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Experimental Investigation of Design and Fabrication of LPG Based Refrigeration

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ABSTRACT

Global warming and ozone depletion are the major problems faced by mankind today. Many activities of Polluting the environment is exploitation of natural resources. LPG refrigeration systems are commonly used in small-scale commercial applications, such as in refrigerators and freezers for food and beverage storage, as well as in air conditioning systems for vehicles and small buildings. They are popular because LPG is a readily available, relatively low-cost sfuel source, and it has a lower global warming potential than traditional refrigerants.

R134a, a refrigerant which is currently widely used, does have a GWP of 1300. LPG refrigeration systems work on the principle of vapor compression. The LPG is compressed, which causes it to heat up and vaporize. The heat is then released from the vapour as it goes through a condenser and condenses back into a liquid. After then, an expansion valve causes the liquid LPG to evaporate and absorb heat. from the surrounding environment, thus providing the cooling effect. Work done COP (coefficient of performance), and Refrigerating effect are performance parameters that are measured under various operating conditions and compared with R134a. IT is less work than R134a. It has every characteristic needed to be a refrigerant. LPG refrigerant is discovered to have a higher COP than R134a.

So, In order to conserve the environment, it is essential that we identify an acceptable replacement for R134a as soon as possible. The current study examines the use of LPG as a refrigerant in place of R134a in a domestic refrigerator. The LPG used has a mixture of propane, butane, and isobutane, and has an extremely low GWP of 8. It has no ozone depletion potential.

Abbreviations

GWP = Global Warming Potential OPD= Ozone depletion potential

LPG = Liquified Petroleum Gas COP= Coefficient of Performance

1. Introduction

The need for comfort, food storage, and medicinal uses is driving up the energy demand for refrigeration systems. The refrigerator is the third-heaviest power user among residential appliances, according to the Indian government. It is one of the few appliances that functions continuously throughout the year. The refrigeration process is the removal of heat from one place or substance and the transfer of that heat to another. A refrigerator is a cooling equipment that compresses a thermally insulated chamber and a refrigeration system to give cooling effect to the insulated compartment. One of the greatest energy-guzzlers among home appliances is the domestic refrigerator. It operates under the premise that an expansion will occur as LPG is transformed into gas. The pressure will decrease as a result of these expansions in LPG gas. Also, as value rises, this will cause a drop in temperature and serve as a refrigerant It is well known that particular capillary tube (expansion restriction) and refrigeration charge configurations operate residential refrigerators most efficiently. In low-capacity refrigeration units like home refrigerators, freezers, and window air conditioners, capillary tubes are used as an expansion n method. They typically range in inner diameter from 0.3mm to 0.5mm.

2. Background

LPG is a byproduct of nearby refineries and is mostly composed of propane (R-290) and butane (R-600). LPG has been utilised as a refrigerant in Cuba for many years. A commercial LPG mixture that can be used as a "drop-in" substitute for R-12 has a mass composition that is roughly determined to be 64% propane and 36% butane. A household refrigerator with a single evaporator and a volume of 10 ft 3 has been tested with liquefied petroleum gas (LPG) that is made up of 60% propane and 40% commercial butane.

Somchai Wongwise et.al., 2005 have carried out experimental study on application of hydrocarbon mixture to be domestic refrigerator as refrigerant as an alternative to R134a with a gross capacity of 239L, the result revealed that hydrocarbon can be used as an alternative refrigerant to

R134a. N.Austinet. al., (2013) has conducted experiment to replace R134a with hydrocarbons. The results shows that COP of mixed refrigerant is 8.1% more when compared with R134a. M.Mohanrajet., (2009) has carried out A 200-liter household refrigerator with a single evaporator was the subject of an experimental inquiry to determine whether R134a could be replaced at a drop in level with a binary mixture of 45.2% R290/54.8% R600a. The energy consumption of HC mixture is reduced, and the draw down time and ON time ratio are higher by 3.25 to 3.6%, respectively.

