

Research Article

A Study Paper on LPG as an Alternative Refrigerant for Refrigeration

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Accepted 01 Oct 2016, Available online 05 Oct 2016, Special Issue-6 (Oct 2016)

Abstract

Domestic refrigerators consume approximately 17,500 metric tons of traditional refrigerants such as Chlorofluorocarbon (CFC) and Hydrofluorocarbon (HFC) every year which contribute to very high Ozone Depletion Potential (ODP) and Global Warming Potential (GWP). There are many remote areas in India where electricity is not available, hence LPG as a refrigerant for refrigeration can be a better alternative. LPG (Liquefied Petroleum Gas) is the combination of propane, isobutene and highest amount of butane with 56.4%. The use of LPG for refrigeration purpose can be eco-friendly since it has no ozone depletion potential (ODP). This paper deals with the study of Refrigeration with LPG as a refrigerant, the properties of LPG and its comparison with the other refrigerants

Keywords: COP, Evaporator Temp, LPG Refrigerant, Refrigerating effect.

1. Introduction

According to the Indian Government, the refrigerator is the 3rd heaviest consumer of power amongst household appliances. It is one of the few appliances that is running 365 days a year. It works on the principle that during the conversion of LPG into gaseous form the expansion will be take place. Due to this expansion in LPG gas the pressure will drops. And the volume will be increase this will be result into dropped in temperature and it acts as refrigerant. According to second law of 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 works in a heat pump to extract heat from a cold body and to deliver it to a hot body is called refrigerant. When we think about refrigerator we only remember refrigeration in kitchen, but actually divided in three types in which each type having their own type of functioning. One which used in Industrial purpose called as Industrial refrigerator, which used as food processing, chemical processing & cold storage. Industrial refrigeration, which frequently uses ammonia refrigeration to maintain temperature, is necessary for computer, foodstuffs, blood, vaccines, and quite a few other goods that must maintain a constant and steady temperature at all times. Temperatures matters in industrial refrigeration companies to pay attention at all times. LPG is expected to result in comparable product

efficiencies based on its characteristics. Therefore, these two types of refrigerants (LPG and CFC 22) can be examined using a modified domestic refrigerator in term of their performance characteristics parameters such as pressure and temperature at specified location at the refrigerator and the safety requirements while conducting the experiment.

2. Literature review

N. Austin, Dr.P. Senthil Kumar, N, (2012) have performed experiments on house hold refrigerator designed to work with R-134a. The recital of the refrigerator using mixed refrigerant was investigated and compared with the performance of refrigerator when R-134a was used as refrigerant. The energy consumption of the refrigerator during experiment with mixed refrigerant and R-134a was measured. The outcome shows the permanent running and cycling results showed that 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 -15oC. This mixture achieved higher volumetric cooling capacity and lower freezer air temperature compared to R134a.

Also, actual COP of mixed refrigerant refrigerator was higher than that of R134a by about 7.6%. From the experiment it was observed that, every mode of mixed refrigerant yields higher COP than HFC-134a. The mixed refrigerant in domestic refrigerator, observed the freezer temperature lower than that of the R134a. When the evaporator temperature increased, COP also

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increases and when the condenser temperature decreases, COP increases.



Fig. 1 Experimental setup of the investigation unit and apparatus

Nikam S.D., Dargude S. B., (2015) had performed experiments on Electricity free refrigerator system throughout which we can make refrigeration system in electricity less areas. There are so many areas in India where electricity not available. So in that areas to preserve food, medicine, meat the electricity refrigeration must be required. LPG (Liquefied Petroleum Gas) is the combination of propane, isobutene and highest amount of butane with 56.4%. The use of LPG for refrigeration purpose can be environment friendly since it has no ozone depletion potential (ODP). In these electricity refrigerator systems, we have to use LPG as refrigerant because of it having low boiling point property and it also have high pressure. "Analysis and performance of domestic refrigerator using LPG as refrigerant" is based on the principle of adiabatic expansion of a refrigerant (In this case LPG) from 80 psi to 10 psi so that thermodynamically it absorbs heat from surrounding and cooling may be done. Using the sophisticated data and instruments the relevant refrigeration system will be develop practically.

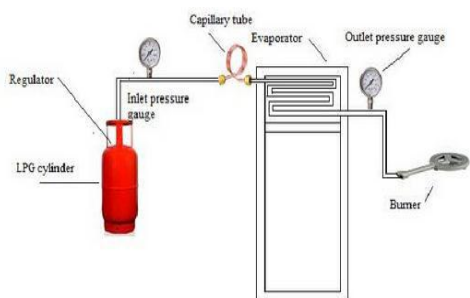


Fig. 2 Setup of LPG refrigeration system

Zainal Zakaria & Zulaikha Shahrum, (2016) had performed experiments on Domestic refrigerators which annually consume approximately 17,500 metric tons of traditional refrigerants such as Chlorofluorocarbon (CFC) and Hydrofluorocarbon (HFC) which contribute to very high Ozone Depletion Potential (ODP) and Global Warming Potential (GWP). Good progress is being made with the phase out of CFC 22 from new equipment manufacture by replacing LPG since it possesses an environmentally friendly nature with no ODP. Therefore, this two types of refrigerants (LPG and CFC 22) to be examined using a modified domestic refrigerator in term of their performance characteristics parameters such as pressure and temperature at specified location at the refrigerator and the safety requirements while conducting the experiment. Based on the present work, it is indicated that the successful of using LPG as an alternative refrigerant to replace CFC 22 in domestic refrigerators is possible by getting LPG COP as 13 compared to 10 for CFC22. The performance of LPG as an alternative refrigerant to CFC 22 in domestic refrigerators will be studied. The following are the conclusion. No operation problems encountered with the refrigerator compressor where no degradation of lubricating oil has been detected for a better COP and refrigerator efficiency. LPG is safe to act as a refrigerant comply with the safety parameter that was highlighted.

