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DESIGN AND DEVELOPMENT OF ZERO COST GREEN REFRIGERATOR

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ABSTRACT

Although government agencies are not able to continuously supply a major portion of electricity in both the rural as well as urban areas. At such circumstances this project will be helpful for cooling. In this project we have analyzed and designed a refrigerator using liquefied petroleum gas (LPG) as a refrigerant. LPG is easily available in domestic LPG cylinder which comprises of 24.4% propane, 56.4% butane and 17.2% isobutane. Usually LPG is cheaper fuel and used in world for cooking purposes and the combustion products of LPG are CO2 and H2O. The LPG having an environmental friendly nature with no Ozone Depletion Potential (ODP) and no Global Warming Potential (GWP). LPG is generally stored at 12.7 bar high pressure for house hold purpose cylinder. As this high pressurized LPG is passed through the long capillary tube of small internal diameter, the pressure of LPG is decreased due to frictional resistance offered by tube walls and phase change of LPG occurs in an isenthalpic process. The temperature drops due to phase change from liquid to gas in evaporator and latent heat is gained by liquid refrigerant. In this way LPG produces refrigerating effect in the insulated chamber. After performing this project we have found that the COP of a LPG Refrigerator is higher than a domestic refrigerator.

KEYWORDS: LPG, Refrigerant, Capillary tube, Evaporator, Refrigerating effect, COP.

I. INTRODUCTION

The term „refrigeration" may be defined as the process of removing heat (i.e. Cooling) from a substance under controlled conditions. It also includes the process of reducing and maintaining the temperature of a body below the general temperature of its surroundings. In other words, the refrigeration means a continued extraction of heat from a body, whose temperature is already below the temperature of its surroundings [7]. The substance which work in a heat pump to extract heat from a cold body and to deliver it to a hot body is called "refrigerant". Before the commercial usage of CFC refrigerants, the first generation refrigerants constituted by methyl chloride (CH3Cl), ammonia, carbon-dioxide, and sulphur dioxide (SO2). The energy crisis persists all across the world. 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 ZERO COST Cooling Systems. Petroleum gas is stored in liquefied state before its utilization as fuel for refrigeration [1].

Accordingly, the global warming potential of R134a has been estimated to be 1550 tons per 100 years [8]. The ozone depletion potentials (ODPs) of HFC-134a relative to CFC-11 are very low and the global warming potentials (GWPs) are extremely high [3]. LPG is the best refrigerant to replace existing ozone depleting and global warming refrigerants like CFC and HFC. So it can be say that the production and use of HFC-134a will be terminated in the near future. So propane is an attractive and environmentally friendly alternative to CFCs used currently. In **Zero Cost Green Refrigerator** running cost is zero and we eliminates the compressor and condenser.

II. METHODOLOGY

LPG is stored in the LPG cylinder under high pressure. When the high pressure regulator valve is open then high pressure LPG passes through the high pressure pipe which is 3 miter long at inlet. This LPG is going at high pressure in LPG gas filter after that LPG passes through capillary tube. The internal diameter of the capillary tube used for the refrigeration process is 0.7874 mm (0.031inch) and the length is 12.192 meter (40 ft.). High pressure

LPG is converted into low pressure in capillary tube where enthalpy remains constant. After capillary tube, low pressure LPG is passed through the evaporator. LPG is converted into low pressure and low temperature vapour forms and passes the evaporator which absorbs heat from the insulted chamber. The insulted chamber gets cool down. Thus we can achieve refrigerating effect in zero cost green refrigerator

After passing through the evaporator low pressure LPG goes to accumulator. An accumulator is a device used in vapour compression system (VCR) to prevent liquid refrigerant from flooding back to the evaporator. After that the low pressure LPG goes to burner through high pressure pipe which is 3 meter long at outlet. We can use the low pressure of LPG in burning process such as cooking.

a) Components of Zero Cost Green Refrigerator

i. LPG Gas Cylinder:

LPG gas pressure is approximate 80-100 psi in LPG gas cylinder. Liquefied Petroleum Gas is combination of Propane and Butane and Isobutane.