Moo-Yeon Lee et. Al. (2008) Ching-song Jwoet. Al. (2010), M.A.Sattaret al. (2007), M.Fatouhet, al.(2006) and K.Mani et al.(2008) proposed alternative refrigerant to R134a with the pure, binary and ternary mixture of hydrocarbons with different proportion. M.S.Kimet. al., (1994) has

From the literature survey, it is found that Today R134a is widely used as refrigerant in many household refrigeration systems. The reason for this is its ODP is zero and has good thermo physical properties. But it has high Global warming potential of 1300. So, researchers have started search for alternative for this problem. Hydrocarbons are good alternatives for the domestic refrigeration system, but the required proportion has to be prepared carefully. R134a can be mixed with the hydrocarbons for better performance (P. Srinivaset.al.,2010). R134a is one of the greenhouse emission gases, it has to be controlled. In India everywhere LPG is used as a fuel for the domestic applications. The boiling point of LPG encouraging is being an alternative refrigerant to the domestic refrigerator. In view of eco friendliness LPG (Liquefied Petroleum Gas) can be considered as best refrigerant. LPG has good thermodynamic and thermo-physical properties. It even has very low GWP i.e,8 and zero ODP as shown in Table

Table : Comparison between R134a and LPG

Properties	**R134a**	**LPG**
GWP	1300	8
ODP	0	0
Latent Heat of vaporization	214.21kJ/kg	428.25kJ/kg
Boiling point	-26.3°C	-6°C

3. Experimental setup

The experimental setup is essentially a household refrigerator with freezer. Pressure gauges are attached at the inlet of compressor and other at the outlet of compressor to record evaporator and condenser pressures respectively. Evaporator is insulated using glass wool and is covered with thermo coal to decrease heat loss. A multi stem LCD portable digital thermometer with external probe is used to measure temperature of the refrigerated substance periodically at different ambient conditions. A digital ammeter is used to measure power consumption of the refrigeration system periodically. The digital ammeter is attached at the electrical terminal.

System with different amounts of charge. A digital weighing machine is used to measure the mass of LPG filled into the system.

4. Experimental Procedure

Initially the refrigerator is made to run with the R134a at different ambient temperatures. Performance parameters like freezer temperature and power consumption, refrigeration effect and COP were determined. Then the system is evacuated using vacuum pump. The temperatures at which readings were noted are 21°C,22°C,and 23°C. After evacuation, LPG is filled in and the same procedure is repeated. The different charges at which LPG is tested are 35gm, 50gm and 65 gm.

5. Results and Discussions

In the present work, experimentation has been carried out with R134a and LPG. Base line experiments are carried out with R134a at different ambient temperatures. After conducting the base line tests, refrigeration system is evacuated and then filled with LPG. To get the better performance mass of the refrigerant need to be optimized

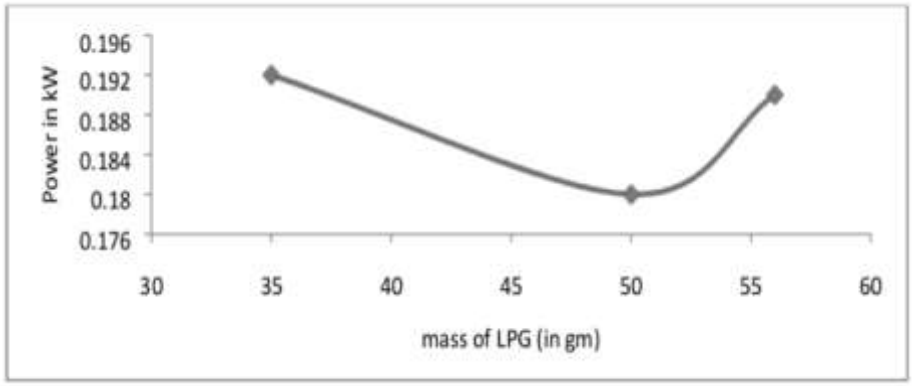

Figure 1: Power consumption versus mass of LPG

From Figure 1 shows that power consumption decreases with the mass of LPG and reaches minimum at 50 grams LPG and then increases with the increase of LPG,

