THEORECTICAL BACKGROUND

The purpose of the compressor is to: Circulate the refrigerant in the circuit.Compress the refrigerant that leaves the evaporator and thus raising its temperature in order to create a temperature difference that will enable heat transfer from the cooled area, toward the outside. The purpose of the condenser is to receive the high-pressure and temperature gas from the compressor and convert this gas into liquid, while emitting heat to the surroundings. The expansion valve fulfills in the cooling circuit a triple function:It releases the pressure from the refrigerant that is in liquid state, on its way to the evaporator. That enables its expansion while reducing its temperature to the lowest value in the cooling circuit, a degree that enables efficient temperature exchange with the air in the refrigerated area. It determines the refrigerant flow intensity through the cooling circuit, according to the momentary cooling request in the refrigerated area. It enables the compressor to accomplish its compressing action by restricting the refrigerant flow.

The evaporator function is the opposite of the condenser function. In the evaporator, the refrigerant turns into gas at low pressure, while absorbing heat. The cooling down is done by the evaporator blower, which sucks the air from the refrigerated area and blows it through the evaporator fines. When the air has passed through the evaporator fines and gave up its heat, it returns to the refrigerated area much cooler and drier.

In the basic refrigerant cycle, the refrigerant, which enters, into the compressor as a low-pressure gas, compresses and moves out of the compressor as a high-pressure and high temperature gas. At the second stage, the gas flows into the **Condenser**. Here the gas condenses into a liquid, giving off its heat to the outside air. The liquid then flows under high pressure, to the **Expansion valve**. This valve restricts the flow of the liquid, thus lowering its pressure as it leaves the expansion valve. The low-pressure liquid moves then to the **Evaporator,** where heat from the inside air is absorbed by the liquid changing its state from liquid into gas. As a hot low-pressure gas, the refrigerant moves back to the compressor where the entire cycle is repeated.

MATERIAL AND METHOD

A Theory Proving System (TPS) consisting of Air-conditioning unit was employed to determine the responses of operating temperatures of Refrigerant (R-134a) with time. The high-pressure refrigerant is sent from the compressor to the condenser, where the heat is dissipated and gaseous refrigerant condensed into a liquid. The high-pressure liquid refrigerant flow to the expansion valve, where it is metered and its pressure is reduces. At the evaporator, the liquid refrigerant absorbs heat from the air and evaporates to gas. The cycle then repeated, starting at the compressor.

The air-conditioning unit consists of the following major components viz; Compressor, Condenser, Expansion device and Evaporator housed by the cooling compartment. Thermometers were placed at each of refrigerant inlet and outlet to each of these components to take the operating temperatures of the refrigerant as it circulates the refrigeration cycle. The time interval were set by the aid of stopwatch through which accurate time were set for the determination of operating temperatures of the refrigerant at the inlet and outlet of each of the major components of the air conditioning unit. The Compressor size is 0.5 horse power and the cooling compartment was made of plastic glass which increases the total cooling load through insolation. The system was made to run for 30 minutes during which operating temperatures were taken at interval of two minutes. T1 and T2 denote operating temperatures of Refrigerant (R-134a) at compressor inlet and outlet, T3 and T4 denote operating temperatures of refrigerant at condenser inlet and outlet while T4 and T5 denote the operating temperatures of refrigerant at evaporator inlet and outlet. Thus T6 is the prevailing temperature at the cooling compartment. Table 1.0 shows the various operating temperatures at various stages and phases within 30minutes.

RESULT AND DISCUSSION

Table 1.0. Time and operating temperatures

Time (min)	T1	T2	T3	T4	T5	T6
0	29	29	29	29	29	29
2	16	38	34	29	19	21
4	15	40	34	29	18	20
6	15	41	34	29	17	18
8	15	42	34	29	16	17
10	15	42	35	29	16	16
12	14	41	35	29	16	15
14	14	41	34	29	16	15
16	14	41	34	29	16	14
18	14	41	34	29	15	13
20	14	41	35	29	15	12
22	14	41	35	29	16	12
24	14	41	35	29	16	11
26	14	41	35	29	15	10
28	14	41	35	29	15	10
30	14	41	35	29	15	10

Table 1.0 shows the operating temperatures with time and Figure 1.0 shows the refrigerant (R-134a) responses to time variation. The initial temperature T1 of the refrigerant was 29^{0}C which

decreased sharply to 16^0C and later to 14^0C hence maintained a balance within 12 minutes. It is evidenced that refrigerant `leaves the compressor at high temperature cools as it recirculates. At the exit of the compressor,the refrigerant temperature T2 increases from 29^0C to 41^0C where it maintains a balance within 10 minutes and this increase resulted from compression process as the refrigerant leaves compressor under high pressure and temperature. In figure 1.0 as time increases the refrigerant temperature T3 at the inlet of the condenser increased steadily to optimum temperature of 35^0C within 10 minutes and maintained a balance. The refrigerant temperature T4 remains unchanged with increases time, the constancy of the temperature is as a result of condensation effect through atmospheric cooling at the condenser. Refrigerant temperature T5 having lost heat as a result of condensation turn to liquid and flow to the evaporator. As time increases the refrigerant temperature drop sharply within few minutes and steadily reduce to 14^0C where it maintains a balance. Refrigerant temperature T6is the prevailing temperature in the cooling compartment. Within 30 minutes the temperature drops 10 degree Celsius. T6 illustrates the cooling effect of refrigeration cycle where refrigerant 134a evaporates into process gaseous state through evaporation and gain heat from the surrounding (cooling compartment) to turn into low pressure liquid refrigerant and back to compressor.

