# LPG Refrigerator

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***Abstract*-This study investigates the result of an experimental study carried out to determine the performance of domestic refrigerator, The LPG is cheaper and possesses an environmental friendly nature with no Ozone Depletion Potential (ODP) and no Global Warming Potential (GDP). 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. It is used in world for cooking purposes 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 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 domestic refrigerant . The evaporator temperature reached 7°C with an ambient temperature of 33°C.And also we can re utilize the refrigerant as a fuel for burner.**

## 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 °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. 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.

## II. TYPES OF REFRIGERATION:

The different types of refrigeration systems are given below.

Cyclic Refrigeration:

In the cyclic process of refrigeration the heat is removed from the low temperature reservoir and is thrown to high temperature. As per the second law of thermodynamics the natural flow of heat is from high temperature to low temperature reservoir. In the cyclic refrigeration process since the flow of heat is reserved, the external work has to be done on the system.

The cyclic process of refrigeration is also reverse of the thermodynamic power cycle or Carnot cycle in which the heat flows from high temperature reservoir to low temperature reservoir. Hence the cycle of refrigeration is also called as Reversed Carnot Cycle. There are two types of cyclic process of refrigeration: Vapor cycle and Gas cycle.

Vapor Cycle:

It is classifies into 2 types: Vapor compression cycle and Vapor absorption cycle.

Vapor Compression Cycle:

In vapor compression system, an evaporator and a gas-liquid separator are received in a common casing, so that the gas-liquid separator and the evaporator are placed close to each other. Thus, it is possible to limit heat absorption of the liquid phase refrigerant from the atmosphere to reduce the heat loss upon discharge of the refrigerant from the gas-liquid separator. Also, it is possible to reduce pressure loss in refrigerant passage between the gas liquid separator and the evaporator.

Vapor Absorption Cycle:

Before the development of the vapor compression system of refrigeration, vapor absorption system was very widely used. The vapor compression system replaced vapor absorption system because it has high coefficient of performance (COP). The vapor absorption system requires very less amount of electricity but large amount of heat; hence it can be used very effectively in industries where very large stocks of excessive stem are available. In such cases there is not only effective utilization of steam, but also lots of savings in electricity costs.

## III. LPG REFRIGERATION:

In India, more than 80% of the domestic refrigerator utilizes HFC 134a as refrigerant, due to its excellent thermodynamic and thermo physical properties. But HFC 134a has a high global warming potential (GWP) of 1300. There is a need to evaluate various refrigerant options considering the existing refrigerators in the field and for the future market. CFC's are principally destroyed by ultraviolent radiations in the stratosphere; the chlorine released in the high stratosphere catalyzes the decomposition of ozone to oxygen; and ultraviolent radiations penetrate to lower altitudes. The ozone impact of car air conditioners also cannot be ignored. Hydro fluorocarbons (HFC's) can be thought of as a replacement, but unfortunately the radiation properties of HFCs like R-134a make them powerful global warming agents. HFC 134a and the HC blend have been reported to be substitutes for CFC 12, but they have their own drawbacks in energy efficiency, flammability and service ability aspects of the systems. HFC 134a is not miscible with mineral oil, and hence polyol ester oil is recommended, which is highly hygroscopic in nature.

Properties of LPG:

- Colorless.
- Odorless (It's normal to odorize LPG by adding an odorant prior to supply to the user, to the aid detection of any leaks).
- Heavier than air.
- Liquid LPG is half the weight of water.
- Non-toxic.
- LPG expands upon release and 1 liter of liquid will form approximately 250 liters of Vapor.

LPG Refrigeration Cycle

LPG Gas Cylinder

From the LPG gas cylinder, LPG flows through the pipe and reaches to the capillary tube. LPG gas pressure is approximate 10 bars. In LPG cylinder gas is stored at 12.7 bars. By using a high pressure regulator LPG is sent to capillary tube using steel reinforced high pressure pipes.

Capillary Tube

At the capillary tube pressure drop takes place from 10 bar to 3 bar. For that pressure drop to take place a suitable dimension capillary tube is selected.

