

A Review of R600a Based Nano Refrigerant and Mixed Refrigerant

¹J.Melvin Jones, ²T.Vasanthakumar, ³S.Somasundaram, ⁴S.Yadhavakumar, ⁵V.Usha

Dept. of Mechanical Engineering, Jay Shriram Group of Institutions, Tiruppur, Tamilnadu, India^{1,2,3,4,5}

ABSTRACT: Refrigeration is a process of removing heat from one place to another place. This refrigeration process is done by using a special device is known as refrigerator. Refrigerant is used as a working fluid in refrigerator. The common refrigerants used in the refrigerator are R12, R22, R717, R32, R134a and R600a. The two different refrigerants with different properties are mixed together is known as mixed refrigerants. In this paper we use type of mixed refrigerants in various proportions. Nano fluids are the nano sized particles of metals, oxides and carbides suspended in conventional heat transfer fluids. In this paper we choose the nano refrigerant as TiO₂, CuO, CNT, Al₂O₃ and R600a, R134a, R141b are used as a base refrigerants. When we compare the mixed refrigerant with nano refrigerant, the cop of nano refrigerant is higher than mixed refrigerant but economically cost for nano refrigerant is too high.

I. INTRODUCTION

The basic purpose of refrigeration is to remove heat from an area where it is not wanted. Refrigeration is a system which helps in remove heat from a closed medium and rejected into the ambient medium. In practice the refrigeration process must transfer heat from one body to another body. Usually, the heat is simply dumped into the outdoor air or down the drain air it is not noticeable. Heat reclaim, heat recovery or energy conservation occurs when the heat is sent to an area where it is needed or desired.

Since refrigeration deals completely with the transfer of heat, to better understand how the refrigeration process works, these necessary to first understand the nature of heat. Then we can control the transfer and removal of heat reduce and maintain the temperature of a space or material below its natural surrounding temperature.

Nowadays we using only one refrigerant in refrigerators that must has one disadvantage. To overcome this problem we use Nano refrigerants and mixed refrigerants. The Nano refrigerants and mixed refrigerants are explained below:

NANO REFRIGERANTS

Nano fluids which promise to significantly increase thermal, rheological and tribological properties of technological fluids. They are produced by mixing solid Nano particles made by metallic oxides, metals, carbon Nano tubes etc., in common fluids such as water, oil and refrigerants.

Relatively low concentration of Nano particles will give strong enhancement of thermal conductivity and heat exchanging capacities with corresponding enhancement of energy efficiency.

Nano refrigerants are produced by dispersing solid Nano particles made by metallic oxides, metals, carbon Nano tubes etc., in common refrigerants such as R12, R22, R134a, R141b and R600a. In refrigeration system, the Nano fluids improve the thermodynamic and mechanical performance of the refrigerators. By adding

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Nano particles in refrigerants can significantly increase their transport properties and the energy efficiency of the refrigeration system.

The available Nano particles are TiO₂, CuO, Al₂O₃, SiO₂, diamond and carbon Nano tubes (CNT).

MIXED REFRIGERANTS

The two different refrigerants with different properties are mixed together in particular quantity is known as mixed refrigerants.

Azeotropic refrigerants: Mixture of two or more refrigerants with similar boiling points. Where the change of phase takes place at a specified single temperature. Examples are R500, R502, R503, R507. They can be charged as a liquid or vapour.

Zeotropic refrigerants: Mixture of two or more refrigerants with dissimilar boiling points. Where the change of phase takes place over a temperature range of over 5.50C (100F). Examples are R404a, R407c. They should be charged as a liquid.

Near azeotropic refrigerants: Mixture of two or more refrigerants with dissimilar boiling points, but the change of phase takes place over a temperature range of less than 5.560C (100F). Example is R410a. They should be charged as a liquid.

