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DESIGN AND OPTIMIZATION OF FIN TUBE EVAPORATOR BY VARYING DIFFERENT PARAMETERS

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Abstract: An evaporator is use in an air-conditioning system or refrigeration system to allow a compressed cooling chemical, such as Freon or R-22, to evaporate from liquid to gas while enthralling heat in the process. It is also use to remove water or other liquids from mixtures. The process of evaporation is widely use to concentrate foods and chemicals as well as salvage solvents. In the concentration process, the goal of evaporation is to vaporize most of the water from a solution which contains the desired product.

In this paper, dissimilar shapes of fins in fin tube evaporator are modeled in 3D modeling software Pro/Engineer. The fins considered are rectangular fin, circular fin a internal finned. The mass flow rate and heat transfer rate are analyzed by CFD analysis completed in Ansys. CFD analysis is completed by varying fluids R134A, R22 and R410 on all the models.

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.

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. In an automobile, the compressor is driven by a belt over a pulley, the belt being driven by the engine's crankshaft (similar to the driving of the pulleys for the alternator, power steering, etc.). Whether in a car or building, both use electric fan motors for air circulation. while evaporation occurs when heat is absorbed, and condensation occurs when heat is released, air conditioners use a compressor to cause pressure changes between two compartments, and actively condense and drain a refrigerant around. A refrigerant is pumped into the evaporator coil, located in the compartment to be cooled, where the low demands causes the refrigerant to evaporate into a vapor, taking heat with it. At the opposite side of the cycle is the condenser, which is located outside of the cooled compartment, where the refrigerant vapor is compressed and forced through another heat exchange coil, condensing the refrigerant into aliquid, thus rejecting the heat previously absorbed from the cooled space.

Cylinder un loaders are a method of load control use mainly in commercial air conditioning systems. On a semi-hermetic compressor, the heads can be fitted with un loaders which remove a portion of the load from the compressor so that it can run better when full cooling is not needed. Un loaders can be electrical or mechanical.

1.1 Introduction To 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 use 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.

In the domestic refrigerators the evaporators are commonly identified as the freezers since the ice is finished in these compartments. In case of the window and split air conditioners and other air conditioning systems where the evaporator is straight use for cooling the room air, it is called as the cooling coil. In case of large refrigeration plants and central air conditioning plants the evaporator is also known as the chiller since these systems are first used to chill the water, which then produces the cooling effect.

2. Introduction to CAD

Computer-aided design (CAD), also known as computer-aided design and drafting (CADD), is the used of computer machinery for the process of design and design-documentation. Computer Aided Drafting describes the process of drafting with a computer. CADD software, or environments, provide the user with input-tools for the reason of streamlining design processes; drafting, documentation, and manufacturing processes. CADD output is often in the structure of electronic files for print or machining operations. The development of CADD-based software is in direct correlation with the processes it seeks to economize; industry-based software typically uses vector-based environments whereas graphic-based software utilizes raster-based environments.

CADD environment repeatedly involve more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must express information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions. CAD can be use to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) objects.

2.1 Introduction To Pro/Engineer

Pro/ENGINEER Wildfire is the usual in 3D creation design, featuring industry-leading efficiency tools that promote best practices in design while ensure compliance with the industry and company standards. Incorporated Pro/ENGINEER CAD/CAM/CAE solutions agree to you to design faster than ever, while maximizing innovation and superiority to eventually generate exceptional products.

Customer necessities may change and time pressures may continue to mount, but your product design needs remain the same - regardless of your project's scope, you require the powerful, easy-to-use, affordable solution that Pro/ENGINEER

