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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

$$Q = h \times A \times \Delta T \text{……..(1)}$$

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.

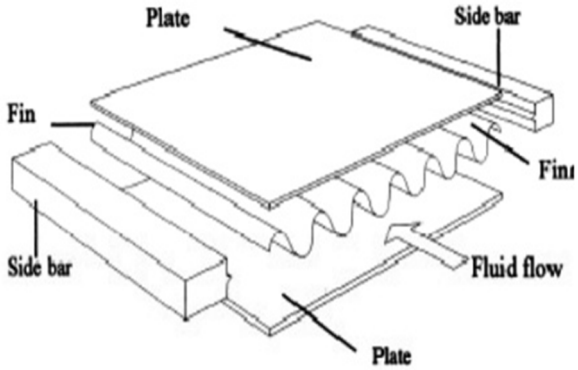


Fig 1 indicates the detonate outlook on 2 layer of plate blade warmth interchanger.

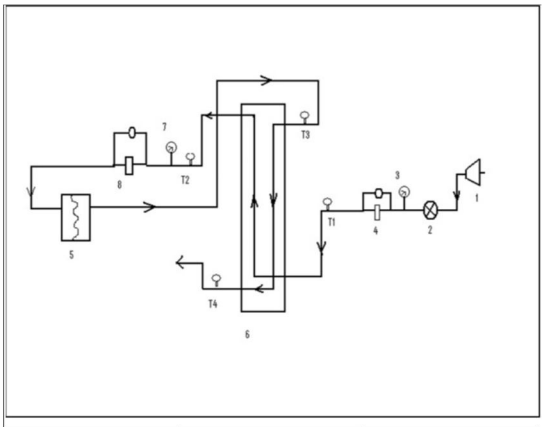
II. OBJECTIVE OF STUDY

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 effectivenes , overall heat transfer coefficient with the values that are obtained from various correlations.

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III. TEST APPARATUS



1- Compressor	2- Control Volume	3,7 – Pressure Taps
4,8 – U- Tube manometer	5- Warmther	6- Test Section
T_1, T_2, T_3, T_4 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 het exchanger is allowed to function until the steady state is reached. After the attainment of steady state, different parameters like air flow rate , pressure drof 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.

Table 1. Experimental data.

Flow rate (lit/min)	P_1 (kg/cm^2)	P_2 (kg/cm^2)	Δh_c (mm of Hg)	Δh_h (mm of Hg)	T_1(^{0}C)	T_2(^{0}C)	T_3(^{0}C)	T_4(^{0}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	0.240	0.200	30	26	39.820	88.830	96.660	43.480
588	0.280	0.240	31	27	40.410	88.450	96.200	43.990
650	0.320	0.260	40	35	41.160	87.860	95.950	44.170
300	0.080	0.060	8	6	40.920	62.060	66.480	43.060
400	0.135	0.100	16	14	42.770	62.900	66.430	44.560
500	0.20	0.160	24	22	39.570	62.520	66.020	41.690
600	0.280	0.230	31	30	39.940	62.440	65.980	41.730
650	0.340	0.280	37	34	42.720	62.770	66.340	44.060

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Table 2
Performance Parameters of Heat Exchanger

Flow rate (lit/min)	Mass flow rate(kg/s)	ϵ_h	ϵ_c	NTU	UA_0 W/K	Re_h	Re_c	ΔT (hot end)	ΔT (cold end)
300	0.0057	89.902	83.749	13.64	80.95	298.67	199.72	8.73	5.87
400	0.0074	90.236	85.90	15.24	117.37	416.04	278.22	7.97	5.53
500	0.0103	91.134	86.92	15.00	160.89	542.44	362.75	7.44	5.05
550	0.0116	92.08	86.365	16.24	196.09	610.9	406.46	7.72	4.53
588	0.0127	92.001	86.247	15.70	207.64	668.83	445	7.64	4.45
650	0.0142	92.786	85.371	17.49	258.57	747.83	497.56	7.98	3.94
300	0.0057	88.108	83.064	11.76	69.74	280.24	186.48	4.3	3.02
400	0.0078	89.937	85.480	13.25	107.6	419.28	277.56	3.36	2.33
500	0.0101	88.48	86.814	9.790	102.89	491.54	399.77	3.48	3.04
600	0.011	90.004	86.597	11.28	135.41	702.63	465.13	3.46	2.58
650	0.014	90.572	85.114	12.00	174.87	789.66	525.48	3.49	2.21

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.