Evaporator

In the evaporator LPG is converted into the vapor form with low pressure. After passing through the evaporator low pressure and temperature LPG vapor absorbs heat from the chamber system and required cooling effect is produced in the evaporator.

GAS BURNER

After performing the cooling effect low pressure LPG goes into the burner where burning takes place.

## IV. PARTS OF LPG REFRIGERATOR:

LPG CYLINDER:

LPG is a mixture of butane and isobutene. It is generally stored at 12.7 bar for house hold purpose cylinder. By using a suitable regulator LPG is sent into capillary tube. LPG is used as a fuel for domestic, industrial, horticultural, agricultural, cooking, heating and drying processes. LPG can be used as an automotive fuel or as a propellant for aerosol, in addition to other specialist applications LPG can also be used to provide lighting through the use of pressure lanterns.

*LPG gas cylinder*

Capillary Tube:

The capillary tube is the commonly used throttling device in the domestic refrigeration. The capillary tube is a copper tube of very small internal diameter. It is of very long length and it is coiled to several turns so that it would occupy less space. The internal diameter of the capillary tube used for the refrigeration applications varies from 0.5 to 2.28 mm (0.020 to 0.09 inch). The capillary tube is shown in picture. The decrease in pressure of the refrigerant through the capillary depends on the diameter of capillary and the length of capillary. Smaller is the diameter and more is the length of capillary more is the drop in pressure of the refrigerant as it passes through the capillary tube.

*Capillary tube*

V. EVAPORATOR:

The evaporators are another important parts of the refrigeration systems. Through the evaporators the cooling effect is produced in the refrigeration system. It is in the evaporators when the actual cooling effect takes place in the refrigeration systems. For many people the evaporator is the main part of the refrigeration system, consider other part as less useful. The evaporators are heat exchanger surface that transfer the heat from the substance to be cooled to the refrigerant, thus removing the heat from the substance.

*evaporator*

Evaporator with insulation

The evaporators are used for wide variety of diverse application in refrigeration and hence the available in wide variety of shape, sizes and designs. They are also classified in different manner depending on the method of feeding the refrigerant, construction of the evaporator, direction of air circulation around the evaporator, application and also the refrigerant control. In the domestic refrigerators the evaporators are commonly known as freezers since the ice is made in these compartments. In the evaporators the refrigerant enters at very low pressure and temperature after passing through the capillary tube. This refrigerant absorbs the heat from the substance that is to be cooled so the refrigerant gets heated while the substance gets cooled. Even after cooling the substance the temperature of the refrigerant leaving the evaporator is less than the substance. In the large refrigeration plants the evaporator is used for chilling water.

VI. PRESSURE GUAGES:

Many techniques have been developed for the measurement of pressure and vacuums. Instruments used to measure pressure are called pressure gauges or vacuum gauges.


Pressure gauge

High Pressure Pipes:

The range of high pressure pipes covers most application where there is a requirement to transfer gas at high pressure. They consist of a steel pipe with steel ball fitted to both ends. Two swiveling

connection nipples press these balls against the seating of the connecting hole and thus sealing against gas leakage.

Wide range of pipes All pipes are pressure tested to 100 M Pa(14,500 psi) over recommended working pressure.

High pressure pipes

High Pressure Regulator:

This type of regulator is used to send high pressure gas from the cylinders. These are mainly used in functions to Bhatti stoves.

