Electricity Free Refrigeration using LPG

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Abstract—The most of the Refrigerators used in India work on electric energy and use traditional refrigerants such as ChloroFlurocarbons (CFC) and HydroFlurocarbons (HFC). Such refrigerators consume too much running cost annually. Also even in current situation electricity is still not available in many remote areas and villages. It results in spoilage of food, meat and medicines. The traditional refrigerants like CFC and HFC have ozone depletion potential (ODP) and global warming potential (GWP). This paper investigates comparative study of domestic electric refrigerators and LPG refrigerators. In LPG refrigerators, refrigerant used is LPG. It is easily available and currently being used in India at both domestic and commercial level. LPG is a byproduct in fuel refinery and comprise of 24.4% propane, 56.4% butane and 17.2% isobutene which have very low boiling point (lower than 0 °C). The use of LPG for refrigeration purpose can be environment friendly since it has no ozone depletion potential (ODP). 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 reduced due to expansion and phase change of LPG by 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 generate refrigerating effect for a confined space. From experimental investigation, we have found that the COP of a refrigerator which uses LPG is higher than a domestic electric refrigerator.

Key words: LPG Refrigeration, LPG, Capillary Tube, Evaporator, Alternative Refrigerant COP, VCR

I. INTRODUCTION

According to the Indian management, the refrigerator is the 3rd heaviest user of power amongst household appliances. It is one of the few appliances that is running 365 days a year. Due to the huge requirement of electricity over the world, we consider of recovering the energy which is already spent but not being utilized further, to overcome this crisis with less investment. Hence, we suggest ‘COST FREE’ Cooling System. When we think about refrigerator we remember that refrigeration in kitchen, but also used in ‘Three Star’ and ‘Five Star’ Hotels. In such places LPG is also used for cooking purpose continuously. In this project we innovate the use of LPG also for the refrigeration purpose without electricity.

It works on the principle that during the conversion of LPG into gaseous form the expansion of LPG takes place. Due to this expansion there is a pressure drop and increase in volume of LPG that results in the drop of temperature it passes through the evaporator where it absorb the heat and create the refrigerating effect. Later than evaporator, it passes through the gas burner where it burns. Generally domestic refrigerant consumes 17500 metric tons of traditional refrigerants as CFC and HFC which produces high ozone depletion potential (ODP) and Global warming potential (GWP). So our project is reducing the formation of ODP and GWP as compare to conventional refrigerator. This provides eco-friendly refrigeration as well as replaces global warming producing refrigerants.

Thus we have to observe the two types of refrigerants LPG and CFC 22 in a modified household refrigerator compare their performance characteristics parameters like pressure, temperature etc. allowing for safety while conduct the practical test. It indicates LPG can be used as an alternative refrigerant to CFC 22 after performing the test on new system.

II. OBJECTIVES

The Objectives of this project “Performance evolution of household Refrigerator using LPG Cylinder” are as follows:
1) To identify the form of residual waste in traditional refrigeration system.
2) To achieve the electricity free refrigeration with zero running cost.
3) To reduced ozone depletion potential and Global warming potential.
4) The performance of existing refrigerator and LPG refrigerator is to be compared.

III. LITERATURE SURVEY

The refrigeration system is known to the man, since the middle nineteenth century. The scientist, of the time, developed a few stray machines to get some satisfaction. But it covered the way by welcoming the focus of scientists for proper study and research. They were able to build a reasonably consistent machine by the end of nineteenth century for the refrigeration plant. But with the beginning of capable rotary compressors and gas turbines, the knowledge of refrigeration reached its present height.

