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PERFORMANCE OF REFRIGERATOR USING R-600A AS REFRIGERANT

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ABSTRACT

A performance analysis on vapor compression refrigeration R134a and R600a are done and results are compared in order to study R600a as possible replacement. The result showed that the alternative refrigerant investigated in the analysis R600a has slightly higher performance coefficient. The hydro fluorocarbons R134a is nonflammable, difficult to synthesize, has zero ozone depletion and negligible global warming. Refrigerant property parameters shows that R 600a has minimum leakage and low power consumption.

Keywords: **Refrigeration Effect, COP, ODP , GWP, Mass Flow Rate For ITR, Pressure , Temperature**

I. INTRODUCTION

Refrigeration**,** the process of removing heat from an enclosed space or from a substance for the purpose of lowering the temperature. In the industrialized nations and affluent regions in the developing world, refrigeration is chiefly used to store foodstuffs at low temperatures, thus inhibiting the destructive action of bacteria, yeast, and mold. Many perishable products can be frozen, permitting them to be kept for months and even years with little loss in nutrition or flavor or change in appearance. Air-conditioning, the use of refrigeration for comfort cooling, has also become widespread in more developed nations.

If a liquid is rapidly vaporized, it expands quickly. The rising molecules of vapor abruptly increase their kinetic energy. Much of this increase is drawn from the immediate surroundings of the vapor, which are therefore cooled. Thus, if water is placed in shallow trays during the cool tropical nights, its rapid evaporation can cause ice to form in the trays, even if the air does not fall below freezing temperatures. By controlling the conditions of evaporation, it is possible to form even large blocks of ice in this manner.

Cooling caused by the rapid expansion of gases is the primary means of refrigeration.

Following are the type of refrigeration

II. CYCLIC REFRIGERATION

This consists of a refrigeration cycle, where heat is removed from a low-temperature space or source and rejected to a high-temperature sink with the help of external work, and its inverse, the thermodynamic power cycle . In the power cycle, heat is supplied from a high-temperature source to the engine, part of the heat being used to produce work and the rest being rejected to a low-temperature sink. This satisfies the second law of thermodynamics.

III. VAPOR COMPRESSION CYCLE

The vapor-compression cycle is used in most household refrigerators as well as in many large commercial and industrial refrigeration systems.

In this cycle, a circulating refrigerant such as Freon enters the compressor as a vapor. The vapor is compressed at constantentropy and exits the compressor as a vapor at a higher temperature, but still below the vapor pressure at that temperature. Then, the vapor travels through the condenser which cools the vapor until it starts condensing, and then condenses the vapor into a liquid by removing additional heat at constant pressure and temperature, the liquid refrigerant goes through the expansion valve (also called a throttle valve) where its pressure abruptly decreases, causing flash evaporation and auto-refrigeration of, typically, less than half of the liquid.

IV. VAPOR ABSORPTION CYCLE

The absorption cycle is similar to the compression cycle, except for the method of raising the pressure of the refrigerant vapor. In the absorption system, the compressor is replaced by an absorber which dissolves the refrigerant in a suitable liquid, a liquid pump which raises the pressure and a generator which, on heat addition, drives off the refrigerant vapor from the high-pressure liquid. Some work is needed by the liquid pump but, for a given quantity of refrigerant, it is much smaller than needed by the compressor in the vapor compression cycle. In an absorption refrigerator, a suitable combination of refrigerant and absorbent is used. The most common combinations are ammonia (refrigerant) with water (absorbent), and water (refrigerant) with lithium bromide (absorbent).

V. GAS CYCLE

When the working fluid is a gas that is compressed and expanded but doesn't change phase, the refrigeration cycle is called a gas cycle. Air is most often this working fluid. As there is no condensation and evaporation intended in a gas cycle, components corresponding to the condenser and evaporator in a vapor compression cycle are the hot and cold gas-to-gas heat exchangers in gas cycles.

VI. THERMOELECTRIC REFRIGERATION

Thermoelectric cooling uses the Peltier effect to create a heat flux between the junction of two different types of materials. This effect is commonly used in camping and portable coolers and for cooling electronic components and small instruments.

VII. MAGNETIC REFRIGERATION

A strong magnetic field is applied to the refrigerant, forcing its various magnetic dipoles to align and putting these degrees of freedom of the refrigerant into a state of loweredentropy. A heat sink then absorbs the heat released by the refrigerant due to its loss of entropy. Thermal contact with the heat sink is then broken so that the system is insulated, and the magnetic field is switched off. This increases the heat capacity of the refrigerant, thus decreasing its temperature below the temperature of the heat sink.