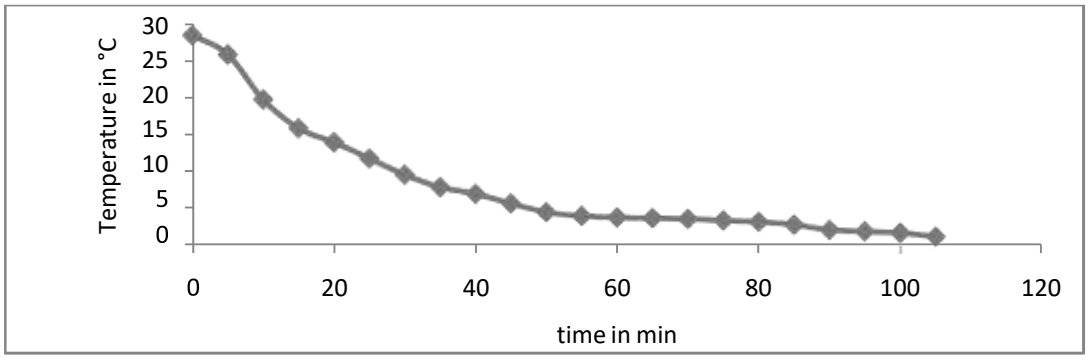

Figure 2: Pull down test for R134a

Pull down time of the freezer is shown in Figure 2. Pull down time is the length of time taken by the refrigeration system to decrease the temperature of a substance which is kept in the freezer to a temperature desired.

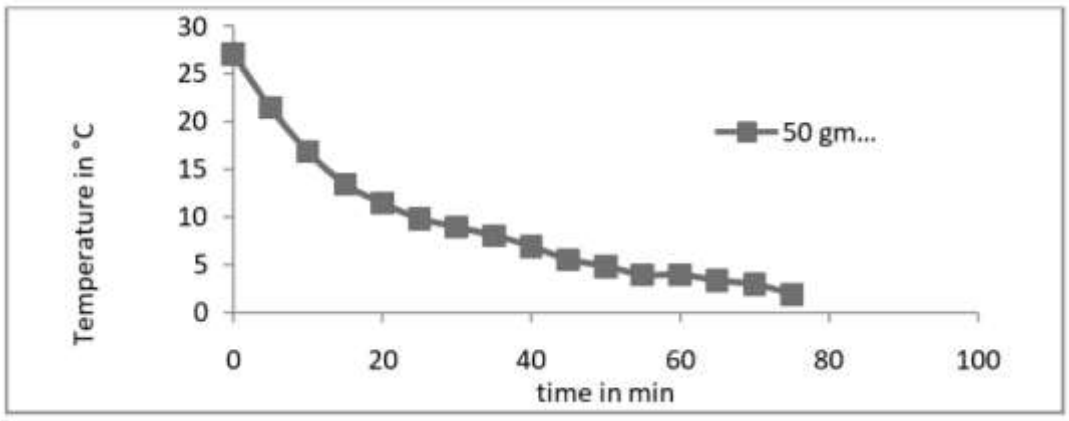

Figure 3: Pull down test of LPG

Down test for mass as shown in Figure 3. Pull down time for LPG is less than that of R134a. It shows that cooling speed is mire for LPG