Hebrews, Greeks, and Romans placed huge amount of snow into storage lowest point dug into the ground and insulated with wood and straw. The ancient Egyptians filled earthen jars with boil water and put them their roofs, thus revealing the jars to the night cool air. In India, evaporating cooling was employed. When a liquid vaporizes rapidly, it expands speedily. The rising molecules of vapor suddenly raise their kinetic energy and this increase in drawn from the immediate surroundings of the vapor. These surroundings are therefore cooled. The middle stage in the narration of cooling foods was to attach chemicals like sodium nitrate or potassium nitrate to water causing the temperature to fall. Cooling wine via above method was recorded in 1550, as were the terms “to refrigerate”. Cooling drinks came into vogue by in France. Instead of cooling water at night, people rotate long-necked bottles in water in which salt petrel had been dissolve. This solution could be used to create very low temperature and to produce ice. By the end of the 17
Century, iced liquors and frozen juices were popular in French society. The first known artificial refrigeration was established by William Cullen at the University of Glasgow in 1748. establishment in the 1840, refrigerated cars were used to transport milk and butter. By 1860, refrigerated move was limited to mostly seafood and dairy products. The refrigerated railroad car was patented by J.B. Sutherland of Detroit; Michigan in 1867. He designed an insulated car with ice bunkers in each end. Air came in on the peak, passed through the bunkers, and circulated through the car by gravity, controlled by the use of hanging flaps that created differences in air temperature. Brewing was the earliest activity in the northern states to use mechanical refrigeration extensively, beginning with an absorption machine used by S. Liebmann’s Sons Brewing Company in Brooklyn, New York in 1870. Commercial refrigeration was mainly directed at breweries in the 1870 and 1891. Nearly every brewery was equipped with refrigerating machines. Natural ice supply became an industry unto itself. There were 35 commercial ice plants in America, more than 200 a decade later, and 2,000 by 1909. No pond was safe from scraping for ice production, not even Thoreau’s Walden Pond, where 1,000 tons of ice was extracted each day in 1847. However, as time went on, ice, as a refrigeration agent, became health problem. Says Bern Nagengast, co-author of Heat and Cold: Mastering the enormous inside published by the American Society of Heating, Refrigeration and Air-conditioning Engineers, “Good sources were harder and harder to find. By the 1890’s, natural ice became a trouble because of pollution and sewage dumping.” Signs of a problem were first evident in the brewing industry.

IV. WORKING PRINCIPLE

The LPG Refrigerator is working on simple Vapour Compression Refrigeration system. The construction and working of simple VCRS is as shown in fig.

A. Process 2-3

When the compressor is started, it draws the low pressure vapor from the evaporator at state 2 and compresses it isentropically to a sufficiently to a high pressure up to state 3. Since the compression work is done on the vapor, its temp also increases.

B. Process 3-4

Hot vapor from compressor under pressure is discharged into the condenser where condenser cooling medium usually water or nearby air is absorb from hot vapor. This convert the hot vapor into liquid and the liquid is collected in liquid receiver at state 4.

C. Process 4-1

The liquid from the liquid receiver at high pressure is then pipe to a refrigerant control valve which regulates the flow of liquid into the evaporator. This control valve, while restricting the flow, also reduce the pressure of the liquid with the result the liquid change into vapor of low dryness fraction represented by state 1. During this process the temperature of the refrigerant reduces corresponding to its pressure.

D. Process 1-2

Finally, the low pressure, low temperature refrigerant passes through the evaporator coil where it absorb its latent heat from the cold chamber or from brine solution at constant pressure and convert into vapor at state 2. It is again supplied to compressor. Thus, the cycle is completed.

V. COMPONENTS OF THE SYSTEM

A. LPG Gas Cylinder

LPG is general composition of two gases mostly Propane (C3H8) and Butane (C4H10), either stored separately or together as a mixture in cylinder. These gases can be liquefied at a normal temperature by application of a pressure increases. LPG is store in a cylinder at about 12.5 bar.

B. Capillary Tube

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

A capillary tube is of copper having a small bore diameter. It deccres 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.

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C. Evaporator

The evaporator is also an vital part of the refrigeration system. The cooling effect is produced by passing the refrigerant through evaporator coil.