2.2 3D MODELS

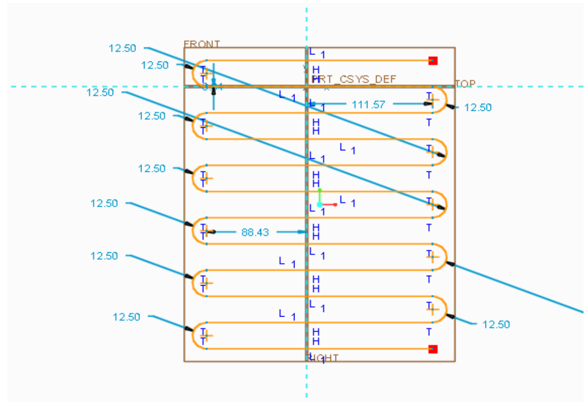


Fig.1 Rectangular Fins Model

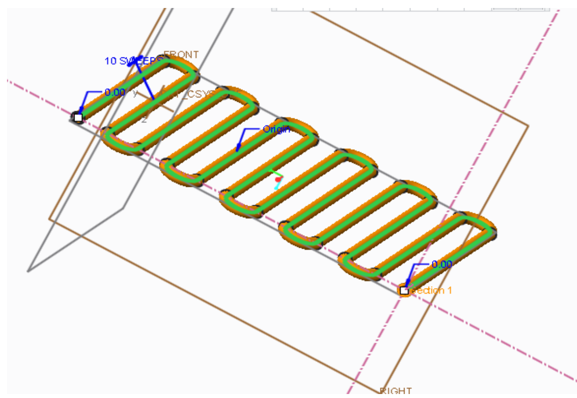


Fig.2 Sweep

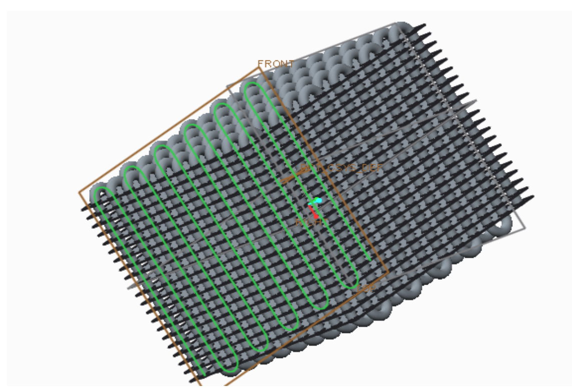


Fig.3 Full Model

3. Introduction to FEA

Finite Element Analysis (FEA) be first developed in 1943 by R. Courant, who utilize the Ritz method of numerical analysis and minimization of variational calculus to take estimated solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Topp established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures".

By the early 70's, FEA was limited to expensive mainframe computers generally own by the aeronautics, automotive, defense, and nuclear industries. Since the rapid decline in the cost of computers and the phenomenal increase in computing power, FEA have be developed to an inconceivable precision. Present day supercomputers are now able to produce exact results for all kinds of parameters.

