Study the Effect of Variable Condenser Length on the Performance of Domestic Refrigerator

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Abstract: The Domestic refrigerator works on the vapor compression refrigeration cycle and the performance of the domestic refrigerator is depends on the performance of all its components such as, condenser, compressor, evaporator and expansion device. The current paper is involved in analysis of the condenser length on the basis of pressure analysis and capillary analysis.
Condenser is nothing but the heat exchanger which is used in the domestic refrigerator to reduce the temperature of the refrigerant by natural convection. The heat is added to refrigerant in the evaporator and also while raising the pressure of refrigerant in the compressor Due to friction some heat addition takes place in the compressor to remove this additional heat a condenser is used.In this present work a condenser coil with different lengths is tested with the help of engineering equation solver software which is developed by Tecumseh industries. All findings are summarized in the form of results and conclusion.

I. INTRODUCTION

1.1 Refrigeration*:*

Refrigeration which is used to reduce the temperature below surrounding and maintaining at particular temperature. In this system continuous heat is extracted from enclosed space and keeping at specific temperature is the main purpose.Vapor compression cycle is improved than the air refrigeration cycle and by using the certain liquids they can absorb enormous amount of heat energy. The process can be controlled at specific temperature and pressure. The vapor after receiving heat are collected and then condensed back in liquid state in condenser. And then the liquid refrigerant again re-circulated. Thus this liquid refrigerant evaporates and condenses in closed loop and rotates again and again and maintains the required temperature. The condenser is most vital component of refrigeration as it rejects the heat to atmosphere.

1.2 Condenser

Condenser is the most vital component of vapor compression refrigeration cycle as it rejects the heat absorbed by refrigerant from the evaporator. It is heat exchanger and which affects the heat transfer between the gas, vapor or super saturated vapor coming from the compressor and cooling medium such as air or water ,it extract the latent of heat from the refrigerant at same pressure and constant temperature. To remove or extract this heat it uses air or water a media. In domestic refrigerator it is obtained by air and with pure natural convection.

II. EXPERIMENTAL SETUP

In vapor compression refrigerating system basically there are two heat exchangers. One is to absorb the heat which is done by evaporator and another is to remove heat absorbed by refrigerant in the evaporator and the heat of compression added in the compressor and condenses it back to liquid which is done by condenser The project focuses on varying the condenser length on the domestic refrigerator and analysis of pressure on condenser and evaporator and capillary analysis. The setup is prepared by cutting the copper tube by copper tube cutter in 1 inch each and brazed at the 30%, 50% and 75% of whole condenser length horizontally. Copper tube is used as it is good conductor of heat and electricity, where it will be useful to measure the temperature at this location by using the pressure temperature coefficient thermistor. The probe is placed inside the 1 inch copper tube to measure the temperature with respect to time. The figure 1 shows the experimental setup of the refrigerator. Experiments are conducted on 190 liter refrigerator.

Domestic refrigerator selected for the project has the following specifications:

Refrigerant used: R-134a
Capacity of The Refrigerator: 190 liters
Compressor capacity: 0.12H.P.
Condenser Sizes
Diameter - 4.80 mm

Evaporator
Width - 335 mm
Height-135 mm
Depth- 305 mm
Capillary
Length - 12 feet
Diameter - 0.031 inch
The condensing length of existing system is 8.16m and in the present work condenser length of 2.448m, 4.08m and 6.12m are tested to analyze its effect on the performance of refrigeration system.

Fig 2.1: refrigerator with condenser lengths at 2.448m, 4.08m and 6.12m

IV.EXPERIMENTAL PROCEDURE

[1]. The domestic refrigerator is selected, working on vapor compression refrigeration system.
[2]. Three Temperature probe are inserted at the three different locations as 30%, 50% and 75%
[3]. Flushing of the system is done by pressurized nitrogen gas
[4]. R 134a refrigerant is charged in to the vapor compression refrigeration system by the following process: The systematic line diagram for charging is shown in the fig 2. it is necessary to remove the air from the refrigeration unit before charging. First the valve V2 is closed and pressure gauge P2, gauge V are fitted.
[5]. Leakage tests are done by using soap solution, In order to further test the condenser and evaporator pressure and check purging daily for 12 hours and found that there is no leakages which required the absolutely the present investigation to carry out further experiment.
[6]. Switch on the refrigerator and observation is required for 1 hour and takes the temperature readings at each location.
[7]. Take condensing temperature at the specified locations.
[8]. Evaluate condensing pressure from r134a table
[9]. Now calculate evaporator pressure based on difference of 100% condenser length calculation.
[10]. Calculate evaporator manually from r134a table
[11]. Calculate suction temperature manually at 20degc from condensing.
[12]. Verify capillary dimensions from software.

