CFD Analysis of Mixed Refrigerants for Industrial Cooling Applications

Raja Sekhar Dondapati

School of Mechanical Engineering, Lovely Professional University, Phagwara 144 401, India

Abstract

Refrigerants are used for mechanical cooling and private refrigeration now and then achieves diminishing in Coefficient of Performance in light of augmentation in cooling loads. As the mass of the refrigerant used, remains reliable considering the fixed blower limit, thusly usage of mixed refrigerants can wind up being a down to earth answer for consider the prerequisites of cooling. In this manner the present examination centers around usage of mixed refrigerants R290 and R600a in mechanical cooling structures. The objective of this endeavor is to measure heat move, pressure drop and temperature qualification related with the as of late referenced mixed refrigerants computationally. For this examination, use of ANSYS FLUENT writing computer programs is proposed. The working weight is set to be 3 MPa in a channel of 0.064m separation across while reenactment considering the way that higher loads are kept up in the mechanical cooling system. At fixed divider temperature of 350K, mixed refrigerants in with varying plan is reproduced in FLUENT. From the start, association of 10% R290 and 90% R600a is picked and with varying mass stream rates for instance from 0.05 kg/sec to 0.1 kg/sec, amusement is performed and pressure drop and warmth move is assessed. After this movement, proliferations are performed for 20% R290 and R600a piece and creation is progressively extended to 90% R290 and 10% R600a. The examination is then connected for furrowed pipes to get updated eventual outcomes of weight drop, heat move and temperature differentiation. Finally, Reynolds number and Nusselt number is resolved from Temperature qualification and Heat move.

Keywords: CFD, heat transfer, pressure drop, refrigerants

1. Introduction

The most routinely utilized system for cooling is with fume pressure cycles, since it is genuinely simple to produce a cooling gadget utilizing this strategy and the expense is low. Taking everything into account, standard fridges utilize this method for cooling to keep your pieces and beverages chilled! Environment control structures in addition utilize a smoke compel cycle to cool the incorporating air temperature in a room. Essentially, rage pressure refrigeration utilizes a shine motor run in reverse, so heat noteworthiness is taken from a fresh store and saved into a hot vault. Ceaselessly Law of Thermodynamics, heat centrality doesn't rapidly move from a cold to a hot stock. So as to have heat advance toward that way (and not from hot to cold, as the framework is regularly masterminded to do), it is basic to do deal with the structure. This refrigeration cycle is around a Rankine cycle run backward. A working liquid (ordinarily called the refrigerant) is pushed through the framework and experiences state changes (from fluid to gas and back). The lethargic warmth of vaporization of the refrigerant is utilized to move a lot of warmth noteworthiness, and changes in pressure are utilized to control when the refrigerant removes or acclimatizes heat centrality.

2. Research Methodology

The absolute initial phase right now is the determination of various refrigerants which are as of now utilized in the Vapor pressure refrigeration framework. Right now work blended refrigerant Propane (R290) and ISO-butane (R600a) are chosen that are utilized in the fume pressure refrigeration framework. As indicated by writing study for choice of refrigerants the base fundamental temperature contrast must be 300 C. Along these lines, for R290 and R600a the basic temperature contrast is 500 C. Thus, these two refrigerants are chosen for our CFD examination. Thermo-physical properties like warm conductivity, thickness, consistency, and explicit warmth of propane and ISO-butane are considered. Diverse chart have been plotted concerning temperature and diagrams are appeared in the succeeding section. These Thermo-physical properties shifts starting with one organization of blend then onto the next arrangement of blend and these qualities are gotten from NIST SUPERTRAPP programming.

In the present research work, pressure drop is assessed for blower pipe and layered funnel moreover regarding diverse mass stream rates at various temperatures shifts from 300-330K for a blended refrigerant at various pieces. So from ANSYS programming most extreme and least weights of the refrigerant blend is determined and the weight drop is assessed. In the present research work, heat move rate is assessed for blower pipe and folded pipe what's more as for various mass stream rates at various temperatures shifts from 300-330K for a blended refrigerant at various organizations. The warmth move rate is evaluated computationally from the Ansys programming from alternatives Fluxes – absolute warmth move – divider.

