ORIGINAL RESEARCH PAPER

Mechanical Engineering

LITERATURE REVIEW ON LPG REFRIGERATION SYSTEM

KEY WORDS: LPG, ODP, Refrigeration system, CFC

Sunil Kumar Ojha	Department of Mechanical Engineering,IIMT College of Engineering Greater Noida
Asmita Singh Bisen*	Department of Mechanical Engineering,IIMT College of Engineering Greater Noida *Corresponding Author
Rishabh Chauhan	Department of Mechanical Engineering,IIMT College of Engineering Greater Noida
Ritesh Kumar	Department of Mechanical Engineering,IIMT College of Engineering Greater Noida
Ritu Raj	Department of Mechanical Engineering,IIMT College of Engineering Greater Noida

ABSTRACT

Supply of continuous electricity is still not available in several areas of the country and the world. At such places, this work will be helpful for refrigeration of food, medicines, etc...This paper investigates the result of an experimental study carried out to determine the performance of domestic refrigerator when a liquefied petroleum gas (LPG) which is locally available which comprises of 24.4% propane, 56.4% butane and 17.2% isobutene which is varied from company to company is used as a Refrigerant. The LPG is cheaper and possesses an environmental friendly nature with no Ozone Depletion Potential (ODP) and no Global Warming Potential (GDP). It is used in world for cooking purposes.

The refrigerator used in the present study is designed to work on LPG. The performance parameters investigated is the refrigeration effect in certain time. The refrigerator worked efficiently when LPG was used as a refrigerant instead of R134a.

Also from the experiment which done in atmospheric condition, we can predict the optimum value of cooling effect with the suitable operating condition of regulating valve and capillary tube of the system. The use of LPG for refrigeration purpose can be environment friendly since it has no ozone depletion potential (ODP). Usually LPG is used as a fuel for cooking food in houses, restaurants, hotels, etc..and the combustion products of LPG are CO2 and H2O. In this project we have designed and analyzed a refrigerator using LPG as refrigerant.

LPG is available in cylinders at high pressure. When this high pressure LPG is passed through the capillary tube of small internal diameter, the pressure of LPG is dropped due to expansion and phase change of LPG occurs in an isoenthalpic process. Due to phase change from liquid to gas latent heat is gained by the liquid refrigerant and the temperature drops. In this way LPG can produce refrigerating effect for a confined space. From experimental investigations, we have found that the COP of a refrigerator which uses LPG is higher than a domestic refrigerator. This work investigates the result of an experimental study carried out to determine the performance of domestic refrigerator when a propane-butane mixture is liquefied petroleum gas (LPG) which is locally available and comprises 24.4% propane, 56.4% butane and 17.2% isobutene which is very from company to company. The LPG is cheaper and possesses an environmental friendly nature with no ozone depletion potential (ODP). It is used in world for cooking purposes. The various methods of refrigeration on the basis of standard refrigerant discussed. He refrigerator used in the present study is of medium size with a gross capacity of 125 litre and is designed to work on LPG. The performance parameters investigated is the refrigeration effect in certain time. The refrigerator worked efficiently when LPG was used as refrigerant instead of CFC 12. The evaporator temperature reached -5 °C with and an ambient temperature of 12 °C. Also from the experiment which done in atmospheric condition, we can predict the optimum value of cooling effect with the suitable operating condition of regulating valve and capillary tube of the system. The results of the present work indicate the successful use of this propane-butane mixture as an alternative refrigerant to CFC 12 in domestic refrigerant.

1.INTRODUCTION

Due to the huge demand of electricity over the world, we think of recovering the energy which is already spent but not being utilized further, to overcome this crisis with less investment. The climatic change and global warming demand accessible and affordable cooling systems in the form of refrigerators and air conditioners. Annually Billions of dollars are spent in serving this purpose. Hence forth, we suggest COST FREE Cooling Systems. Although government agencies are not able to continuously supply a major portion of electricity in both the urban as well as in rural areas. Still the people in these regions require refrigeration for a variety of socially relevant purposes such as cold storage or storing medical supplies and domestic kitchens this project has the novelty of using LPG instead of electricity for refrigeration. This solution is convenient for refrigeration in regions having scares in electricity.

