A review: Design and fabrication of LPG as refrigerant in AC and working fluid in burner

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***Abstract*—Several areas of the world is still suffering for the supply of continuous electricity specially like hilly areas. At such places, this system will be extremely useful for human comfort, Air conditioning, etc... In this work we have investigated the performance of an Air conditioner which uses liquefied petroleum gas (LPG) as refrigerant since LPG is locally available and is easy to transport anywhere. The use of LPG for refrigeration purpose can be environment friendly since it has no ozone depletion potential (ODP). LPG is primarily used as a fuel for cooking food in houses, restaurants, hotels, etc…and the products of combustion of LPG are CO2 and H2O. LPG can produce refrigerating effect for a confined space which can be used for air conditioning with the help of blower. From experimental investigations, we have figure out that the COP of a refrigerator which uses LPG is higher than a domestic refrigerator.**

I. INTRODUCTION

Although government agencies are not able to continuously supply a major portion of electricity in both the rural as well as urban areas. Still the people in these regions require refrigeration and air conditioning for a variety of socially relevant purposes such as human comfort air conditioning cold storage or storing medical supplies and domestic kitchens this project has the novelty of using LPG instead of electricity for refrigeration. This solution is convenient for refrigeration in regions having scares in electricity. LPG is a byproduct in petroleum refineries and comprises of 24.4% propane, 56.4% butane and 17.2% isobutene which have very low boiling point (lower than 0 oC). 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 and further utilized for air conditioning. So this system provides air conditioning effect for socially relevant needs as well as replaces global warming creator refrigerants. While going through the literature review in LPG refrigeration system, Conventional VCR(Vapour Compression Refrigeration System) uses LPG as refrigerant and produced the refrigerating effect . But in proposed work, very simple type of refrigeration system in which the high pressure LPG is passing through a capillary tube and expands. After expansion the phase of LPG is changed and converted from liquid to gas and then it passes through the evaporator where it absorbs the heat and produces the refrigerating effect. After evaporator it passes through the gas burner where it burns.

II. LITERATURE REVIEW

N. Austin, Dr.P. Senthil Kumar, N, (2012)[1]., 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.

Also, actual COP of mixed refrigerant refrigerator was higher than that of R134a by about 7.6%. From the experiment it was observed that, every mode of mixed refrigerant yields higher COP than HFC-134a. The mixed refrigerant in domestic refrigerator, observed the freezer temperature lower than that of the R134a. When the evaporator temperature increased, COP also increases and when the condenser temperature decreases, COP increases.

Fig. 1 Experimental setup of the investigation unit and apparatus

Ibrahim Hussain Shah, Kundan Gupta, (2014)[2]., has studied 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. In this work we have investigated the

performance of a refrigerator based on liquefied petroleum gas (LPG) refrigerant since LPG is locally available and is easy to transport anywhere. LPG is a by-product in petroleum refineries and comprises of 24.4% propane, 56.4% butane and 17.2% isobutene which have very low boiling point The use of LPG for refrigeration purpose can be environment friendly since it has no ozone depletion potential (ODP). Usually LPG is used as a fuel for cooking food in houses, restaurants, hotels, etc. and the combustion products of LPG are CO2 and H2O.In this project we have designed and analyzed a refrigerator using LPG as refrigerant. 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 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 from experimental investigations, we have found that the COP of a refrigerator which uses LPG is higher than a domestic refrigerator. The aim of the LPG refrigerator was to use LPG as a refrigerant and utilizing the energy of the high pressure in the cylinder for producing the refrigerating effect.

