THOMSON REUTERS ENDNOTE

[Bilal* *et al.*, 6(6): June, 2017] **ISSN: 2277-9655**
IC™ Value: 3.00 **Impact Factor: 4.116**

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

REVIEW OF REFRIGERANT FLOW IN ADIABATIC CAPILLARY TUBE

Bilal Mohammed*, Ganpat Lal Rakesh
* PG Students, Mechanical Department, Christian College of Engineering and Technology Bhilai, INDIA
Assistant Professor, Mechanical Department, Christian College of Engineering and Technology, Bhilai, INDIA

DOI: 10.5281/zenodo.817897

ABSTRACT

After study of many literatures gives the knowledge of flow of characteristics of refrigerant through capillary tube as well as to know about the working fluids for refrigeration system. In present study, the many household refrigerators used a different type of refrigerants as per as their characteristic, the R600a refrigerant have been discussed. In study of many literatures it is concluded that the capillary tube used in refrigerator for refrigerant flow has been suitable for helix coiled tube. Also it is concluded that R600a refrigeratnt is low GWP and low flammable refrigerant, so application of this of refrigerant is suitable for replacing R12, R22 and R134a.

KEYWORDS: Capillary tube, Refrigerant, R12, R22, R134a, R600a.

I. INTRODUCTION

Capillary tubes are the simplest of all refrigerant flow controls, with no moving parts. They normally consist only of a copper pipe, diameter 0.5 to 1.5 mm and length 1.5 to 6 m. The expansion function is caused simply by the pressure drop induced by the long, narrow tube. The mass flow through the tube depends on the pressure difference between the condensing and evaporating sides.

Capillary tubes can be found on small, high-volume commercial systems such as household refrigerators, but can also be used for larger systems if the operating conditions are relatively stable. The capillary tube is vulnerable to clogging, which is why a filter drier and filter are normally mounted before the inlet. A refrigeration system with a capillary tube installed is shown in Figure 1.

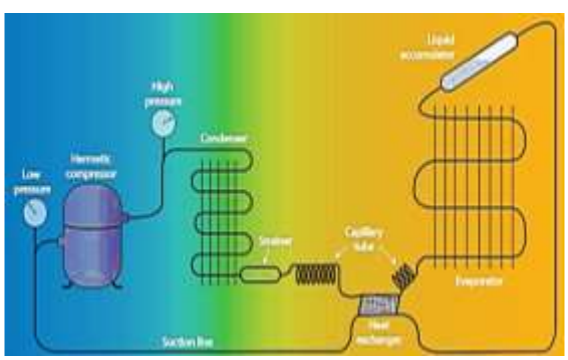

Fig 1. The capillary tube system details.

II. LITERATURE REVIEW

Akintunde et al. (2006), examined the performance of the helical-coiled capillary tube. They concluded that the pitch variation has no significant effect on the system performance [1].

Paliwal and Kant (2006), developed a flow model for designing and studying the performance of helical coiled capillary tubes and to mathematically simulate a situation closer to one existing in real practice. Homogeneous flow of two phase fluid was assumed through the adiabatic capillary tube. The model included the second law restrictions. The effect of the variation of different parameters like condenser and evaporator pressures, refrigerant flow rate, degree of sub cooling, tube diameter, internal roughness of the tube, pitch and the diameter of the helix and the length of the capillary tube were included in the model. Theoretically predicted lengths of helical coiled capillary tube for R-134a are compared with the length of the capillary tube actually required under similar experimental conditions and majority of predictions were found to be within around 10% of the experimental value [5].

Akintunde (2007), are more recently, studied the effect of various geometries of capillary tube. He also studied the effect of the pitches of both helical and serpentine coiled capillary tubes on the performance of a vapor compression refrigeration system. He developed a correlation to describe the relationships between straight and coiled capillary tube and between helical coiled and serpentine coiled capillary tubes [2].

Park et al. (2008), simulated the effects of a non-adiabatic capillary tube on refrigeration cycle. The simulation focused on the effect of capillary tube- suction line heat exchangers (CT-SLHX). The simulation of steady state was based on the fundamental conservation equations of mass and energy and these equations were solved simultaneously through iterative process. The non – adiabatic capillary tube model was based on homogenous two-phase model. The length and location of soldering region between capillary tube and suction line tube were changed and performance of the refrigeration cycle was compared in terms of condenser pressure, evaporator pressure, refrigeration effect, compressor work and cop. The simulation results showed that both the location and length of the heat exchange section influence the cop of the system [7].

