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EXPERIMENTAL INVESTIGATION ON BLENDS USED IN AIR CONDITIONERS

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ABSTRACT

The resource of energy and development of the country are interrelated. In India, energy sector has received top priority in all the five year plans so far. The industrial revolution increased the utilization of the new technological products in our daily life which has led to the consumption of more energy. The gap between supply and demand of electrical energy is increasing every year. The proven reserves of fossil fuel in India are not very large. Thus a miserable scenario awaits India in future unless absolutely new strategies are adopted. The limitation of world's energy resources has caused many countries to re-examine their energy policies and to take measures in elimination of waste energy. It has also urged the researchers to take a closer look at the energy conservation devices and to develop new techniques to utilize the existing limited resourceefficiently.Also the global warming and ozone depletion are the two major environmental problems faced by the world today. The growing national and international concern towards reduction of global warming and emphasis on energy saving has leads to the study of this work. Green House gas is one of the major reasons for Global Warming. One of the Green House gases is Hydro floro carbon, which is used in refrigeration and air- conditioning. In India about 80% of the domestic refrigerators working under simple vapour compression system use R134a as the refrigerant. The major concern of using R134a in domestic refrigeration system is that, it has a high global warming potential of 1300, which causes many harmful effects on the environment. Therefore the use of R134a must be replaced. This factor forces to find a suitable environmental friendly alternate refrigerant for vapour compression refrigerationsystem

INTRODUCTION

In the early days of vapour compression refrigeration, many different working fluids like Ammonia and Halocarbons have been used. Ammonia is generally used in larger plants and the halocarbons are used in smaller installations. The halocarbons are in many respects, the ideal refrigerants. Recently serious drawbacks were noticed with the emission of some of the halocarbons such as CFCs and HCFCs causing

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breakdown in the ozone layer round the earth. In addition, these chemicals are strong greenhouse gases and suspected of causing global warming. Because of the drawbacks it has been agreed internationally to phase out the production and use of CFCs and HCFCs. The most likely strategy to meet the phase out is an increased use of NH3 coupled with the introduction of newer halocarbonrefrigerants.

ENVIRONMENTAL IMPACTS OF REFRIGERANTS AND REGULATIONS

In 1970s Lovelock and co-workers, using a newly developed electron capture detector demonstrated that CFC-11 and CFC-12 were trace constituents in the atmosphere. This observation should not have been surprising, showing that a significant fraction of CFC production was either purposely vented from aerosol packages or inadvertently lost from leaking of refrigeration and air-conditioning systems. In 1972, at a meeting initiated by DuPont, the leading CFC manufacturers discussed the environmental fate of their products and summarized their remit in the following way: 'Fluorocarbons are intentionally or accidentally vented to the atmosphere world-wide at a rate approaching one billion pounds per year'.

In 1973, Chemists Frank Sherwood Rowland and Mario Molina at the University of California began studying the impacts of CFCs in the earth's atmosphere. They discovered that CFC molecules were stable enough to remain in the atmosphere until they got up into the middle of the stratosphere where they would finally be broken down by ultraviolet radiation releasing a Chlorine atom. Rowland and Molina then proposed that these Chlorine atoms might be expected to cause the breakdown of large amounts of ozone (03) in the stratosphere. The environmental consequence of this discovery was that, stratospheric ozone absorbs most of theultraviolet-B (UV-B) radiation reaching the surface of the planet and depletion of the ozone layer by CFCs would lead to an increase in UV-B radiation at the surface results in an increase in skin cancer and other impacts such as damage to crops and to marine phytoplankton. But the Rowland-Molina hypothesis was strongly disputed by representatives of the halocarbon industries. The chair of the board of DuPont was quoted as saying that ozone depletion theory is 'a science fiction tale...a load of rubbish...utternonsense'.

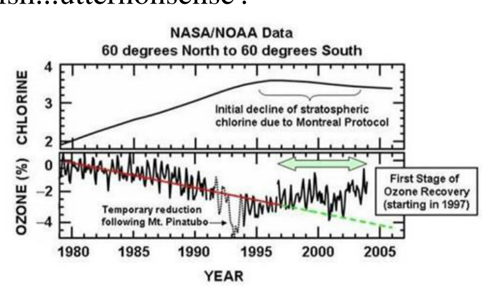

Fig. NASNNOAA Satellite data showing the rise in stratospheric chlorine and corresponding decline in ozone layer thickness from 1979 to 1997 and decline of stratospheric chlorine due to Montreal Protocol from 1997 to 2007

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This agreement originally mandated a 50% reduction in CFC production and consumption by 1 July 1999, but allowed future revision in light of new scientific evidence. The Montreal Protocol stipulates the production and consumption of compounds that deplete ozone in the stratosphere to be phased out by 2000. Due to widespread adoption and implementation, the Montreal Protocol has been hailed as an example of exceptional international co-operation with Kofi Annan quoted as saying it is "Perhaps the single most successful international agreement to date". The phasing-out of the less active HCFCs started only in 1996 and will go on until a complete phasing-out is achieved in 2030. Figure shows the decline in stratospheric chlorine since introduction of Montreal Protocol from1997.