V.PERFORMANCE CALCULATIONS

1 Readings for 30% Condenser Length

Table5. 1: temperature reading at 30% of total length of condenser

Reading no.	Time in min	Discharge Temperature In ˚ C	Condenser Temperature In ˚C	Evaporator Temperature In ˚C
1	0.5	42	43	14
2	1	45	45	13
3	2	41	38	12
4	2.5	42	43	11
5	3.5	42	45	10
6	4.5	40	40	9
7	6	40	41	7
8	7	40	42	5
9	8	36	37	3
10	9	36	37	0

11	10	34	36	-1
12	11	33	34	-3
13	12	41	32	-4
14	13.5	40	42	-6
15	14.5	38	40	-7
16	16	39	41	-8
17	19	36	38	-10
18	22	37	38	-11
19	25	37	40	-12
20	28	37	39	-13

2 Readings for 50% Condenser Length

Table 5.2: temperature reading at 50% of total length of condenser

Reading no.	Time in min	Discharge Temperature In ˚ C	Condenser Temperature In ˚C	Evaporator Temperature In ˚C
1	0.5	42	43	14
2	1	45	45	13
3	2	41	40	12
4	2.5	42	43	11
5	3.5	42	43	10
6	4.5	40	41	9
7	6	40	42	7
8	7	40	42	5
9	8	36	38	3
10	9	36	39	0
11	10	34	37	-1
12	11	33	34	-3
13	12	41	42	-4
14	13.5	40	41	-6
15	14.5	38	40	-7
16	16	39	41	-8
17	19	36	39	-10
18	22	37	38	-11
19	25	37	39	-12
20	28	37	40	-13

3 Readings for 75% Condenser Length

Table 5.3: temperature reading at 75% of total length of condenser

Reading no.	Time in min	Discharge Temperature In ˚ C	Condenser Temperature In ˚C	Evaporator Temperature In ˚C
1	0.5	42	42	14
2	1	45	45	13
3	2	41	42	12
4	2.5	42	42	11
5	3.5	42	42	10
6	4.5	40	43	9
7	6	40	42	7
8	7	40	40	5
9	8	36	39	3
10	9	36	38	0
11	10	34	37	-1
12	11	33	33	-3
13	12	41	40	-4
14	13.5	40	43	-6
15	14.5	38	40	-7

16	16	39	41	-8
17	19	36	40	-10
18	22	37	40	-11
19	25	37	40	-12
20	28	37	39	-13

VI.RESULTS AND DISCUSSION

1 Pressure Analysis for Condenser Length

Table 6.1: pressure analysis for condenser length

Pressure analysis		100%	75%	30%
condenser coil length in m	Co	8.16	6.12	2.44
CondenserPressure in psi	Cp	167	176.5	187.4
EvaporatorPressure in psi	Ep	4.576	14	25

