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Cfd and Thermal Invistigation of Fin Tube Evaporator by Shape Optimyzation Process

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ABSTRACT

An evaporator is used 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 absorbing heat in the process. It can also be used to remove water or other liquids from mixtures. The process of evaporation is widely used 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 thesis, different shapes of fins in fin tube evaporator are modeled in 3D modeling software Catia. The fins considered are continuous rectangular fin, interrupted rectangular fin, continuous circular fin, interrupted circular fin and tapered shaped 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, R32 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.

INTRODUCTION

An air conditioner (often referred to as AC) is a homeappliance, system, or mechanism designed to dehumidify and extract heat from an area. The cooling is done using a simple refrigerationcycle. In construction, a complete system of heating, ventilation and air conditioning is referred to as "HVAC". Its purpose, in a building or an automobile, is to provide comfort during either hot or cold weather.

In the refrigeration cycle, a heat pump transfers heat from a lower-temperature heat source into a higher-temperature heat sink. Heat would naturally flow in the opposite direction. This is the most common type of air conditioning. A refrigerator works in much the same way, as it pumps the heat out of the interior and into the room in which it stands.This cycle takes advantage of the way phase changes work, where latent heat is released at a constant temperature during a liquid/gas phase change, and where varying the pressure of a pure substance also varies its condensation/boiling point.

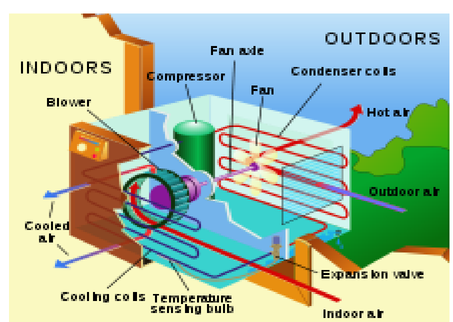

Fig. A typical home air conditioning unit.

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A simple stylized diagram of the refrigeration cycle: 1) condensing coil, 2) expansion valve, 3) evaporator coil, 4) compressor.

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The most common refrigeration cycle uses 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. Since 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 pump a refrigerant around. A refrigerant is pumped into the evaporator coil, located in the compartment to be cooled, where the low pressure 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 a liquid, thus rejecting the heat previously absorbed from the cooled space.

By placing the condenser (where the heat is rejected) inside a compartment, and the evaporator (which absorbs heat) in the ambient environment (such as outside), or merely running a normal air conditioner's refrigerant in the opposite direction, the overall effect is the opposite, and the compartment is heated. This is usually called a heat pump, and is capable of heating a home to comfortable temperatures (25 °C; 70 °F), even when the outside air is below the freezing point of water (0 °C; 32 °F).

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

LITERATURE SURVEY

1. **Parametric Optimization of Fin-Tube Type Evaporator Using FEA-DOE Hybrid Modeling.**
   An Evaporator is the Main component of Air-conditioning system. An evaporator is mainly used in different refrigeration and air-conditioning applications in food and beverage industry, in the pharmaceutical industry etc. An evaporator in air conditioning system is used to evaporate liquid and convert in to vapour while absorbing heat in the processes, this paper 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.
2. **Thermal and CFD Analysis of Fin Tube Evaporator with Different Configurations, Materials and Fluids.**
   An evaporator is used in an air-conditioning system or refrigeration system to allow a compressed cooling chemical, such as Freon or R-22, to

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evaporate from liquid to gas while absorbing heat in the process. It can also be used to remove water or other liquids from mixtures. The process of evaporation is widely used 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 thesis, different configurations of fin tube evaporator are modeled in 3D modeling software Catia. 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.

