A REVIEW ON TABLE TOP REFRIGERATOR SYSTEM

[1]Sandeep Jain, [2]N.K Sagar
[1]Research Scholar (Dept. Of Mechanical Engineering, SIRT, Bhopal M.P.)
[2]Asst. Prof. (Dept. Of Mechanical Engineering, SIRT, Bhopal M.P.)

ABSTRACT

Domestic refrigerators had become the member of the every family. It had made our busy life more simple and comfortable. Also it becomes an essential part of the life in summer for chilled drinking water and preserving the food stuff for short period throughout the year. An Evaporator is the Main component of refrigeration system, which is mainly used in different refrigeration and air conditioning applications in food and cold storage, in the mechanical industry etc. Evaporator in air conditioning system is used to evaporate liquid and convert in to vapor. While absorbing heat in the processes for the refrigeration cycle to be efficient; the design parameters for its key components play a vital role. In the present research papers an in-depth study has been performed covering the details of affecting parameters like effect of velocity, change in heat flux and mass transfer, effect of varying the Reynolds number on refrigerator's were studied. This study also covers various tools used for studying and simulating the conditions of refrigerator conditions along with the aid of using different designs in the simulation.

Keywords: Table top Refrigerator, Evaporator, Cold Storage, ANSYS

1. Introduction

An air conditioner (often referred to as AC) is a home appliance, system, or mechanism designed to dehumidify and extract heat from an area. The cooling is complete using a simple refrigeration cycle. In construction, a complete system of heating, ventilation and air conditioning is referred to as "HVAC". Its use, in a building or an automobile, is to present comfort during either hot or cold weather the most common refrigeration cycle use an electric motor to drive a compressor.

1.1. Structure Evaporator

It is in the evaporators where the actual cooling effect takes place in the refrigeration and the air conditioning systems. For several people the evaporator is the main part of the refrigeration system and they think other parts as less useful. The evaporators are heat exchanger surfaces that transfer the heat from the substance to be cooled to the refrigerant, thus remove the heat from the substance. The evaporators were used for large variety of diverse applications in refrigeration and air conditioning processes and hence they are available in wide variety of shapes, sizes and designs. They are also classify in different manner depending on the method of feeding the refrigerant, construction of the evaporator, direction of air circulation around the evaporator, application and also the refrigerant control.

1.2. Structure EvaporatorRefrigeration cycle analysis

The pressure – enthalpy diagram is analyzed by selecting a particular region of the Moller diagram of refrigerant is shown in Figure 1. Basically, point 1 to 2 represent the compressor work input, point 2 to 3 represent heat dissipation from the condenser to the surroundings, while point 3 to 4 is the expansion process by capillary tube. Evaporator (point 4 to 1) works vice versa to the compressor, which extracts heat from the surrounding into the cycle.

Heat load calculations for direct cool refrigerator without freezer compartment

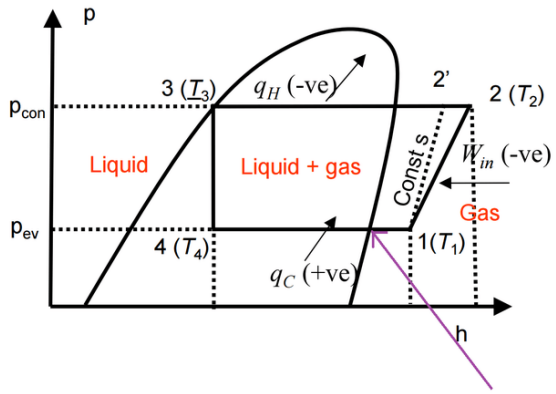

Figure 1 Pressure – enthalpy diagram.

Below are the steps defined to make the design calculations for the refrigerator? All the design calculation for the refrigerator is based on heat and mass transfer fundamentals.

