Analysis of Performance of Plate Fin Heat Exchanger

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Abstract: Plate fin heat exchanger is a kind of smaller heat exchange device which has applications in cars, low temperatures, rockets space vehicles etc. The plate fin heat exchanger devices are mostly utilized for liquefaction of nitrogen. So that they are highly efficient because no liquid oxygen will be produced if the efficiency of the system is below the required value, and that is nearly 87%. That’s ‘why it is very necessary to check their efficiency before bringing them in actual application. This efficiency has been calculated here. The required heat exchanger has different shape and its effectiveness is tested experimentally in the heat and mass transfer lab. Experiment is carried out by putting the Quantity of hot and cold fluid same, but the result is obtained by taking different quantity of fluid for different experiment. It means that for one test quantity of both the fluid is taken same and this test is repeated for different quantity. So, in this way productiveness of the required exchanger is determined for different quantity.

Keywords: Plate fin heat exchanger, low temperatures, effectiveness, heat transfer coefficient, conduction and convection

I. INTRODUCTION

A heat exchanger is a device which is used to transfer heat from a very warm fluid to a cold fluid across a wall. Rate of heat transfer depends upon heat transfer coefficient of conduction and convection. Such type of relation was formulated by Newton and is known as Newton’s law of cooling, which is given as

\[ Q = h \times A \times \Delta T \] ..........................(1)

A. Plate Fin Heat Exchanger

Plate fin heat exchanger is a sort of smaller heat exchanger where the heat transfer area is increased by extended metal surface interface between two fluids.

Fig 1 indicates the detonate outlook on 2 layer of plate blade warmth interchanger.

II. OBJECTIVE OF STUDY

A. Design and fabrication of the test rig for plate fin heat exchanger.
B. To determine the thermal performance parameters like overall heat transfer coefficient, effectiveness and pressure drop of plate fin heat exchanger through hot testing under balanced flow condition.
C. To compare the experimentally obtained values of effectiveness, overall heat transfer coefficient with the values that are obtained from various correlations.
III. TEST APPARATUS

![Diagram of test apparatus]

- 1- Compressor
- 2- Control Volume
- 3- Pressure Taps
- 4.8- U- Tube manometer
- 5- Warmer
- 6- Test Section

T₁, T₂, T₃, T₄ are RTDs

IV. PROCEDURE FOR HOT TESTING

Experiment is done by using air as working substance. The apparatus is connected to a compressor which supplies the compressed air to the testing heat exchanger. This stream of air acts as cold stream. When this stream comes out, it is passed through a heater to heat this air. Then again this air is passed through the heat exchanger and acts as a hot fluid stream. Heat input given to the heater are controlled by two variacs. For measuring the pressure drop across the heat exchanger, pressure taps are fitted at the end of the heat exchanger and these taps are connected to a U-tube manometer by using tubes to measure the pressure drop across the heat exchanger. For measuring the flow rate of air Rotameter is used whereas to measure the mass flow rate of air Orificemeter is used. The apparatus is insulated properly to prevent any kind of heat loss from the heat exchanger. The flow rate of air is controlled by the control valve and the temperatures are recorded at the ends of the heat exchanger by using four RTD. Also the pressure drop across the heat exchanger and the room pressures were recorded. After that, the heat exchanger is allowed to function until the steady state is reached. After the attainment of steady state, different parameters like air flow rate, pressure drop and temperature is measured to calculate the rate of heat transfer, pressure drop and performance parameters like effectiveness, NTU and heat transfer coefficient.

V. EXPERIMENTAL DATA

The main aim of present work is to calculate the performance parameters like, effectiveness, overall heat transfer coefficient of the plate fin heat exchanger. Following data shows the experimentally observed data.

| Flow rate (lit/min) | P₁ (kg/cm²) | P₂ (kg/cm²) | Δhₑ (mm of Hg) | Δhₙ (mm of Hg) | T₁(°C) | T₂(°C) | T₃(°C) | T₄(°C) |
|-------------------|------------|------------|----------------|----------------|--------|--------|--------|--------|
| 300               | .080       | .060       | 9              | 6              | 41.240 | 86.340 | 95.20  | 46.150 |
| 400               | .140       | .120       | 15             | 12             | 37.350 | 86.020 | 95.120 | 42.010 |
| 500               | .20        | .170       | 25             | 22             | 38.930 | 88.490 | 96.120 | 43.110 |
| 550               | .240       | .200       | 30             | 26             | 39.820 | 88.830 | 96.660 | 43.480 |
| 588               | .280       | .240       | 31             | 27             | 40.410 | 88.450 | 96.200 | 43.990 |
| 650               | .320       | .260       | 40             | 35             | 41.160 | 87.860 | 96.120 | 44.170 |
| 300               | .080       | .060       | 8              | 6              | 40.920 | 62.060 | 66.480 | 43.060 |
| 400               | .135       | .100       | 16             | 14             | 42.770 | 62.900 | 66.430 | 44.560 |
| 500               | .20        | .160       | 24             | 22             | 39.570 | 62.520 | 66.020 | 41.690 |
| 600               | .280       | .230       | 31             | 30             | 39.940 | 62.440 | 65.980 | 41.730 |
| 650               | .340       | .280       | 37             | 34             | 42.720 | 62.770 | 66.340 | 44.060 |
VI. CONCLUSIONS

Thermal performance parameter which are found for plate fin heat exchanger at distinctive mass flow rates and two distinctive very hot inlet temp of 96 & 66. a very. A mean effectiveness of 91% is produced. When the mass flow rate is increased, effectiveness is also increased. It is observed that experimental results are in agreement within 4% of the different correlations. Experimental results may be more close to the theoretical results if the losses in pipes and manufacturing defect are taken into account.

VII. SCOPE OF FUTURE STUDIES

Current testing is based on room temperatures. Later it can be performed at low temperatures for low temp. applications. For this experiment air will be taken at 100 K as cold fluid.

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