3. **Parametric Study of Plain Fin and Tube Evaporator Using CO_2 as A Refrigerant.**

At the turn of the century, annual fluorocarbon refrigerant emissions from mobile and unitary airconditioningequipments is likely to pass 100,000 metric tonnes, corresponding to a global warming impact of more than 150 million metric tonnes of CO_2 . Even larger indirect CO_2 emissions result from the generation of power to drive the systems. With its use of a non-flammable and non-toxic natural fluid, the transcritical CO_2 system is a primary candidate for next-generation air-conditioning systems. This motivated the authors to design a CO_2 air-conditioning system. In this paper, the authors present Effectiveness-NTU method of thermal design of a plain-fin and tube evaporator for CO_2airconditioning system. Using Engineering Equation Solver, the authors have proposed an optimum design of the CO_2 evaporator by parametric optimization. Generally CO_2 heat exchangers are designed for high refrigerant mass flux and use small-diameter tubes or extruded flat micro-channel tubes. The designed plain-fin and tube evaporator uses 3/16” OD tubes giving near-mini channel effect. Achieving sufficient compactness of $787 m^2/m^3$ this evaporator is capable of giving 2.2 kW of cooling effect. For CO_2, refrigerant-side heat transfer coefficients are higher than with fluorocarbons, and reduced internal surface areas can therefore be tolerated. In current design, the authors achieved around 7,500 W/m2 -K of CO_2 heat transfer coefficient.

4. ENHANCED FINNED-TUBE CONDENSER DESIGN AND OPTIMIZATION

Finned-tube heat exchangers are widely used in space conditioning systems, as well as any other applications requiring heat exchange between liquids and gases. Their most widespread use is in residential air conditioning systems. Residential systems dictate peak demand on the U.S. national grid, which occurs on hot summer afternoons, and thereby sets the expensive infrastructure requirement of the nation’s power plant and electrical distribution system. In addition to peak demand, residential air conditioners are major energy users that dominate residential electrical costs and environmental impact.

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5. DESIGN ANALYSIS OF A FINNED-TUBE CONDENSER FOR A RESIDENTIAL AIR-CONDITIONER USING R-22.

The purpose of this study was to develop an optimization methodology and software for the detailed design of a finned-tube condenser heat exchanger coil in a residential air-conditioning unit using the Engineering Equation Solver (EES) software. The superheat, saturated, and subcool portions of the heat exchanger have been modeled separately and in detail using appropriate pressure drop and heat transfer fundamental equations for both the air-side and refrigerant-side of the heat exchangers. The study uses accurate refrigerant property data for R-22, but can easily be modified to accommodate other refrigerants. The cooling output and electrical input for the compressor and fans have been calculated for various ambient temperature conditions. The compressor, condenser fan, and evaporator components of the cycle are also modeled but in a more global manner using thermal science laws. Ambient temperature weighting factors used by the U.S. Department of Energy are used to determine the seasonal coefficient of performance (COP) of the system.

6. Improving the Heat Transfer Rate for Ac Condenser by Material and Parametric Design Optimization

Air conditioning systems have condenser that removes unwanted heat from the refrigerant and transfers that heat outdoors. The primary component of a condenser is typically the condenser coil, through which the refrigerant flows. Since, the AC condenser coil contains refrigerant that absorbs heat from the surrounding air, the refrigerant temperature must be higher than the air. In my paper I have designed an air-cooled Condenser for an air conditioner. Presently the material used for coils is Copper and the material used for Fins is Copper or aluminum G Al Cu 4IMG 204 whose thermal conductivity is 110-150W/m K. A 3D model of the condenser is done in parametric software Catia. To reduce the cost of condenser, we are optimizing the design parameters by changing the thickness of the fin for the same length without failing the load conditions. To validate the temperatures and other thermal quantities like flux and gradient, thermal analysis is done on the condenser by applying copper for coil and Fin materials G Al Cu 4IMG 204, Aluminum Alloy Al99 and Magnesium alloy. Thermal analysis is done in Cosmos works. And also we are varying inside cooling fluid Hydrocarbon (HC) and Hydrochloroflourocarbon (HCFC).The best material and best fluid for the condenser of our design can be checked by comparing the results. Optimization is done by changing the thickness of the fin.Catia is a parametric 3D modeling software and Cosmos works is analysis software.