CONCLUSION

The time-temperature response of refrigerant R-134a has been investigated. R-134a being environmentally friendly is universally accepted to replace R-12 which has high ozone depleting potential (ODP) and global warming potential (GWP). Since the compressor works on-stopped for 30 minutes, operating temperatures of R-134a were determined with the aid of Theory Proving System (see plate 1). The operating temperature of the refrigerant in each stages is time dependent though attain optimum and then maintain balance except the operating temperature at the outlet of the condenser that remain constant due to environmental impact on the condensing unit. Thus Time-Temperature response of other synthetic refrigerant can also be determined using the same equipment.

REFERENCES

Alexander D. J and Libretto S.E (1995):" An overview of the toxicology of HFA-134a (1,1,1 2-tetrafluoroethane) Hum Exp.

Ali Kilicarstan and Norbert Muller (2005): "A comparative study of water refrigerant with some current refrigerants. International Journal of Energy Research 2005 29, 947-959.

Brandon F Lachner 2004:" The use of water as a Refrigerant: Impact of cycle modification on commercial feasibility. A MSC thesis, Mechanical Engineering Department, University of Wisconsin-Madison.

Corr Stuart 2005: "1,1,1 2-Tetrafluoroethane (R-134a); A selective solvent for the generation of flavor and frangrance ingredients." Natural flavours and frangrance ACS symposium series 908.

Dincer I (2003): "Refrigerants systems and applicaton". Willey, England.

Dossat R.J and Horan T.J (2002):" Principles of refrigeration. Prentice-Hall: New Jersey

Eckels S.J and Pate M.B (1990): "An experimental comparison of evaporation and condensation heat transfer coeficients for HFC-134a CFC-12" International Journal of Refrigeration 14(2): 70-77.

Handy G.F and Pham H.M (2001): "Effect of refrigerant Choice on Efficiency in Air Conditioning. Annual conference of the Institute of Refrigeration, pp1-17.

Harris Catherine (2010): "Anti-inhalant Abuse campaign, Target 'Huffing' of Air conditioning refrigerants a dangerous Risk" The Nations health. America Public health Association, 2010. Web 05 Dec 2010 (http//the nation alpha publications.org/content/39/4/20 extract.

Meyer J.P 2004: "The performance of refrigerants R-134a, R-290, R-404A, R-407C and R-410A in Air conditioners and Refrigerators".strjnniskivestnik/ Journal of Mechanical Engineering 47 (8): 366-373.

Wattelet J.P, Chato A.L Souza and Christofersen B.R (1993): "Evaporative Characteristics of R-134a, MP39 and R-12 at low mass fluxes". Department of Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign.

Siegfried Haaf and Helmut Henrici (2002): "Refrigeration Technology" in Ullmann'sEncyclopaedia of Industrial chemistry 2002, Willey-VC.

Spatz M.W and Yana Motta S.F (2004): "An evaluation of options for replacing HCFC-22 in medium temperature refrigeration systems. International Journal of Refrigeration 27; 475-483.

GSJ: Volume 6, Issue 9, September 2018
ISSN 2320-9186

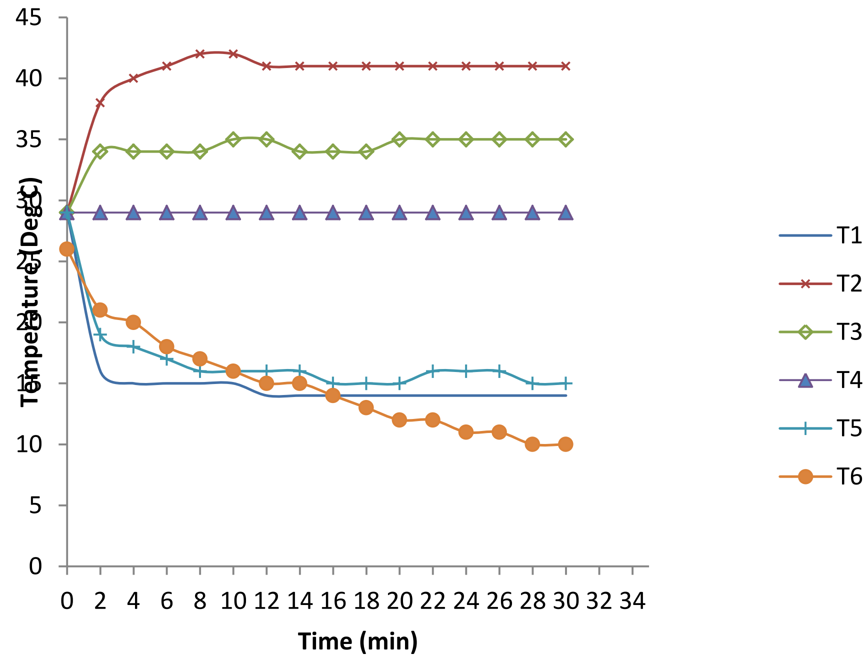

Figure 1: Refrigerant operating Temperatures against Time Variation.

Plate 1.0: Theory Proving System for Air conditioning Unit