3.1 CFD Analysis Of Fin Tube Evaporator

RECTANGULAR FIN

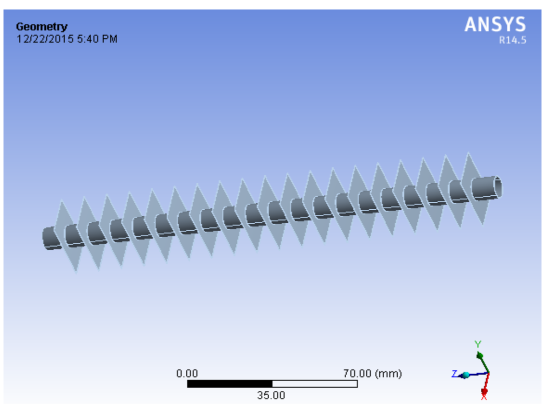


Fig.4 Imported model

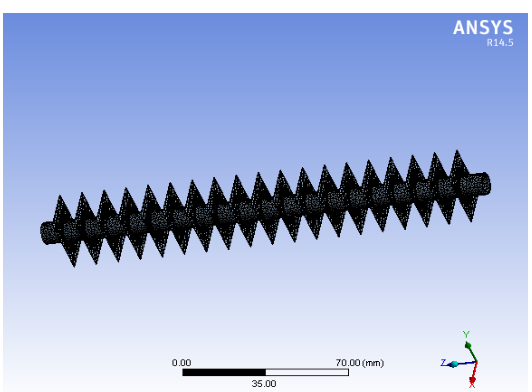


Fig.5 Meshed model

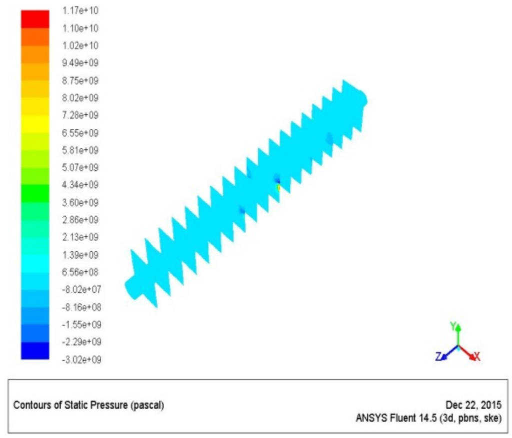


Fig.6 Pressure Contours

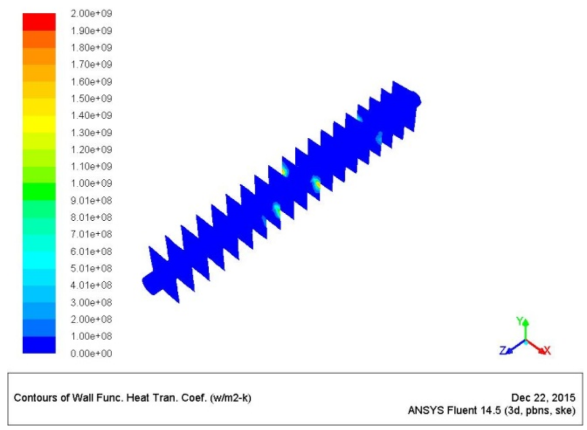


Fig.7 Heat Transfer Co-Efficient

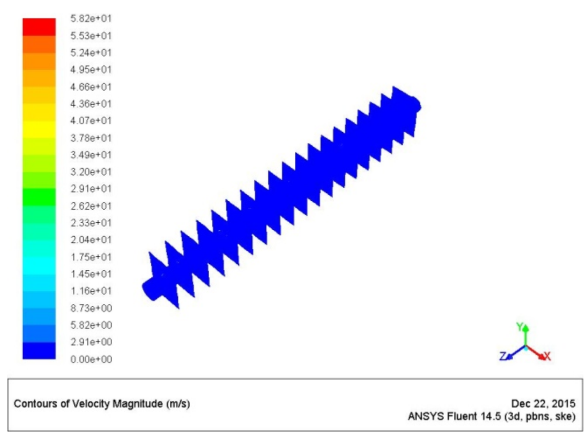


Fig.8 Velocity Magnitude

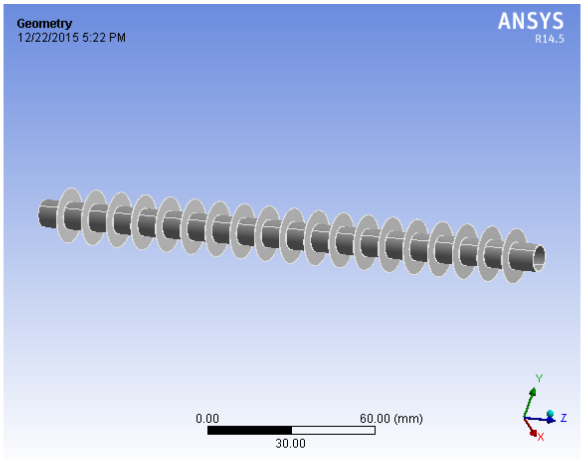


Fig.9 Circular Fin

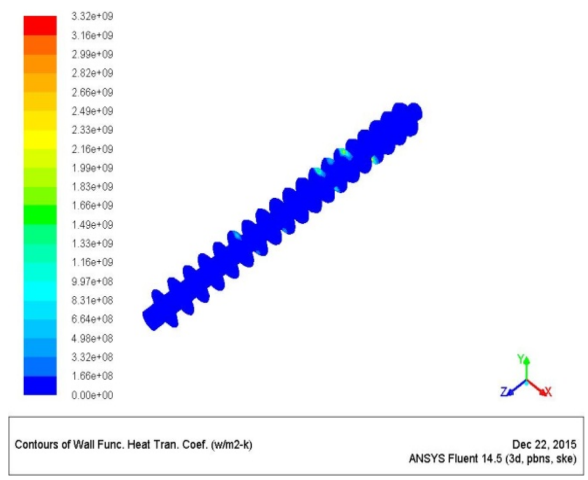


Fig.12 Heat Transfer Co-Efficient

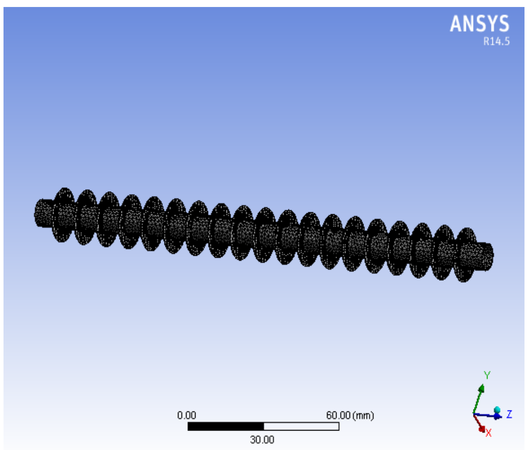