CFD ANALYSIS OF FIN TUBE EVAPORATOR BY VARYING DIFFERENT PARAMETERS

EVAPORATOR- INTERRUPTED RECTANGULAR FIN WITH TUBE FLUID- R32

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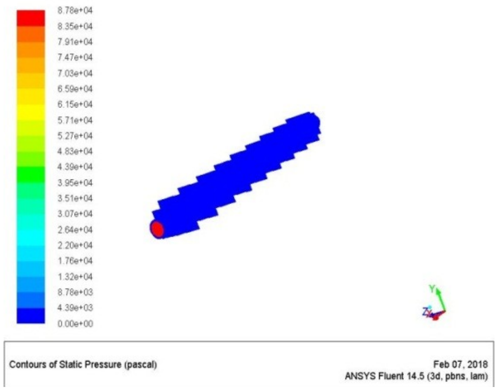
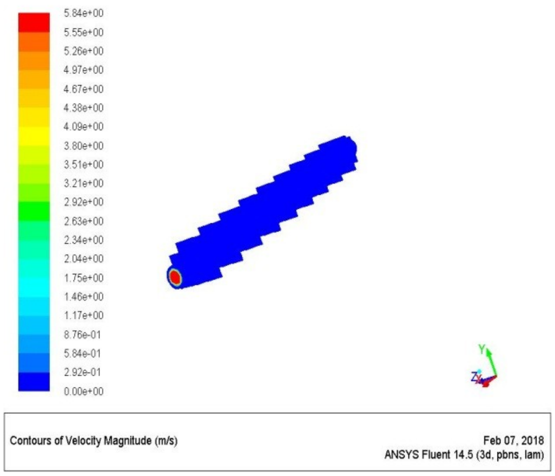
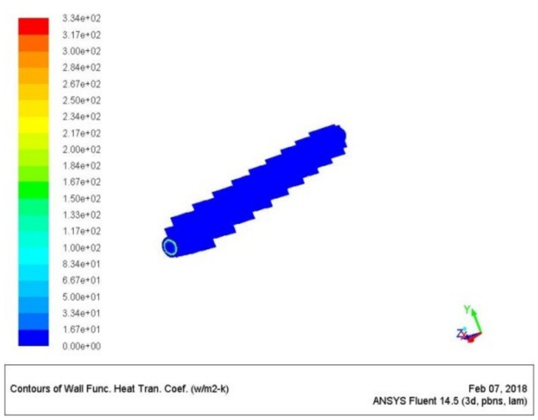


