RESEARCH PAPER ON NO COST REFRIGERATION BY USING LPG GAS

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Abstract - Supply of continuous electricity is still not available in several areas of the Country and the world. At such places, this work will be helpful for refrigeration of food, medicines, etc... This paper investigates the result of an experimental study carried out to determine the performance of domestic refrigerators. In this project a new concept for air-conditioning systems by using Liquefied Petroleum Gas (LPG) is proposed. In this work we have investigated the performance of a refrigerator by using LPG as refrigerant as LPG is locally available and is easy to transport anywhere. LPG is a byproduct in petroleum refineries and comprises 24.4% propane, 56.4% butane and 17.2% isobutene which have very low boiling point (lower than 0°C). The purpose of using LPG for refrigeration is because it is environment friendly, since it has no ozone depletion potential (ODP =0) and the combustion products of LPG are CO_2 and H_2O. In this project we have designed and analyzed a car ac using LPG as refrigerant. LPG is available in cylinders at high-pressure. When this high-pressure LPG is passed through a small internal diameter of the capillary tube, the pressure of LPG gets dropped due to expansion and phase change of LPG occurs in an 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 produce refrigerating effect for a confined space.

***Key Words*: Refrigeration, Refrigerant, Traditional, Evaporator etc.**

1. INTRODUCTION

The climatic change and global warming demand accessible and affordable cooling systems in the form of refrigerators and air conditioners. Annually Billions of dollars are spent in serving this purpose. Hence forth, we suggest COST FREE Cooling Systems. Although government agencies are not able to continuously supply a major portion of electricity in both the urban as well as in rural areas. Still the people in these regions require refrigeration for a variety of socially relevant purposes such as cold storage or storing medical supplies and domestic kitchens this project has the novelty of using LPG instead of electricity for refrigeration. It works on the principle that during the conversion of LPG into gaseous form, 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 and a refrigerating effect is produced. This refrigerating effect can be used for cooling purposes.

1.1 Problem statement

LPG which is stored in storage devices like cylinders at high pressure is extracted. Its pressure and flow rate is controlled by a valve connecting it to the capillary tube at requisite quantity. Evaporator converts it from liquefied state to gaseous state and expands, so it absorbs heat in the form of latent heat due to this process. However heat from the surroundings is absorbed, so a cooling effect is produced. This results in calculating the cooling effects at different flow rates of LPG gas

1.2 Objectives

1) Compare the important characteristics between LPG Refrigeration system and traditional refrigeration system.
2) To distinguish between the current existing refrigerator Cost and estimated cost of LPG refrigerator.
3) The performance of existing refrigerator and LPG Refrigerator is to be compared.
4) To determine the cop of refrigerator using LPG as refrigerant

2. Scope

1) The future scope of this project is to focus on implementation of the project in the restaurant and community hall for preserving vegetables, dairy products with the refrigeration, where it serves the purpose of preservations.

2) This kind of system can be implemented on the food trucks as well where it can store in various quantities.

Future scopes of the LPG refrigeration system

2.1 Selection of parts:

1) **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.

2) **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).

Fig -2: Capillary tube

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Fig 3: Evaporator

3) **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.

4) **Pressure gauges**: Many techniques have

5) **High pressure pipes:** The range of high pressure pipes covers most applications where there is a requirement to transfer gas at high pressure.

They consist of a steel pipe with a steel ball fitted

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6) **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.

been Developed for the measurement of pressure and Vacuums. Instruments used to measure pressure to both ends. Two swiveling connection nipples press these balls against the seating of the connecting hole and thus sealing against gas leakage. All pipes are pressure tested to 100 M Pa (14,500 psi) over recommended working

3. Design and specification of components:

Design of capillary tube : The capillary tube is a fixed restriction-type device. It is a long and narrow tube connecting the condenser directly to the evaporator. The pressure drop through the capillary tube is due to the following two factors: 1. Friction, due to fluid viscosity, resulting in frictional pressure drop. 2. Acceleration, due to the flashing of the liquid refrigerant into vapor, resulting in momentum pressure drop. Design parameters for capillary tube are: Cylinder size = 14 kg,
Cylinder = 295 mm capillary = 1.05mm

Design of evaporator: The evaporator is the component of a refrigeration system in which heat is removed from air, water or any other body required to be cooled by the evaporating refrigerant. In experimental setup plate and tube type evaporator has been used because it provides a gentle type of evaporation with low residence time. It also preserves the food and other products from bacterial attack and requires low installation cost.

