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RESEARCH ARTICLE

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CFD AND THERMAL ANALYSIS OF FIN TUBE EVAPORATOR

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ABSTRACT

In this paper, different shapes of fins in fin tube evaporator are modeled in 3D modeling software Pro/Engineer. The fins considered are continuous rectangular fin, interrupted rectangular fin, continuous circular fin, and interrupted circular fin. The mass flow rate and heat transfer rate are analyzed by CFD analysis done in Ansys. CFD analysis is done by varying fluids R600A, R124 and R22 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. Thermal analysis is done by considering Aluminum alloy for fins and Copper for tubes.

I. INTRODUCTION TO EVAPORATOR

It is in the evaporators where the actual cooling effect takes place in the refrigeration and the air conditioning systems. For many people the evaporator is the main part of the refrigeration system and they consider 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 removing the heat from the substance. The evaporators are used for wide 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 classified 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 evaporator the refrigerant enters at very low pressure and temperature after passing through the expansion valve. This refrigerant absorbs the heat from the substance that is to be cooled so the refrigerant gets heated while the substance gets cooled. Even after cooling the substance the temperature of the refrigerant leaving the evaporator is less the than the substance. The refrigerant leaves the evaporator in vapor state, mostly superheated and is absorbed by the compressor.

II. LITERATURE SURVEY

In the paper by Kiran. B. Parikh[1], presents the study of the fin tube type Evaporator; an Experimental data were collected from the IC ICE MAKE Company. After collecting data of fin tube evaporator model is prepared using solid works. At the end, FEA analysis is carried out on it using ANSYS CFD. At the end, by using DOE Method get optimum Model of Evaporator.

In the thesis by L. Omkar Goud[2], different configurations of fin tube evaporator are modeled in 3D modeling software Pro/Engineer. The temperature distribution, heat transfer rate is analyzed by thermal and CFD analysis done in Ansys. Thermal analysis is done on four different configurations are continuous fin, continuous fins with zig-zag tubes, interrupted fin and interrupted fin with zigzag tubes with different materials for evaporator Aluminum, Aluminum alloy 7075 and Copper. CFD analysis is done by varying fluids R134a, R22a and R410a on all the configurations.

