ISSN:2348-2079

Volume-6 Issue-1

International Journal of Intellectual Advancements and Research in Engineering Computations

Design and Fabrication of LPG Refrigerator

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Abstract - This work investigates the result of an experimental study carried out to determine the Coefficient of performance of domestic refrigerator when a propane- butane mixture is liquefied petroleum gas (LPG) which is available and comprises 56.4% butane, 24.4%propane, and 17.2% isobutene. This paper also presented an experimental investigation of COP by the effect of changing capillary tube length, capillary tube inner diameter and capillary coil diameter on the mass flow rate of refrigerant in an adiabatic helical capillary tube. Large amount of electricity supply is not available easily in large part of underdevelopment country like India. It will also prove to be an effective for remote area such as research sites, mines, & deserts where electricity is generally not available. The LPG is cheaper and possesses an environmental free in nature with no ozone depletion potential (ODP). Also LPG is available as a side product in local refineries. The results of the present work indicate the successful use of this propane-butane mixture as an alternative refrigerant to CFCs and HFCs in domestic refrigerator. It would include Experimental setup of working model and detailed observation of the LPG refrigerator and represents its application in refinery, hotel, chemical industries where requirement of LPG is more.

Index words - LPG refrigerator, ecofriendly refrigerants, Mixed evaporator, zero cost refrigerators, electricity free refrigerator.

I. INTRODUCTION

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 ^{o}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 ^{o}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. The scientist, of the time, developed a few stray machines to achieve some pleasure. But it paved the way by inviting the attention of scientist for proper studied and research. They were able to build a reasonably reliable machine by the end of nineteenth century for the refrigeration jobs. But with the advent of efficient rotary compressors and gas turbines, the science of refrigeration reached its present height. Hebrews, Greeks, and Romans places large amounts of snow into storage pits dug into the ground and insulated with wood and straw. The ancient Egyptians filled earthen jars with boiled water and put them their roofs, thus exposing the jars to the night’s cool air. In India, evaporating cooling was employed. 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. The intermediate stage in the history of cooling foods was to add

chemicals like sodium nitrate or potassium nitrate to water causing the temperature to fall. Cooling wine via above method was recorded in 1550.

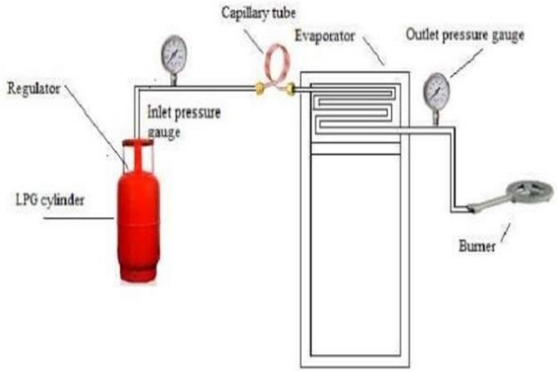

Fig. 1 LPG refrigerator block diagram

According to the energy survey, the refrigerator is one of the heaviest power consumers amongst household appliances.

The energy consumption of refrigerators has improved steadily year over year. It works on the principle that the expansion of LPG will be takes place during the conversion of liquid LPG into gaseous form. As a result of this, LPG gas pressure drops and the volume of gas will be increase this will be result into dropped in temperature of gas and it acts as refrigerant.

II. LITERATURESURVEY

[1] A.Baskaran&P.Koshy Mathews
A Performance Comparison of Vapor Compression Refrigeration System Using Eco Friendly Refrigerants of Low Global Warming Potential.R600a have a slightly coefficient performance (COP) of this mixture was up to 5.7% higher.

[2] N. Austin, Dr.P. Senthil Kumar, N
They 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.

[3] 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 various 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% and 28.57% 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.

[4] Zainal Zakaria &ZulaikhaShahrum,
They had performed experiments on Domestic refrigerators which annually consume approximately 17,500 metric tons of traditional refrigerants such as Chlorofluorocarbon (CFC) and Hydro fluorocarbon (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.

[5] Nikam S.D., Dargude S. B.,
They 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 area 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 80psi to 10psi 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.
[6] Mhaske M. S., Deshmukh T. S.,
They 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

III. CONSTRUCTION FEATURES

A.LPG Gas Cylinder

LPG is general synthesis of two gases for the most part Propane (C3H8) and Butane (C4H10), either put away independently or together as a blend in a chamber.These gases can be melted at a typical temperature by utilization of weight increments. LPG is put away in a barreled around 12.5 bars.LPG is used as a fuel for industrial, horticultural, cooking, etc.