4. EXPERIMENTAL ANALYSIS

4 SPECIFICATION OF COMPONENTS

Time [min]	Inlet Pressure [bar]	Water Temp [°C]	Evaporator Temp [°C]
0	5.2	28.8	27.9
10	5.2	25.4	21.3
20	5.2	23	17.7
30	5.2	20.6	15.2
40	5.2	18	13.2
50	5.2	15.7	11.6
60	5.2	13.6	10

1. Copper Tubes: According to the pressure 100 psi the outside diameter of tube = 7 mm and the thickness of the tube is = 1.5 mm.

2. Capillary tube: By considering the pressure and flow rate we select the capillary tube with internal diameter 0.78mm and length 2.95m.

3. Evaporator: We select the evaporator of standard size of domestic refrigerator which is plate and tube type evaporator.

The evaporator has following dimensions: Length = 365 mm, Breadth = 255 mm and Height = 140 mm

The evaporator is covered by thermo coal sheets of 12 mm thickness which enclose wooden plywood sheet of 10 mm thickness so as to prevent heat transfer.

9.2 RESULT & DISSCUSSION

1. Initial temperature of water at the time of experiment: 28.8°C
2. Initial temperature of evaporator at the time of experiment: 27.9°C

9.3 REFRIGERATING EFFECT

REFRIGERATING EFFECT

The properties of LPG at 5.35 bars
Enthalpy h1 = 430.3 kJ/Kg
The properties of LPG at 1.22 bars are Enthalpy hf = 107.3 kJ/Kg Temp. tsat= -30 ^{0}C
Heat extracted from evaporator in 1.5 hour (Qeva) = Heat absorbed by LPG (QLPG) (Qeva) = Heat absorbed from (water + surrounding air inside of evaporator + leakage) mw = mass of water =1kg cpw = specific heat of water=4180J/kg. K
(ΔT) W =15.2°C
XLPG = Dryness fraction of LPG from graph =0.5 (Qeva) = Qeva + Qair +QL = mwcpw(ΔT) + macpa(ΔT) +QL

We have taken 1 kg of water in glass.
Since there is very less amount of air so it is neglected. = 1×4180×10 = 41800 J
Heat absorbed by LPG (QLPG) = Latent heat absorbed (QL)LPG +Sensible heat gain (QSen)LPG
We have the volume flow rate of LPG is 0.1 liter per min. and the specific volume of LPG at 1.22 bar pressure is 1.763×10^-3 m3/Kg.
Therefore, mass flow rate of LPG is = 0.0001/1.763×10^-3 = 0.0567 Kg/min m = 9.448×10^-4 Kg/sec
= mLPG .xLPG .hfg + mLPG .cpLPG . (Tsup-Tsat) = 9.448×10^-4×0.5×375×103×3600+ 9.448×10^-4×1.67×(40)
= 65.687×10^3 J/Hr.
= 0.65687MJ/Hr.
h2 = hf+X.hfg = 107.3 + 0.5 x 375 = 294.8 KJ/Kg hg = hf+ hfg = 107.3 + 375 = 482.3 KJ/Kg.
h3 = hg + Cp. ΔT = 482.3 + 1.67 x 40 = 549.1 KJ/Kg
So, the refrigerating effect is,

RE = h3 – h2 = 549.1 – 294.8 = 254.44 KJ/Kg

For calculating the COP of the system, we required the work input. For work input we have a 14.5 Kg. LPG cylinder. Hence, input work is the amount of power required for filling 1 cylinder. From the PCRA energy audit report power required to refill 1 cylinder is 3.1354kWh. Therefore, for filling 1 kg of LPG power required is,

= 3.1354/14.5 = 0.2162 kWh

We run the setup for 1hr. for that power is

= 0.2162×1000/ (9.45/10000) ×3600 = 63.55W

9.4 COP OF REFRIGERATING SYSTEM

COP = (h3-h2)/W = 254.44/63.55= 4.0

After finding out the COP of the LPG refrigerator we found out the heat liberated by LPG after burning in the burner with the burner efficiency of 92 %. Heat liberated by LPG to atm.