The term 'refrigeration' in a broad sense is used for the process of removing heat (i.e. Cooling) from a substance. It also includes the process of reducing and maintaining the temperature of a body below the general temperature of its surroundings. In other words, the refrigeration means a continued extraction of heat from a body, whose temperature is already below the temperature of its surroundings. For example, if some space (say in cold storage) is to be kept at -2 ?C, we must continuously extract heat which flows into it due to leakage through the walls and also the heat, which is brought into it with the articles stored after the temperature is one reduced to -2 °C. Thus in a refrigerator, heat is virtually being pumped from a lower temperature to a higher temperature. The refrigeration system is known to the man, since the middle nineteenth century.

When a liquid vaporizes rapidly, it expands quickly. The rising

modules of vapor abruptly increase their kinetic energy and this increase is drawn from the intermediate surroundings of the vapor. These surroundings are therefore cooled. Cooling wine via above method was recorded in 1550. According to the second law thermodynamics, this process can only be performed with the supply of some external work. It is thus obvious, that supply of power (say electrical motor) is regularly required to drive a refrigerator. The substance which work in a heat pump to extract heat from a cold body and to deliver it to a hot body is called "refrigerant".For example, if some space (say in cold storage) is to be kept at -2 °C, we must continuously extract heat which flows into it due to leakage through the walls and also the heat, which is brought into it with the articles stored after the temperature is one reduced to -2 °C. Thus in a refrigerator, heat is virtually being pumped from a lower temperature to a higher temperature. According to second law of thermodynamics, this process can only be performed with the aid of some external work. It is thus obvious, that supply of power (say electrical motor) is regularly required to drive a refrigerator. Theoretically, the refrigerator is a reversed heat engine, or a heat pump which pumps heat from cold body and delivers to a hot body. The substance which works in a heat pump to extract heat from a cold body and to deliver it to a hot body is called refrigerant. When people hear the word refrigeration they immediately think of the refrigerator in their kitchen. However there are actually quite a few different kinds of refrigeration out three and they each have their own methods of functioning. One particular type of refrigeration is industrial refrigeration. This type of refrigeration is typically used for cold storage, food processing, and chemical processing

2. LITERATURE REVIEW

A.Baskaran&P.Koshy Mathews

A Performance Comparison of Vapour Compression Refrigeration System Using Eco Friendly. Refrigerants of Low Global Warming Potential VCR system with the new R290/R600a refrigerant mixture as a substitute refrigerant forCFC12 and HFC 134a. The refrigerantR290/R600a had a refrigerating capacity28.6% to 87.2% higher than that ofR134a [1].

M.Mohanrajet. al.

Have studied experimentally the drop in substitute forR134a with the environment friendly, energy efficient hydrocarbon (HC) mixture which consists of 45% HC290and 55% R600a at various1 mass charges of 50g, 70g and 90g in domestic refrigerator. The experiments were carried out in 165 liters domestic refrigerator using R134a with POE oil as lubricant. The power consumption of HC mixture at 50g and 70g are lower by 10.2% and 5.1% respectively and90g shows higher power consumption by 1.01%. The percentage reduction in pull down time is 18.36%, 21.76% and28.57% for 50, 70 and 90g mass2870charges respectively when compared toR134a. The HC mixture because of its high energy efficiency will also reduce the indirect global warming. In conclusion HC mixture of 70g is found to be an effective alternative to R134a in 165 liters of domestic refrigerator [2].

B.O.Bolaji

Have Experimental study of R152a/R32 to replace R134a in a domestic refrigerator and find out that COP obtained by R152a is 4.7%higher than that of R134a. COP of R32is 8.5% lower than that of R134a and propane is an attractive and environmentally friendly alternative to CFCs used currently [3] .

R.W.James&J.F.Missenden

Have use of propane in domestic refrigerators and conclude that the implications of using propane in domestic refrigerators are examined in relation to energy consumption, compressor lubrication, costs, availability, environmental factors and safety propane is an attractive and environmentally friendly alternative to cfcs used currently [4].

Bilal A. Akashet. al.

Has conducted performance tests on the performance of liquefied petroleum gas (LPG) as a possible substitute for R12in domestic refrigerators. The refrigerator which is initially design to work with R12 is used to conduct the experiment for LPG (30% propane, 55%N-butane and 15% isobutane). Various mass charges of 50, 80 and 100g of LPG were used during theexperimentation.LPG compares very well to R12. The COP was higher for all mass charges at evaporator temperatures lower than ?15?C. Overall, it was found that at 80g charge, LPG had the best results when used in this refrigerator. The condenser was kept at a constant temperature of47?C.Cooling capacities were obtained and they were in the order of about three to fourfold higher for LPG than those forR12 [5].