Fig.10 Meshed model

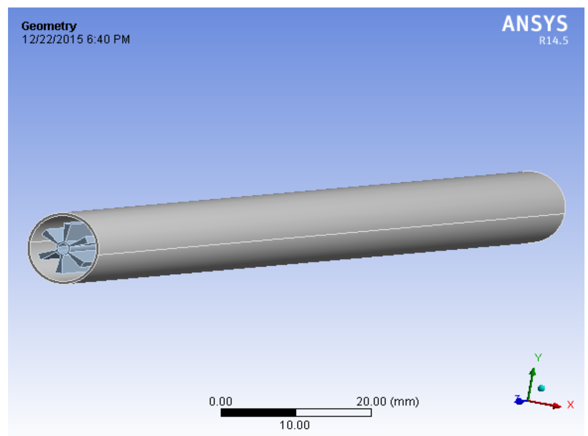


Fig.13 Imported model

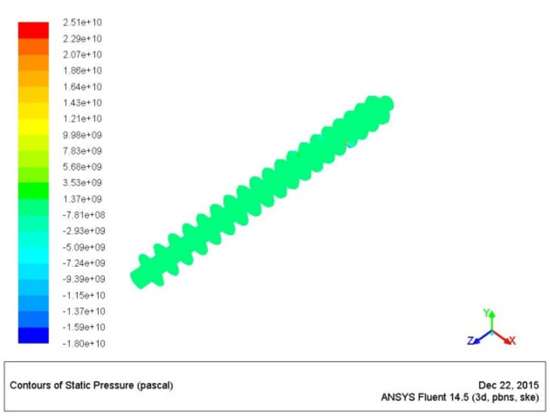


Fig.11 Pressure Contours

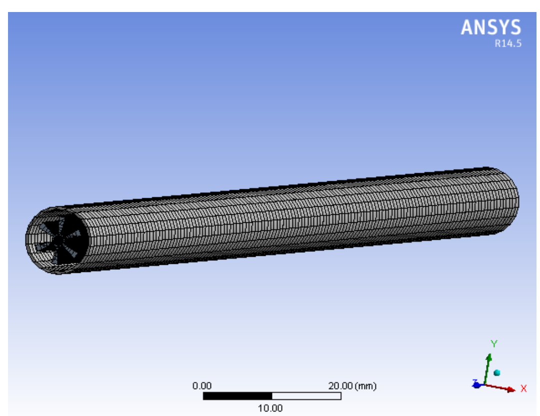


Fig.14 Meshed model

4. RESULTS

Results Table

Rectangular Fin

Fluids	Pressure(Pa)	Velocity(m/s)	Heat transfer coefficient(W/m^2-k)	Mass flow rate(Kg/s)	Heat transfer rate(W)
R-134	1.17e+10	1.20e+02	2.00e+09	0.32307386	1.0035105e+08
R-22	6.07e+07	5.82e+01	4.36e+08	0.11760426	26601.906
R-410	5.86e+08	5.36e+01	1.01e+09	0.067638099	-25346.453

