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EFFECT ON GEOMETRY OF EVAPORATOR COIL FOR REFRIGERATOR ENHANCING EFFICIENCY OF HEAT TRANSFER- AS A REVIEW

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ABSTRACT

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. For this research work, the effort is to identify the effect of geometry for the evaporator coil over the performance of the refrigerator. Typically, the cross section of the tube and the method of fitment e.g.-grooved construction, over the evaporator shall be studied using methodology. The results using CFD methodology shall be validate using representative miniature prototype for demonstration for the enhancement. The evaporator is one of the four basic and necessary hardware components of the air conditioning system, drop in pressure, heat transfer, evaporation rate and the important thing is efficiency of evaporator, all these things are improve by considering optimum parameter of evaporator, this optimum parameter of evaporator will generate with the help of experimental data and CFD analysis.

KEY WORDS: *Cross-section, Refrigerators, Pro-E, Optimization*

I. INTRODUCTION

Refrigeration is an enabling technology in a wide range of applications from air conditioning for occupant comfort to freezing gas required in food preservation. Evaporators are the critical component responsible for extracting heat from conditioned spaces or processes. The focus of this paper is on evaporators that cool air to temperatures below the freezing point of water. When an air-cooling evaporator operates at a temperature below the freezing point with a coincident entering air dew point temperature that is above the evaporator coil temperature, frost form on the evaporator coil. In the evaporator, the refrigerant is evaporated by the heat transferred from the source of heat, which may be a gas or liquid. In evaporation, the temperature of refrigerant is constant, where pressure not changes. This low refrigerant temperature is attained as a result of the reduction in pressure caused by the compressor. When the compressor is started and pressure minimizes, the equilibrium between vapour and liquid in the evaporator is changed. To regain equilibrium condition, where large vapour is formed through evaporation of liquid. The evaporator is one of our basic and necessary hard-ware components of the air conditioning system. Drop in pressure, evaporation rate, heat transfer rate and the efficiency of evaporator, all these things are improve by considering optimum parameter of evaporator, this evaporator optimum parameter are generated with the help of experimental data and computational fluid dynamics. From the equations of fluid mechanics over a century are solvable only or a limited number of flows. The known solutions are extremely useful in understanding fluid flow but rarely used directly in engineering analysis. By CFD we evaluate pressure, temperature, velocity of fluid flow through out a solution, by design to optimize the prototype phase.

II. LITERATURE REVIEW

MAN-HOE KIM et al, Presented paper on thermal Performance of a Compact Evaporator Coil in Household Refrigerator-Freezers **[1].** A high-efficiency evaporator coil, which is keep horizontally between refrigerator and freezer surface, for domestic auto-defrost refrigerator was developed. Some experiments were performed for find the thermal performance of the recent compact evaporator coil in a auto-defrost refrigerator. And the results are compared with those of the conventional evaporator.
MARTIN RYHL KAEN et al (2011), Presented paper on analysis of flow misdistribution in fin-and tube evaporators for residential air-conditioning systems **[2]**. This thesis is concerned with the effects of flow misdistribution in fin-tube. Coil evaporators for residential air-conditioning and compensation potentials with regards to performance. The aim is to create a good understanding of flow misdistribution. However, the study to find out the individual and combined effects of non-uniform inlet liquid or vapor distribution, number of feeder tube bending and non-uniform flow rate of air.
CARLES OLIET et al (2010), Presented paper on analysis of Fin-and-Tube Evaporators in No-Frost Domestic Refrigerators **[3].** This paper contains the research work carried out by the authors on refrigerator no-frost condition of evaporator. It includes an explanation of the experimental unit that is currently being constructed to test. The first preliminary experimental results using single-phase coolants are then given together with their numerical counterparts. Mathematical results are presented in detail in order to both complementing the experimental information obtained and to show its potential as an analysis and design tool.
A. D. SOMMERS et al, Presented paper on air-side heat transfer enhancement of a refrigerator evaporator using vortex generation **[4].** In most domestic and commercial refrigeration systems, Formation of frost on the air-side surface of the air-to-refrigerant heat exchanger. The frost-tolerant designs typically employ a large fin spacing in order to delay the need for a defrost cycle. Due to some problem, this approach does not allow for a very high air-side heat transfer coefficient, The performance of these heat exchangers is often air-side limited. Vortex generation is a proven and effective technique for thinning the thermal boundary layer and enhancing transfer of heat, but its efficacy in a frosting environment is essentially unknown.
S.A. KLEIN et al. Presented paper on experimental investigation of the performance of industrial evaporator coils operating under frosting conditions **[5].** This paper shows a field experimental solution of the effects of frost formation on the performance of a low temperature large evaporator coil used in industrial refrigeration systems. A number of experiments were conducted to determine the coil cooling rate of the evaporator over time as frost builds on its surfaces. Measured quantities include inlet and outlet air temperatures, relative humidity of inlet and outlet air, volume flow rate of air. These measurements provide a baseline set of experimental data that can be used to validate numerical models of industrial evaporators operating under frosting conditions.
BRAU J. E. et al. Presented paper on hybrid method for refrigerant flow balancing in multi-circuit evaporator**[6].** Hybrid approach for providing control of refrigerant flow distribution in evaporators that contain the use of small balancing valves for each circuit along with a primary expansion device to control the overall superheat from the evaporator. However, the companion paper demonstrated that the flow balancing valves should be located upstream rather than downstream of the evaporator in order to realize good benefits. This paper utilizes the model presented in the companion paper to more fully evaluate the effects of uneven air and refrigerant flow distributions and the benefits of upstream hybrid control in response to these effects.
N. Austin et al. said that the experiment was performed on the domestic refrigerator purchased from the market, the components of the refrigerator was not changed or modified. This indicates the possibility of using mixed refrigerant as an alternative of HFC-134a in the existing refrigerator system. The COP of the domestic refrigerator using R-134a as a refrigerant was considered as benchmark and the COP of mixed refrigerant compared. From this experimental investigation carried out to determine the performance of a domestic refrigerator when a propane/butane mixture is used as a possible replacement to the traditional refrigerant R134a.