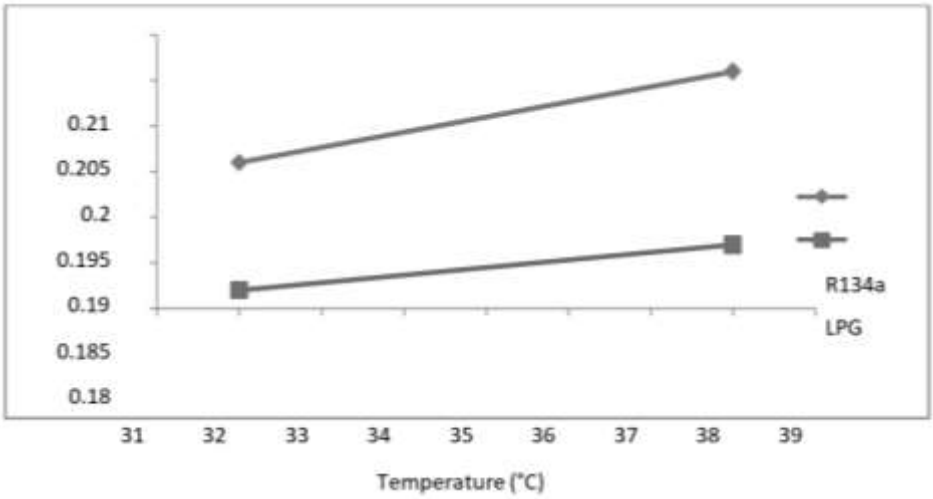

Figure 4: Power versus temperature for LPG and R134a

Optimum conditions for R134a and LPG has carried out at different ambient conditions. From Figure 4 shows that with the increase of atmospheric temperature power of compressor increases for both R134a and LPG. R134a requires more power than LPG. This is because higher work of compression is required for higher mass than when required for lower mass.

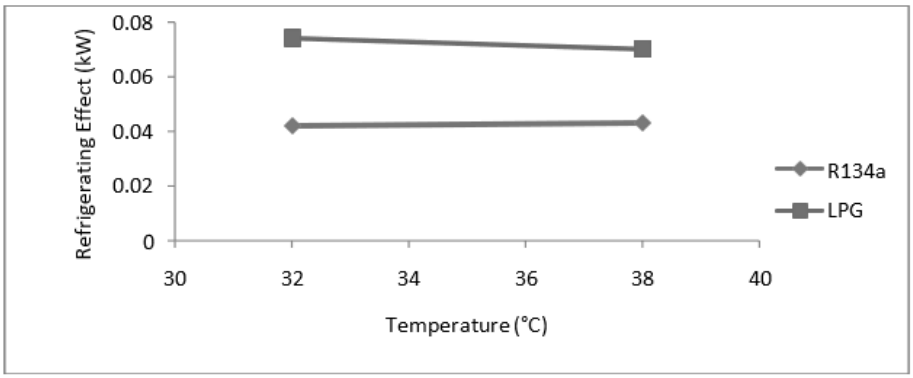

Figure 5: Refrigerating effect vs ambient temperature for R134a and LPG

From Figure 5 shows that refrigerating effect for LPG is higher than that of R134aThis is because Latent of vaporization for LPG is higher than that of R134a

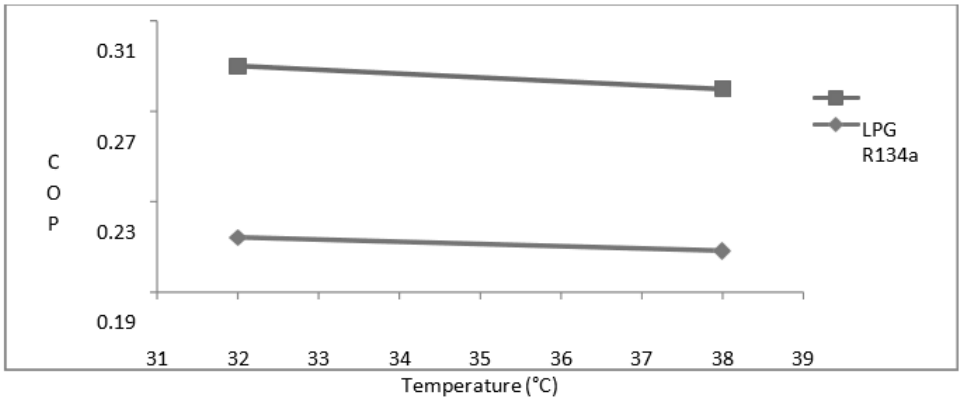

Figure 6: COP vs ambient temperature for R134a and LPG

CONCLUSION

From the graphical representation of result it can be concluded that

- Refrigerating effect for LPG is higher than R134a by 76.19%
- There is no issue of safety when the mass of LPG used does not exceed 150gm.
- COP for LPG is higher than R134a by 34.6%
- The GWP is 8 for LPG and it is eual to 1300 for R134a
- It is found that 50gm of LPG is the optimum mass of LPG for higher COP when compared to R134a
- Power consumption for R134a as refrigerant is higher than LPG as refrigerant by 9.2%

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