Fig-2: LPG Gas Cylinder

B. Capillary Tube

The capillary tube is the commonly used throttling device in the domestic refrigeration. As you know, the fluid pressure drops when it flows through a conduit. Same principle is used in the capillary tube

Fig-3: Copper Capillary Tube

A capillary tube is of copper having a small bore diameter. It reduces the pressure of liquid refrigerant from condenser pressure to evaporator pressure when connected to a liquid line. The length of capillary tube is greater when the evaporator pressure is lower. The capillary tube is a simple device with no moving part. However its small bore makes it necessary that a filter and drier is fitted before the capillary tube to prevent choking.

C. Evaporator

The evaporator is also an important component of the refrigeration system. The cooling effect is produced by passing the refrigerant through evaporator coil.The actual cooling effect takes place inside the evaporator in the refrigeration systems. The heat is removed from the substance by transferring the heat from the substance to be cooled to the refrigerant with the help of evaporator.

Fig -4: Evaporator

Thus the evaporator acts as heat exchanger surface. The application of evaporator in refrigeration system is variant, thus evaporator is available in various design, dimensions and shapes. Depending on the method of input of refrigerant they are also classified in different ways, the air circulation direction around the evaporator. The freezers are the evaporators as the water freezes into ice in this compartment. The refrigerant is passed through the capillary tube at very low temperature and pressure to the evaporators. The heat is absorbed by this refrigerant from the substance that is to be cooled and thus the refrigerant gets heated while the substance is cooled. Inspire of cooling the substance the refrigerant temperature leaving the evaporator is lower than that of the substance. In large refrigeration system the application of evaporators is mainly for chilling water, thus shell and tube type heat exchangers are used as evaporator.

D. Pressure Gauge

There are many techniques for the measurement of pressure and vacuums. Pressure gauges and vacuum gauges are the instruments used to measure pressure.The most commonly used mechanical gauge is Bourdon type pressure gauge.
It is a stiff, flattened metal tube bent into a circular shape.

Fig-5: Pressure Gauge

The fluid whose pressure is to be measured is inside the tube. One end of the tube is fixed and other end is free to move inward or outward. The inward and outward movement of free end moves a pointer, through a linkage and gear arrangement, a dial graduated in pressure unit i.e. bar. Pressure gauge records the gauge records the gauge pressure which is the difference between fluid pressure and outside atmospheric pressure. These gauges are available in the different ranges of pressure.

E. High Pressure Pipes

Fig-6: High Pressure Pipe

When there is a need of transferring gas at high pressure, the range of high pressure pipes are used. It consists of a steel pipe with steel spheres fixed at both the terminals. These spheres are pressed against the seating of connecting hole with the help of two swiveling nipple and thus the gas leakage is prevented.

IV. WORKING PRINCIPLE

LPG is stored in the LPG cylinder under high pressure. When the gas tank of regulators is opened then highPressure LPG passes in gas pipe. This LPG is going byhigh pressure gas pipe in capillary tube.High pressure LPG is converted in low pressure atcapillary tube with enthalpy remains constant.After capillary tube, low pressure LPG is passed throughevaporator. LPG is converted into low pressure andtemperature vapor from and passing through theevaporator which absorbs heat from the chamber. Thusthe camber becomes cools down. Thus we can achievecooling effect in refrigerator. After passing through the evaporator low pressure LPGis passed through pipe by burner. And we can uses thelow pressure of LPG is burning processes.

5. CONCLUSION

The aim of the LPG refrigerator was to use LPG as a refrigerant and utilizing the energy of the high pressure LPG cylinder for producing the refrigerating effect. We also conclude that, we are trying to burn the exhaust LPG, the pressure of exhaust gas is less than 10 PSI, so that the flame produce by the burner is spreading outside. This system most suitable for hotel, industries, refinery, chemical industries where consumption of LPG is very high. We are continuing this project with some fabrication work and we have collected various equipment's which is required for this project like high pressure pipes, regulator valve, and capillary tube.

REFERENCES

1) Zainal Zakaria and ZulaikhaShahrun " The possibility of using liquefied petroleum gas in domestic refrigeration system" International Journal of Research and Reviews in Applied Science(IJRRAS), December 2011, Volume9

2) Vishwadipsingh J. Ghariya and Swastik R. Gajjar"International Journal for Scientific Research and Development" ISSN (online): 2321-0613, March 2014, Vol.2

3) Ibrahim Hussain Shah and Kundan Gupta "International Journal of Engineering Sciences and Research Technology" ISSN: 2277-9655, July 2014, Vol. 3(206-213).

4) Khandare R. S. and Bhane A. B "International Journal of Emerging Technology and Advanced Engineering" ISSN: 2250-2459, March 2015

5) Shank K. Wang, "Handbook of air conditioning and refrigeration" page no. 11.14 chapter 11.

6) S. J. Cleg, "Thermodynamic analysis of LPG as refrigerant for industrial refrigeration and transportation", Institute of Transport Studies, University of Leeds, Working paper of 471, 2006.

7) Dr. IqbalHusain, "Analysis of VCR and VAR systems using organic refrigerants", CRC press, Taylor and Francis Group, USA, 2012.