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EXPERIMENTAL ANALYSIS OF A COOLING SYSTEM BY USING DOMESTIC LIQUEFIED PETROLIUM GAS (LPG) CYLINDER WITH OUT ELECTRICITY

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Abstract— Preservation of some medicine and food are impossible in remote areas, mines and deserts due to lack of electricity. So instead of electricity a liquefied petroleum gas (LPG) can be used for refrigeration. In this cooling system domestic LPG can be used because of its low boiling point temperature and high pressure. Liquid petroleum is under high pressure in the cylinder therefore there is no need of compressor and condenser for this cooling system. The principle in this present LPG cooling system is isenthalpic expansion of high pressure LP gas by passing through capillary tube. Smaller internal diameter of capillary tube provides high pressure drop there by phase change of liquid petroleum from liquid to gas due to this temperature of the LPG decreases. Then this low temperature LPG is passed through the evaporator for cooling. This LPG gas can be sent for heating the water by gas geyser or burner for cooking or etc .In this present work experimental analysis of the LPG cooling system is carried out by changing the different diameters of capillary (sizes 36, 44, 55 or 0.036, 0.044, 0.055 inches) and also changing the length of each capillary.The experiment is carried out and test results are compared for each diameter and lengths of the capillary tubes by measuring the pressures at inlet and outlet of capillary tube, temperatures at inside of the evaporator and time required to bring down evaporator temperature from atmospheric temperature to required low temperature. By comparing the above measured values 0.036 diameters, 18 feet length of capillary can reduce evaporator temperature less than 5^0C within half an hour.

Keywords— liquefied petroleum gas (LPG) , refrigeration, LPG cooling system, capillary tube, evaporator, burner.

I. INTRODUCTION

Today world is facing the major problems regarding energy crisis. 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. Still the people in rural areas 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. This solution is convenient for refrigeration in regions having scares in electricity. So it is very useful when LPG is used for cooling to minimize the use of electricity. The LPG cooling system uses evaporation of LPG to absorb heat. LPG is stored in cylinders at pressure at about 80 psi. By lowering this pressure to pressure of 10 psi so that the heat absorbed adiabatically from refrigeration box and cooling is obtained on surrounding. 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 passed to capillary tube at high pressure. High pressure LPG is converted in low pressure at capillary tube with enthalpy remains constant. Low pressure LPG is passed through evaporator. LPG is converted into low pressure and temperature vapor from passing through the evaporator which absorbs heat from the refrigeration box. Thus the refrigeration box becomes cools down. Therefore evaporator temperature decreases. LPG from evaporator is then passed through pipe to the burner.

II. LITERATURE REVIEW

Nikam S.D., Dargude S. B. 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 those 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 free refrigerator 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.

Ronald reagonr, chetankumar The energy crisis persists all across the globe. The supply of continuous electricity is still not available in several areas of the world and also the climatic changes and global warming demand accessible and affordable cooling system in the form of refrigerators and air conditioners. These can be overcome by using Eco-Friendly refrigerant like LPG, Biogas, Natural gas etc.. Eco friendly refrigerant is available in cylinders at high pressure. When this high pressure refrigerant is passed through the capillary tube the pressure of refrigerant is dropped due to expansion and phase change of refrigerant occurs. Due to phase change from liquid to gas latent heat is gained by the liquid refrigerant and temperature drops. Thus it acts as a refrigerant and produces cooling effect.

Dr Harry Rosin, could not consider using a CFC refrigerant and so tried propane and iso butane. Greenpeace Australia imported a Foron refrigerator in February 1993 and in December 1993 Email Ltd, Australia's largest appliance manufacturer, displayed prototype LPG refrigerators

III. OBJECTIVE

The main objectives of this work are given below:

1. LPG cooling system can use the high pressure liquefied petroleum in the LPG cylinder there is no need of compressor and condenser for this cooling system.
2. The ozone depletion potential (ODP) of LPG is zero and Global warming potential (GWP) is 8 which is significantly negligible as compare to other refrigerant, electricity is not required for this system.
3. Observing the effects capillary diameters and length of the capillary on evaporator temperature of the LPG cooling system.
4. Comparing the results of the experiments done using different types and lengths of capillaries and selected the better capillary diameter and length for the LPG cooling system.