VIII. OTHER METHODS

Other methods of refrigeration include the air cycle machine used in aircraft; the vortex tube used for spot cooling, when compressed air is available; and thermoacoustic refrigeration using sound waves in a pressurized gas to drive heat transfer and heat exchange; steam jet cooling popular in the early 1930s for air conditioning large buildings; thermoelastic cooling using a smart metal alloy stretching and relaxing. Many Sterling cycle heat engines can be run backwards to act as a refrigerator, and therefore these engines have a niche use in cryogenics. In addition there are other types of cryocoolers such as Gifford-McMahon coolers, Joule-Thomson coolers, pulse-tube refrigerators and, for temperatures between 2 mK and 500 mK, dilution refrigerators.

IX. LITERATURE REVIEW

The HCF refrigerant is considered as one of the six targeted greenhouse gases under Kyoto protocol of united nations frame work convention on climate change (UNFCCC) in 1977 [1]. Fatosh and Kafafy [2] theoretically assessed the mixture composed of 60% propane and 40% commercial butane is the best drop in substitute for HCF134a based domestic refrigerators. Park et al [3] tested two pure hydrocarbons and seven mixtures composed of propylene, propene, HCF152a and dimethyl ether as an alternative to HCF22 in residential air compressors. Mani and Selladurai [4] performed experiment using a vapor-compression refrigeration system with the new R290/R600a refrigerant mixture as a substitute refrigerant for CFC12 and HCF134a. Bolaji[5] performed experimental study of R152a and R32 to replace R134a in a domestic refrigerator. G.D Mathur [6] conducts theoretical investigation to compare the COP of vapor compression refrigeration system using various refrigerants under condition -6^{0}C evaporator temperature and 48^{0}C condenser temperature.

X. PARTS OF REFRIGERATOR

1. Refrigerant R-600a canister
2. Capillary tube
3. Evaporator
4. Pressure gauges
5. High pressure pipes
6. Digital thermometer

XI. CALCULATIONS

For R-134a refrigerant

Enthalpy value

H1=395 KJ/Kg

H2=445KJ/Kg

H3=243KJ/Kg

H4=243KJ/Kg

ITR=3.5

1. Work input to compressor = h2-h1 = 50 KJ/Kg
2. Refrigerating effect = h1-h4 = 152 KJ/Kg
3. Theoretical COP = (h1-h4)/(h2-h1)= 3.04
4. Mass flow rate of ITR = ITR/ (h1-h4) = 0.023Kg/s

For R600a refrigerant

H1=575 KJ/Kg

H2=630 KJ/Kg

H3=390 KJ/Kg

H4=370 KJ/Kg

ITR = 3.5

1. Work input to compressor = h2-h1 = 55 KJ/Kg
2. Refrigerating effect = h1-h4 = 205 KJ/Kg
3. Theoretical COP = (h1-h4)/(h2-h1)= 3.727
4. Mass flow rate of ITR = ITR/ (h1-h4) = 0.017

XII. OBSERVATION

S.No	PARAMETERS	R-134a	R-600a
1	SUCTION PRESSURE(BAR)	0.919	0.5631
2	DISCHARGE PRESSURE(BAR)	13.29	11.499
3	INLET TO COMPRESSOR(T1^{0}C)	-3.56	-2.77
4	OUTLET FROM COMPRESSOR(T2^{0}C)	57.1	56.7
5	OUTLET FROM CONDENSOR(T3^{0}C)	43.24	46.86
6	OUTLET FROM EXPANSION VALVE(T4^{0}C)	-10.8	-13.13
7	REFRIGERATION EFFECT(KJ/Kg)	145.33	206
8	THEORETICAL COP	3.313	3.725
9	ODP (STANDARD VALUE)	0	0
10	GWP(STANDARD VALUE)	1200	8
11	MASS FLOW RATE FOR ITR(Kg/s)	0.0236	0.0169