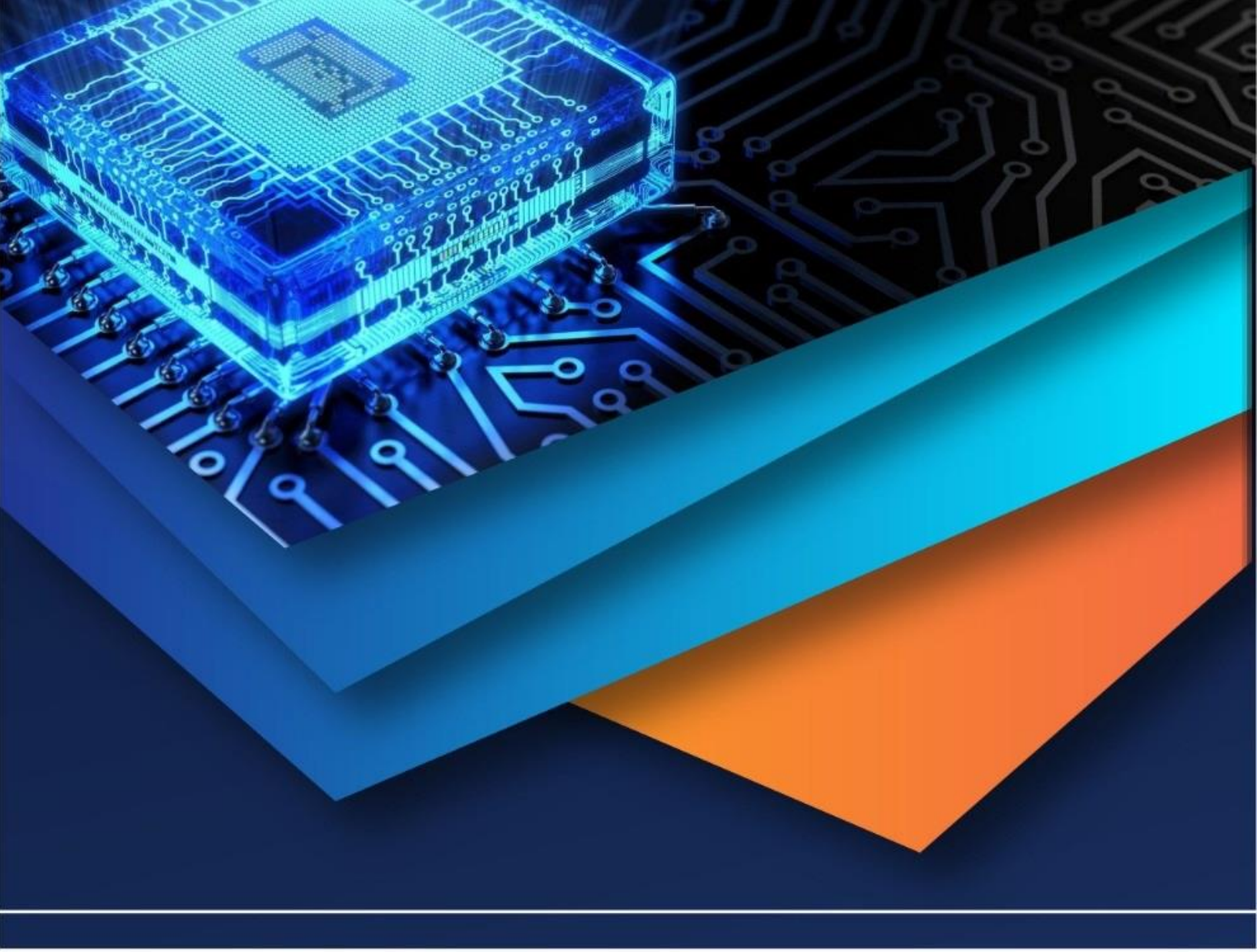
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