3. Results and Discussion

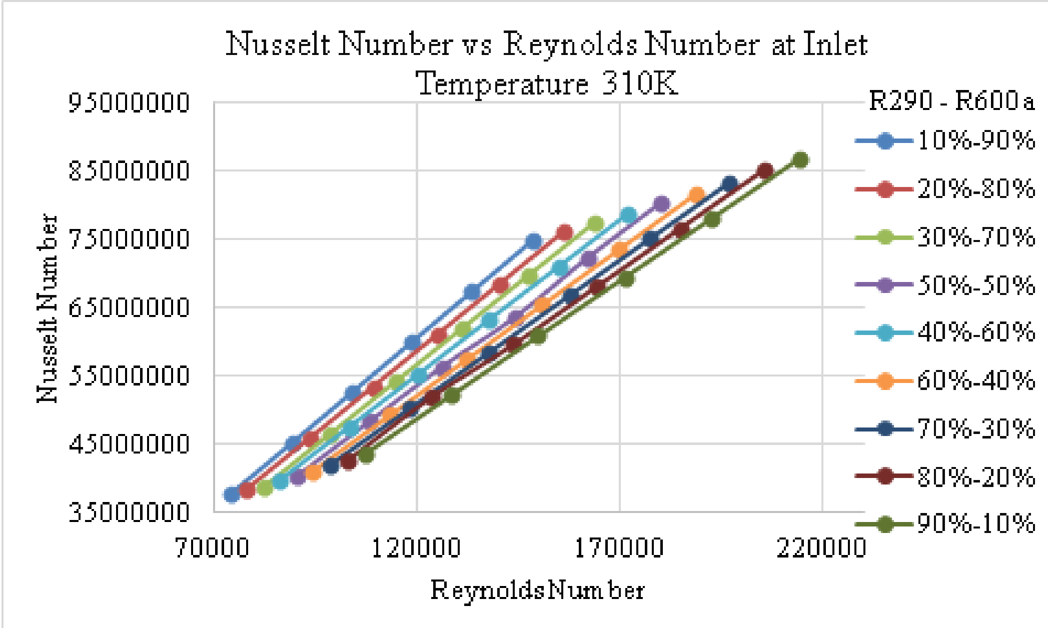

Figure 1 Nusselt number v/s Reynolds number

Figure 1 shows that variety of weight drop concerning distinctive mass stream rate at 300K channel temperature and various sytheses of a blended refrigerant. Besides, it was seen that as the mass stream rate increments and weight drop is increments exponentially.

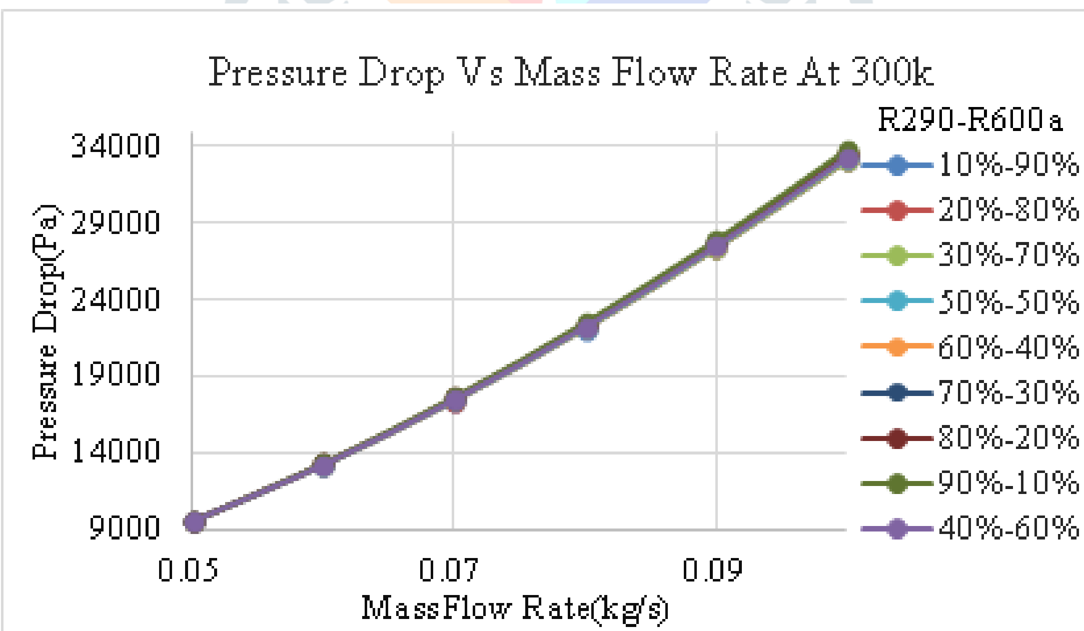

Figure 2 Pressure drop v/s mass flow rate

Figure 2 shows that variety of warmth move rate regarding diverse mass stream rate at 300K gulf temperature and various organizations of a blended refrigerant. In addition, it was seen that as the mass stream rate increments and weight drop is increments directly.