Step 1- Calculation of outside Heat Transfer Coefficient (ho)

Step 2- Calculation of Internal Heat Transfer Coefficient (hi)

Step 3 -Wall Heat Load Calculations

Step 4 - Air Change Load Calculations

Step 5 - Calculations for Commodity Load for Refrigerator Compartment

Step 6 - Calculations for Commodity Load for Freezer Compartment

Step 7 - Calculation of Water Load for RC

2. Literature review

GeorgiTodorov (2017) aims to assess and to improve existing design of evaporators for household table top refrigeration appliances using Computational Fluid Dynamics (CFD). This category of refrigerators is compact and cheap solutions for domestic appliance. The requirement for low cost solution does not cancel necessity of high affectivity, usually referred as “energy class”. The evaporator is important component of refrigerator heat transport system and to its efficiency. Existing design of evaporator is improved in two directions – as shape of the serpentine and as cross section – constrained by overall cost limit. Two groups of thermal CFD analyses are performed over various design variants. Used virtual prototypes enable to view in detail heat transfer process and to reach a better solution in means of overall price/performance.

JyothiSivashankar Reddy et al. (2017) thermal characteristics are analyzed by mixing R12 mixing with R134A, Ethylene glycol and propylene glycol with 0.03% volume fraction when used in a refrigerator. From the CFD analysis, comparing the results between refrigerants blend, the heat transfer rate is more with R134A blend and heat transfer coefficient is more with Ethylene Glycol.

Carlos Caballero et. al (2017) study of an air conditioner HACEB AA FS09 115 V was done. A CFD simulation with two geometries (17.92 m and 10 m) was done to study the change from liquid to vapor phase. Results gave an approximation to the reality of the evaporation process. For all simulation a quality of 0.5 at least was reached.

Juan M. Belman-Flores et. al (2017) Combinations were performed to use three 2D interpolation methods in order to simulate the temperature mean and the temperature variance. The methods used were: Lagrange’s interpolation, cubic spline interpolation and bilinear interpolation. Two validation points were chosen to verify the proposed methods. Average temperature was obtained when one shelf was located at 24.5 cm while the second shelf was located at 29.5 cm measured from the top of the compartment. In the same way, it can be seen that the minimum temperature variance was obtained when only one shelf was inside the compartment and this shelf was located at 29.5 cm.

(Chouhan, P, & Kumar, 2017) Capillary tubes are used as expansion device in low capacity refrigeration machines like domestic refrigerators and window type air conditioners. The advantages of the capillary tube over other expansion devices are simple, inexpensive and cause compressor to start at low torque as the pressure across the capillary tube equalize during the off-cycle. The flow characteristics of refrigerants through capillary tubes have been studied extensively in past six decades, both experimentally and analytically, most of these studies mainly focused on straight capillary tubes. In this thesis, the effects of the relevant parameters on the flow characteristic of R134a and R-22 flowing through adiabatic helical capillary tubes were experimentally studied.

(Direk, Harun, Ekrem, & Bayrak, 2017)pressure drops at lower levels and to maintain uniform refrigerantdistribution, flow behavior of refrigerants in the distributors at the entrance of evaporators should be elucidated.

The aim of this study is to obtain a validated computational simulation of two-phase flow distribution in conventional and new designs refrigerant distributor. The results of the computational simulations of the distributor are validated against the experimental results. The influence of the flow distribution on the evaporator performance has been considered. Distribution of mass flow rate in the distributor channels and pressure drop are numerically calculated and then compared to the data obtained from the experimental facility. As a result, the difference between numerical and experimental study of the pressure drop is less than 2%.

(Honra, Berana, Danao, & Manuel, 2017)one-dimensional mathematical modelling and physical experimentation. Data acquisition from physical investigations requires extensive effort and considerable time and is very expensive; whereas, Computational Fluid Dynamics (CFD) could be a more efficient diagnostic tool for ejector design analysis and performance optimization than one-dimensional mathematical modelling prior to actual experimentation. This study presents CFD simulation results of an ejector for air conditioning applications using popular commercial CFD software and attempts to have a highly dependable simulation that features a model based on the interpolation of real fluid properties from NIST-REFPROP database embedded through user-defined functions (UDF's) with R134a as the working fluid. Primarily, density and speed of sound are polynomial functions of both pressure and temperature.