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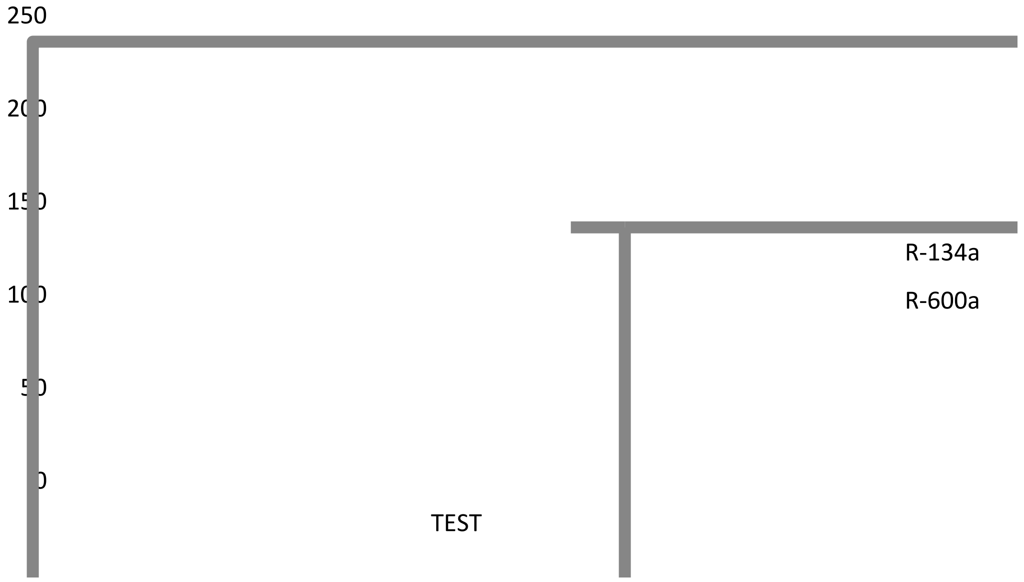
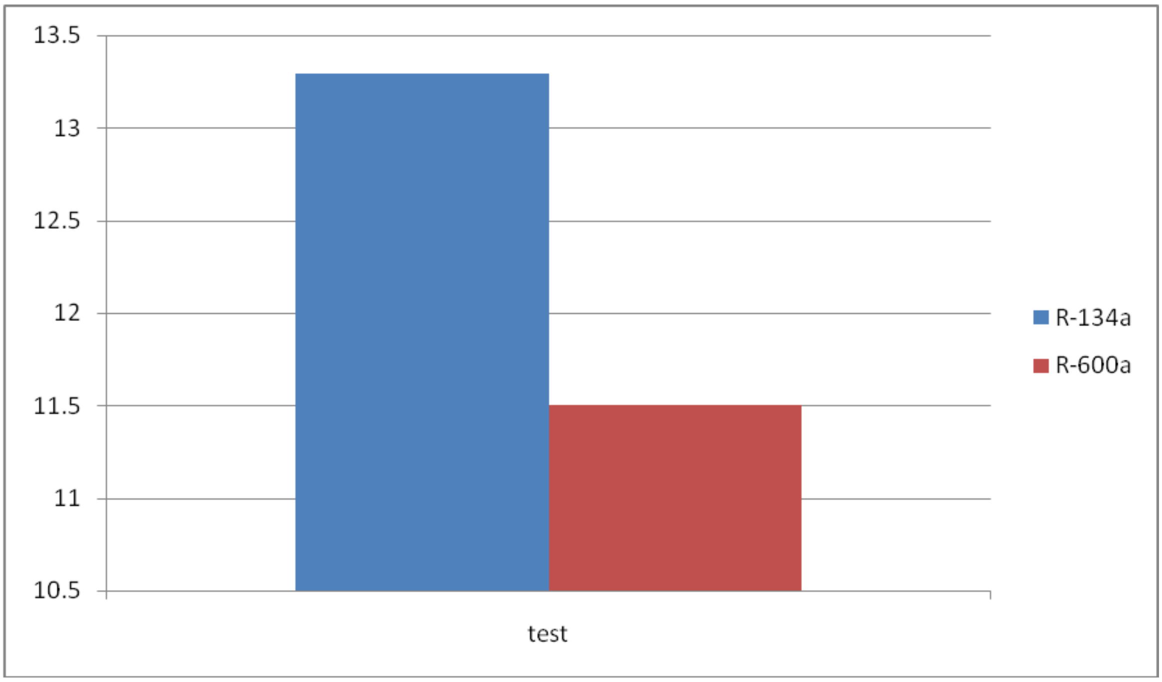
XIII. RESULT

Comparison of refrigerating effect



COMPARISON OF DISCHARGE PRESSURE



ANALYSIS OF THEORETICAL COP

XIV. CONCLUSION

The performance parameters investigated are the refrigeration effect, discharge pressure and the coefficient of performance (COP). The refrigerator worked efficiently when R-600a i.e. LPG refrigerant was used as refrigerant instead of R134a.

1. Every mode of LPG refrigerant yields higher COP than R-134a
2. From using refrigerant in domestic refrigerator, we observed that freezing temperature waslower than that of R-134a

XV. NOMENCLATURE

1. CFC- Chlorofluorocarbon
2. COP- Coefficient Of Performance
3. ODP- Ozone Depletion Potential
4. GWP- Global Warming Potential

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