II. LITERATURE REVIEW

M.Rasti (2011) [1] presented that the mixed refrigerant of R600a and R436a in a domestic refrigerator. R600a has zero ozone depletion potential and very low global warming potential. Power consumption measured and temperature sensed at arbitrary points in the test unit and other important parameters measured for R600a, R436a and R134a refrigerants. The observed readings are

Parameter	R600a
Ambient temperature, °c	32
Freezer air temperature, °c	-18
Discharge temperature, °c	62
Suction temperature, °c	26
Energy consumption, kWh/day	1.543
Evaporator temperature, °c	-29.5
Coefficient of performance	2.43

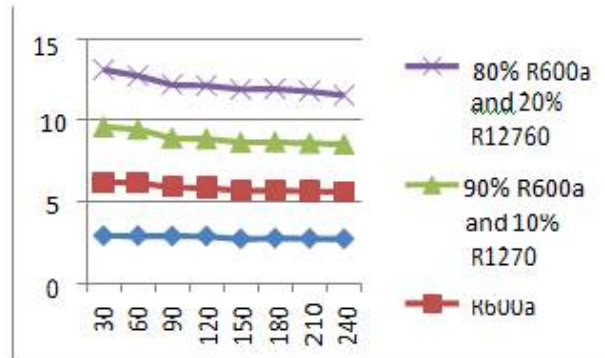
M.Rameshkumar (2016) [2] focused on the comparative study of isobutene (R600a) and blends of (R600a/R1270) as a domestic refrigerant. This journal revealed that the new refrigerant mixture performed better than that tetrafluoroethane(R134a).The above mentioned mixture of the refrigerant gives better performance but improved the coefficient of performance of the system by 5-12% and that is 9.7-15.6% higher than tetrafluoroethane (R134a). Due to this mixture the freezer air temperature is reducing, refrigerating capacity is increased than the R134a.

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Dong yeon lee (2007) [3] investigated the performance test of a refrigerator by using propane/isobutane (R290/R600a) in the ratio of 55% and 45%. The power consumption of R134a is higher than the mixture of R290 and R600a. The mixture of R290 and R600a give superior performance to the R134a system. The power consumption of R134a system was 12.3% higher than that of the R290/R600a system. Relatively this mixture would give high heat performance in the ratio of 55% and 45%.

M.A.Akintunde (2013) [4] investigated to identify the long term replacement refrigerant for Freon 12 (R12). This research contains the mixture of three refrigerants, they are isobutene (R600a), 1, 1, 1, 2-tetrafluoroethane (R134a) and R406a (55%R22/6%R600a/41% R141b). R12 is a chemical compound, is found to be stable in troposphere. It moves to the stratosphere and breakdown by strong ultra-violet rays were it releases chlorine atom which then deplete the ozone layer catalyzing the breakdown of ozone molecules. The relative coefficient performance of the above mixture of three refrigerants is greater than that of the Freon 12(R12).

Pooja yadav (2015) [5] experimentally studied that exergy analysis of R134a in vapour compression system. Chlorofluorocarbons used in the refrigeration and air conditioning system because of some good characteristics such as low freezing point, non-flammability, non-toxicity and chemically stable behavior. But the ozone depletion potential of CFCs is too high so we need long term replacement refrigerant that is R134a. R134a refrigerant has some good characteristics such as non-flammable, non-corrosive, non-toxicity and zero ozone depletion potential. The results are given below

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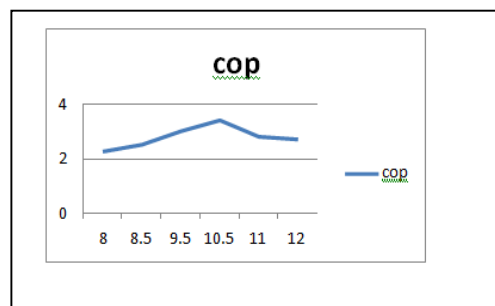
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State points	Description of state points	Pressure Bar	Temperature K
1	Evaporator outlet	1.9	279.5
2	Compressor inlet	1.9	296.5
3	Compressor outlet	11	349
4	Condenser outlet	12.12	320
5	Before expansion valve	12.12	317
6	After expansion valve	2.4	279.5

