



LPG Refrigeration System

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ABSTRACT: We know that (LPG) which constitutes about 24.4% propane, 56.4% butane and 17.2% isobutene is most commonly used for cooking purpose is less expensive and has an ecological agreeable nature with no Ozone Exhaustion Potential (ODP) and no Global Warming Potential (GWP). In our experiment we have investigated that LPG can be used as refrigerant for producing cooling effect. 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. The evaporator temperature achieved was 17°C with a surrounding temperature of 31°C. From experimental investigations, we have found that the COP of a LPG Refrigerator is almost comparable to that of the domestic refrigerator.

KEYWORDS: Coefficient of Performance, Global Warming Potential, Chlorofluorocarbons.

I. INTRODUCTION

A refrigerator is one of the heaviest power consuming devices among family unit apparatuses. The utilization of refrigerators has improved consistently year over year. According to the second law of thermodynamics, cooling must be performed with the guide of some outside work. As a result a power supply is normally required to drive a cooler. The substance which works in a refrigerator to separate heat from a space to be cooled and convey it to a hot body is known as a refrigerant. Around 17500 metric huge amounts of customary refrigerants is devoured by residential refrigeration like CFC, HFC which causes high consumption of ozone layer (ODP) and Global Warming Potential (GWP). The utilization of LPG rather than CFC 22 has gained a superior ground since it has no cordial direction with ODP. Great item productivity can be obtained by the utilization of LPG due to its attributes. Therefore we need to inspect these two sorts of refrigerants (LPG and CFC 22) in an adjusted residential cooler contrasting their presentation attributes parameters like weight, temperature and so forth.

International Journal of Energy et al. [1] shows that the pressure ratio of R600A is higher than that of LPG, which is an indication that LPG operates at a relatively very low pressure ratio than R600A. A high pressure ratio will affect the systems performance and reliability of the components negatively, while a low pressure ratio will prolong the equipment life and greatly improve its performance.

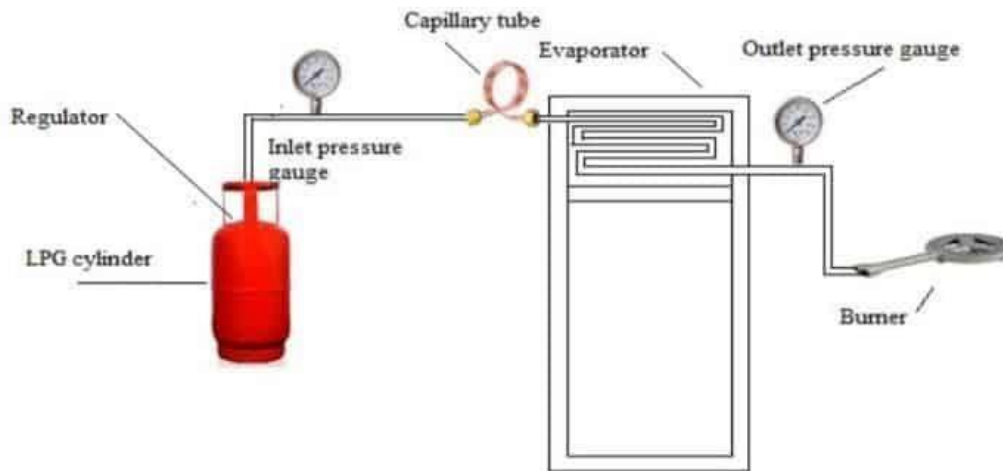
II. RELATED WORK

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Zainalzakaria & Zuliaikhashahrum et al. [2] have investigated that in an LPG refrigerator if a leak occurs, an explosive mixture will not form inside the compartment. Circuit that has a part of the cooling system inside the food storage

compartment and can be considered to be as leak-proof is one of the examples. Because an explosive mixture will not occur at any alert, precautions need not be taken to prevent a spark from occurring in the compartment.

III.METHODOLOGY



The schematic diagram of the LPG refrigeration working is shown above. The thought behind LPG refrigeration is to remove the heat from a space by utilizing the LPG as a refrigerant. The pressure of LPG which is released from barrel is at around 4 bar and we bring down this pressure of LPG up to 2 bar at the output of the evaporator. Pressure of LPG in cylinder is high, when the regulator of gas cylinder is opened then high pressure LPG goes through gas pipe. After that it then passes through the capillary tube from high pressure pipe. In the capillary tube phase transition of high pressure LPG is to low pressure takes place adiabatically by keeping the enthalpy constant.

Dr Amir S Dawood et al. [3] theoretically assumed that refrigerant flows in one direction through the capillary tube and at a steady state. The capillary tube is adiabatic.