IV. EXPERIMENTAL SETUP

The experimental set up of a LPG cooling system is consists of LPG cylinder, Regulator (un reduced pressure), High pressure pipes, Clamps, Copper tube, Capillary tube, Evaporator, Thermo couples, Pressure gauges, and Burner. All this components are connected as shown in figure.

Specifications of the components used in LPG cooling system are given below.

Evaporator Length 350 mm, Width 250 mm, Height 175 mm,

Insulated box Length 400 mm, Width 350 mm and Height 225 mm,

LPG high pressure pipes length of 2000mm,

Copper tube length 1000mm,

Pressure gauges low and high pressure gauge,

LPG cylinder 5 kg cylinder,

Capillary tubes,

1. Size 55=0.055inches =1.375mm
   Lengths 6mm, 8mm, 10mm.
2. Size 44=0.044inches =1.1mm
   Lengths 6mm, 8mm, 10mm.
3. Size 36=0.036inches=0.9mm
   Lengths 8mm, 10mm, 14mm, 18mm.

Temperature at evaporator in insulated cabinet is measured with digital thermocouples. Two pressure gauges are used to measure inlet and outlet pressures of LPG cooling system all these values are used to compare the experimental observations.

Fig 1: Experimental setup

V. WORKING OF LPG COOLING SYSTEM

The LPG Refrigerator uses evaporation of LPG to absorb heat. LPG is stored in cylinders at pressure at about 80 psi. By lowering this pressure to pressure of 10 psi so that the heat absorbed adiabatically from refrigeration box and cooling is obtained on surrounding. 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 passed to capillary tube at high pressure. High pressure LPG is converted in low pressure at capillary tube with enthalpy remains constant. Low pressure LPG is passed through evaporator. LPG is converted into low pressure and temperature vapour from passing through the evaporator which absorbs heat from the refrigeration box. Thus the refrigeration box becomes cools down. Therefore evaporator temperature decreases. LPG from evaporator is then passed through pipe to the burner.

VI. EXPERIMENTAL PROCEDURE

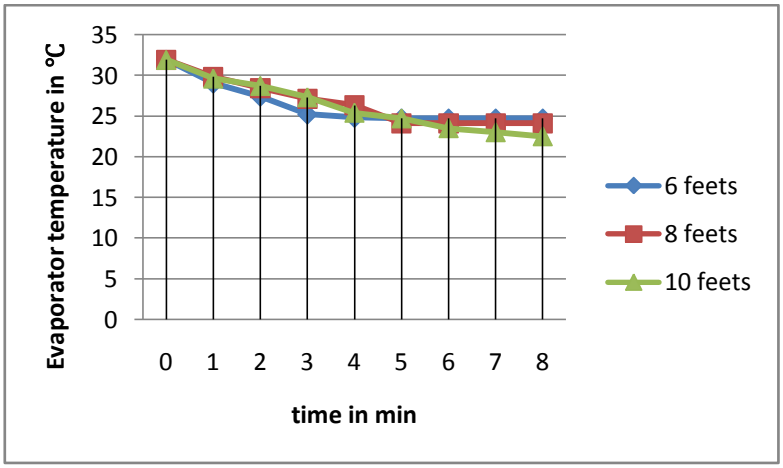
In the present work experimental analysis of the LPG cooling system will be done by changing the different diameters of capillary (sizes 36, 44, 55 or 0.036, 0.044, 0.055 inches) and also changing the length of each capillary. The experiment is carried out and test results are compared for each diameter and lengths of the capillary tubes by measuring the pressures at inlet and outlet of capillary tube, temperatures at inside, inlet and outlet of the evaporator and time required to bring down evaporator temperature from atmospheric temperature to required low temperature.
Experimental procedure involved in LPG cooling system as given below

1. Before going to do the experiments ensure that all the connections are tightly clamped or not, otherwise LPG can leaks from the loose connections.
2. Similarly check the welding is leak proof
3. LPG cylinder regulator and burner valves should be closed at the beginning of the experiment.
4. Slowly turn on the regulator valve and then make the cylinder upside down position.
5. Also turn on the burner valve and fire the burner.
6. Liquid petroleum is entering into the high pressure LPG pipes and then passes through the capillary tube.
7. Capillary diameter is very small as compared to the high pressure LPG pipe, when high pressure liquid petroleum passes through capillary pressure decreases and with expense of this pressure energy velocity increases and temperature of the liquid petroleum decreases.
8. This low temperature liquid petroleum passes through the evaporator.
9. Evaporator is act as heat exchanger, it transfers heat from insulated box to the low pressure liquid petroleum gaining heat and phase transformation occurs from liquid to vapor.
10. Due to phase change from liquid to vapor latent heat of evaporation is gained by the LPG and the temperature decreases. Then this low temperature LPG is passed through the evaporator.