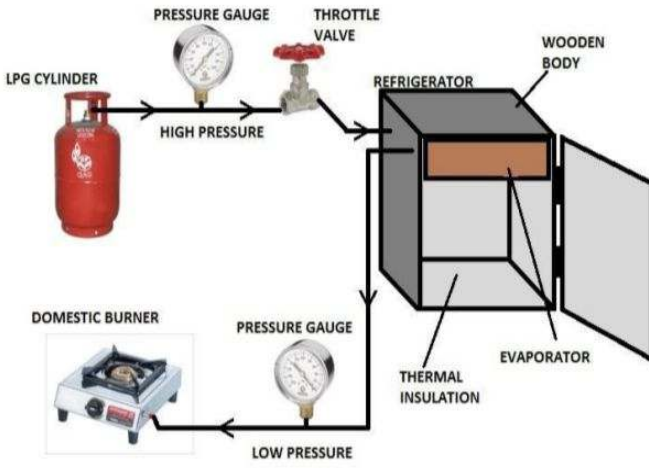

Fig.2 Experimental set up

Nikam S.D., Dargude S. B., (2015)[3]., 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 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 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 80 psi to 10 psi 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.

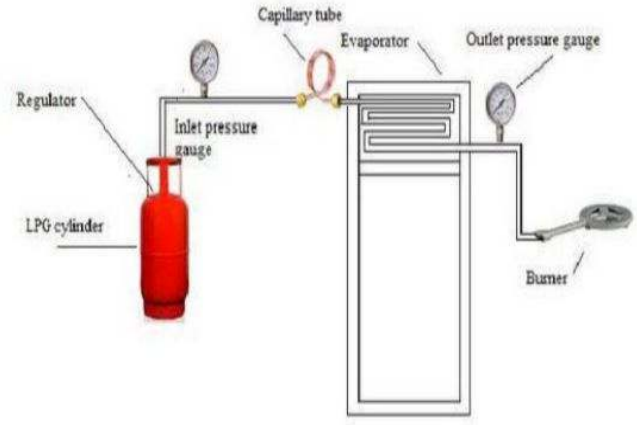

Fig. 3 Setup of LPG refrigeration system

Zainal Zakaria & Zulaikha Shahrum, (2016)[4]., had performed experiments on Domestic refrigerators which annually consume approximately 17,500 metric tons of traditional refrigerants such as Chlorofluorocarbon (CFC) and Hydrofluorocarbon (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.

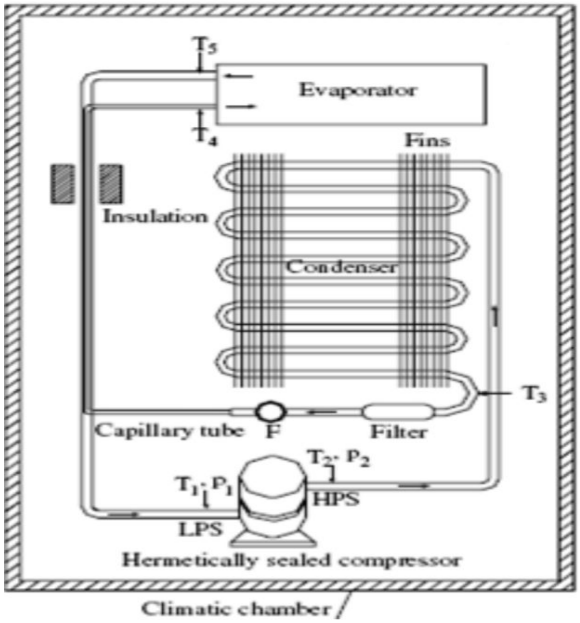

Fig.4 Schematic Diagram of Equipment in Fridge Circuit

Mhaske M. S., Deshmukh T. S., (2016)[5]., 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.

Fig .5 Actual Setup of LPG Refrigerator

Bilal A. Akash et. al.,[6]., has conducted performance tests on the performance of liquefied petroleum gas (LPG) as a possible substitute for R12 in domestic refrigerators. The refrigerator which is initially designed to work with R12 is used to conduct the experiment for LPG(30% propane, 55% n-butane and 15% isobutane). Various mass charges of 50, 80 and 100g of LPG were used during the experimentation.LPG compares very well to R12. The COP was higher for all mass charges at evaporator temperatures lower than −15˚C. Overall, it was found that at 80g charge,LPG had the best results when used in this refrigerator. The condenser was kept at a constant temperature of 47˚C.Cooling capacities were obtained and they were in the order of about three to fourfold higher for LPG than those for R12.