III. 3D MODELS OF FIN TUBE EVAPORATOR IN CREO 2.0

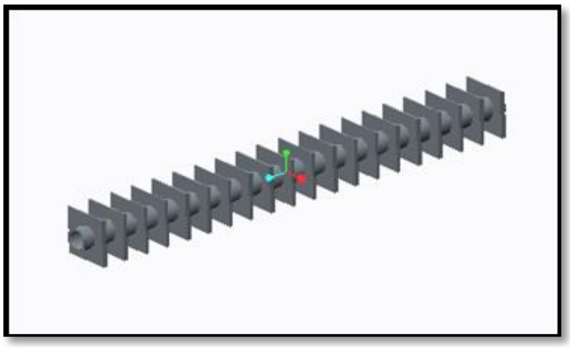


Fig -1- 3D model of Continuous rectangular fins with tube

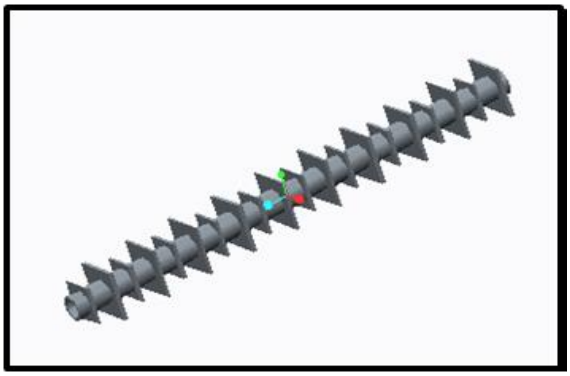


Fig -2- 3D model of Interrupted rectangular fins with tube

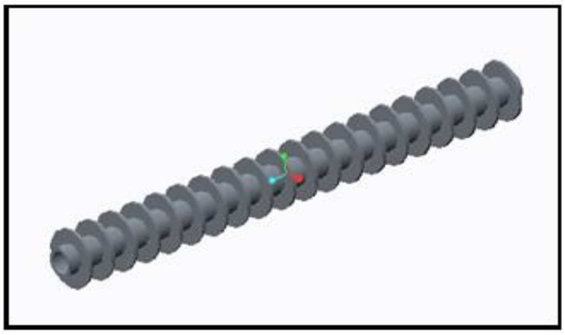


Fig -3- 3D model of Continuous circular fins with tube

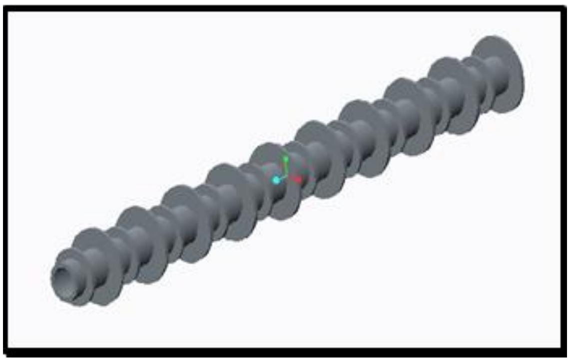


Fig -4- 3D model of Interrupted circular fins with tube

IV.CFD ANALYSIS OF FIN TUBE EVAPORATOR

A. INTERRUPTED RECTANGULAR FIN WITH TUBE

1) FLUID- R600A

Boundary conditions: For CFD analysis, mass flow rate and pressure are applied at the inlets. The boundary conditions are the pressure obtained from the result of CFD analysis mass flow rate and heat transfer rate.

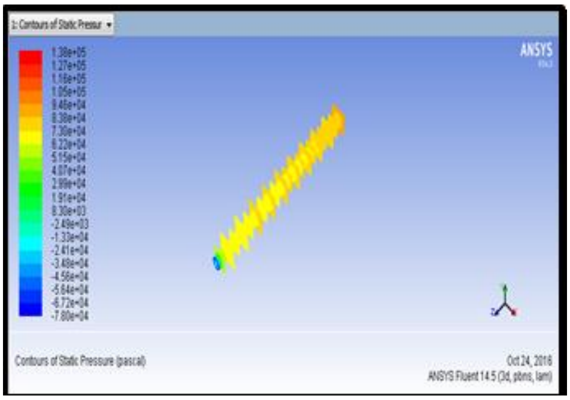


Fig –5- Contours of Static Pressure for Interrupted rectangular fin with tube for fluid R600A

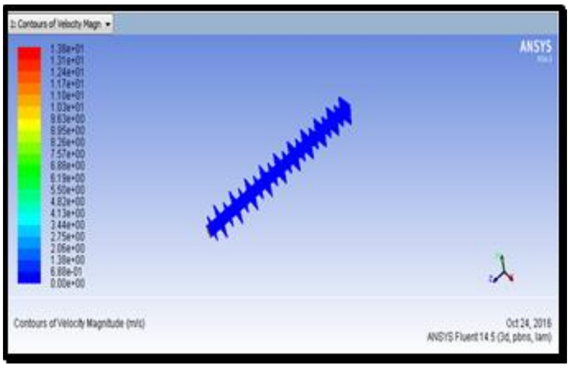


Fig –6- Contours of Velocity Magnitude for Interrupted rectangular fin with tube for fluid R600A