(Clito Afonso & Joaquim Gabriel, 2017)sustainability in refrigeration systems is a mandatory goal to achieve, namely at house holdings, bars and restaurants, where small-scale refrigerators and freezers are widely used. The aim of this work is to demonstrate experimentally, trough measurements carried out in these equipments, the improvement that can be achieved if several modifications are implemented in traditional household refrigeration systems. In addition, it was also simulated and analysed experimentally a slightly different equipment, a refrigeration system used for draught beverages. Both systems work on a single vapour compression refrigeration with R-134a as working fluid. In the end, by implemented the modifications tested in the virtual model, it was possible to improve their thermal behaviour, a decrease in electrical energy consumption, as well as, the associated CO2 emissions reduction can be attained.

(Dinesh, Sai Manikanta, Dishal Kumar, & Sahu, 2016)refrigeration is one of the most energy consuming sector. In conventional Vapor Compression refrigeration system, compressor is the major power consuming element. Vapor Adsorption refrigeration system is one of the best replacement for the Vapor Compression refrigeration system. Our main objective is to analyze, design and develop a Vapor Adsorption refrigeration system which is cost effective and environment friendly. A prototype model that is capable of producing a temperature drop in closed evaporator chamber was designed, fabricated and tested. Activated carbon/Methanol pair is chosen as Adsorbent/Refrigerant pair. The system is analyzed in ANSYS 14.5 using the inlet conditions obtained from the experimental setup.

(Yu, 2016)consumption quantity of high-value fruits, vegetables and seafood products have been increasing year by year. As a consequence, the traffic volume of refrigerated products also increases yearly and the popularization degree of the cold-chain transportation enhances. A low-temperature environment should be guaranteed during transportation, thus there is about 40% of diesel oil should be consumed by the refrigerating system and the cold-chain transportation becomes very costly. This study aimed to explore a method that could reduce the cost of transport packages of refrigerated products. On the basis of the heat transfer theory and the fluid mechanics theory, the heat exchange through corrugated cases during the operation of refrigerating system was analyzed, the heat transfer process of corrugated cases and refrigerator van was theoretically analyzed and the heat balance equation of corrugated cases was constructed. Besides, this study simulated the temperature field of the corrugated box during transportation.

(Abhinav, 2016)capillary tube used in the mostly in the refrigerant flow control devices. Hence performance of the capillary tube is best for good refrigerant flow. The many researchers

had been concluding performance using experimentally, theoretically and analysis based. In this present work analyze the flow analysis of the refrigerant inside a capillary tube for adiabatic flow conditions. The proposed model can predict flow characteristics in adiabatic capillary tubes for a given mass flow rate. In the present work R-22 is replaced by Ammonia refrigerant has been used as a working fluid inside the capillary tube and the capillary tube design is changed straight to coiled capillary, which taken from good literature. The analysis is done in ANSYS CFX 16.2 software.

KasireddyTejashwi et.al (2016) Thermal analysis is done by considering Aluminum alloy for fins and Copper for tubes. The inputs of CFD analysis are velocity and pressure and the results determined are Pressure, Velocity, Mass Flow Rate, Heat Transfer Rate and Heat Transfer Coefficient. Heat transfer rate is more for tapered fin. When R600A is used, heat flux is more. CFD analysis is done by varying fluids R600A, R32 and R410A on all the models. By comparing the results between refrigerants, pressure drop is more when R32 is used, heat transfer coefficient and heat transfer rate are more when R600A is used.

(Khalaji Assadi, Gilani, & Jun Yen, 2016)develop and integrate solar hybrid system into conventional air conditioning system which provides the same cooling load with considerably less electricity demand. Solar evacuated tube and DC compressor are used for compressing the refrigerant in an air conditioning system, thus effectively reducing the air conditioning electricity consumption by up to 45%. For the flow through type selected geometry of the designed evacuated U-tube collector, a three dimensional simulation and analysis of the thermal performance was done, using the solar ray-tracing model provided by the ANSYS-FLUENT software.

(Diwan, 2016)shell and tube heat exchanger is the most common type heat exchanger widely used in oil refinery and other large chemical process, because it suits high pressure application. The process in solving simulation consists of modelling and meshing the basic geometry of shell and tube heat exchanger using CFD package ANSYS 12.0. The objective of the project is design of shell and tube heat exchanger with helical baffle using catia software and study the flow and temperature field inside the shell using ANSYS software tools. The heat exchanger contains 27 tubes and 5490 mm length shell diameter 540 mm. The helix angle of helical baffle will be varied from 0 to 200 degree. In simulation, we will show how the temperature and heat flux vary throughout the surface of the condenser. The flow pattern in the shell side of the heat exchanger with continuous helical baffles was forced to be rotational and helical due to the geometry of the continuous helical baffles, which results in a significant increase in heat transfer coefficient per unit pressure drop in the condensers.