The actual cooling effect is done 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 by use of evaporator. Thus the evaporator behaves as a heat exchanger surface. The application of evaporator in refrigeration system is variant, thus evaporator is available in various design, sizes and shapes. According to 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 converted into ice in this section. 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 whose temperature is to be lowered and thus the refrigerant gets heated while the substance is cooled. Inspire of cooling the substance the refrigerant temperature departure the evaporator is lesser than that of the substance. In large refrigeration system the use of evaporators is mainly for chilling water, thus shell and tube type heat exchangers are use as evaporator.

D. Pressure Gauge

There are lot of techniques for the measurement of pressure and vacuums. Pressure gauges and vacuum gauges are the instruments used to measure pressure. The usually used mechanical gauge is Bourdon type pressure gauge. It is a stiff, flattened metal tube bent into a circular shape. The fluid whose pressure is to be measured is in the tube. One end of the tube is fixed and other end is free to move inner or outer.

VI. WORKING OF ACTUAL SYSTEM SETUP

The simple mechanism of the LPG refrigeration Working is shown in figure, The principle behind LPG refrigeration is to suck heat from nearby space by using the evaporation of a LPG. The pressure of LPG which is stored in cylinder is at about 80 psi. We lowering this pressure of LPG up to pressure 15 psi by using capillary and so that cooling is done on surrounding by absorbing heat isentropically. Pressure of LPG in cylinder is high, when the regulator of gas tank is opened then high pressure LPG. After that this high pressure LPG is goes in the capillary tube from high pressure pipe. In the capillary tube this high pressure LPG is converted in to low pressure adiabatically i.e. enthalpy remains even. Later than capillary tube, this low pressure LPG is passed through evaporator. In the evaporator LPG is converted into low pressure and temperature vapor form which absorb the heat from the cooling chamber. Thus the cooling chamber becomes cools down.

E. High Pressure Pipe

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

COP of refrigerator is normally up to 2.95 which is lesser than LPG refrigerator. Domestic refrigerator require high input power than LPG refrigerator. Also there are more moving part in domestic refrigerator and not eco-friendly. Domestic refrigerator require more maintenance and operation is noisy.

VIII. FUTURE SCOPE

An introduction of new product in the field of refrigeration is expected and to give out positive result with this normal product. The aim is to focus on restaurant and community program hall, mid-day meal of school so to preserve food product like vegetables, milk etc. Also at small snack stores by increasing the probability of refrigerator by reducing its weight, removing compressor totally as well as maximum cost reduction due to no cost of refrigeration.

- The mine, desert and research areas countries where lack of electricity this product might be beneficial.
- This product can also hold good application in an LPG Car air conditioning

IX. ADVANTAGES

1) No moving parts.
2) No vibration or noise on small system.
3) Its maintenance is simple.
4) It doesn’t require electricity.
5) This system causes no harmful to environment i.e. It is Eco-friendly and non-polluting.
6) It gives good cooling effect.
7) This system doesn’t require any kind of work input, so zero running cost.
8) Initial cost of the system is low because so many parts of general refrigeration system like compressor, electric parts, etc are eliminated.

X. LIMITATIONS

1) Potential refrigerant leaks.
2) Operates under narrow vibration and orientations.
3) Complicated and difficult to service and repair.
4) Install in a hot ambient.
5) Very bulky.
6) Poor efficiency.

XI. CONCLUSION

The project “study and performance of household refrigerator use LPG as refrigerant” is based on the principle of adiabatic expansion of a refrigerant from 80 psi to 10 psi so that thermodynamically it could absorb heat from surrounding and cooling can be done. Expected cooling is predicted up to range of 20 to 50 degrees. Using the sophisticated data and instruments the relevant refrigeration system will be develop practically. In this project the capillary tube is more suitable throttling device in LPG refrigeration system.

This system is very affordable in not only initial but also in 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, as we daily do but also the refrigeration is obtained which is inherent process takes place daily. In this system this refrigeration is amplified remarkably and a cheaper and eco-friendly method is developed. This system is most suitable for hotel, industries, refinery, chemical industries where consumption of LPG is very high.

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