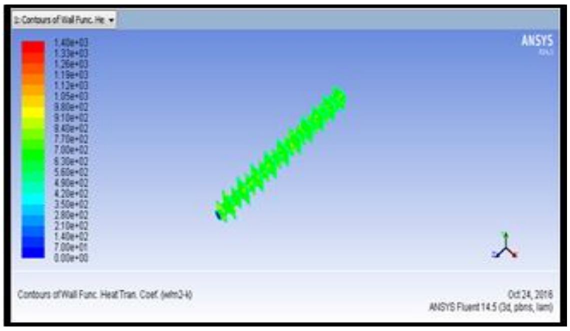


Fig –7- Contours of Heat Transfer Coefficient for Interrupted rectangular fin with tube for fluid R600A

```
      Mass Flow Rate                      (kg/s)
-------------------------------- --------------------
contact_region-src                 0.058331411
contact_region-trg                -0.058331233
             inlet                         1.5
        interior-7                0.0067245341
  interior-____msbr                  -6.072865
    interior-solid                   -152.3714
            outlet                  -1.4842119
           wall-12                           0
           wall-13                           0
     wall-____msbr                           0
---------------- --------------------
               Net                 0.015788257
```

Fig-8-Mass flow Rate for Interrupted rectangular fin with tube for fluid R600A

```
  Total Heat Transfer Rate                         (w)
-------------------------------- --------------------
         contact_region-src                         0
         contact_region-trg                         0
                      inlet                -61225.516
                     outlet                  60581.73
                    wall-12                         0
                    wall-13                         0
              wall-____msbr                         0
---------------- --------------------
                        Net                -643.78516
```

Fig-9-Heat Transfer Rate for Interrupted rectangular fin with tube for fluid R600A

V. RESULT TABLES OF CFD ANALYSIS

1. Interrupted rectangular fin with tube

Fluids	Pressure(Pa)	Velocity(m/s)	Heat transfer coefficient (W/m^2-k)	Mass flow rate (Kg/s)	Heat transfer rate(W)
R600A	1.38E+05	1.38E+01	1.40E+03	0.01578826	643.7352
R22	3.87E+05	2.71E+01	7.52E+03	0.00035714	7.580078
R124	2.73E+05	2.22E+01	6.13E+03	0.01404196	270.5606

2. Continuous rectangular fin with tube

Fluids	Pressure(Pa)	Velocity(m/s)	Heat transfer coefficient (W/m2-k)	Mass flow rate (Kg/s)	Heat transfer rate(W)
R600A	8.60E+04	1.38E+01	1.40E+03	0.05516569	1716.781
R22	3.86E+05	2.71E+01	7.52E+04	0.00029619	6.166016
R124	3.39E+05	2.39E+01	6.13E+04	0.00049255	9.597197

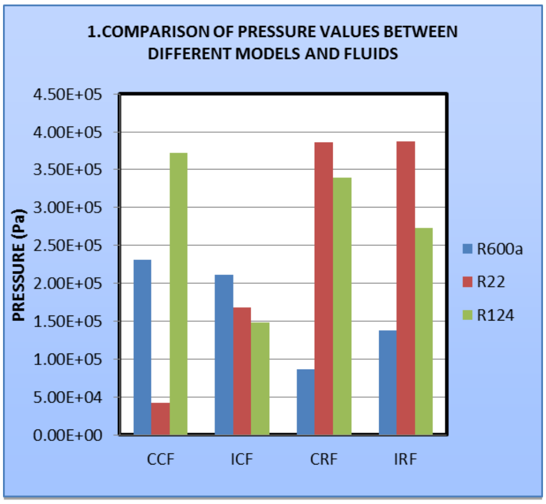
3. Interrupted circular fin with tube

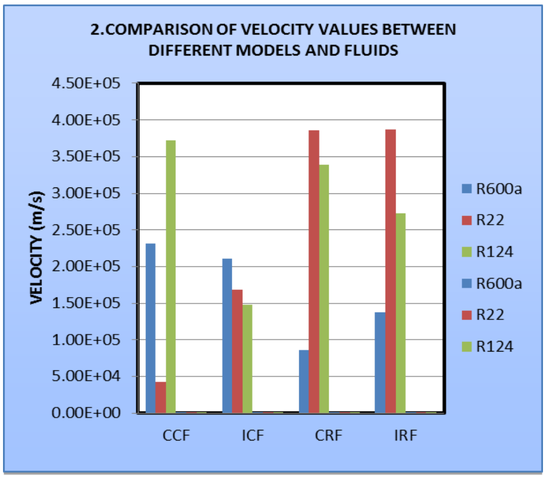
Fluids	Pressure(Pa)	Velocity(m/s)	Heat transfer coefficient (W/m2-k)	Mass flow rate (Kg/s)	Heat transfer rate(W)
R600A	2.11E+05	1.48E+01	2.10E+03	0.00149796	60.19922
R22	1.68E+05	2.51E+01	1.13E+04	0.06440138	644.998
R124	1.48E+05	2.22E+01	9.19E+03	0.06386219	596.0332