Pressure

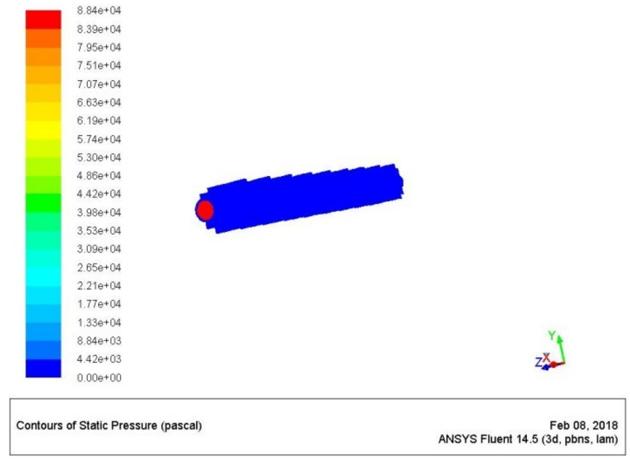


Velocity



Heat transfer co-efficient

FLUID- R600A



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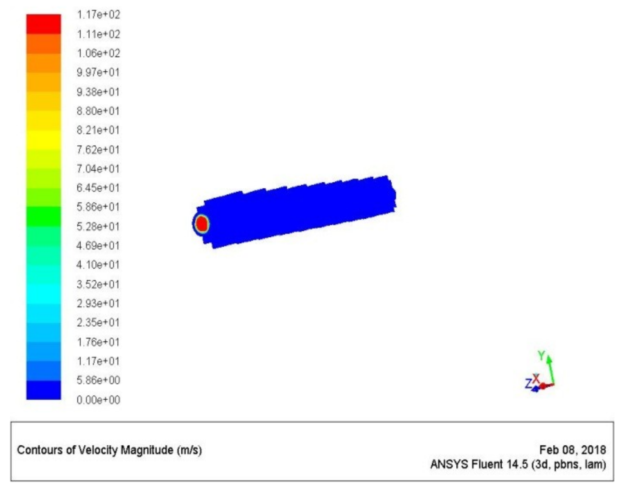

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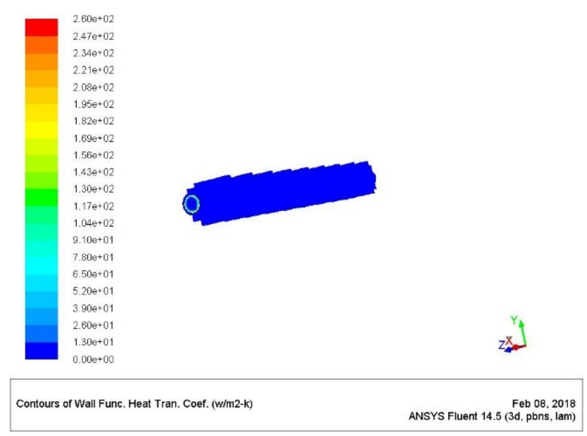

Heat transfer co-efficient

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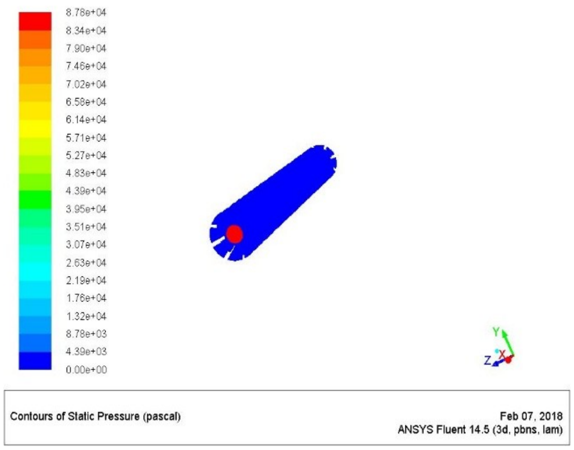
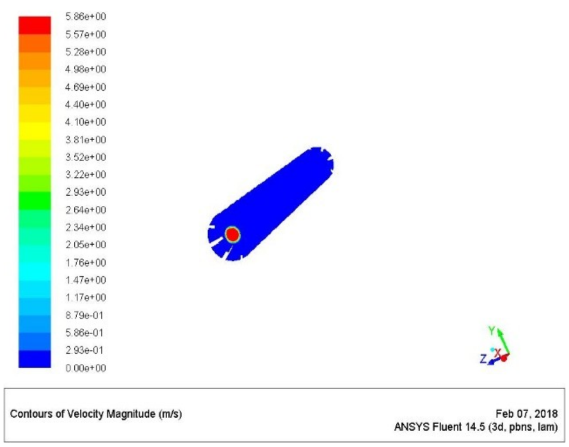
EVAPORATOR- TAPERED FIN WITH TUBE

