Experimental Study of R406A & R600A Blends As Alternatives To R12

Parag Dubey[1], Mr. Sohail Bux[2]

[1]M.Tec Scholar Agnos college of Technology, [2]HOD,ME Agnos College of Technology

Abstract - Abstract: In the vent of chlorofluorocarbons (CFCs) phase-out, identify long term alternative to meet requirements in respect of system performance and service is an important area of research in the refrigeration and are conditioning industry. This work focuses on experimental study of the performance of eco-friendly refrigerant mixtures. Mixtures of three existing refrigerants namely: R600a (n-butane), and R406A (55%R22/4%R600a/41%R142b)were considered for this research. These refrigerants were mixed in various ratios, studied and compared with R-12 (dichlorodifluoromethane) which was used as the control for the experimentation. The rig to be used in the experimentation is a 2 hp (1.492 kW) domestic refrigerator, designed based on 40c condensing and -10c evaporating temperatures. The rig was tested with R-12, and blends of the three refrigerants. During the experimentation, both evaporator (Te) and condenser (Tc) temperatures were measured. These were used to determine the heat absorbed in evaporator (Qe) and the heat rejected in condenser (Qc) The results show that R406a/R600a mixture in the ratio 9:11 can be used as alternative to R-12 in domestic refrigerators, without the necessity of changing the compressor lubricating oil.

Keywords: Refrigerants, Alternatives, Blends, COP, Performance, Comparison, new-refrigerants.

1. INTRODUCTION

Chlorofluorocarbons (CFCs) proved to be one of the most useful classes of compounds, ever developed as refrigeration and air conditioning working fluids called refrigerants, because of their desirable thermal properties. These refrigerants promote workers and consumers safeties because they are non-flammable, noncorrosive and very low in toxicity. As a result, these compounds are used in a wide variety of applications, such as refrigerators, foam bowings, aerosol propellants and cleaning solvents due to their desirable physical and chemical properties that enhance energy efficiency and product reliability, (Lee et al., 2002). However, some of the properties that make CFCs desirable, such as chemical stability, had led to global environmental problems. As a result of chemical stability, CFCs have long environmental residence time and its emissions lead to accumulation in the lower atmosphere. CFCs migrate and mix with chemicals in the upper atmosphere where they dissociate, releasing chlorine atoms that catalyze the destruction of Ozone molecules. Past and recent scientific findings have clearly linked chloride from CFCs and other man-made compounds to the seasonal ozone losses over the northern and southern hemisphere, Eckels and Tesene (2003). Since ozone provides a screen against solar ultraviolet radiation (UV-B) and excess UV-B has a potential of contributing to health and environmental hazard, hence significant depletion of ozone layer should be avoided. This provides a sound basis for the Montreal Protocol, an international agreement amended in 1990 requiring a total phase out of CFCs production and consumption by 2000, (Calm, 2002)

In developing nations, the vapour compression based refrigeration; air conditioning and heat pump, continue to run on halogenated refrigerants due to its excellent thermodynamics and thermophysical properties, apart from the low cost. Hence, the need for alternative refrigerants to fulfill the objectives of the international protocol (Montreal and Kyoto) so as to satisfy the growing worldwide demand. Refrigerant-12 (dichlorodifluoromethane), which is a chlorofluorocarbon (CFC) compound, is found to be stable in the troposphere, (Chivian et al., (1993)). It moves to the stratosphere and breaks down by strong ultraviolet light where it releases chlorine atom which then deplete the ozone layer by catalyzing the breakdown of ozone molecules. The CFCs in the stratosphere undergoes photo decomposition by the action of high energy ultraviolet radiation resulting in equation (1.1)

$$^{*}Cl_2F_{2(g)} + UV \longrightarrow Cl^{*}_{(g)} + ^{*}Cl_2F_{2(g)} \qquad (1.1)$$

which releases chlorine atoms, denoted simply as CI. These atoms react with ozone, reducing it and undergo a chemical reaction as shown in equation (1.2).

$$Cl^{*}_{(g)} + O_{3(g)} \longrightarrow ClO_{(g)} + O_{2(g)} \qquad (1.2)$$

In the atmosphere is an appreciable concentration of atomic oxygen by virtue of the reaction sows in equation 1.3

$$O_{3(g)} + UV \longrightarrow O_{2(g)} + O_{(g)} \quad (1.3)$$

In the presence of Nitric oxide (NO), the * species may react with either "O" or "NO", regenerating * atoms and resulting in chain reaction that cause the net depletion of ozone as shown in equations. Chlorofluorocarbons (CFCs) and hydrochlorofluorocarbon (HCFCs) have a long and successful association with the refrigeration industry. This started to decline only after the environmental hazard associated with their release into the atmosphere. The first known artificial refrigeration was by putting ethylethene to boil in a partial vacuum vessel. Methyl chloride was first employed in 1878, and remains in use for many years until 1960s. A mixture called chemogene (consisting of petrol, ether and naphtha) was patented as a refrigerant for vapour compression system in 1866 while dimethyl-ether was introduced as a refrigerant two years later. In the same year an ice production machine that uses carbon (IV) oxide was invented, (Hwang et al., 1998). The progression of refrigerants from early stage to the present addressing future direction and candidates, breaks the history into four refrigerant generations based on selection criteria. The generation of refrigerants are as summarized in Fig. 1 by, Calm and Didon (1997). Alternative refrigerants are the present and future refrigerants options. Although production and use of the fully halogenated refrigerants such as R11, R12, R13,R113, R114, and R115 will be phased out under the auspice of the Montreal Protocol. The partially halogenated CFC refrigerants such as R22 and R123 may remain in use for years to come as they are not as stable fully halogenated refrigerants and cause little damages to the ozone layer, (Bhatti, 1999). The range of possibilities includeshydrofluorocarbons (HCFCs), refrigerant mixtures and natural fluids such as shown in Table 1. Among these groups of alternatives, hydro chlorofluorocarbons (HCFCs) and the hydro fluorocarbons (HFCs) are most useful. The HCFCs were developed to serve as interim replacement for CFCs. They are used in existing equipment. HCF refrigerants are developed to serve as alternative to CFC and HCFC refrigerants, since they do not contain chlorine and have almost zero ODP. Hence, to develop possible alternative refrigerant that has zero ozone depletion potential (ODP) and, lower global warming potential (GWP), it is necessary to consider HCFs.