LITERATURE REVIEW

Antonellis, D.S ,Joppolo, C.M., Molinaroli, L.(2010)Efficiency Analysis Of Home Refrigerators By Replacing Hydrocarbon Refrigerants, in this experiment they considered 440 liters home refrigerator for test facility, which officially works with 150g R-134a refrigerant. In this test R-134a refrigerant is replaced by varied mass hydrocarbon refrigerant, which was mixed with R-290 and R-600a with each 50% component ratio. The result shows the Refrigerating Effect was improved by using hydrocarbon refrigerants. Even there was a reduction in energy consumption and applied mass of refrigerant is reduced by 40%.

Anyanwu, E.E. (2003)A Performance Comparison Of Vapour- Compression Refrigeration System Using Various Alternative Refrigerants, a theoretical performance study on Vapor compression refrigeration system with refrigerant mixtures based on HFC134a, HFC152a, HFC32, HC290,HC1270,HC600 and HC600a was done for various ratios and the results were compared with CFC12, CFC22 and HFC134a as a possible alternate replacements. Theoretical results shows that all of the alternate refrigerants investigated in this analysis have a slightly lower coefficient of performance than CFC12, CFC22 and HFC134a for the condensation temperature of 50ºC and evaporating temperature ranging between -30ºC and 10ºC. HFC290/HC600a (40/60 weight %) instead of CFC12 and HC290/HC1270 (20/80 byweight %) instead of CFC22 are used as replacement refrigerant among the alternatives in this paper as a result of analysis.

Badawy, M. T., (1998)examined The Use Of Liquified Petroleum Gas (LPG) with 24.4% of R290, 56.4% of R600 and 29.2% of R600a as a refrigerant for drop in domestic refrigerator with R12. The author reported an evaporator temperature of -15°C and coefficient of performance for condensing temperature of 27ºC when LPG isused.

Aute, V.C., Radermacher, R., Naduvath, M.A., (2004).An Experimental Investigation Of Refrigerant Mixture R32/R290 As Drop-In Replacement For HFC410A In Household Air Conditioners, In this paper the refrigerant mixture R32/R290 (68%/32%

by weight) was investigated as the drop in replacement for R410a household air conditioners. Compared with the R32/R290 system using finned tube heat exchanger the R32/R290 charge amount and power consumption are reduced by 34.1% and 0.4% respectively; the cooling capacity and the coefficient of performance are increased by 64.4% and6.8%.

Assoa, Y. B., Menezo, C., Fraisse, G., Yezou, R., &Brau, J. (2007).Experimental Study Was Carried Out With HC Refrigerants R290, R600,R600a And R134a As Baseline Refrigerants. Experimental result showed that the mixture of R290 and R600 (60%& 40% according to mass respectively) was the most appropriate alternative compared with using R134a, using this HC mixture Reduced the refrigerators power consumption by 86%. the refrigerant charge of the HC mixture system was approximately 50% of that of R134a system (120g). Adusting the refrigeration system was not required. The flammability of the mixture of R290 & R600a is not a problem in a small capacity refrigeration system with the refrigerant charge below 100g based on R-134a.

Arora, J.S., (2004)Experimental Evaluation Mechanical Performance Of The Compressor With Mixed Refrigerants R-290 And R-600a, In this work, two refrigerants are chosen (R-290 and R-600a) to evaluate the mechanical performance of compressor of domestic refrigerators. This work aims to investigate the mechanical performance of compressor with mixed refrigerants (R-290 and R-600a)

METHODOLOGY

Refrigerants with good thermo physical properties and which satisfy the new environmental restrictions must be made available to replace those phased out. Furthermore, the concept of employing a multi component refrigerant introduces a desirable degree of freedom in developing substitute refrigerants, since a mixture exhibits a critical locus, depending on composition, ranging between the critical points of its components.

The selection of alternative working fluids for vapor compression processes depends on the particular application and on some distinctive properties according to the chemical nature of the refrigerant, its thermo physical properties, and on their compliance with health, safety and environmental restrictions. The refrigerant must be stable and inert. The saturation pressure of the refrigerant must be kept high for correspondingly small equipment. High capacity and low power requirements are also important for most applications. For the commercial sector, the refrigerant must also be nontoxic and nonflammable. High oil solubility and low freezing point are also desirable. Since the compressor operates at volumes of gas, refrigerants with similar boiling points will produce similar capacities in the same compressor. Some properties not directly related to the compounds ability to transfer heat, for example flammability, toxicity, density, viscosity and availability, are sometimes deciding factors of their utilization.During the initial stage of an investigation, one

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should identify and select alternative refrigerants that combine these properties and exhibit characteristics similar to previously proven successful compounds. However, thermo physical data from novel refrigerants and especially mixtures are not readily available.