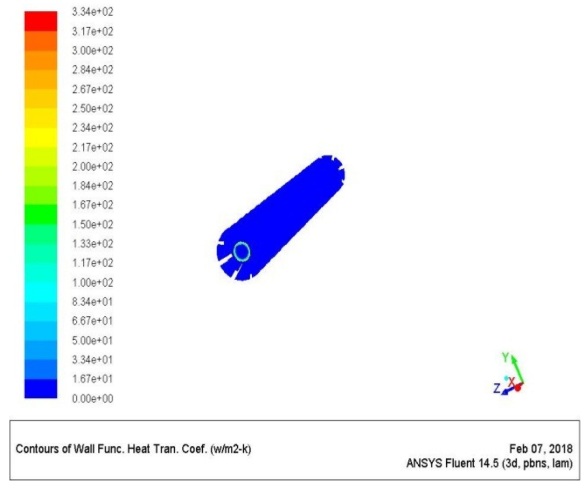
FLUID- R32



Pressure

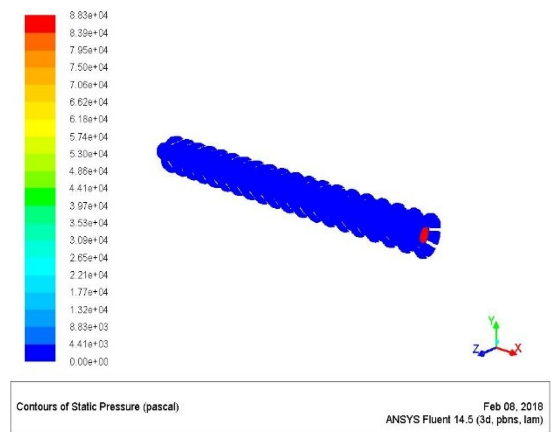


Velocity

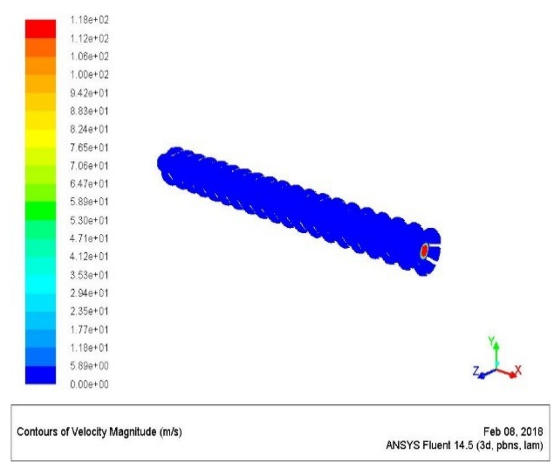


Heat transfer co-efficient

FLUID- R600A



Pressure



Velocity

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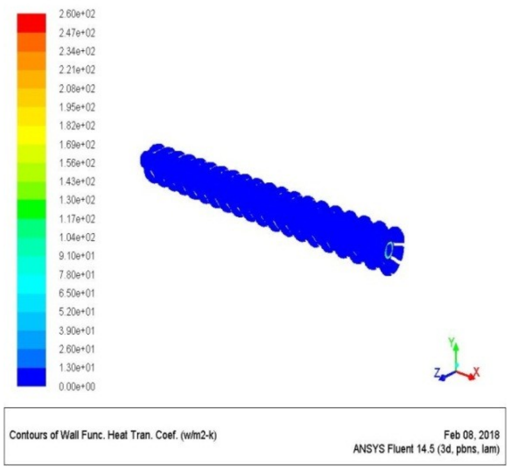
Heat transfer co-efficient



RESULTS TABLE

CFD ANALYSIS RESULTS TABLE

CONTINOUS CIRCULAR 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)
R32	8.79E+04	5.84E+00	3.34E+02	0.000951886	30.808811
R600A	8.83E+04	1.17E+02	2.60E+02	1.8338673E-05	0.67467668

INTRRUPTED CIRCULAR 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)
R32	8.78E+04	5.84E+00	3.34E+02	0.00035411119	11.4246
R600A	8.84E+04	1.17E+02	2.60E+02	3.2730401E-05	1.1987013