3. PREVIOUS WORK

The overall performance of vapour compression refrigeration system was evaluated by the thermodynamic properties of refrigerant blends and the operational parameters such as energy consumption (input to the compressor) of the system. The quantity of heat absorbed at the evaporator (Qe) and the quantity of heat rejected at condenser (Qc) for R12, and the various mixtures were estimated and The coefficient of performance and compressor power was calculated, shows the variation of refrigerant flow rate with charging.

4. PROPOSED METHODOLOGY

My proposed work is to find such kind of blend of refrigerant which has no ODP and very low GWP compared to the existing blends of Refrigerants.

REFERENCES

[1]. Akintude, M.A; Adegoke C.O; Fapetu, O.P (2004), "Experimental Investigation of the Performance of A Design Model for Vapour Compression Refrigeration System". West Indies Journal of Engineering. Vol. 28 No: 2, pp 80-87

[2]. Akintunde, M. A. (2004), Experimental Investigation of the Performance of R12 and R134a in Capillary Tubes for Refrigeration Systems. Journal of Engineering Science and Technology, University of Ilorin. Vol. 4 No:1, pp 1 – 12.

[3]. Akintunde, M. A. (2004b) "Theoretical Design Model for Vapour Compression Refrigeration Systems". –AMSE Periodicals, France. Vol. 73 No: 5, pp 1 – 14.

[4]. Akintude, M.A. (2006). Experimental Investigation and Modeling solubility in R12 and R13a. Journal of Engineering and Applied science, Vol 1 No 1 pp 14-22

[5]. Akintude, M.A. (2006). Validation of a Vapour Compression Refrigeration System Design Model. American Journal of scientific and Industrial Research (AJSIR). Vol 2 No 4, pp 504-510.

[6]. Akintude, M.A. (2013)Experimental Investigation of Thermal Conductivity and Thermal Diffusivity of New Refrigerants Blends. International Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS). Vol. 4 No: 2, pp 328 – 332.

[7]. Bhatti, M.S. (1999). A historical Look at chlorofluorocarbon Refrigerant ASHRAE transaction, part 1.Pp 1186-12006.

[8]. Calm, J. M. (2002). Emission and environmental impacts from air-conditioning and refrigeration.International Journal of Refrigeration. Vol. 25, No: 7, pp 293 – 305.

[9]. Calm, J.M and Didion, D.A. (1997). Trade- offs in refrigerants selections: Past, present and future. American

Socierty of Heating refrigerating and Air-conditioning Engineers (ASHRAE), Inc. Altanta (GA):pp 433-444

[10]. Chivian, A.E; McCally, M; Hu and Haines, A. (1993).Loss of stratospheric Ozone and health effect of increase ultra violent radiation. The MIT press Cambridge.

[11]. Domanski, P.A and Mclinden, M.O (1992). A simplified Cycle Simulation model for the performance rating of Refrigerants and Refrigerants Mixtures. International Journal of Refrigeration.Vol 115, No: 2 pp 81-88

[12]. Eckels, S.J and Tesene, B.A (2003). A Comparison of R22, R134a, R410A and R407C, Condensation Performance in Smooth and Enhance Tubes: Part 1, Heat Transfer ASHIRAE Transaction, pp 428-441.

[13]. Gopalnarayanan S. (1998). Choosing the right refrigerant.Mechanical Engineering, published by the American society of Mechanical Engineer (ASME).Vol 11120 No 11.Pp 1181- 1189

[14]. Hwang, Y. Ohadi; M and Radermacher, R (1998).Natural Refrigerants. Mechanical Engineering published by American society of Mechanical Engineers (ASME). Vol 1120 No 10, pp 96-99

[15]. Kuijper, L. (1995). Hydrocarbon and the Montrel Protocol Mechanism. Proceedings of International CFC and Halon attentive conference, Washington D.C., October 23-25: pp 167-173.

[16]. Lee, J. H.; Bae, S. W. Bang, K. H.; and Kim, M. H. (2002).Experimental and numerical research on condenser performance for R-22 and R- 407C refrigerants. International Journal of Refrigeration. Vol. 25, No: 8, pp 372 – 382.

[17]. McMullian, T.J (2002). Refrigerator and the environment issues and strategies for the future international Journal of refrigeration Vol. 25 No 5; pp 89-99

[18]. Radermacher, R and Kim, K (2006).Domestic refrigeration Recent Development. International Journal of Refrigeration, Vol 119 pp 58-62

[19]. Stoecker, W.F. (1983). Improving the Energy Effectiveness of demerits refrigerator by the application of refrigerant mixtures cont- 830568-1, in; proceeding of the international technical application conference Indiana, pp 3-9

[20]. Wongwises, S. and Chimres, N, (2005). Experimental study of hydrocarbon mixtures to replus HCF134a in a Domestic refrigerator, Energy Conservation and Management, Vol. 46 pp 85-100.

.