To overcome this problem, certain fundamental properties must be estimated by applicable correlations or use standard software's to get properties of mixtures. This information can then be used to predict the performance of systems using the candidate refrigerants as working fluids. Eventually, estimated property data and predicted equipment performance must be verified experimentally.

RESULTS

Experiments are carried out on a specially modified vapour compression refrigeration test rig. The vapour compression refrigeration test rig used in this test setup is tested with R134a and hydrocarbons propane/isobutanezeotropic blend of 50/50%. Initially transient test is carried out to test the time taken to attend the steady temperature.

The procedure for performing the test is given below:

i. Optimization of refrigerant charges for R290 and R600a for retrofitting.

ii.Energy consumption Test.

v.Performance Test.

From numerical, theoretical analysis 50gms of R600a and 50gms of R290 gives the more refrigeration effect and it consumes less power compare to remaining proportions (25%+75%,75%+25%) and the global warming potential and TEWI given less compare to remaining proportions.

Firstly the vapour compression test is carried out with R-134a and the parameters which are evaporator temperature, coefficiencient of performance, power consumption, refrigerating effects are obtained. Later the same test is performed by the alternate blended mixture that is R290/R600a with (50/50% weight proportion) and tested the following parameters were investigated and compared with theR-134a.The test is done at various refrigerants and refrigerants mixture. Fig. shows the Evaporator temperature drop for R-134a refrigerant and blend (50%/50% R290/R600a) mixture refrigerant. The lowest Evaporator temperature is achievedas0.1ºCwith135gchargeforR134aat variationofcoolingcapacityand 1.05ºC with 135g of (50%/50% R290/R600a) blend. It is observed that as time increases the cooling capacity increases and reaches 200 W at 0.05ºC with hydrocarbon blend and 0.1ºC forR-134a.

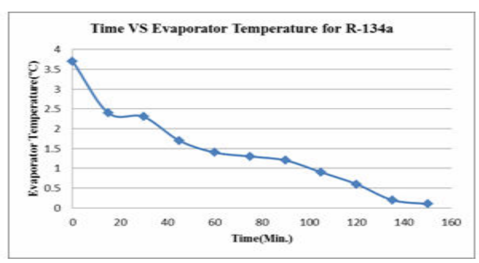

Fig.Variation of Evaporator temperature with respect to time for R-134a

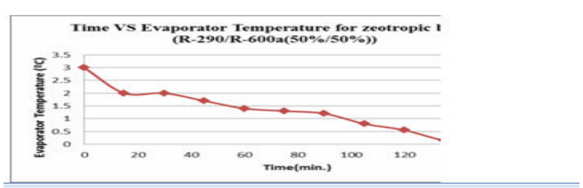

Fig. Variation of Evaporator temperature with respect to time for blend (50%/50% R290/R600a)

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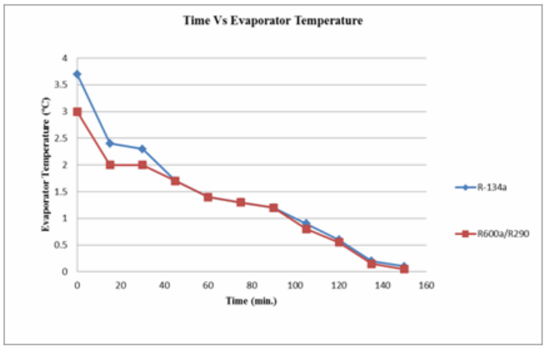

Fig. 5.3 Variation of Evaporator Temperature of Vapour compression refrigeration system with respect total time

Above figure shows the falling of evaporator temperature of R134a and blended mixture

Fig. show the variation of power consumption blend of R600a/R290 and 134a. The power consumption with R134a is higher due to larger amount of charge, almost 0.25 times in comparison with hydrocarbon blend. Maximum power consumption is noted as 0.10 kWh for R134a and 0.07 kWh for HC blend and, almost 30% higher withR134a.

CONCLUSION

In the present work experimental investigation is carried out to investigate the performance of vapour compression refrigeration system of a modified vapour compression refrigeration system for water chiller of 30liters capacity, with R134a and blend mixture of isobutane(R290) and propane(R600a) as refrigerantsby adopting different lengths of liquid line suction line heat exchanger for domestic refrigerator

1. R290/R600a (50/50%) zeotropic blend can act as drop insubstitute
2. There is an optimum charge 134gms for R290/R600a (50/50%) zeotropic blend with choosing operatingconditions.
3. The R290/R600a (50/50%) zeotropic blend exhibits higher COP value at all operating conditions, due to it require less power consumption for considered compressor
4. The cooling capacity of the system with blend is comparatively more than R134a, because of amount of heat extracted from the blend in easy compare to R134a
5. The temperature of condenser, during the condensation process for blended is less. It shows the it won't requires any external energy forcondensation
6. The vapour compression

Propane and isobutane have a flammable characteristics, if we reduces this characteristics in future, then it will be use full for any domestic and industrial applications.

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