M. Fatouhet. al.

Investigated substitute for R134a in a single evaporator domestic refrigerator with a total volume of 0.283 m3 with Liquefied petroleum gas (LPG) of 60% propane and 40% commercial butane. The performance of the refrigerator, tests were conducted with different capillary lengths and different charges of R134aand LPG. Experimental results of the refrigerator using LPG of 60g and capillary tube length of 5 m were compared with those using R134a of100g and capillary tube length of 4 m. Pull-down time, pressure ratio and power Consumption of LPG refrigerator were lower than those of R134a by about7.6%, 5.5% and 4.3%, respectively. COP of LPG refrigerator was 7.6% higher than that of R134a. Lower on-time ratio and energy consumption of LPG refrigerator was lower than 14.3% and 10.8%, respectively, compared to R134a. In conclusion, the proposed LPG is dropping in replacement for R134a, to have the better performance, optimization of capillary length and refrigerant charge was needed [6].

M.A.Hammadet.al.

Has experimentally investigated the performance parameters of a domestic refrigerator with four proportions ofR290, R600 and R600a are used as possible alternative replacements to theR12.An unmodified R12 domestic refrigerator was charged and tested with each of the four hydrocarbon mixtures that consist of 100% R290, 75%R290/19.1%R600/5.9%R600a, 50%R290/38.3%R600/11.7%R600a and25%R290/ 57.5%R600/17.5% R600a. The results show that the hydrocarbon mixture with 50%R290/38.3%R600/11.7%R600a is the most suitable alternative refrigerant which has COP which is 2.7% higher than the R12[7].

SomchaiWongwiseset. al.

Has conducted to substitute R134a in a domestic refrigerator with hydrocarbon Mixtures of R290,R600 and R600a. A239 liter capacity refrigerator initially designed to work with R134a was chosen in the experiment. The experiments are conducted with the refrigerants under the same no load condition at a surrounding temperature of 25?C. The results show that 60%R290/40%R600 is the most suitable alternative refrigerant to R134a [8].

Sanjeevsinghpunia&Jagdev Singh

Have Experimental investigation on the performance of coiled adiabatic capillary tube with lpg as refrigerant and conclude that There was an increase in mass flow rate by 106%, When the capillary inner diameter was increased from 1.12mm to 1.52mm.When the coil diameter of capillary tube was decreased from 190mm to 70mm, the mass flow rate was decreased by13%, 7% and 9% for 1.12mm, 1.4mmand 1.52mm inner diameter of capillary Tube respectively. 1.40 mm diameter capillary affected the system more as compared to 1.12 mm diameter capillary tube. Mass flow rate increases with increase in capillary inner diameter and coil diameter where as mass flow rate decreases with increase in length. It was observed that the COP of system increases with

similar change in geometry of capillary tube [9].

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Gouvernement du Québec ,Régie du bâtiment du Québec
Propane gas refrigerators , installations designed to be supplied with gas requires that any new propane-powered refrigerator be equipped with a gas detector that can shut off propane supply when the burner gives off CO. The flame produced by the burner must be completely blue; if the flame is partly yellow or orange coloured, it is a sign that the burner needs to be cleaned or adjusted.Installing a propane gas refrigerator propane gas refrigerators require a sufficient supply of fresh air to operate safely and efficiently Inadequate ventilation, incomplete combustion or poor evacuation of the combustion products may all cause the building-up of (CO) . the requirements of the Construction Code Verify the tuning of the burner Make sure that the ventilation of the premises is adequate Install a CO detector [11].

M. Rasti ,M.S. Hatamipour, S.F. Aghamiri, M.Tavakoli
Have invesigate on Enhancement of domestic refrigerator's energy efficiency index using a hydrocarbon mixture refrigerant,and sowed that R436A (a mixture of R290 and R600a with a mass ratio of 56/44) in a 238 L single evaporator domestic refrigerator without any modification in refrigeration cycle. The refrigerator's compressor was charged with different amount of R436A.In comparison with R134a, the charge amount of R436A is reduced by 48%; the ON time ratio is reduced by 13%; the energy consumption is reduced by 5.3% in 24 h; the evaporator inlet temperature is reduced by 3.5 C; The results showed that TEWI of R436A is 11.8% less than R134a.According to our results and known environmental effects,R436A appears to be a suitable replacement for R134a[12].