CONTINOUS 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)
R32	8.78E+04	5.84E+00	3.34E+02	0.00038058	12.309705

R600A	8.79E+04	5.84E+00	2.60E+02	0.00035766	11.577767

INTRRUPTED 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)**
R32	8.78E+04	5.84E+00	3.34E+02	0.0003489	11.295508
R600A	8.84E+04	1.17E+02	2.60E+02	4.0451996E-05	1.4741295

TAPER SHAPED 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)**
R32	8.78E+04	5.86E+00	3.34E+02	0.00018304586	5.9156316
R600A	8.83E+04	1.18E+02	2.60E+02	1.4774501E-05	0.54040268

CONCLUSION

In this thesis, different shapes of fins in fin tube evaporator are modeled in 3D modeling software Catia. The fins considered are continuous rectangular fin, interrupted rectangular fin, continuous circular fin, interrupted circular fin and tapered fin.
CFD analysis is done by varying fluids R600A, R32 on all the models. By observing CFD analysis results, the pressure drop is more for tapered shape fin and even for continuous circular fin, heat transfer coefficient is more for continuous circular fin and mass flow rate and even heat transfer rate are more for continuous circular fin. By comparing the results between refrigerants, pressure drop is more when R32 is used and even heat transfer coefficient and heat transfer rate are more when R32 is used.

So it can be concluded that using refrigerant R32 for circular continuous fin is better.

REFERENCES

[1] CFD analysis of tube-fin 'no-frost' evaporators by Jader R. Barbosa, Jr.; Christian J. L. Hermes; CláudioMelo

[2] Numerical Modeling and Experimentation on Evaporator Coils for Refrigeration in Dry and Frosting Operational Conditions by ZineAidoun, Mohamed Ouzzane and AdlaneBendaoud

[3] FEA of fin tube evaporator by Kiran B. Parikh, Diptesh R. Patel, Sapna A. Solanki,

International Journal of Advanced Engineering Research and Studies, E-ISSN2249–8974

[4] Analysis of Fin-and-Tube Evaporators in No-Frost Domestic Refrigerators by Carles OLIET, Carlos D. PEREZ-SEGARRA, Joaquim RIGOLA, Assensi, International Refrigeration and Air Conditioning Conference

[5] Heat Transfer Analysis of Room-Temperature Finned-Tube Evaporator for Cryogenic Nitrogen by Shun Ching Lee and Tzu-Min Chen, J. Heat Transfer 133(9), 091502 (Aug 01, 2011) (9 pages) doi:10.1115/1.4003924

[6] Performance of a finned-tube evaporator optimized for different refrigerants and its effect on system efficiency by Piotr A. Domanski, David Yashar, Minsung Kim, International Journal of Refrigeration 28 (2005) 820–827

[7] An Optimized Design of Finned-Tube Evaporators Using the Learnable Evolution Model by Piotr A. Domanskia, David Yashara, Kenneth A. Kaufmanb&Ryszard S. Michalskibc, DOI:10.1080/10789669.2004.10391099

[8] Thermoeconomic optimization for a finned-tube evaporator configuration of a roof-top bus air-conditioning system by M. Khamis Mansour, Md Nor Musa and Mat Nawi Wan Hassan, International Journal of Energy Research, Vol 32, Issue 4

[9] Parametric Study of Plain Fin and Tube Evaporator Using CO_2 as A Refrigerant by Ashish D. Kadam, Dr. Atul S. Padalkar, Avadhoot V. Wale, International Journal of Engineering Research and Development, e-ISSN: 2278-067X, p-ISSN: 2278-800X, Volume 3, Issue 2 (August 2012), PP. 59-69

[10] Evaluation of a Refrigerant R410A as Substitute for R22 in Window Air-conditioner by S. S. Jadhav, K. V. Mali, 5th International Conference on Sustainable Energy and Environment (SEE 2014): Science, Technology and Innovation for ASEAN Green Growth 19-21 November 2014.