

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