M. Fatouh et. al.,[7]., investigated substitute for R134a in a single evaporator domestic refrigerator with a total volume of 0.283 m3 with Liquefied petroleum gas (LPG) of 60% propane and 40% commercial butane. The performance of the refrigerator, tests were conducted with different capillary lengths and different charges of R134a and LPG. Experimental results of the refrigerator using LPG of 60g and capillary tube length of 5 m were compared with those using R134a of

100g and capillary tube length of 4 m. Pull-down time, pressure ratio and power
consumption of LPG refrigerator were lower than those of R134a by about 7.6%, 5.5% and 4.3%, respectively. COP of LPG refrigerator was 7.6% higher than
that of R134a. Lower on-time ratio and energy consumption of LPG refrigerator
was lower than 14.3% and 10.8%, respectively, compared to R134a. In conclusion, the proposed LPG is drop in replacement for R134a, to have the better performance, optimization of capillary length and refrigerant charge was needed.

Sanjeev singh punia & Jagdev singh[8].,have Experimental investigation on the performance of coiled adiabatic capillary tube with LPG as refrigerant and conclude that there was an increase in mass flow rate by 106%, when the capillary inner diameter was increased from 1.12mm to 1.52mm. When the coil diameter of capillary tube was decreased from 190mm to 70mm, the mass flow rate was decreased by 13%, 7% and 9% for 1.12mm, 1.4mm and 1.52mm inner diameter of capillary tube respectively. 1.40 mm diameter capillary effected the system more as compared to 1.12 mm diameter capillary tube.Mass flow rate increase with increase in capillary inner diameter and coil diameter where as mass flow rate decreases with increase in length. It was observed that the COP of system increases with similar change ingeometry of capillary tube.

III. PROPOSED WORK

In this project we are going to design and fabricate a system of Air conditioner which uses LPG as refrigerant. LPG is compressed in cylinders at high pressure. When this LPG having high pressure is passed through the capillary tube of small internal diameter, the pressure of LPG is dropped due to expansion and phase change of LPG occurs in an iso-enthalpic process. Due to phase change from liquid to gas latent heat is gained by the liquid refrigerant and the temperature drops.

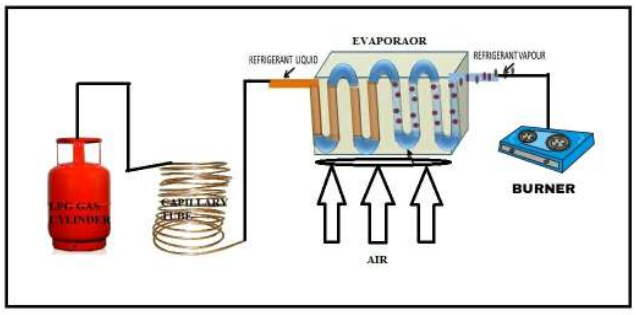

Fig .6 Line Diagram of Project

The LPG air conditioning is shown in the figure. We kept the thermo-coal sheet because the cold air cannot transfer from inside to outside of compartment And the evaporator is wrapped totally with aluminium tape. The schematically diagram of the LPG air conditioning system is shown in above 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 gauge 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 gauge is put between capillary tube and cylinder and another is put at the end of the evaporator

CONCLUSION

According to lots of research papers it can be found that A system can be designed and manufactured for the purpose of human comfort based air conditioning system This system can be useful for human comfort for basic needs like air conditioning. LPG based air conditioning system will be helpful ,LPG can be further utilized for cooking food in domestic purpose , hotel and restaurant. Due to low cost and availability of LPG, operating cost of this system is low.

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