QL= m×Cv

The volume flow rate of LPG is 0.1 liter per min. and the specific volume of LPG at 1.35 bar pressure is 1.763×10^-3 m3/Kg.

Therefore, mass flow rate of LPG is

= 0.0001/1.763×10-3 = 0.0567 Kg/min m

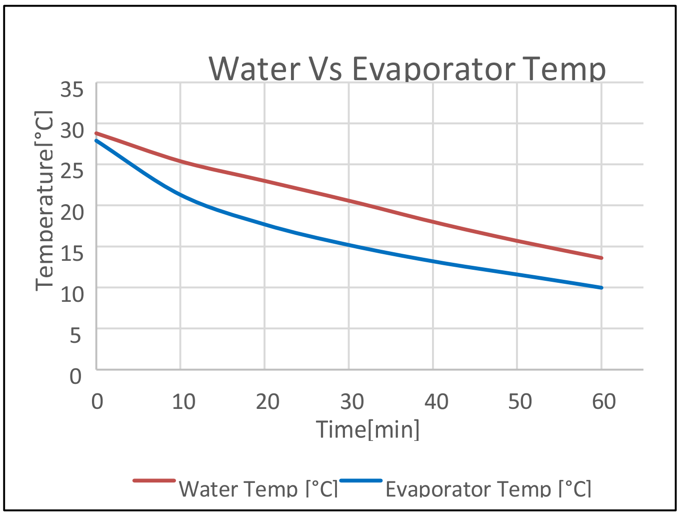
= 9.448×10^-4 Kg/sec

Cv = 46.1 MJ/Kg

QL= 9.448×10^-4× 46.1×103 = 43.56 W

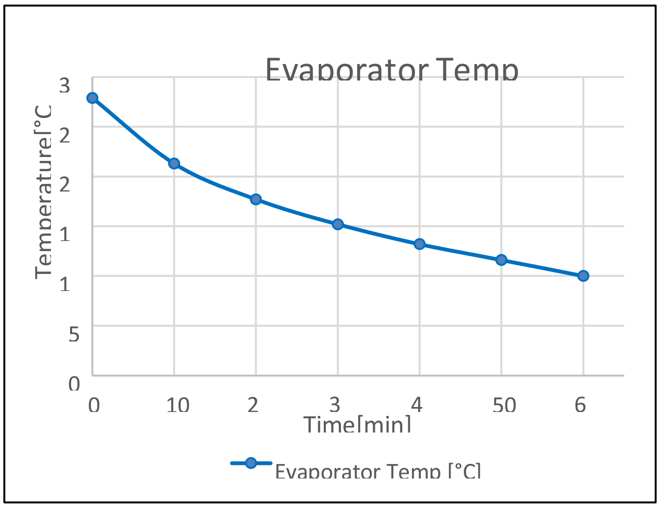
TABLE 2: Observation table

CHARTS:



4. CONCLUSIONS

1. Propane is an attractive and environmentally friendly alternative to CFCs used currently.
2. Mass flow rate increases with increase in capillary inner diameter and coil diameter whereas mass flow rate decreases with increase in length. It was observed that the COP of system increases with similar change in geometry of capillary tube.
3. Cooling capacities were obtained order of about three- to four fold higher for LPG than those for R- 12. Capillary tube. COP of LPG refrigerator was higher than that of R134a by about7.6%. LPG seems to be an appropriate long-term candidate toreplaceR134a in the existing refrigerator, 4. High COP values were obtained No operation problems have been encountered compressor. The use of LPG as a replacement refrigerant can contribute to the solution of (ODP) problem and global warming potential.



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