Dr.R.Elansezhian (2011) [6] investigated experimental study on nano refrigerant Al₂O₃ while using R134a as a base refrigerant in refrigeration system. R134a has one good property that is strong chemical polarity. Nano Al₂O₃ – R134a with 0.2% concentration of PAG oil (poly alkaline glycol) was feed to the experimental set up and test were conducted under the normal operating conditions. The important results obtain from this experiment are the cop of the system increases with increasing capillary tube length; the maximum cop of this system is 3.5 for a capillary tube length of 10.5 metre, the discharge pressure increases with time and attains a maximum value and then decreases. The suction pressure decreases initially and then increases with time.



R.Amalina et al. (2013b) [7] experimentally investigated the thermal conductivity of Al₂O₃/R141b nano refrigerant for volume concentration between 0.5 and 2% where the temperature ranges from 5-

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200C. He concluded that the thermal conductivity of the above mentioned nano refrigerant increased and 1.626 times greater than R141b.

Bi et al. (2011) [8] experimentally investigated the nano refrigerant of TiO₂ while R600a is used as a base refrigerant. The influence of nano particles about domestic refrigerator performance is investigated by means of energy consumption and freezing capacity. The results shows that the usage of 0.1 and 0.5 g/l concentrations of R600a/TiO₂ instead of pure R600a in domestic refrigerators resulted in 5.94% energy consumption savings, freezing rate increases to 9.60%.

Abdel-Haidi et al. (2011) [9] investigated the performance of R134a/CuO nanorefrigerant in the vapour compression system. In this paper, they conducted experiments with the intension of clarification of the influence of heat flux and heat transfer coefficients.

Researcher	Refrigerant	Nano particles	Evaluation
Sun and Yang et al. (2013)	R141b	Al ₂ O ₃	The viscosity and thermal conductivity were up to 179 and 1.626 times greater than the base R141b, respectively.
Wakabayashi et al. (2013c)	R141b	Al ₂ O ₃	The thermal conductivity was enhanced with increase both volume fraction and temperature.
Sun and Yang (2013)	R141b	Al ₂ O ₃	The heat transfer coefficient was about 1.18 times higher than pure R141b.
Wakabayashi et al. (2013a)	R141b	Al ₂ O ₃	Heat transfer and pressure drop characteristics increased significantly with the enhancement of nano particle volume concentrations.
Mahmoud et al. (2013)	R134a	Al ₂ O ₃	Heat transfer and pressure drop characteristics increased significantly with the enhancement of nano particle volume concentration.
Kumar and Thiruganesh	R134a	Al ₂ O ₃	10.32% less energy consumption and increased cop.
Researcher	Refrigerant	Nano particles	Evaluation
Sun and Yang (2013)	R141b	Al ₂ O ₃	The heat transfer coefficient was 1.14 times higher than pure R141b.
Bi et al. (2008)	R134a	TiO ₂	26% less energy consumption.
Jiang et al. (2009)	R113	CNT	Thermal conductivity increased between 50% and 104%.
Wakabayashi (2013)	R134a	Diamond	98% enhancement in boiling heat transfer with R134a/nanofluid.
Henderson et al. (2010)	R134a	SiO ₂	The boiling heat transfer coefficient decreased up to increasing particle concentration.
Wang et al. (2010)	R410a	NiFe ₂ O ₄	Energy efficiency ratio increased approximately 6%.

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III RESULT AND CONCLUSION

From all the above results we found that the usage of nano refrigerants provided with good results, showing the temperature difference is better, when compared to the mixed refrigerants. The coefficient of performance is one of the important parameter for a refrigerant to obtain good cooling effect. Since nano particles costly it can be green synthesized and can be mixed with refrigerant.

The mixed refrigerant will be the cost effective when compared to nano refrigerant and nano refrigerants enhance the heat transfer than the mixed refrigerants. Hence both the categories of refrigerant have sufficient advantages to justify for using them in day to day applications.

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