11. In this way LPG can be produced cooling effect. This LPG gas can be sent for heating the water by gas geyser or burner for cooking or for other applications.
12. Measure the temperature in evaporator and inlet and outlet pressures of the capillary tube, and also measure the time required.
13. All the above values are tabulated for particular length and diameter of the capillary tube.
14. In the present work experiments are conducted by changing the different lengths and diameters of the capillary and repeating the entire experiments.

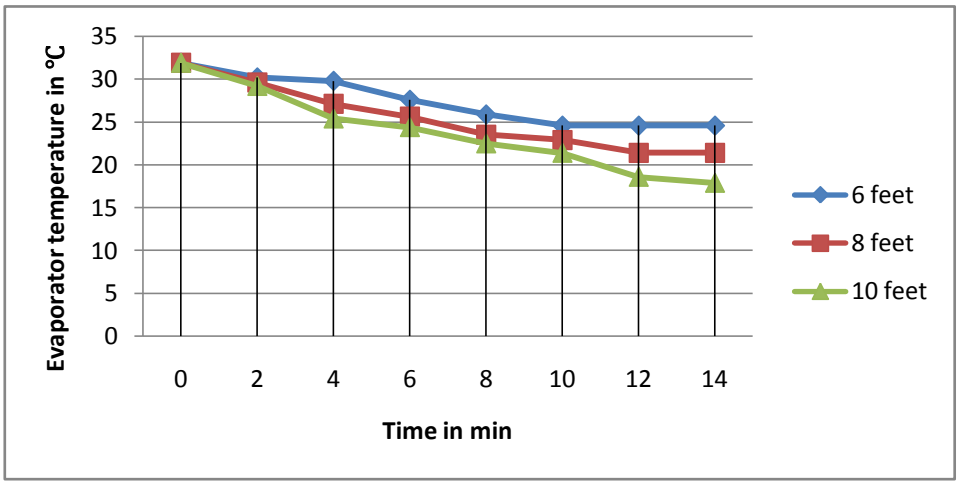
VII. RESULTS AND DISCUSSIONS

Capillary 0.055 inch diameter



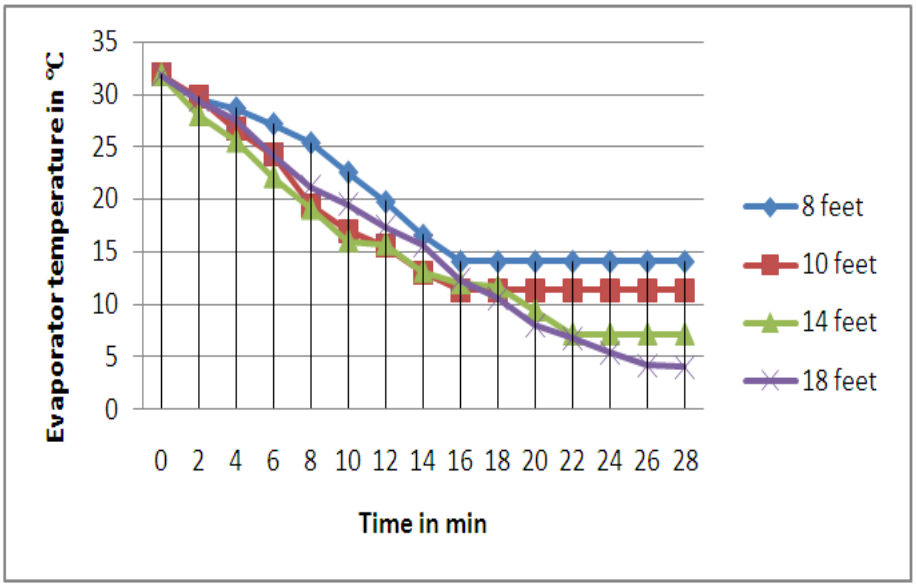
- The above graph shows the observations of LPG cooling system with 0.055 inches diameter capillary lengths of 6feet, 8 feet, and 10 feet.
- For same capillary diameter pressure variations are different for different lengths of the capillary.
- If the length of the capillary decreases pressure variations between inlet and outlet of the LPG cooling system are decreased.
- Similarly length of the capillary increased pressure variations between inlet and outlet of the LPG cooling system are increased.
- Pressure difference between inlet and out let of the LPG cooling system is proportional to the evaporator temperature. If the pressure difference is more the temperature decrease in the evaporator.
- From the graph 10 feet length of 0.055inch diameter capillary gives the better results as compared to 6 and 8 feet length of capillary.