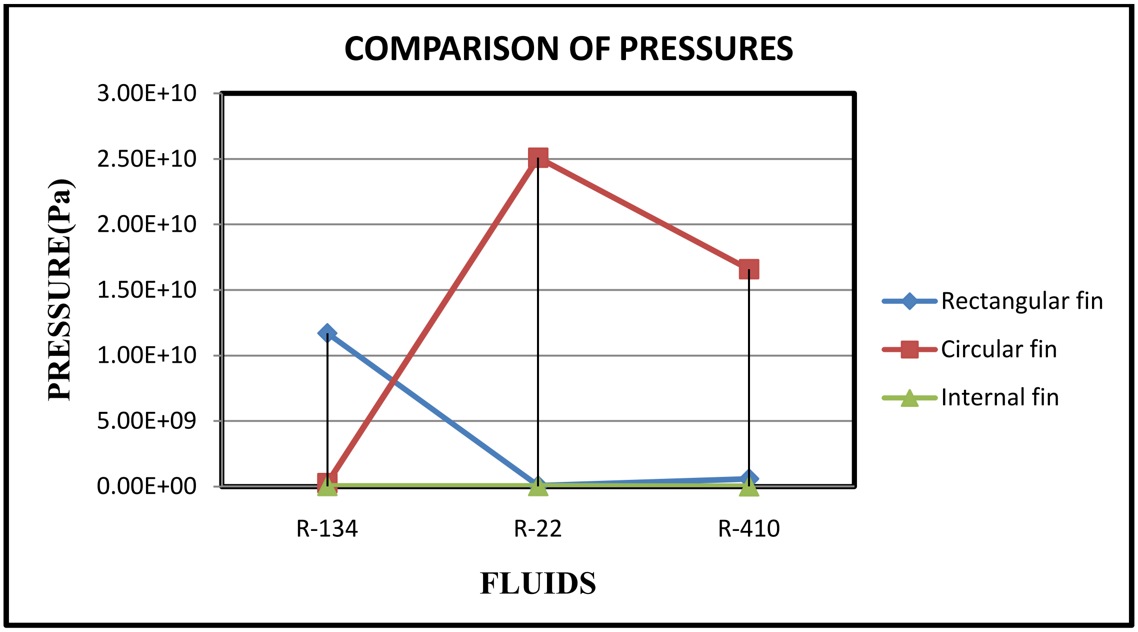
Circular Fin

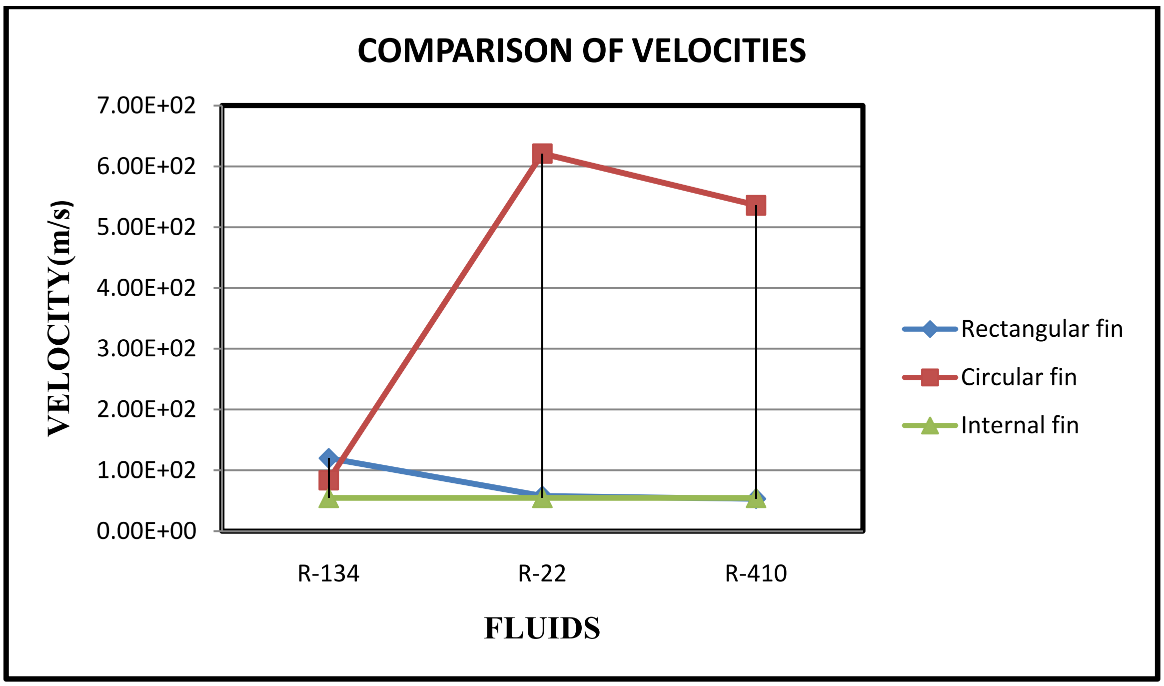
Fluids	Pressure(Pa)	Velocity(m/s)	Heat transfer coefficient(W/m^2-k)	Mass flow rate(Kg/s)	Heat transfer rate(W)
R-134	2.58e+08	8.41e+01	1.14e+09	0.23466635	57347.31
R-22	2.51e+10	6.21e+02	3.32e+09	0.18172956	-51574594.9
R-410	1.66e+10	5.36e+02	4.42e+09	0.15147561	42093.625

