An Experimental Analysis of Heat Transfer through Spiral Coil Condenser in Domestic Refrigerator-A Review

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Abstract - The present study deals with Experimental Analysis of Heat Transfer through Spiral Coil Condenser in Domestic Refrigerator. An experimental setup was built for carrying out the outside heat transfer coefficient under natural (free) convection. The experimental setup was developed with domestic refrigerator of 165 liters capacity. Spiral coil condensers used in this experiment. The main objective of this investigation was to obtain outside heat transfer coefficient of existing condenser as well as that of spiral coil condenser. A comparative analysis based on the experiments has been done. The effect of coil was investigated and the results show that outside heat transfer coefficient increases as surface area unit volume increases

Keywords: Heat Transfer coefficient, Spiral Coil Condenser, domestic refrigerator, natural (free) convection.

I. INTRODUCTION

Domestic refrigerators are widely used home appliance for refrigeration and freezing of food. A domestic refrigerator works on vapour compression refrigeration system. This system consists of four basis parts i.e. compressor, condenser, expansion device and evaporator. The system is divided in to two parts i.e., after expansion device to the inlet of compressor it is known as low pressure system and after compressor to inlet of expansion device it known as high pressure system. Evaporator is a device for extracting heat from the refrigerator compartment with evaporation of the liquid refrigerant. In this process the refrigerant changes its phases from liquid to vapour. The refrigerator is designed for a certain evaporation capacity and evaporating temperature. This can be controlled by keeping the pressure of the evaporator to a predefined value. Similarly the condenser is used for rejecting the heat absorbed by the refrigerant in the evaporator to a sink, which is generally ambient air. For rejecting the heat to the environment it is necessary that the temperature of the refrigerant remains higher than atmospheric air. This is also maintained by keeping the high side pressure to the saturation pressure to the temperature to be maintained. In this process the refrigerant changes its phases from vapour to liquid again. The compressor is used to rise the pressure of the system from a low to high value by consuming electrical work. During the process the temperature of the refrigerant increases isentropically. For the cycle to complete, it is required that the temperature of the refrigerant is again brought to its initial value i.e. to evaporator temperature, and this is done by expanding the refrigerant iso- enthalpyally with the help of a capillary ore some kind of expansion value. In doing so some refrigerant is converted from liquid phase to vapour (Body, 10pt, Normal)

II. PREVIOUS WORK

This chapter present the review of research work done on various condenser coil heat exchanger.

Jader et al. (1) investigated experimentally air side thermal hydraulic performance spiral wire and tube condenser. The inspection of out-side thermal conductance and pressure drop were carried out for air flow rate, from 70 to 220 m3/h. largest value of pressure drop is for which have less radial spacing, since these give to smallest face area.

Naphon et al. (2) the heat transfer characteristics and performance of spiral coil condenser under cooling and dehumidifying conditions are investigated. Air and water used as working fluid Newton-Raphons iterative method used to heat transfer characteristics. The enthalpy effectiveness and humidity effectiveness decreases as the air and water mass flow rate increases. Air mass flow rate and in let air temperature have significant effect on the increase of the out let air and water temperature.

Ameen et al. (3) they investigated different kind of thermo physical properties. The exit of the compressor is superheated vapour that contains 3 tubes which have to be investigated.

Ohgaki et al. (4) investigated the air side heat transfer and pressure drop characteristic of spiral wire-on- tube condenser, he stated that spiral coil condenser has relatively larger heat transfer rate per unit volume s compare to existing one.

Bansal et al. (5) it was experimentally tasted a condenser in a real refrigerator for some operating conditions by using finite element method and variable conductance approach along with thermodynamics correlations. They optimized the condenser capacity per unit weight. Using variety of wire, tube pitches and diameter. The experiment is carried in closed door- experiment on the refrigerator pressure and mass flow rate and power consumption by the refrigerator.

Patil et al. (6) produce the double- pipe heat exchanger is to be used for many continuous systems having small to heavy work. However spiral coil heat exchanger better choice (a) where space is limited so that not straight pipe can be laid, (b) where the pressure drop of one fluid is limited, by setting the velocity of the annulus fluid in spiral coil heat exchanger at about 1m/s, pressure drop will be low.

Londons et al. (7) investigated the method of entropy generation and minimization. It was found that higher effectiveness heat exchanger has not necessarily that best thermal hydraulic design. It was also found that higher mass flow rate for the same pumping power reduces the condenser temperature and increase the evaporative temperature. It was also found that the heat exchanger design prevents the local performance in terms of minimum entropy generation leads to the global performance.

Hook et.al. (8) Analyzed the experimentally the thermal performance of single layer coil made from carbon. It was found that ±16.7% error in heat transfer coefficient; also conclude that angle of attack is important parameter for heat transfer coefficient increases two times as angle of attack is increases 0 to 20. It was found that as radial and longitudinal spacing is small heat transfer coefficient increases.

Bukasa et.al (9) reported that condensations heat transfer and pressure drop of three micro tube of 12.7 mm outside and three different angles 150C, 180C and 250C it was found that as the spiral angle increases heat transfer coefficient increases for different refrigerant. 150C is best for refrigerant R-12, 180C for refrigerant R-22 and 250C is for R-134a.

From a critical review of the literature on a spiral coil heat exchanger presented above, it is apparent that further studies are warranted to provide better understanding of comparative study of existing conventional condenser and spiral coil used in domestic refrigerator.

III. PROPOSED METHODOLOGY

Spiral coil condenser consists of soft copper tube, screw and aluminium plated fins. The spiral- coil condenser consists of a single layer of copper tube. A straight tube is constructed by the bending a 6 mm diameter straight copper tube into a spiral coil of three turns maintaining parallel to the central line. Each end of the spiral- coils is connected to the vertical manifold tube with compressor and expansion valve respectively. Painting outside of the tube so that the escape from the corrosion. The aluminium fins are welded to the surface of spiral coil.

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