High pressure regulators

Construction of LPG Refrigerator:

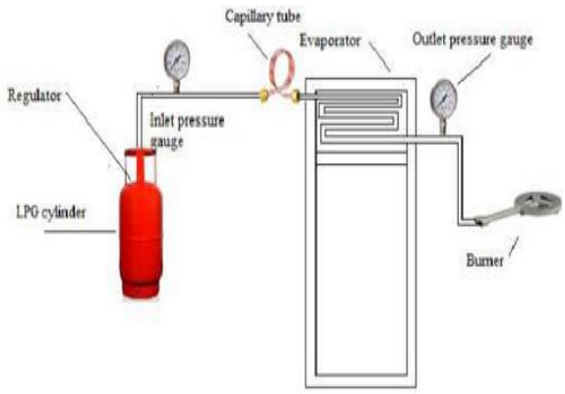
The LPG refrigerator is shown in the figure. We make the one box of the Thermo-coal sheet. The thermo-coal sheet size is 15mm used for the LPG refrigerator. The size of the evaporator is 355*254*152 $mm^3$. We kept the thermo-coal sheet because the cold air cannot transfer from inside to outside of refrigerator. And the evaporator is wrapped totally with aluminum tape. The schematically diagram of the LPG refrigeration system is shown in below diagram. The gas cylinder is connected to high pressure regulator, which is connected to high pressure pipes. To the other end of the high pressure pipes pressure guage is connected. To another end a copper tube is connected which is connected to the capillary tube. The capillary tube is fitted with evaporator. The evaporator coil end is connected to the stove by another high pressure pipe. One pressure guage is put between capillary tube and cylinder and another is put at the end of the evaporator.

LPG refrigeration and heating system

## VII. WORKING OF LPG REFRIGERATOR

The basic idea behind LPG refrigerator is to use the LPG to absorb heat. The simple mechanism of the LPG refrigeration working is shown in the figure.

- LPG is stored in the LPG cylinder under high pressure. When the gas tank of regulators is opened then high pressure LPG passes through the high pressure pipe. This LPG is going by high pressure gas pipe to capillary tube.
- High pressure LPG is converted in low pressure at capillary tube with enthalpy remains constant.
- After capillary tube, low pressure LPG is passed through the evaporator. LPG is converted into low pressure and temperature vapor from and passes the evaporator which absorbs heat from the chamber. Thus the chamber becomes cool down. Thus we can achieve cooling effect in refrigerator.
- After passing through the evaporator low pressure LPG is passed through the pipe to burner. And we can use the low pressure of LPG in burning processes.




LPG refrigeration and heating system

Advantages of LPG Refrigeration System:

- Use of LPG as a refrigerant also improves the overall efficiency of by 10 to 20%.

- The ozone depletion potential (ODP) of LPG is 0 and Global warming potential (GWP) is 8 which is significantly negligible as compare to other refrigerant.
- A part from environment friendly, use of LPG also gives us lot of cost advantages.
- LPG does not form acids and there by eliminates the problem with blocked capillaries.
- There is 60% reduction in weight of the system due to higher density of LPG.
- This fridge works when electricity is off.
- The parts are effectively silent in operation.
- Running cost is zero
- Eliminates the compressor and condenser.

Application of LPG Refrigeration System:

- It can play an important role in restaurants where continuously cooling and heating is required.
- It can be used in chemical industries for refrigeration purpose.
- It can be useful in remote parts where electricity is not available.
- It can be used in refineries where consumption of LPG is high.

VIII. RESULTS AND CONCLUSIONS

| Time (in min) | Capillary inlet pressure (in bar) | Evaporator outlet pressure (in bar) | Evaporator temp (in $^{o}$C) |
|---|---|---|---|
| 0 | 9 | 2.5 | 33 |
| 5 | 9 | 2.5 | 26 |
| 10 | 9 | 2.5 | 20 |
| 15 | 9 | 2.5 | 11 |
| 20 | 9 | 2.5 | 7 |

CONCLUSION

In this experimental study "LPG REFRIGERATOR", it is concluded that refrigerating effect is produced with the use of LPG. From observation table, It is concluded that, when the regulating valve is fully open then the evaporator temperature downs from 33$^{o}$ C to 7$^{o}$ C in 20 minutes. It is also concluded that, in the capillary tube pressure of gas 9 bar from the cylinder is reduced to 2.5 bar. The capillary tube is more suitable throttling device in LPG refrigeration system. This system is cheaper at 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 cost is also very low. This type of LPG refrigerant system is used in home needs, restaurants, industries and chemical processing units are mostly used LPG refrigerants Etc.

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