iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VIII **Month of publication:** August 2021

DOI: https://doi.org/10.22214/ijraset.2021.37298

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

Analysis of Performance of Plate Fin Heat Exchanger

Ajai Kumar Verma[1], Nausad Khan[2]
[1]M.Tech Scholar of Mechanical Engg. at FCEM , Faridabad
[2]Asst. Professer, Deptt Of Mechanical Engg. at FCEM , Faridabad

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

$$Q = h \times A \times \Delta T \qquad (1)$$

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.

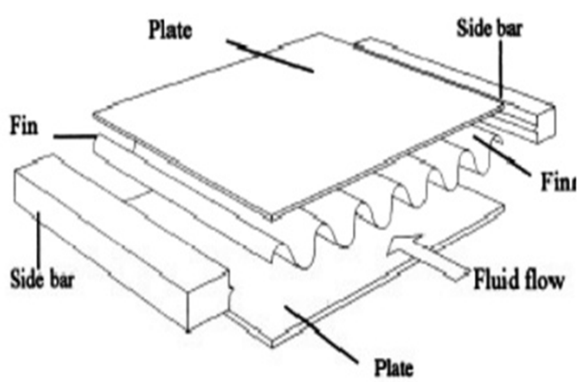


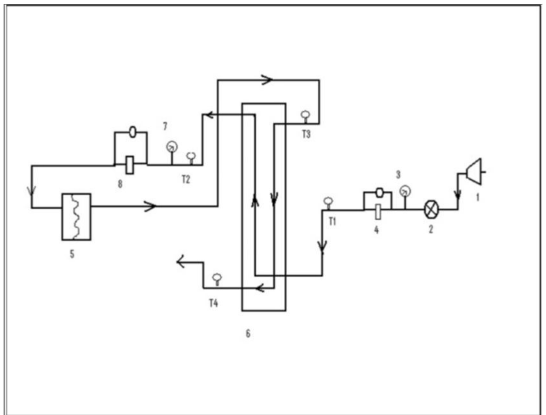
Fig 1 indicates the detonate outlook on 2 layer of plate blade warmth interchanger.

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.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

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

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.

