ISSN (ONLINE): 2321-3051

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING

An experimental study of the effect of evaporator temperature on the compressor work of a simple vapour compression refrigeration system

Shashank shekhar pathak[1], Prakhar shukla[2] , Sanjeev chauhan[3],A.K.Srivastava[4]

[1,2,3]Student, Department of Mechanical Engineering, S.R.M.G.P.C, Lucknow, India
[4]Head of Department, Department of Mechanical Engineering, S.R.M.G.P.C Lucknow,India
Author correspondence: Shashank shekhar pathak, 350-A, Lane-8, Khushal nagar, bada lalpur, post – lamahi, sindhora road, bhojubeer, Varanasi, Uttar Pradesh, India - 221007, 09415358999, spathak501@gmail.com.

ABSTRACT:

The experimental study was done to investigate the effect of evaporator temperature on the performance of the compressor of a simple vapour compression refrigeration system. The experimental results showed that increasing evaporator temperature decreases the compressor work of the refrigeration system. Curves were plotted to obtain a relationship between the evaporator temperature and the compressor work and best fit line was drawn and error analysis was done to find the error between the values obtained from the best fit line equation and experimental values of the compressor work. The errors obtained were found to be within satisfactory limits.

Keywords: Compressor work, evaporator temperature, refrigeration system.

1. INTRODUCTION

A simple vapour compression refrigeration system consists of mainly five components namely compressor, condenser, expansion device, evaporator and a filter/drier. The compressor is the work consuming device in the whole system and thus it is of utmost importance to study the possible ways to reduce the work consumed by the compressor in order to increase the cop of the cycle. In the study, capillary tubes of different diameters i.e. 36 gauge and 40 gauge were used and R134a was used as the refrigerant charge in the system. Helical coiled configuration of the capillary tubes were used for the study. Hermetic sealed compressor unit, specific for R134a refrigerant, was used for the compression of the working fluid. The evaporator temperature was recorded using a digital temperature meter. The pressure of the high pressure line and low pressure line was recorded using two analogue pressure gauges. The pressure and temperature values for different capillary tubes for different load conditions were plotted on a standard ph chart for R134a and the corresponding compressor work was determined from the chart.

2. METHODOLOGY

The experimental study was done in the refrigeration and air conditioning laboratory of Shri Ramswaroop Memorial Group of Professional Colleges, Lucknow, India in the best possible controlled environment. Hermetic sealed compressor unit and tubular condenser unit were used. The evaporator unit was properly insulated to the best of the effort so as to minimize the heat leakage into the system from the surrounding. Copper tubes of diameter ¼ inches were used for providing the supply and return lines to the flowing fluid in the system. Refrigerant R134a was used as the cooling fluid. A filter/drier, specific for R134a, was installed just after the condenser unit in order to avoid any situation of choking of the flow lines. The filter/drier does not allow the ice to be formed in the flow lines by absorbing all the moisture particles present in the flowing fluid. Two analogue pressure gauges were used to determine the pressure of the flowing fluid in the high pressure and the low pressure line. The pressure gauge in the high pressure line was installed just after the filter/drier and just before the capillary tube. Another pressure gauge was installed in the low pressure retun line to measure the pressure of the fluid returning back to the compressor. A digital temperature meter was used to determine the temperatures that were to be used in the analysis of the system. The readings of the temperature and pressure were plotted on the PH chart and the corresponding enthalpies were noted down and from the obtained values of the enthalpies the compressor work was determined.

3. EXPERIMENTAL OBSERVATION AND RESULT DISCUSSION

Capillary tubes of 36 gauge and 40 gauge were used as the test sections. The length of each test section was kept constant to 3.5m. Every set of readings consists of at least five readings, two for no load condition and one each for loaded condition of 600ml, 1200ml and 1800ml.

Readings for 36 gauge helical coiled capillary tube:-

Run no.	Load condition	Evaporator temperature (^{0}c)	Compressor work (kj/kg)
1	No load	-12	38.19
2	No load	-13	38.33
3	600ml load	-10	36.99
4	1200ml load	-1.8	35.19
5	1800ml load	1	28.67

Table 1: Readings for 36 gauge helical coiled capillary tube

Readings for 40 gauge coiled capillary tube:-

Run no.	Load condition	Evapoarator temperature (^{0}c)	Compressor work (kj/kg)
1.	No load	-13.3	41.33
2.	No load	-13	40.61
3.	600ml load	-11.2	38.4
4.	1200ml load	-4.3	35.34
5.	1800ml load	-2.5	33

