Electricity Free Refrigeration System using Domestic LPG
Design of Energy Saving Refrigerator

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Abstract—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 refrigeration system we have to use LPG as refrigerant because of it having low boiling point property and it also have high pressure. When high pressure LPG passed through the capillary tubes because of small internal diameter the pressure of LPG dropped suddenly due to isentropic cycle. While changing property of LPG from liquid to gas latent heat of refrigerant increased, and temperature will be dropped and it acts as a refrigerant predominately.

Keywords— LPG Refrigeration, LPG, Capillary tube, Evaporator, COP, VCR, Refrigerating Effect.

I. 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, increasing the importance, whenever possible, to have an eco-friendly refrigerator in your household. A new eco-friendly refrigerator in 2006 was estimated to consume 481 kilowatt hours per year. The energy consumption of refrigerators has improved steadily year over 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 aid 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. Domestic refrigerator consumes 17500 metric tons of traditional refrigerator as CFC, HFC and which contribute 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. LPG is expected to results in comparable product efficiencies based on its characteristics. 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. By performing the tests on new system, it is indicate that the successful of using LPG as an alternative refrigerant to replace CFC 22 in domestic refrigerators is possible by getting LPG.

II. 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 achieve some pleasure. But it paved the way by inviting the attention of scientist for proper studies 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 placed 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 molecules of vapor abruptly increase their kinetic energy and this increase is drawn from the immediate 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, as were the words “to refrigerate”. Cooling drinks came into vogue by 1600 in France. Instead of cooling water at night, people rotate long-necked bottles in water in which salt petre had been dissolved. This solution could be used to produce very low temperature and to make ice. By the end of the 17 Century, iced liquors and frozen juices were popular in French society. The first known artificial refrigeration was demonstrated by William Cullen at the University of Glasgow in 1748. Beginning in the 1840, refrigerated cars were used to transport milk and butter. By 1860, refrigerated transport 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 top, 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 first 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 primarily directed at breweries in the 1870 and 1891, nearly every brewery was equipped with refrigerating machines. Natural ice supply became an industry unto itself. By 1879, 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 a health problem. Says Bern Nagengast, co-author of Heat and Cold: Mastering the Great Indoors (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 problem because of pollution and sewage dumping.” Signs of a problem were first evident in the brewing industry.

III. CONSTRUCTION & WORKING

The basic idea behind LPG refrigeration is to use the evaporation of a LPG to absorb heat. LPG is stored in cylinders at pressure at about 80 psi. We lowering this pressure to pressure of 1 psi so that the heat absorbed adiabatically and cooling is obtained on surrounding.

The simple mechanism of the LPG refrigeration working is shown in figure.

Fig. 3.1 Circuit diagram of LPG refrigerator

LPG is stored in the LPG cylinder under high pressure. When the gas tank of regulators is opened then high pressure LPG passes in gas pipe. This LPG is going by high pressure gas pipe in capillary tube.

High pressure LPG is converted in low pressure at capillary tube with enthalpy remains constant.

After passing through the evaporator low pressure LPG is passed through pipe by burner. And we can use the low pressure of LPG is burning processes.

In this project instead of compressor a recompressed LPG cylinder is used. The compressed gas in cylinder expands adiabatically while using for cooking purpose or combusting, as result of its adiabatic expansion a refrigeration cycle takes place. Causes cooling of surrounding.

Construction Features:

A. LPG Gas Cylinder

LPG is Liquefied Petroleum Gas. This is general description of Propane (C3H8) and Butane (C4H10), either stored separately or together as a mix. This is because these gases can be liquefied at a normal temperature by application of a moderate pressure increases, or at normal pressure by application of LPG using refrigeration.
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 propellant for aerosol, in addition to other specialist applications. LPG can also be used to provide lighting through the use of pressure lantern. LPG is Liquefied Petroleum Gas. This is general description of Propane (C3H8) and Butane (C4H10), either stored separately or together as a mix. This is because these gases can be liquefied at a normal temperature by application of a moderate pressure increases, or at normal pressure by application of LPG using refrigeration. 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 propellant for aerosol, in addition to other specialist applications. LPG can also be used to provide lighting through the use of pressure lantern.

C. Evaporator

The evaporators are another important parts of the refrigeration systems. It through the evaporators that the cooling effect is produced in the refrigeration system.

B. 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. When the refrigerant enters in the capillary tube, its pressure drops down suddenly due to very small diameter. 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 it.
In the large refrigeration plants the evaporator is used for chilling water. In such cases shell and tube type of heat exchanger are used as the evaporators.

D. Pressure Gauge

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

A manometer could also referring to a pressure measuring instrument, usually limited to measuring pressures near to atmospheric. The term manometer is often used to refer specifically to liquid column hydrostatic instruments.

Catering to the requirements of to power and allied Industry, we offer quality array of stainless steel, weatherproof pressure gauges. Renowned for offering resistance in corrosive environments and modes, these find wide application in power generation, pollution control equipment, chemicals and petrochemicals and also exploration. These gauges are available in 63mm, 100mm, and 150mm sizes and can be customized as per client.

E. 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.

Fig. 3.4 Stainless steel pressure gauge

Fig. 3.5 High Pressure pipes.

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

IV. DESIGN CONSIDERATION

There are many requirements that need to be met to produce a product that is both feasible and optimal. There are also some constraints, both geometric and engineering that also need to be satisfied. The following list describes these requirements and constraints:

- Refrigeration capacity: This is the main requirement and the overall objective of the device and must be suitable to meet the different cooling loads.
- Inexpensive and affordable: This product must be able to make a profit and be desirable.
- Safe to user and environmentally friendly: Safety is always a very important aspect whenever there is a consumer product.
- Economical: The product economical and the products for this design must be cheaply available.
- Reliable: It is important to have a product that is reliable and this requirement will affect the normal bicycling process and must be easy to use.
- Manufacturability: In order to make anything economical, it needs to be manufacturability, hence the important of having a product that can be made easily and cheaply.
- Aesthetically pleasing: This is not a requirement that needs to be taken heavily, but the design should always have nice look about it, because looks will persuade the consumer.
Modular: Having a device that can be adapted to existing refrigerators is essential to be added to the existing ones so that it’s easier to adopt. This also can reduce other types of manufacturing costs.

Advantages:
1. No moving parts.
2. No vibration or noise on small system.
3. Small systems can operate without electricity using only heat, large systems require power for chemical pumps
4. Can make use of waste heat

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

V. CONCLUSION
The project “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 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 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. 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 most suitable for hotel, industries, refinery, chemical industries where consumption of LPG is very high.

REFERENCES