Akash Deep Singh, (2009) developed a mathematical model for adiabatic capillary tube. The mathematical model was developed using equations of conservation of mass, momentum and energy and was used for predicting the length of adiabatic capillary tube. Moody (1944) correlation was used to calculate the friction factor. McAdams et al. (1942) viscosity correlation was used to evaluate the two-phase viscosity of the refrigerant. Input parameters were taken from the data. A geometric model was developed in Pro-E and the mesh was created in Ansys ICEM CFD and analysis is carried out in Ansys CFX which has three modules CFX-Pre, Solver and CFX-Post [14].

Taib et al. (2010), studied the performance of a domestic refrigerator and developed a test rig from refrigerator model NRB33TA. The main objective of the performance analysis was to obtain the performance of the system in terms of refrigeration capacity, coefficient of performance (cop), and compressor work by determining three important parameters which are temperature, pressure and refrigerant flow rate. The analysis of the collected data gave the cop of the system as 2.75 while the refrigeration capacity was ranging from 150 watts to 205 watts. [6]

Jain et al. (2011) have reported with extensive thermodynamic analysis of R407C and other alternatives in comparison to R22 have concluded from that R407C is a potential HFC refrigerant replacement for new and existing systems presently using R22 with minimum investment and efforts. Their study of a refrigerant property dependent thermodynamic model of a simple reciprocating system, which can simulate the performance of actual system as closely as possible, has been used to compare the characteristics of various refrigerants [R22, R134a, R410A, R407C and M20] used by world manufacturers to meet the challenges of higher efficiency and environmental responsibility while keeping their system affordable [3].

Dabas et al. (2011), studied the behavior of performance parameters of a simple vapour compression refrigeration system while its working under transient conditions occurred during cooling of a fixed mass of brine from initial room temperature to sub-zero refrigeration temperature. The effects of different lengths of capillary tube over these characteristics were also investigated. The investigation showed that with constantly falling temperature over evaporator, refilling of it with more and more liquid refrigerant causes increase in heat transfer coefficient which maintains the refrigeration rate at falling temperature. The study revealed that larger capillary tubes decreases the tendency of refilling but offers less evaporator temperature while shorter capillary tubes ensure higher cop initially but it deteriorates at a faster rate in lower temperature range [8].

Tekade et al. (2012), reviewed the investigation about the coiling effect of spiral capillary tubes on the refrigerant mass flow rate for the same cooling load. The work also reviewed the effects of changes in the parameters such as capillary tube dimension i.e. capillary tube diameter, capillary tube length, coil pitch and inlet conditions of the refrigerant to the capillary tube i.e. degree of subcooling and inlet pressure of the refrigerant charge [10].

Salim (2012), experimentally investigated the performance of the capillary tube expansion device using R134a as the refrigerant in the system. All the properties of the refrigeration system was measured for the mass flow rate ranging from 13 kg/hour to 23 kg/hour and capillary tube coil number (0-4) with fixed length (150 cm) and capillary tube bore diameter (2.5 mm). the test results showed that the theoretical compression power increases by 65.8% as the condenser temperature increases by 2.71% and the theoretical compression power decreases by 10.3% as the capillary tube coil number increases. The test results also showed that cooling capacity increases by 65.3% as evaporator temperature increases by 8.4% and the cooling capacity increases by 1.6% as the capillary tube coil number increases in the range (0-4). The cop decreases by 43.4% as the mass flow rate increases by 76.9% and the cop of the system increases by 13.51% as the capillary tube coil number increases in the range (0-4). The study showed that coil number 4 was the best for the lowest mass flow rate (13 kg/hour) and the highest mass flow rate (23 kg/hour) [13].

Soni and Gupta (2013), The performances of the adiabatic capillary tubes with several length and inner diameter combinations for R22 and its alternative R410A were experimentally investigated. it is observed that for refrigerant R-22 and R-410A the mass flow rate, cooling capacity COP and EER of capillary 1.4mm more than capillary 1.6 mm and 1.3 mm but compressor work done and heat transfer rate of capillary 1.4mm are lower than capillary 1.6mm and 1. 3mm.Capillary 1.4mm is 32% efficient than capillary 1.6mm and 40% efficient than 1.3mm for R-22. Capillary 1.4mm is 38% efficient than capillary 1.6mm and 47% efficient than 1.3mm for R-410A [4].