This low pressure LPG is passes through evaporator. In the evaporator LPG is changed to vapour form and temperature is decreased, as a result cooling effect is produced.

IV.EXPERIMENTAL RESULTS

Table.1. Experimental Readings

Time (min)	Inlet pressure (bar)	Outlet pressure (bar)	Evaporator temperature (C)
10	4	2	31
20	4	2	29
30	4	2	25
40	4	2	20
50	4	2	17



Calculations

The properties of LPG at 4 bars are Enthalpy $h_1 = 81.5$ kJ/kg
 Mass flow rate of LPG at 4 bars = $1\text{kg/hr} = 2.78/(10000)$ kg/sec

The properties of LPG at 2 bars are Enthalpy $h_f = 33.5$ kJ/kg
 $h_{fg} = 406.9$ kJ/kg
 $h_g = 440.4$ kJ/kg.

$$\begin{aligned}
 h_2 &= h_f + x h_{fg} \\
 &= 33.5 + 0.5 \times 406.9 \\
 &= 236.96 \text{ kJ/kg} \\
 h_3 &= h_g + C_p \Delta T \\
 &= 440.4 + 1.67 \times (31 - 17) \\
 &= 463.78 \text{ kJ/kg}
 \end{aligned}$$

So the refrigerating effect is, $RE = h_3 - h_2 = 463.78 - 236.96 = 226.82$ kJ/kg

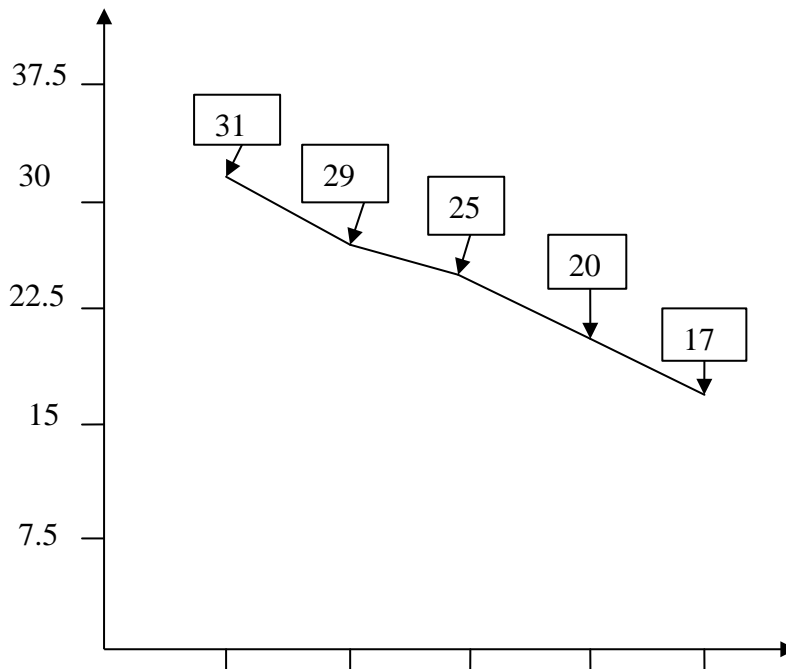
For calculating the COP of the system, we required the work input. For work input we have a 14.5 Kg LPG cylinder. Hence, input work is the amount of power required for filling 1 cylinder. From the PCRA energy audit report et al. [4] power required to refill 1 cylinder is 3.1354kWh.

Therefore, for filling 1 kg of LPG power required = $3.1354/14.5 = 0.2162$ kWh

We run the setup for 1.5 hr. for that power is = $0.2162 \times 1000 / (2.78/10000) \times 3000 = 259.23$ W

COP of the LPG Refrigeration System = $RE/W = 226.82/259.23 = 0.87$

Temperature (C)



01020304050 Time (min)

Graph showing Temperature vs Time



The performance of the refrigerating system was evaluated by analyzing the COP of the system. The refrigerating effect produced and work input was used to find out the COP. When the inlet pressure was 4bar, the refrigerating effect was found to be 226.82kJ/kg and COP was 0.87. The curve plotted between temperature and time shows that the temperature in evaporator decreases with increase in time. Within a span of 50 minutes the temperature observed was 17C.

V. CONCLUSION

The aim of this LPG based refrigeration was to produce refrigerating effect by utilizing LPG as a refrigerant. The use of LPG as a replacement refrigerant can contribute to zero global warming potential. Propane which is an important constituent in LPG is an attractive and environment friendly alternative to CFC's used currently. The initial and running cost of this LPG refrigeration system is really less. No external energy source in any form is required to run the system. As well as no moving components are present in the system which further helps in reducing 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. The obtained COP is about 0.87 which is comparable to that of common refrigerator.

REFERENCES

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