Table 2: Readings for 40 gauge helical coiled capillary tube

Graphical representation of compressor performance for 36 gauge capillary tube:-

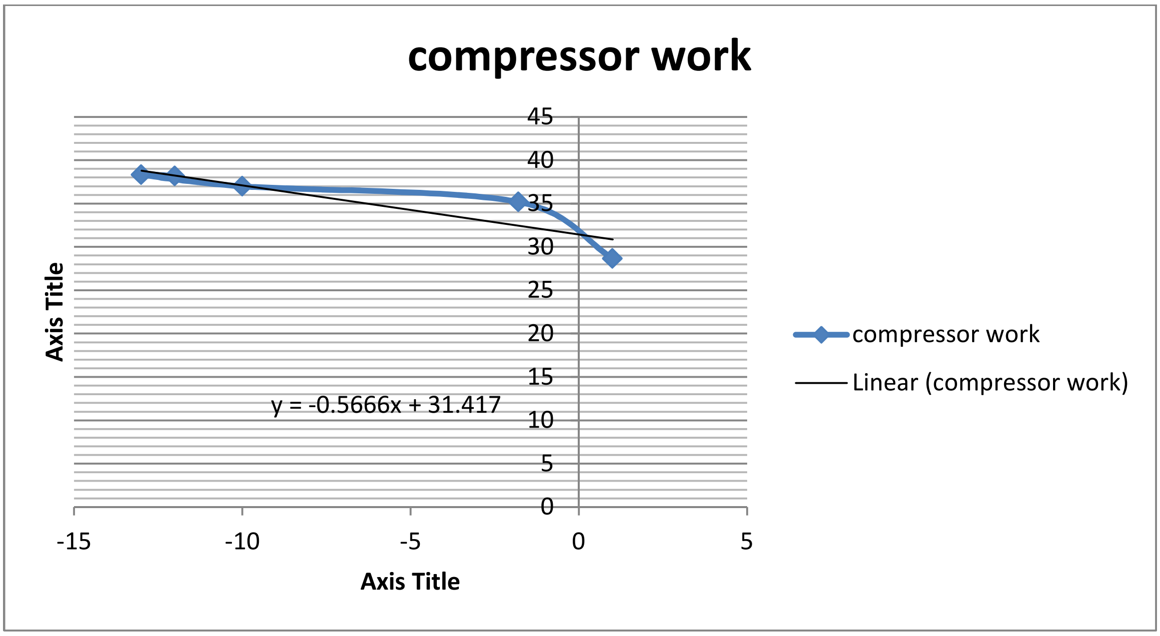

Figure 1: Evaporator temperature Vs Compressor work for 36 gauge helical coiled capillary tube

Graphical representation of compressor work for 40 gauge helical coiled capillary tube:-

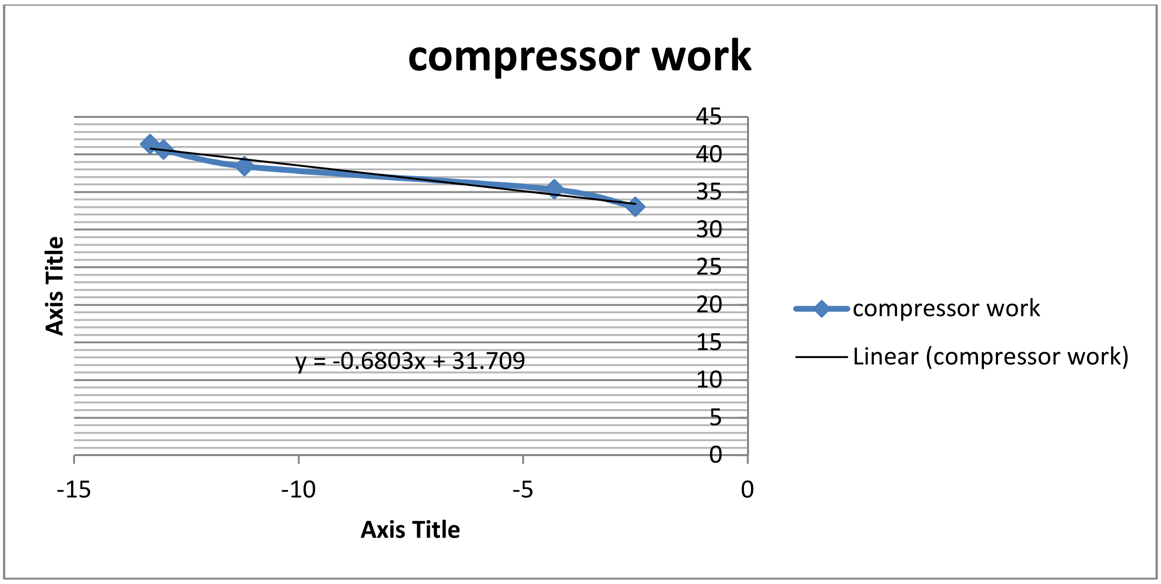

Figure 2: Evaporator temperature Vs Compressor work for 40 gauge helical coiled capillary tube