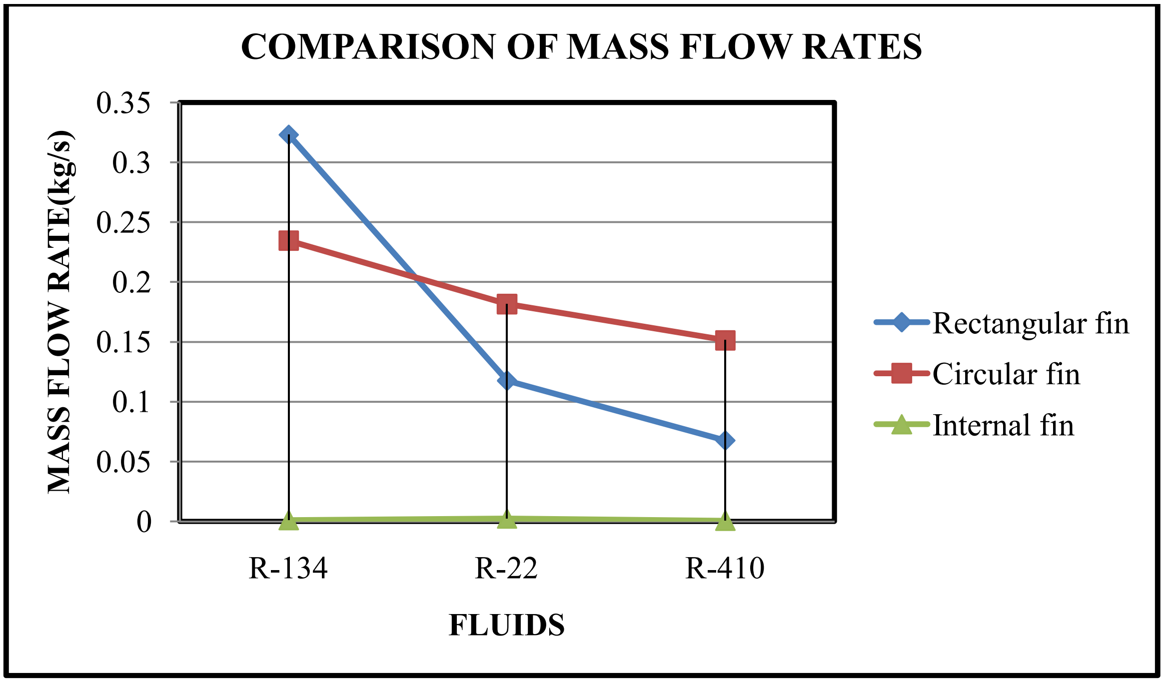
Internal Fins

Fluids	Pressure(Pa)	Velocity(m/s)	Heat transfer coefficient(W/m^2-k)	Mass flow rate(Kg/s)	Heat transfer rate(W)
R-134	3.93e+07	5.50e+01	1.13e+07	-0.001073	-239.375
R-22	3.31e+07	5.50e+01	1.10e+07	-0.002956299	-521.125
R-410	1.24e+07	5.50e+01	5.42e+06	-0.00061798096	-169.14063

GRAPHS


COMPARISON OF PRESSURES
PRESSURE(Pa)
3.00E+10
2.50E+10
2.00E+10
1.50E+10
1.00E+10
5.00E+09
0.00E+00
R-134
R-22
R-410
FLUIDS
Rectangular fin
Circular fin
Internal fin


COMPARISON OF VELOCITIES
VELOCITY(m/s)
7.00E+02
6.00E+02
5.00E+02
4.00E+02
3.00E+02
2.00E+02
1.00E+02
0.00E+00
R-134
R-22
R-410
FLUIDS
Rectangular fin
Circular fin
Internal fin



CONCLUSION

In this thesis, different shapes of fins in fin tube evaporator are modeled in 3D modeling software Pro/Engineer. The fins considered are rectangular fin, circular fina dn internal finned. The mass flow rate and heat transfer rate are analyzed by CFD analysis done in Ansys. CFD analysis is done by varying fluids R134A, R22 and R410 on all the models.CFD analysis is done in Ansys.

By observing the CFD analysis results, heat transfer coefficient, heat transfer rate, mass flow rate are more for rectangular fin. Heat transfer coefficient and pressure are more for circular fin. By comparing the fluids, heat transfer rate, mass flow rate are more for R134, heat transfer coefficient is more for R410 and outlet pressure is more for R22.

By observing the thermal analysis results, the heat flux is more for rectangular fin than circular and internal fins. R134 has more heat flux than R22 and R140. So using rectangular fins and R134 is better.

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