Sven Wellsandt Said that experimental part of project has existing facility was used which has been constructed over several years to make controlled investigation of horizontal evaporator tubes possible. At this facility the test section has to be modified to enable the global measurements for the two tubes and closely resemble conditions in a large scale evaporator.

2.1. Concluding Remark from Literature Review

From study of above research paper following concluding remark is drawn that Thermal performance of evaporator depend upon:

•Air flow rate from the evaporator coil
•Refrigerant circuitry of the evaporator coil
•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.

2.2. Problem Definition:

While attempts are being made by researchers over the material for refrigerant and for improving the physical components for each stage of refrigeration cycle, this work intends to pursue the evaluation of the generic con-figuration of the evaporator in terms of the type of cross section, pitch between tubes and presence of fins. The effect on the rate of heat transfer shall be evaluated for each configuration. The parameters to be constant through the exercise are identified as material of the coil ambient temperature, mass flow rate of refrigerant.

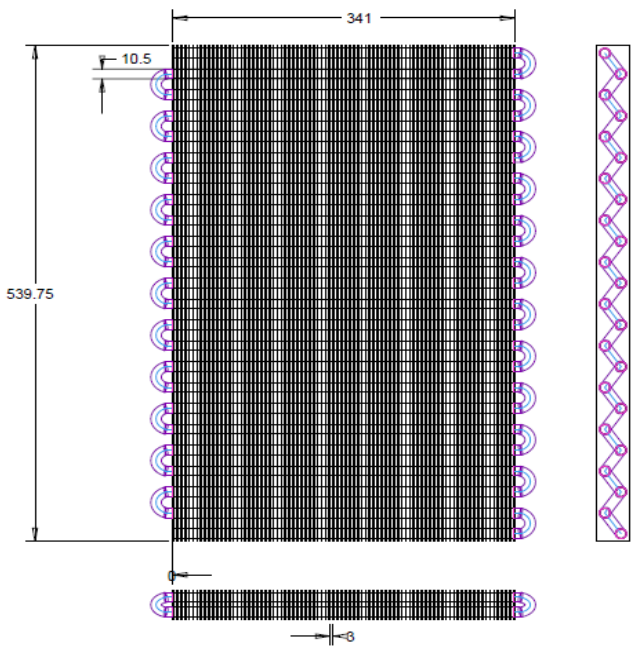

Fig -1: Drawing of fin tube Evaporator

III. TRANSIENT CONDITION OF FIN TUBE AND MICROCHANNEL 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. Constants for mechanical strength and esthetics and maintenance need to be considered for final proposal and should be the outline for development of the prototype.Fig.2 shows the graph of transient behaviour of fin tube evaporator and microchannel evaporator.