Fig-1: LPG Gas Cylinder

ii. High Pressure Regulator:

This type of regulator is used to send high pressure gas from LPG cylinders. These are mainly used in functions to Bhatti stoves. It send the LPG at a pressure of 6 bar.

Fig-2: High Pressure Regulator

iii. High Pressure Pipes:

We uses 6 meter high pressure pipes as 3 meter input and 3 meter at output.

Fig-3: High Pressure Pipes

iv. Pressure Gauges:

A Bourdon gauge hydraulic pressure gauges are available to measure up to 10,000 psi although maximum hydraulic pressure is typically in the 3,000 to 5,000 psi range.

Fig-4: Pressure Gauges

v. LPG Filter:

The gas filter make the LPG fuel more clean before it get into capillary tube for expansion. It is made of Brass Sintered Particles.

Fig-5: LPG Filter

vi. Capillary Tube:

Capillary tube is long length and it is coiled to several turns. The internal diameter of the capillary tube used for the refrigeration applications is 0.7874 mm (0.031inch) and the length is 12.192 meter.

Fig-6: Capillary Tube

vii. Evaporator:

The evaporator is an important device used in the low pressure side of a refrigeration system. We uses plate type evaporator. In this type of evaporator the coils are either welded on one side of a plate or between two plates which are welded together at the edges. The evaporator has following dimensions:

Length is 350 mm; Width is 260 mm and Height is 140 mm.

Fig-7: Evaporator

viii. Insulated Chamber:

The chamber is made of GI sheet. The chamber dimension is 500 mm cube. In this chamber thermocol and foil paper used for insulation.

Figure: 8 Insulated Chamber

ix. Digital Temperature probe:

It is a device that uses for temperature measurement through an electrical signal.

Fig-9: Digital Temperature Probe

x. Stand:

The use of stand is to carry and support the insulated chamber. The stand is made of Iron and having dimension- Leg is 838 mm, the top base is 350 mm.

Fig-10: Stand

xi. Accumulator:-

An accumulator is a device used in VCR system to prevent liquid refrigerant from flooding back to the evaporator.

Fig-11: Accumulator

xii. Gas Burner

After performing the cooling effect in insulated chamber low pressure LPG goes into the burner where burning takes place and the energy is utilized for various purposes such as for heating and cooking.

Fig-12: Gas Burner

III. MODELING AND ANALYSIS

We design the block diagram on Auto CAD for better understanding.