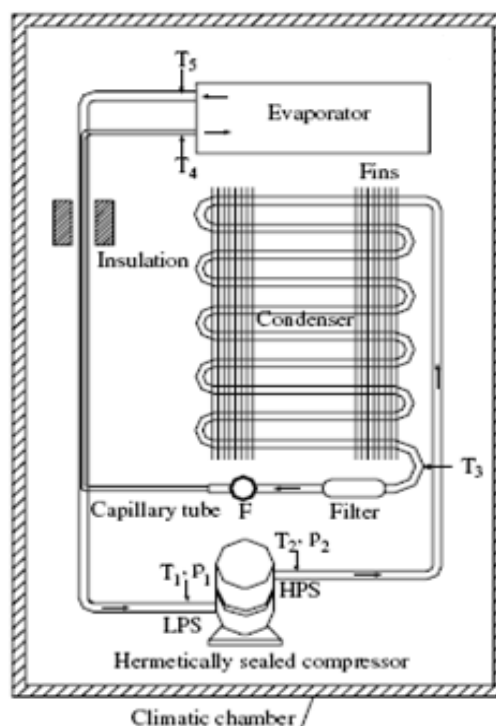


Fig.3 Schematic Diagram of Equipment in Fridge Circuit

Mhaske M. S., Deshmukh T. S., (2016) have performed experiments on designed and analyzed on refrigerator using LPG as refrigerant. As the pressure of LPG is high this stored in cylinder. As this pressurized LPG is

passed through the capillary tube of small internal diameter, the pressure of LPG is decreased due to expansion and phase change of LPG occurs in an isenthalpic process. Due to phase change from liquid to gas latent heat of evaporation is gained by the liquid refrigerant and the temperature decreased. In this way LPG can produce refrigerating effect in the surrounding. From experimental investigations, we have found that the COP of a LPG Refrigerator is higher than a domestic refrigerator. To avoid this, the refrigerating effect was calculated by us by varying the LPG properties like (pressure, temperature and enthalpy) to and from the evaporator using a high pressure regulator and the quantity of refrigerating effect we get is 267.66 KJ/kg. We get slow rate of refrigerating effect because of leakages present in the system. This can be improved by using precise manufacturing techniques and methods. For input energy we have taken the amount of energy required to refill 1 kg of LPG through the bottle filling plant which is 0.216 kWh. The input energy for different plant might be different. If we give an energy input in this way, we get the COP of the LPG refrigerator 6.3 and which is again higher than the domestic refrigerator. There also might be a change in future scope if the energy input for 1kg of LPG filling would be taken from any of the refinery energy audit report. In LPG refrigeration system capillary tube is more adjustable and better device. The initial and running cost of this LPG refrigeration system is really less. No outside energy source is required to run the system. As well as no moving components are present in the system which further reduces the maintenance cost as well. This LPG refrigeration system has wide scale application in hotel industries, chemical industries where the LPG consumption is at a higher level



Fig. 4 Actual Setup of LPG Refrigerator

Ibrahim Hussain Shah, Kundan Gupta, (2014) has studied 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. In this work we

have investigated the performance of a refrigerator based on liquefied petroleum gas (LPG) refrigerant since LPG is locally available and is easy to transport anywhere. LPG is a by-product in petroleum refineries and comprises of 24.4% propane, 56.4% butane and 17.2% isobutene which have very low boiling point. 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 isenthalpic 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. The aim of the LPG refrigerator was to use LPG as a refrigerant and utilizing the energy of the high pressure in the cylinder for producing the refrigerating effect.

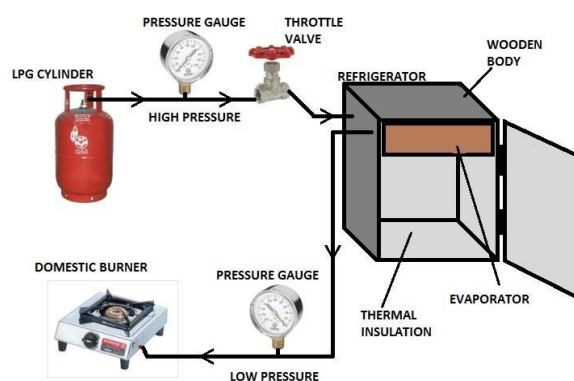


Fig.5 Experimental set up

Conclusions

From this above papers we concluded that LPG is better alternative refrigerant and eco-friendly than other refrigerant. It is studied that the evaporator temperature reached -20°C with COP value of 6.4 and an ambient temperature of 30°C. 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. LPG is safe to act as a refrigerant comply with the safety parameter that was highlighted. This LPG refrigeration system has wide scale application in hotel industries, chemical industries where the LPG consumption is at a higher level. It is observed that the COP range between the 6 to 13 and it is better than other domestic refrigerant.

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