V. U. Elavande et al. (2015) Air flow rate from the evaporator coil Refrigerant circuitry of the evaporator coil. The direction of air flow in respect to evaporative coil Misdistribution, Non uniform air flow reduces the COP. Microchannel evaporator has faster transient behavior than the fin-and-tube evaporator. Use of the existing refrigeration system can be considered for finding the behavior foe heat transfer. The coils in the form of arrays connected with circular fins (rods) are found as the ‘typical’ feature of the evaporator.

T.Balasubramanianet. al (2015) comparison of the pressure loss and velocity of the various eco-friendly refrigerants that were taken for the study. Theoretical analysis of S-shaped coil was carried out for the single phase flow and the pressure drop was calculated by summing the frictional pressure loss and geometric pressure loss due to change in momentum within the liquid/Vapour mixture. pressure loss calculation was carried out on CFD and the results showed that, the performance of the new eco-friendly refrigerants R407b, R407c to be better than of R12 refrigerant.

Kesani Dinesh (2015)modern industries, commercial refrigerators play a major role in preserving food groceries, beverages, etc. Hence designing and analysis of these refrigerators to withstand given load has become a major concern in recent years. The objective of this dissertation was to analyses and optimize the refrigerator shelf and to find maximum stress and deflections of entire refrigerator assembly for given loading and boundary conditions using Finite Element Method. First stage consists of Analysis and

optimization of refrigerator shelf. Second stage consists of the Analysis of entire refrigerator assembly. While lifting the structure from one place to another place, structure has to be tilted to a small angle so that the structure sits firmly on the automated guided vehicle. Hence it is very important to find the critical angle of tilt for safe transportation and thereby preventing from a huge loss.

(Arunkumar, George, Sunny, & Antony, 2015)investigate outlet temperatures in heat exchanger within generator by varying fluid velocities and also used to investigate outlet temperature in evaporator and heat flux rate at walls of evaporator. The solar refrigeration absorption system taken for analysis is a continuously operating refrigerant storage system. R- 717(Ammonia) is used as refrigerant. Aqua-ammonia vapor absorption refrigeration systems, which operate such that both, the generation of aqua ammonia vapors and the production of cold utilizing the generated aqua-ammonia vapors, take place at the same time are known as continuous-based operation systems. Model is completed using Solid works. Analysis is carried out in ANSYS 14. FLUENT is the software used to simulate fluid flow problems. It is generally used for computational Fluid Dynamics problems. It uses the finite-volume method to solve the governing equation for a fluid. It provides a wide field to solve problems. Numerical computations have been carried out to find coefficient of performance (COP). Variation of temperature at outlet of heat exchanger and evaporator are studied.

3. Conclusion

In the above literature review various refrigerator concepts were studied to obtain the in-depth details of refrigerator systems. In previous studies authors have studied about different shapes of evaporator and compressor coils. Most of the work has been carried out on changing the inlet velocities to obtain high performance in refrigerator systems. A few of the studies were also on changing the Reynolds number to obtain the effect of laminar or transient flow in refrigerator systems. Various tools like ANSYS CFD (Fluent), Open foam etc. were used for the simulation purpose. This paper also presents a comprehensive review of the state of the art of vapour compression refrigeration for personal cooling. A great number of refrigeration system prototypes have been presented in the literature, and several mathematical models for the system and its components have been proposed. In this paper, described a miniature refrigeration system that is capable of obtaining high performance in a form factor compatible with today's small scale used. Also from the detailed literature survey it has been observed that a lot of work has been carried out in this direction particularly on changing the design and other affecting parameters but still there are several parameters which need to be optimized for obtaining the large amount of efficiency using these systems. Further various ranges of parameters can be used to achieve optimum parameter range for further use in these table top refrigerators.

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