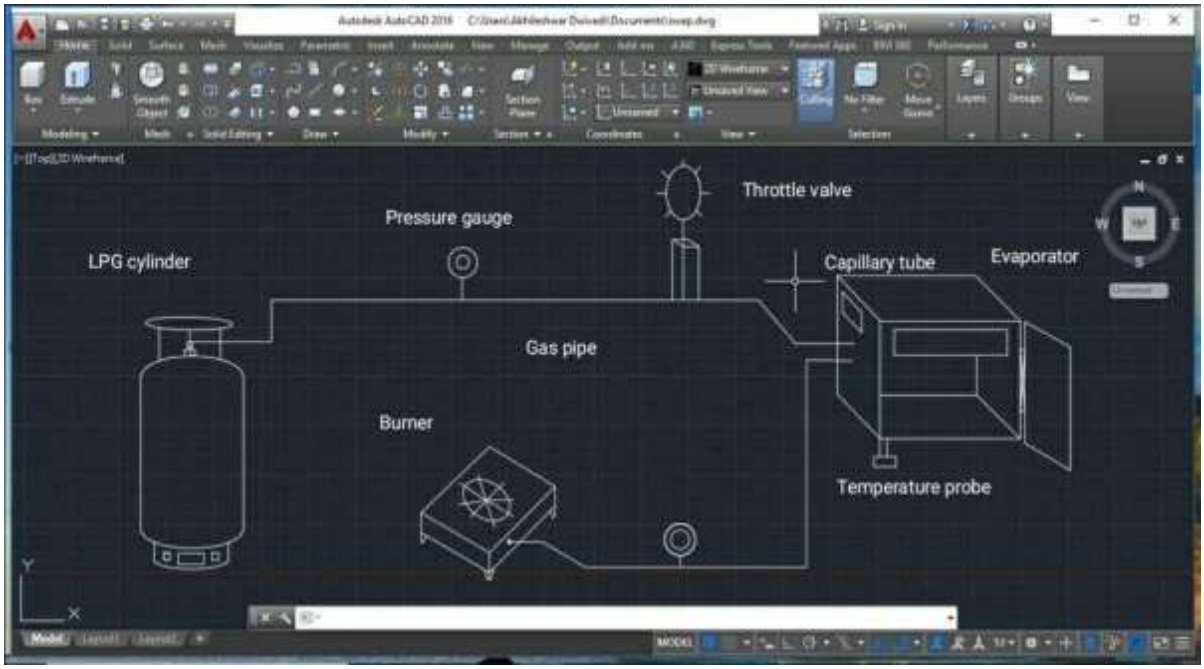

Fig-13: 2D view of Zero Cost Green Refrigerator**.**

The experiment of this project was done on 10 March, 2020 at 11.40 a.m and readings were taken at 1 hour which is as shown in table:

Table: 1 Observation Table

Time	Inlet pressure (bar)	Outlet pressure (bar)	Water temperature (°C)	Evaporator temperature (°C)
11.40 a.m.	6.12	.65	22.2	27.2
12.40 p.m.	6.12	.65	2.0	-6.8

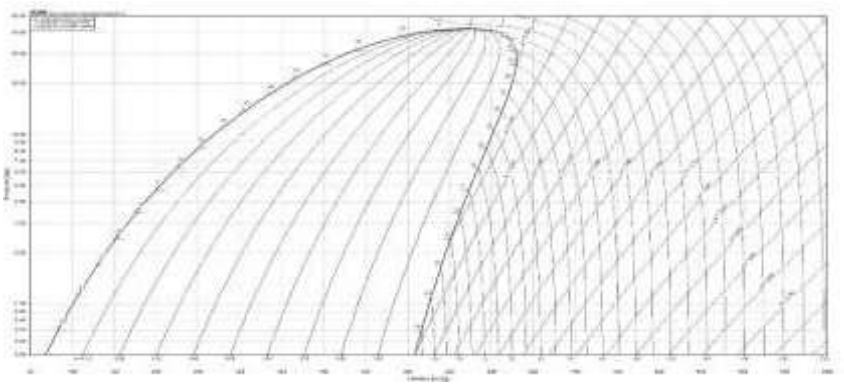

Fig-14: p-h Chart of Propane (R290)

a) Calculation and Analysis:

- Initial evaporator temperature = 27.2℃
- Initial water temperature =22.2℃

  Using steam table, the properties of LPG for R.E.
- The properties of LPG at 6.12 bars are;

  Enthalpy h1 = 583.9 kJ/Kg; Temp. t1= 14 ^{0}C.
- The properties of LPG at 0.65 bars are;

  Enthalpy h3 = 78.6 kJ/Kg;Temp. t3= -65 ^{0}C.
- Here, Fig 1.2 shows a p-h Chart of LPG

  hf =78.6KJ/Kg ; hfg= 375 KJ/Kg; x=0.5

So,

h2 = hf+(x)×hfg1 = 78.6 + 0.5×(375) = 266.1 KJ/Kg

hg = hf + hfg2 = 78.6 + 375 = 453.6 KJ/Kg

h3 = hg + cp ×ΔT = 453.6 + 1.67× (79) = 585.53 KJ/Kg

Now, refrigerating effect

R.E. = h3-h2 = 585.53-266.1 = 319.43 KJ/Kg

b) Total consumption for LPG pumps:

- When considering PCRA Energy Audit energy / fuel consumption on per ton
- Consumption = 40×4200=168000kWh
- For lighting energy consumption= 227340kWh
- LPG compressor consumption= 153360 kWh
- One pump having 40 kW motor and 96 m head or 150cubic meter /hour discharge
- Annual operating = 4200 hrs
- Annual energy 6 hrs /day in 350 days=168000+227340+153360= 548700kWh
- Per day consumption=548700/350 =1567.71 kWh
- 500 cylinders are refilled every day, so per cylinder electricity consumption.=1567.71/500=3.1354kWh
- For filling of 1 LPG cylinder of 14.5 kg the power input is =3.1354kWh
- So 1 kg of LPG is=3.1354/14.5 =0.2162 kWh
- We run the set up for 1 hr=0.2162×1000/ (9.45/10000) ×3600=63.55W.

c) COP Calculation of LPG Refrigeration System:

COP = (h3-h2)/W

= (590.53-271.1)/63.55

= 5.02

Here 5.02 is the COP of our Zero Cost Green Refrigerator.

IV. RESULTS AND DISCUSSION

The COP of our Zero Cost Green Refrigerator is 5.02. The evaporator temperature changes from 27.2 ^{0}C to -6.8 ^{0}C in 1 hour. The pressure range varies from 6.12 bar at inlet and 0.65 bar at outlet. This pressure can be controlled by using the pressure gauge so that one can operate on his own convenience and need. Pressure of gas burner can directly be controlled by the pressure gauge at outlet yet one can get control the gas burner through the gas regulator. On comparing the COP of our Zero Cost Green Refrigerator to a domestic refrigerator we get that COP of a domestic refrigerator is normally up to 2.7 which is lesser than the our LPG refrigerator as domestic refrigerator are also not eco-friendly and requires more maintenance.

V. CONCLUSION

After performing this project "DESIGN AND DEVELOPMENT OF ZERO COST GREEN REFRIGERATOR", it is concluded that refrigerating effect is produced with the use of LPG as a refrigerant. When the regulating valve is fully open then the evaporator temperature downs from 27.2 ◦ C to -6.8 ◦ C in 1 hour and the quantity of refrigerating effect we get is 319.43 KJ/KG. The main aim is to focus on restaurant and community program hall, mid-day meal of school so to preserve food products like vegetables, milk etc. LPG as a refrigerant will not harm the eco system. The potential of ozone layer depletion and global warming will be reduced due to usage of LPG refrigerant in the domestic refrigerators. Therefore as a conclusion we can use LPG as refrigerant in refrigeration system.

VI. REFERENCES

[1] Ibrahim Hussain Shah, Kundan Gupta (2014). Design of LPG Refrigeration System and Comparative Energy Analysis with Domestic Refrigerator, International journal of engineering sciences and research Technology ISSN: 2277-9655, Scientific Journal Impact Factor: 3.449 (ISRA), Impact Factor: 1.852.

[2] Narle P.D. and Bhosale Sagar S. (2017). Design And Analysis of Domestic Refriherator Using LPG Cylinder, NOVATEUR PUBLICATIONS International Journal of Research Publications in Engineering and Technology [IJRPET] ISSN: 2454-7875 VOLUME 3, ISSUE 4.

[3] Shah Mohsin Raza Dilbar Shah, Sushant S Bhansali, Shubham Dnyaneshwar Jaisingpure (2018). A review: Design and fabrication of LPG as refrigerant in AC and working fluid in burner, International Journal of Electronics, Communication and Soft Computing Science & Engineering (IJECSCSE), 59-63.

[4] Sethu Sathayan, Gopakumar M.G. (2018). Design of LPG Refrigeration System, International Journal of Innovative Research in Science, Engineering and Technology (A High Impact Factor, Monthly, Peer Reviewed Journal) Vol. 7, Issue 5.

[5] "PCRA energy audit report", HPCL LPG bottling plant Asauda Bahadurgarh (Haryana) Dec. 2006.

[6] ASHRAE, (2002). Adiabatic capillary tube selection, Refrigeration Handbook, chapter.45, pp.45.26-45.30.

[7] A Textbook of Refrigeration And Air Conditioning By R.S. Khurmi, S. Chand Publication.

[8] Catalogue of Gas Authority of India on Properties of combustible gases for industrial purpose.