4. Conclusions

The reason this exploration work, was done in Fluent Analysis Work bench® for reviewing the weight drop, heat move rate, Reynolds number, Nusselt number, of Propane (R290) and ISO-butane (R600a) at a temperature of 300-350K and weight of 3MPa furthermore, results are determined.

Weight drop of a blended refrigerant at various gulf temperatures at worked pressure for various mass stream rates expanded for blower pipe and creased pipe. Warmth Transfer Rate of a blended refrigerant at various bay temperatures at worked pressure for various mass stream rates expanded for blower pipe and folded pipe. Reynolds Number of a blended refrigerant at various channel temperatures at worked pressure for various mass stream rates expanded for blower pipe and creased pipe. Nusselt Number of a blended refrigerant at various delta temperatures at worked pressure for various mass stream rates expanded for blower pipe and creased pipe. Nusselt Number of a blended refrigerant at various bay temperatures at worked pressure as for Reynolds Number expanded for blower pipe and folded pipe. From the above outcomes and conversations, we have presumed that weight drop, heat move rate, Reynolds number, Nusselt number expanded for both the blower pipe and folded pipe. Besides, it is additionally watched, that as the folded channel frees more weight drop, heat move rate, Reynolds number and Nusselt number because of disturbance impact is caused for the ridged funnel.

References

[1] Dawidowicz, B., & Cieśliński, J. T. (2012). Heat transfer and pressure drop during flow boiling of pure refrigerants and refrigerant/oil mixtures in tube with porous coating. *International Journal of Heat and Mass Transfer*, *55*(9–10), 2549–2558.

[2] Wen, M. Y., & Ho, C. Y. (2009). Condensation heat-transfer and pressure drop characteristics of refrigerant R-290/R-600a-oil mixtures in serpentine small-diameter U-tubes. *Applied Thermal Engineering*, *29*(11–12), 2460–2467.

[3] Wen, M. Y., & Ho, C. Y. (2009). Condensation heat-transfer and pressure drop characteristics of refrigerant R-290/R-600a-oil mixtures in serpentine small-diameter U-tubes. *Applied Thermal Engineering*, *29*(11–12), 2460–2467.

[4] Dalkilic, A. S. (2011). Condensation pressure drop characteristics of various refrigerants in a horizontal smooth tube. *International Communications in Heat and Mass Transfer*, *38*(4), 504– 512. Huang, J., Sheer, T. J., & Bailey-Mcewan, M. (2012). Heat transfer and pressure drop in plate heat exchanger refrigerant evaporators. *International Journal of Refrigeration*, *35*(2), 325– 335.

[5] Huang, X., Ding, G., Hu, H., Zhu, Y., Gao, Y., & Deng, B. (2010). Flow condensation pressure drop characteristics of R410A - Oil mixture inside small diameter horizontal microfin tubes. *International Journal of Refrigeration*, *33*(7), 1356–1369.

[6] Longo, G. A. (2010). Heat transfer and pressure drop during HFC refrigerant saturated vapour condensation inside a brazed plate heat exchanger. *International Journal of Heat and Mass Transfer*, *53*(5–6), 1079–1087. http://doi.org/10.1016/j.ijheatmasstransfer.2009.11.003

[7] Zou, Y., & Hrnjak, P. S. (2014). Single-phase and two-phase flow pressure drop in the vertical header of microchannel heat exchanger. *International Journal of Refrigeration*, *44*, 12–22.

[8] Sami, S. M., & Song, B. (1996). Heat transfer and pressure drop characteristics of HFC quaternary refrigerant mixtures inside horizontal enhanced surface tubing. *Applied Thermal Engineering*, *16*(6), 461–473.

[9] Cao, R., Qi, Y., & Chen, R. (2017). pVTx properties of binary R1234ze(E)/R600a system. *The Journal of Chemical Thermodynamics*, *111*, 191–198.

[10] Choudhari, C. S., & Sapali, S. N. (2017). Performance Investigation of Natural Refrigerant R290 as a Substitute to R22 in Refrigeration Systems. *Energy Procedia*, *109*(November 2016), 346– 352.