Error analysis for 36 gauge helical coiled capillary tube:-

Governing equation => Y= -0.5666X + 31.417

Run no.	Evaporator temperature(^{0}c)	Experimental compressor work(kj/kg)	Best fit compressor work(kj/kg)	Error(%)
1.	-12	38.19	38.21	0.05
2.	-13	38.33	38.78	1.16
3.	-10	36.99	37.08	0.24
4.	-1.8	35.19	32.43	8.51
5.	1	28.67	30.85	7.06

Table 3: Error analysis for 36 gauge helical coiled capillary tube

Error analysis for 40 gauge helical coiled capillary tube:-

Governing equation => Y= -0.6803X + 31.709

Run no.	Evaporator temperature(^{0}c)	Experimental compressor work(kj/kg)	Best fit compressor work(kj/kg)	Error(%)
1.	-13.3	41.33	40.75	1.4
2.	-13	40.61	40.55	0.15
3.	-11.2	38.4	39.32	2.33
4.	-4.3	35.34	34.63	2.05
5.	-2.5	33	33.41	1.23

Table 4: Error analysis for 40 gauge helical coiled capillary tube

4. CONCLUSION

The study reveals that when the evaporator temperature increases, the compressor work tends to decrease. The evaporator temperature increases as the load on the system increases. This reduces the volumetric flow from the return line from the evaporator back to the compressor. This causes the reduction in the specific compressor work.

5. ACKNOWLEDGEMENTS

The experimental study was completed on time all because of the blessings of the almighty and hard work of the whole team. The authors would like to convey special thanks to Mr. Pankaj Aggarwal(Executive director, S.R.M.G.P.C, Lucknow, India) and Mrs. Pooja Aggarwal(Dean, S.R.M.G.P.C, Lucknow, India) for providing all the necessary equipments and space which was required for the experimental study.

REFERENCES

[1] Hirendra Kumar Paliwall, Keshav Kant , " A model for helical capillary tubes for refrigeration systems," International Refrigeration and Air Conditioning Conference Purdue University , 2006

[2] 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, 2010.

[3] J.K.Dabas, A.K.Dodeja, Sudhir Kumar and K.S.Kasana, “Performance characteristics of “vapour compression refrigeration system” under real transient conditions”, International Journal of Advancements in Technology, 2011.

[4] Ankush Sharma and Jagdev Singh, “Experimental investigation of refrigerant flow rate with spirally coiled adiabatic capillary tube in vapour compression refrigeration cycle using eco friendly refrigerant”, International Journal of Mechanical and Production Engineering Research and Development, 2013.

[5] Sudharash Bhargava and Jagdev Singh, “Experimental study of azeotropic blend(30% propane, 55% n-butane, 15% iso-butane) refrigerant flow through the serpentine capillary tube in vapour compression refrigeration system”, International Journal of Mechanical and Production Engineering Research and Development, 2013.

[6] Thamir K. Salim, “The effect of the capillary tube coil number on the refrigeration system performance”, Tikrit Journal of Engineering Sciences, 2012.

[7] M.A. Akintunde, Ph.D. "Effect of Coiled Capillary Tube Pitch on Vapor Compression Refrigeration System Performance," The Pacific Journal of Science and Technology Volume 9. Number 2. November (2008), pp. 284-294.

[8] M.M.Tayde, Pranav Datar and Pankaj Kumar, “Optimum choice of refrigerant for miniature vapour compression refrigeration system”, Indian journal of Applied Research, 2013.

[9] Nishant P. Tekade and Dr. U.S.Wankhede, “Selection of spiral capillary tube for refrigeration appliances”, International Journal of Modern Engineering Research, 2012.

[10] Akash Deep Singh, "Flow characteristics of refrigerant inside diabatic capillary tube," Thapar University, Patiala, (2009), pp. 1-96.

[11] D.V.Raghunatha Reddy, Dr P.Bhramara and Dr K.Govindarajulu, “Performance and Optimization of Capillary Tube Length In a Split Type Air Conditioning System”, International Journal of Engineering Research & Technology (IJERT), 2012.

[12] Shashank shekhar pathak, Prakhar shukla, Sanjeev chauhan, “Effect of capillary tube on the performance of a simple vapour compression refrigeration system”, International Organisation of Scientific Research – Journal of Mechanical and Civil Engineering(IOSR-JMCE), 2014.