Tayde et al. (2013), compared the performance of a miniature vapour compression refrigeration system with four different refrigerants namely NH3, R12, R22 and R134a. The study revealed that NH3 gives maximum value of cop for the system. Next highest cop for the system came out for R12 and then for R134a. Refrigerant R22 gave the least cop for the miniature system [9].

Sharma and Singh (2013), experimentally investigated about the effects simple and twisted spirally coiled adiabatic capillary tubes on the refrigerant flow rate. Several capillary tubes with different bore diameters, lengths and pitches were taken as test sections. LPG was used as an alternative for R134a. mass flow rates for different capillary tubes were measured for different degrees of sub cooling with constant inlet pressure of the capillary tube. Experiments were conducted on straight capillary tubes as well so as to facilitate proper comparison. The test results showed that mass flow rate is greater in straight capillary tube and least in twisted spirally coiled capillary tube. [11]

Bhargava and Singh (2013), experimentally investigated the of pitch and length of the serpentine coiled adiabatic capillary tube on the flow of a ecofriendly gas. The azeotropic blend (30% propane, 55% n-butane, 15% iso-butane) is used as refrigerant in the experiment. Various capillary tubes with distinct lengths, pith and bore diameter were used as the test sections in the experiment. Inlet pressure of the capillary tubes was kept constant and then mass flow rates for different capillary tubes with different lengths and pitches were measured. Straight capillary tubes were also investigated. The data from the experiments showed that mass flow rate of the refrigerant in the system was less for serpentine coiled capillary tubes and was grater for straight capillary tubes [12].

III. CONCLUSION

After Study of many literatures it is concluded that the capillary tube used in refrigerator for refrigerant flow has been suitable for helix coiled tube. Also it is concluded that R600a refrigeratnt is low GWP and low flammable refrigerant, so application of this of refrigerant is suitable for replacing R12, R22 and R134a.

IV. REFERENCES

[1] Akintunde, M. A., Adegoke, C. O. and Papetu, O.P, "Experimental investigation of the performance of a design model for vapor compression refrigeration systems", West Indian J. Engin., Vol. 28, No. 2, (2006).

[2] Akintunde, M. A., "Effect of coiled capillary tube pitch on vapor compression refrigeration system performance", Au. J.T., vol. 11,no. 1, pp. 14-22, July (2007).
[3] Vaibhav Jain, S. S. Kachhwaha, R. S. Mishra. "Comparative performance study of vapour compression refrigeration system with R22/R134a/R410A/R407C/M20". International Journal of Energy and Environment, Volume 2, Issue 2, pp.297-310, 2011.
[4] Richa Soni*, P.K.Jhinge and R.C.Gupta, "Performance of window air conditioner using alternative refrigerants with different configurations of capillary tube", International journal of current research and academic review, ISSN: 2347-3215 Vol 4 (2013), pp 46-54.
[5] Hirendra Kumar Paliwall, Keshav Kant2 , " A model for helical capillary tubes for refrigeration systems," International Refrigeration and Air Conditioning Conference Purdue University , 2006
[6] 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.
[7] Sanggoon Park, Kidong Son, Jihwan Jeong and Lyunsu Kim, "Simulation of the effects of a non-adiabatic capillary tube on refrigeration cycle", International Refrigeration and Air Conditioning Conference, 2008.
[8] 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.
[9] M.M.Tayde, Pranav Datar and Pankaj Kumar, "Optimum choice of refrigerant for miniature vapour compression refrigeration system", Indian journal of Applied Research, 2013.
[10] Nishant P. Tekade and Dr. U.S.Wankhede, "Selection of spiral capillary tube for refrigeration appliances", International Journal of Modern Engineering Research, 2012.
[11] 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.
[12] 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.
[13] Thamir K. Salim, "The effect of the capillary tube coil number on the refrigeration system performance", Tikrit Journal of Engineering Sciences, 2012.
[14] Akash Deep Singh, "Flow characteristics of refrigerant inside diabatic capillary tube," Thapar University, Patiala, (2009), pp. 1-96.

CITE AN ARTICLE

Mohammed, B., & Rakesh, G. L. (2017). REVIEW OF REFRIGERANT FLOW IN ADIABATIC CAPILLARY TUBE. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, 6*(6), 515-518. doi:10.5281/zenodo.817897