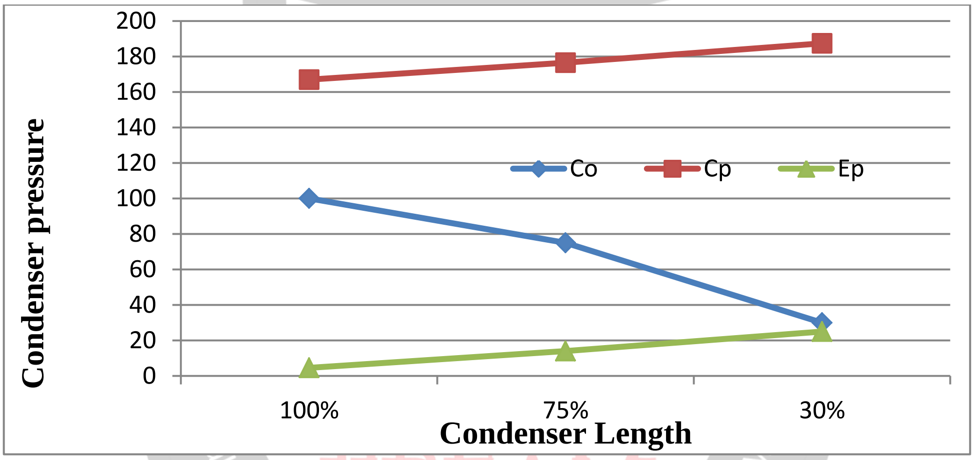

Fig6.1: graph of pressure analysis for condenser length

2 Capillary Analysis for Condenser Length

Table 6.2:capillary analysis for condenser length

CapillaryAnalysis				
condenser coil length	Co	100%	75%	30%
Capillarylength for0.031 Dia. in Feet	C -0.031	15.07	16.82	18.37
Capillarylength for0.028 Dia. in Feet	C -0.028	9.14	10.21	11.18

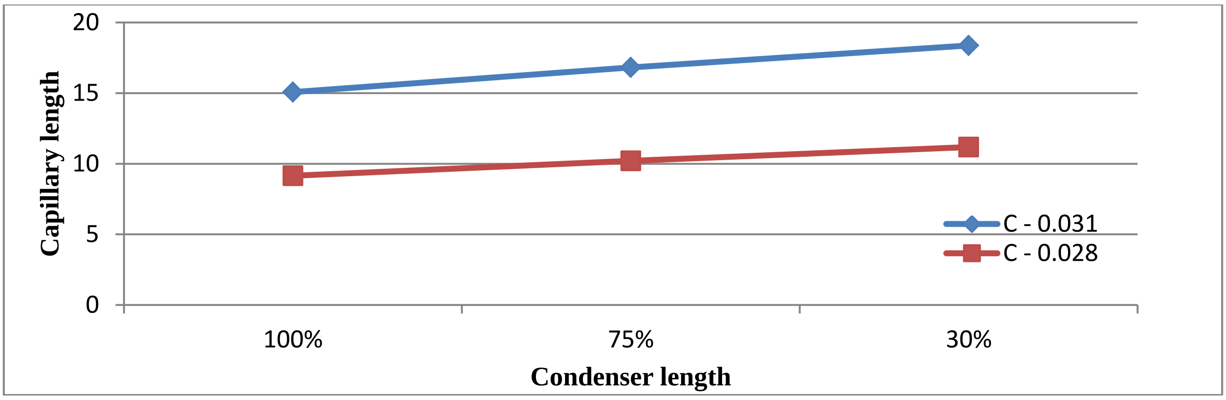

Fig 6.2: graph of pressure analysis for condenser length

VII.CONCLUSIONS

From the experimental investigation following conclusions were drawn:

[1]. The condensing pressure is higher at lower temperature resulting in increase in evaporating pressure. This is reason that proper condensing temperatureis required to facilitate proper evaporation of refrigerant in the evaporator. This is the primary conditionto attainproperEvaporatingtemperature The reducing the Condensing coil length results in higher pressure required for proper evaporation of the refrigerant in the evaporator.This requiredhigher pressureis achievedbyincreasingthe lengthof capillary. Software basedanalysis of capillarylengthconfirms this anda copyis also here with attached.

[2]. Capillary length changes with cooling capacity.

[3]. Difference between evaporator &condenser pressure is constant.

[4]. With decrease in condenser length the evaporating temperature gets disturbed.

[5]. The capillary length needs to be readjusted to achieve the perfect evaporating temperature.

REFERENCES

[1] M. Y. Taib, A. A. Aziz and A. B. S. Alias, “Performance analysis of a Domestic Refrigerator”, National Conference in Mechanical Engineering Research and Postgraduate Students (1st NCMER 2010), ISBN: 978-967-5080-9501 (CD ROM), (May, 2010).

[2] T. Mahaboob Basha, H.Ranganna, G. Maruthi Prasad Yadav, “Optimum Length of a Condenser for Domestic Vapor Compression refrigeration System”, International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 2, February 2015

[3] P. Sarat Babu, and Prof. N. Hari Babu, “Experimental Study of a Domestic Refrigerator Using Variable Condenser Length”, international journal of engineering research and technology, ISSN: 2278-0181, Vol. 2, Issue 12, December - 2013.