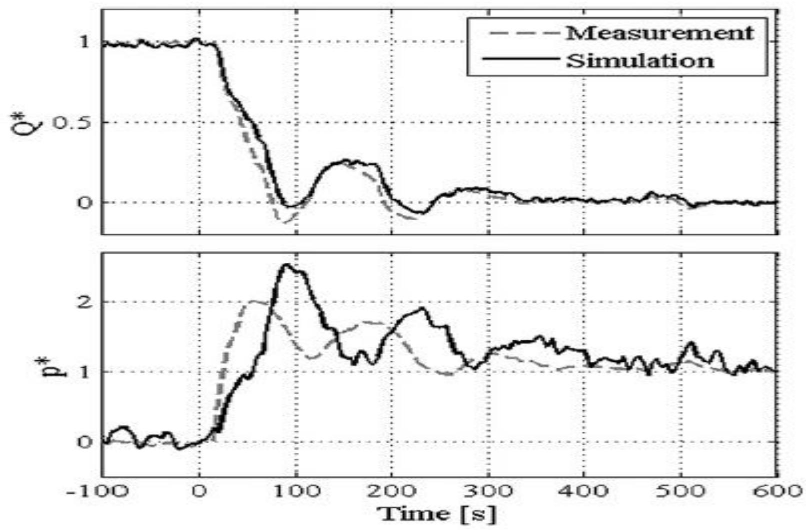

Fig -2: Transient Behaviour of fin tube Evaporator[16]

To compare the transient behavior in simulation and experiment, data shown in Fig.2 and 3 have was study with the steady states values of the simulation. Fig. 3 shows the data for the microchannel evaporator, Fig. 2 shows the fin-and-tube geometry. The upper diagrams show the normalized transferred heat, the lower the evaporation pressure.

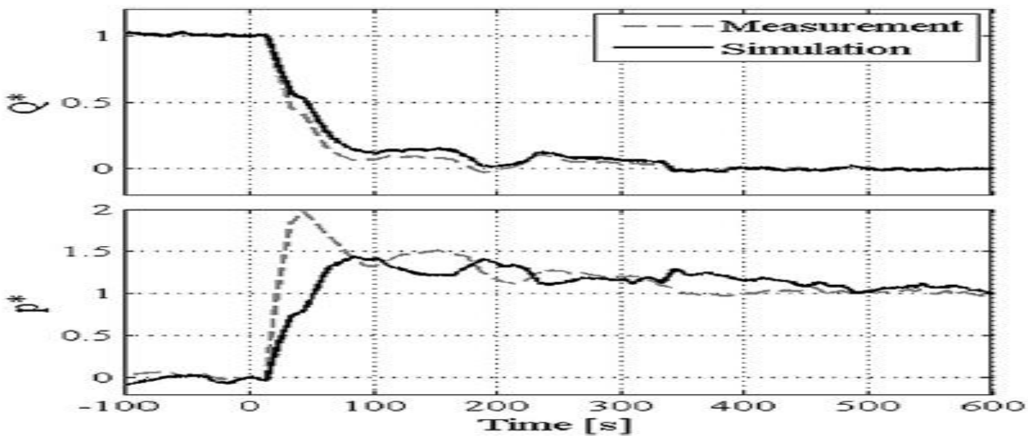

Fig -3: Transient Behaviour of Microchannel evaporator[16]

3.1. Validation

The inputs are typically secured from the mathematical treatment of the data are further used for comprising or evolving the analytical model. The results offered by CFD analysis as a methodology shall be compared with the physical experiment.

IV. CONCLUSIONS

In this way we are concluded that instead of change in refrigerant, by inserting inserts in to evaporator tube and using different type of fins we can get better results by using different cross-section of evaporator tube and find the optimum cross section and geometry of tube that will give the high heat transfer rate and it will improve COP of refrigerator.

Transient behaviour of fin tube evaporator is not stable as compared to the microchannel evaporator and behaviour of pressure also fluctuate more in fin tube evaporator as compared to the microchannel evaporator.

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