N.Austin,Dr.P.Senthil Kumar, N.Kanthavelkumaran
Have performed on Thermodynamic Optimization of Household Refrigerator Using Propane –Butane as Mixed Refrigerant and find that Pull-down time, pressure ratio and power consumption of mixed refrigerant refrigerator were under those of R134a refrigerator by about 7.6%, 5.5% and 4.3%, respectively. Also, actual COP of mixed refrigerant refrigerator was higher than that of R134a by about 7.6%. Lower on-time ratio and energy consumption of mixed refrigerant refrigerator by nearly 14.3% and 10.8%, respectively, compared to those of R134a refrigerator were achieved.R134a with a charge of 100 g or mixed refrigerant with charge of 80 mg or more satisfy the required freezer air temperature of −12 °C. The lowest electric energy consumption was achieved using mixed refrigerant with heat level is less than -15°C [13].

Moo-Yeon Lee et. al.
Have studied the cooled refrigerator by using the mixture of R600a/R290 with mass fraction of 45:55 as an alternative to R134a. The compressor displacement volume of the alternative system with R600a/R290 (45/55) has modified from that of the original system with R134a to match the refrigeration capacity.The refrigerant charge of the optimized R600a/R290 system was approximately 50% of that of the optimized R134a system. The capillary tube lengths for each evaporator in the optimized R600a/R290 system were 500 mm longer than those in the optimized R134a system. The power consumption of the optimized R134a system was 12.3% higher than that of the optimized R600a/R290 system. The cooling speed of the optimized R600a/R290 (45/55) system at evaporator temperature of 15°C was improved by 28.8% over that of the optimized R134a system [14].

A.S. Raut ,U.S. Wankhede
Have worked on Selection of the Capillary Tubes for Retrofitting in Refrigeration Appliances and try to Use of alternative refrigerants play an important role in forming problems such as global warming and ozone depilationThe coefficient of performance of refrigeration appliances improves in case of retrofitting the capillary tube. It is possible to obtain the effective size (diameter & length) of capillary tube by using of mathematical techniques and by maintaining proper pressure equalization between condenser and evaporator.The coefficient of performance of refrigeration appliances improves in case of retrofitting the capillary tube [15].

3. CONCLUSION

Cop of a domestic refrigerator is normally up to 2.95 which is lesser than the LPG refrigerator. Domestic refrigerator required high input power than LPG refrigerator. Also there are more moving parts in domestic refrigerator and not eco-friendly. Domestic refrigerator requires more maintenance and operation is noisy.

We conclude that:
Propane is an attractive and environmentally friendly alternative to CFCs used currently.Mass flow rate increases with increase in capillary inner diameter rand coil diameter where as mass flow rate decreases with increase in length. It was observed that the COP of system increases with similar change in geometry of capillary tube.Cooling capacities were obtained order of about three- to four fold higher for LPG than those for R- 12. capillary tube. COP of LPG refrigerator was higher than that of R134a by about7.6%. LPG seems to be an appropriate long-term candidate tore placeR134a in the existing refrigerator,High COP values were obtained No operation problems have been encountered compressor. The use of LPG as a replacement refrigerant can contribute to the solution of (ODP) problem and global warming potential.

After performing this project "LPG Refrigeration", we conclude that refrigeration effect is produced with the use of LPG. From observation table, we conclude that, the regulating valve is fully open that, we achieve the chamber temperature down from 38°C to 10°C in a 100 minute. We achieve the evaporator temperature down from 1°C to -9.3°C in a same time interval. We put the water in one plastic bottle in the evaporator. The initial temperature of water is 35 °C. From observation table, we conclude that, the condition of regulating valve is fully opened, the same time period we achieve the temperature of water is 0.30 °C. We also conclude that, the capillary tube is maximum pressure of gas cylinder is reduces the less then of 1 psi. The capillary tube is more suitable throttling device in LPG refrigeration system.

This system is cheaper in initial as well as running cost. It does not require an external energy sources to run the system and no moving part in the system so maintenance is also very low. We also conclude that, we try the burnt to the exhaust LPG, the pressure of exhaust gas is less than 1 psi, the small flame produce by the burner. This system most suitable for hotel, industries, refinery, chemical industries where consumption of LPG is very high.

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