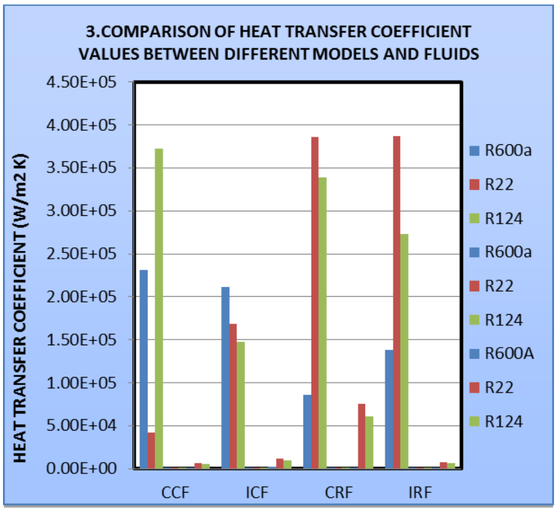
4. Continuous circular fin with tube

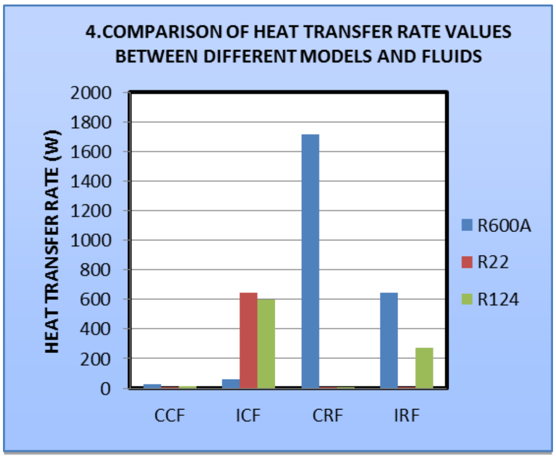
Fluids	Pressure(Pa)	Velocity(m/s)	Heat transfer coefficient (W/m2-k)	Mass flow rate (Kg/s)	Heat transfer rate(W)
R600A	2.31E+05	1.54E+01	1.30E+03	0.00071612	29.3475
R22	4.21E+04	2.81E+01	6.98E+03	0.00015122	3.193359
R124	3.72E+05	2.48E+01	5.69E+03	0.00072595	13.7207

VI GRAPHS









VII THERMAL ANALYSIS RESULT TABLE

FLUID – R22

MODELS	TEMPERATURE(K)		HEAT FLUX (W/m2)
	Min.	Max.	
Interrupted Rectangle	281	273.65	4.38E+05
Continuous Rectangle	281	273.65	4.38E+05
Interrupted Circular	281	278.95	1.21E+05
Continuous Circular	281	275.15	3.95E+05

VIII CONCLUSION

By observing CFD analysis results, the pressure drop, velocity heat transfer coefficient and heat transfer rate are more for continuous rectangular fin. By comparing the results between refrigerants, pressure drop, heat transfer coefficient is more when R22 is used, and heat transfer rate is more when R600A is used. Thermal analysis is done on the evaporator using R22, which has got more heat transfer coefficient in CFD analysis by considering Aluminum alloy for fins and Copper for tubes. By observing the heat flux values, the values are more for continuous rectangular fin. So heat transfer rate is more for continuous rectangular fin. So it can be concluded that using refrigerant R22 for rectangular continuous fin is better.

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