Liquefied Petroleum Gas as a Refrigerant: A Review

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Abstract- *In present day, a huge amount of money is spend on electricity to run refrigerator and refrigerants, also refrigerants like CFC, HFC, etc have negative impact on environment. Hence people are looking towards efficient and environment friendly refrigerant. HC's have thermodynamic properties as well as reduce environmental pollution. The term 'refrigeration' in a broad sense is used for the process of removing heat (i.e. Cooling) from a substance. It also includes the process of reducing and maintaining the temperature of a body below the general temperature of its surroundings. 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, increasing the importance, whenever possible, to have an eco-friendly refrigerator*

Keywords- LPG, Refrigerant, COP, Eco-Friendly

I. INTRODUCTION

Refrigerators are divided into three types based on their function. One is Industrial refrigerator which is used in food processing, chemical processing and cold storage. Second is industrial refrigerator which uses ammonia refrigeration to maintain temperature for computer, food stuff, etc. The third type is domestic refrigerator used in household application.

The pressure of LPG is high in cylinder. As this pressurised LPG is passed through the capillary tube of small internal diameter, the pressure of LPG is decreased due to expansion and when passed in the evaporator 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 decreases. In this way LPG can produce refrigerating effect in the surrounding.

II. LITERATURE REVIEW

Global warming is the current increase in temperature of the Earth's surface (both land and water) as well as its atmosphere. The natural greenhouse effect maintains the Earth's temperature at a safe level making it possible for humans and many other life forms to exist. However, since the industrial revolution human activities have significantly enhanced the greenhouse effect causing Earth's average temperature to rise. The causes of global warming is the increasing quantity of greenhouse gases in the atmosphere produced by human activities, like burning of fossil fuels, deforestation, carbon emission, etc.

Global warming potential (GWP) is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide. Effects of global warming, Sea ice decline and sea level rise, Extreme weather, Ecological systems

Carbon Credits

One carbon credit is equal to tonne of CO2 and it is called a CO2e (CO2 equivalent).The carbon credit has become a new currency which can be traded in the International market. Based on Kyoto protocol, each country can set 'quotas' or 'caps' on the emissions of installations run by local business houses and other organizations. These are termed as "operators". A nation may have a short fall of 1 Lakh tonne of CO2 and according to Kyoto protocol, it must seek to purchase carbon credits from another nation that has been planting trees or using efficient and clean energy technologies to reduce emissions. Cost of each carbon credit ranges between US dollars 10-40. Such a variation in cost is possible due to the fact that CO2 emissions and their demand affected by slowdown of products demand and users using better technologies. It's rate also fluctuates according to oil prices in International market.

Montreal Protocol

The Montreal Protocol on substances that deplete the ozone layer is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion. In 1973, the chemist Frank Sherwood Rowland and Mario Molina began studying the impacts of CFC's on the Earth's atmosphere. They discovered that CFC's molecules were stable enough to remain in the atmosphere until they got up into the middle of stratosphere where they would finally be broken by ultraviolet radiations releasing chlorine atom. It was observed that this chlorine atom breaks large amount of ozone (O3) in the stratosphere. Since stratospheric ozone absorbs most of

ultraviolet-B radiation reaching the surface of planet, depletion of the ozone layer by

CFC's would lead to increase in UV-B radiation at the surface, resulting in an increase in skin cancer and other impacts such as damage to crops and marine phytoplankton . Thus the Montreal

Protocol entered into force on 1st January 1989. As a result of the international agreement, the ozone hole in Antarctica is slowly recovering.

Kyoto Protocol

The Kyoto Protocol is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits State Parties to reduce greenhouse gas emissions, based on the scientific consensus that global warming is occurring and it is extremely likely that human made CO2 emissions have predominantly caused it. Refrigeration systems consume electricity that contributes indirectly to the emission of large amounts of CO2 because of burning of fossil fuels that produces CO2. Therefore, improving the energy efficiency of refrigeration systems and the use of refrigerants with zero ozone depletion potential (ODP) and negligible global warming potential (GWP) are the most important parameters for refrigeration. Whereas HFC refrigerant do not have ODP but have GWP hence Kyoto in 1997 has decided to put HFC's together with other five gases such as CO2, N2O, CH4, PFCs and SF6. Here we try to look after various studies that were carried out in the direction of using LPG as a refrigerant.

- Vishwadipsinh J. Ghariya, Swastik R.Gajjar (2014) [1] They studied by changing the design of capillary tube, and concluded that, maintaining the regulating valve of LPG at 87 Psi ,the achievement of chamber temperature decrease from 34.5 ºC to 18ºC in a 150 minute. Though capillary tube with inner diameter 0.78mm, length of 2.83m and outer coil diameter about 190mm gives the most efficient refrigerating effect.

- Nikam S.D, Dargude S. B, Dhanagar V. L, Patharwat A. A, Khandare R. S, Bhane A. B (2015) [2] They performed experiment 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 done. Expected cooling is predicted up to 20˚C. The capillary tube is more suitable throttling device in LPG refrigeration system. This system is cheaper in initial as well as running cost. It does not require an external energy sources to run the system and no moving part in the system so maintenance is also very low.