Capillary 0.044 inch diameter



- The above graph shows the observations of LPG cooling system with 0.044 inche diameter capillary lengths of 6feet, 8 feet, and 10 feet.
- For same capillary diameter pressure variations are different for different lengths of the capillary.
- If the length of the capillary decreases pressure variations between inlet and outlet of the LPG cooling system are decreased.
- Similarly length of the capillary increased pressure variations between inlet and outlet of the LPG cooling system are increased.
- Pressure difference between inlet and out let of the LPG cooling system is proportional to the evaporator temperature. If the pressure difference is more the temperature decrease in the evaporator.
- From the graph 10 feet length of 0.044 inch diameter capillary gives the better results as compared to 6 and 8 feet length of capillary.

Capillary 0.036 inch diameter

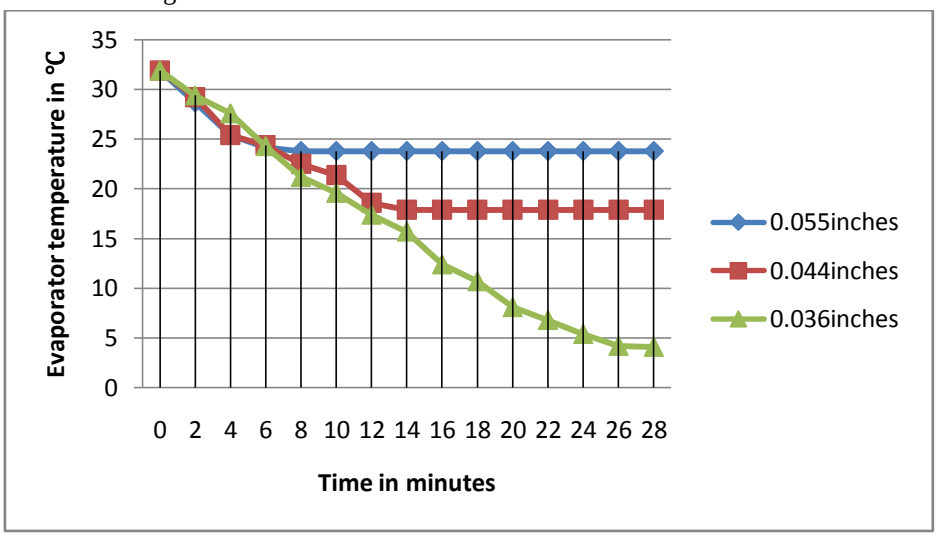


- The above graph shows the observations of LPG cooling system with 0.036 inches diameter capillary lengths of 8 feet, 10 feet, 14 feet and 18 feet.
- For same capillary diameter pressure variations are different for different lengths of the capillary as shown in the tables.
- If the length of the capillary decreases pressure variations between inlet and outlet of the LPG cooling system are decreased.
- Similarly length of the capillary increased pressure variations between inlet and outlet of the LPG cooling system are increased.
- Pressure difference between inlet and out let of the LPG cooling system is proportional to the evaporator temperature. If the pressure difference is more the temperature decrease in the evaporator.
- From the graph 18 feet length of 0.036 inch diameter capillary gives the better results as compared to 8, 10, and 14 feet length of capillary.

VIII. CONCLUSION

The present experimental work of LPG cooling system with different lengths and diameters of the capillary tube are carried out and observed the effect of capillary diameter and lengths on the evaporator temperature and the pressure difference between inlet and outlet of the LPG cooling system.

From the obtained results following conclusions are made



The above graph shows the decrease in evaporator temperature with respect to time for different capillary diameters used in LPG cooling system.

Hence from the above graph we can conclude that 0.036 inch diameter capillary of length 18 feet can reduce the evaporator temperature to less than 5℃ within half an hour.

This system can be adopted where cooling requirements are necessary and where the traditional cooling devices like refrigerators are not available. This system caters to the cooling needs in remote areas particularly in community health centers where cooling of medicines are necessary.

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