- Ajeet Kumar Rai, Amit Kumar, Pravin Kumar and Ayaj Ahamad Ansari (Nov 2015) [3] They used LPG gas (used in kitchen for cooking purpose) as refrigerant in domestic refrigerator of 165 litre capacity, basically designed for R-134a as refrigerant. Experiment tested the performance of refrigerator by charging 40g of LPG and checked its performance and has been performed under load of 500g water kept in steel vessel. Temperature of water; initially was 27˚C and was brought down at 7˚C. Although the refrigerator has been designed for 105 g R134a, it was capable to work with LPG.

- Ronald Reagon R, Chetan Kumar D S (2016) [4] This experiment conclude that, when regulating valve is fully open, the evaporator temperature achieved is from 38˚ C to 23˚ C in a 60 minute; also in capillary tube the maximum pressure of gas cylinder reduces less than 1 Bar. Hence the capillary tube is more suitable throttling device in LPG refrigeration system.

- Mhaske M. S., Deshmukh T. S., Ankush D. D., Palkar S. M., Gaikwad V. S. (April 2016) [5] There basic goal of the LPG refrigerator was to use the LPG as refrigerant and usage of this high pressure energy in the LPG cylinder for refrigerating effect. The LPG pressure is as high as 12.41 bars in a domestic 14.5 kg cylinder which we have regulated with the use of capillary tube and brought down up to 1.41 bars. 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. This LPG refrigeration system has wide scale application in hotel industries, chemical industries where the LPG consumption is at a higher level.

- Ajeet Kumar Rai and Salem Alabd Mohamed (May 2016) [6] They studied the performance of a domestic refrigerator using LPG as refrigerant.

This simulation aimed at comparing the performance characteristics of the domestic refrigerator working with R134a, mixtures with 24.4% propane, 56. % butane and 17.2% isobutene. Based on the simulation results, the following conclusions are drawn: The Evaporator temperature of R134a and the ternary hydrocarbon mixture with amount of 20g are nearly the same. However, the hydrocarbon mixtures with amount of 25g yield lower, than that of R134a. The optimum charge amounts for LPG were found to be in between 25g to 35g. Moreover, results showed that energy consumption was reduced.

- N.Satwik, B Satosh Kumar, T Gopala Krisna, M.Ravindra, B. Kiran Kumar (May 2016) [7] After performing this project "LPG REFRIGERATION", they found when the regulating valve is fully open then the evaporator temperature downs from 35^{o} C to 5^{o} C in 30 minutes. It is also concluded that, in the capillary tube pressure of gas 10 bar from the cylinder is reduced to 3 bar. The capillary tube is more suitable throttling device in LPG refrigeration system.

- Amit Parmar, Axay Patel, SaubanhussainMalek, Harshil Patel, Himmatsinh Gohil (April 2017) [8] There project is predicated on the principle of adiabatic enlargement of a refrigerant (In this case LPG) from 80 psi to 10 psi so thermodynamically it absorbs heat from encompassing and cooling could done. Expected cooling is up to vary of 10 to 35 degrees. This technique most fitted for building, industries, refinery, and chemical industries wherever consumption of LPG is extremely high.

III. CONCLUSION

LPG is prepared by refining petroleum or "wet" natural gas, and is almost entirely derived from fossil fuel sources, being manufactured during the refining of petroleum (crude oil), or extracted from petroleum or natural gas streams as they emerge from the ground. It currently provides about 3% of all energy consumed, and burns relatively cleanly with no soot and very few sulphur emissions. As it is a gas, it does not pose ground or water pollution hazards, but it can cause air pollution. It is increasingly used as an aerosol propellant and a refrigerant, replacing chlorofluorocarbons in an effort to reduce damage to the ozone layer. When specifically used as a vehicle fuel it is often referred to as auto-gas.

REFERENCES

[1] Vishwadipsinh J. Ghariya, Swastik R.Gajjar," Thermodynamically Evolution of LPG Refrigerator for Restaurant, IJSRD, Vol 2. Issue 03, ISSN 2321-0613 (2014)

[2] Nikam S.D, Dargude S. B, Dhanagar V. L, Patharwat A. A, Khandare R. S, Bhane A. B, " Electricity free Refrigeration

[3] system using domestic LPG Design of energy Saving Refrireration , Vol 5. Issue 03, March (2015)

[4] Ajeet Kumar Rai, Amit Kumar, Pravin Kumar and Ayaj Ahamad Ansari, "Study of performance Evaluation of Domestic Refreigerator working with mixture of Propane, Butane and Iso Butane Refrigerant, IJMET (Nov 2015)

[5] Ronald Reagon R, Chetan Kumar D S, "Design and Development of Eco Friendly Refrigant system.IJRET Vol 3. Issue 04 April (2016)

[6] Mhaske M. S., Deshmukh T. S., Ankush D. D., Palkar S. M., Gaikwad V. S.," Performance Evolution of Domestic Refrigerator Using LPG Cylinder." (April 2016)

[7] Ajeet Kumar Rai and Salem Alabd Mohamed Experimental Study on a domestic refrigerator using LPG as a Refreigerator." (May 2016)

[8] N.Satwik, B Satosh Kumar, T Gopala Krisna, M.Ravindra, B. Kiran Kumar," Refrigeration System by Using LPG."IJMETMR , (May 2016)

[9] Parmar, Axay Patel, Saubanhussain Malek, Harshil Patel, Himmatsinh Gohil , "Domestic LPG refrigerator."IJAERD (April 2017)