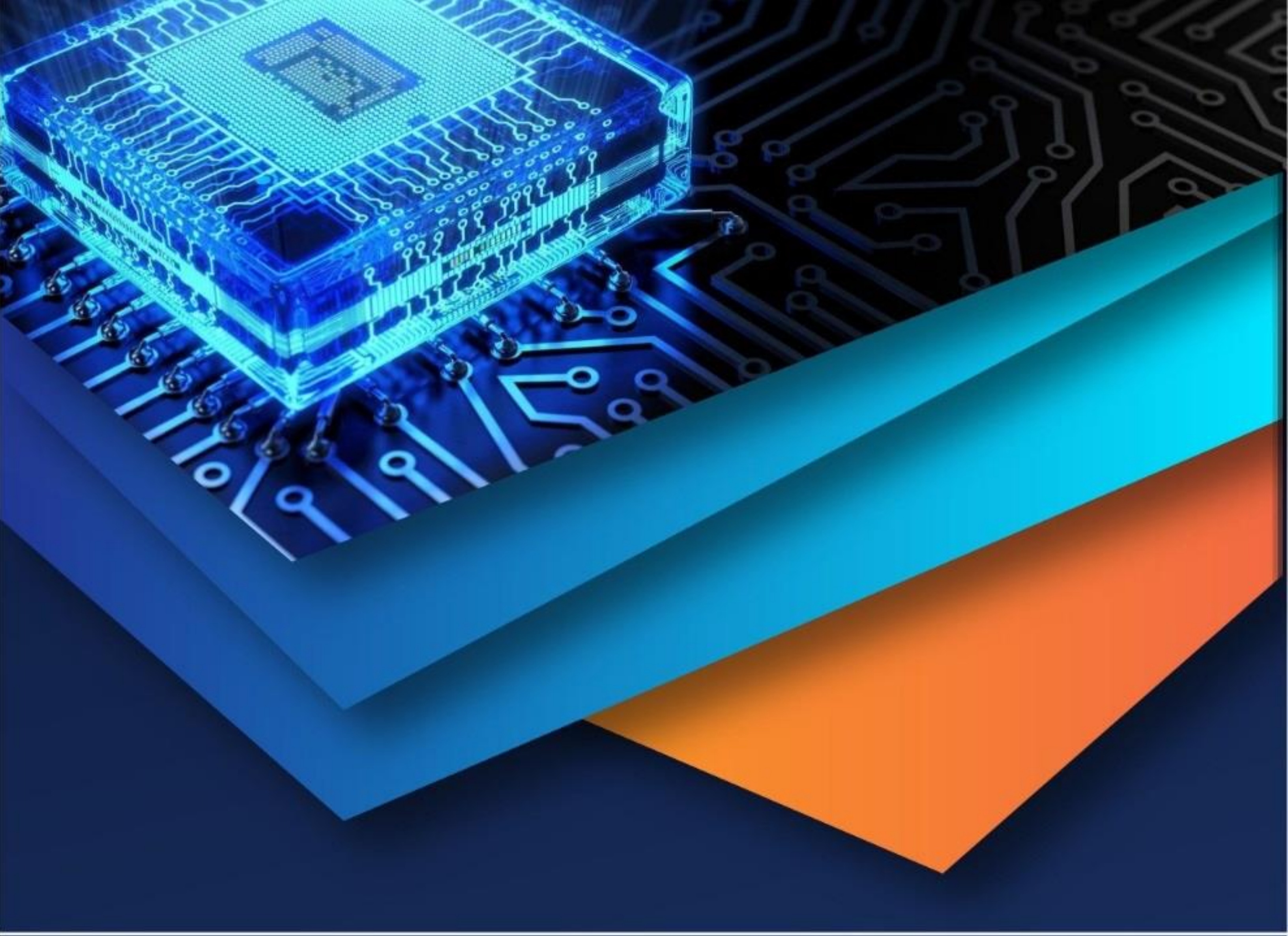
VII. SCOPE OF FUTURE STUDIES

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.

REFERENCES

[1] Patankar S. V. and Prakash C. 1981 An Analysis of Plate Thickness on Laminar Flow and Heat transfer in Interrupted Plate passages. International Journal of Heat and Mass Transfer 24:1801-1810.
[2] Joshi H. M. and Webb R. L. 1987. Heat Transfer and Friction in Offset Strip Fin Heat Exchanger, International Journal of Heat and Mass Transfer. 30(1): 69-80
[3] Suzuki, K., Hiral, E., Miyake, T., Numerical and Experimental studies on a two Dimensional Model of an Offset-Strip-Fin type Compact Heat Exchanger used at low Reynolds Number. International Journal of Heat and Mass Transfer 1985 28(4) 823-836.
[4] Tinaut F. V., Melgar A. and Rehman Ali A. A. 1992 Correlations for Heat Transfer and Flow Friction Characteristics of Compact Plate Type Heat Exchangers. International Journal of Heat and Mass Transfer. 35(7):1659:1665
[5] Manglik and Bergles A. E. 1995 Heat Transfer and Pressure drop Correlations for Rectangular Offset Strip Finn Compact Heat Exchangers. Experimental Fluid Science 10:171-180.
[6] Hu S and Herold K. E. 1995a Prandtl Number Effect on Offset Strip Fin Heat Exchanger Performance: Predictive Model for Heat Transfer and Pressure Drop. International Journal of Heat and Mass Transfer 38(6) 1043-1051 Hu S and Herold K. E. 1995b Prandtl number Effect on Offset Strip Fin Heat Exchanger Performance: Experimental Results. International Journal of Heat and Mass Transfer 38(6) 1053-1061.
[7] Zhang L. W., Balachandar S., Tafti D. K. and Najjar F. M. 1997. Heat Transfer Enhancement Mechanisms in Inline and Staggered Parallel Plate Fin Heat Exchanger. International Journal of Heat and Mass Transfer 40(10):2307-2325
[8] Dejong N. C., Zhang L. W., Jacobi A. M., Balchandar S. and Tafti D. K. 1998. A Complementary Experimental and Numerical Study of Flow and Heat Transfer in Offset Strip Fin Heat Exchangers. Journal of Heat Transfer 12:690:702
[9] Bhowmik H., Kwan- Soo Lee 2009. Analysis of Heat Transfer and Pressure Drop Characteristics in an Offset Strip Fin Heat Exchanger. International Journal of Heat and Mass Transfer 259-263
[10] Saidi A. and Sudden B. 2001. A Numerical Investigation of Heat Transfer Enhancement in Offset Strip Fin Heat Exchangers in Self Sustained Oscillatory Flow. International Journal of Numerical Methods for Heat and Fluid Flow. 11(7): 699-716
[11] Dong J., Chen J., Chen Z. and Zhou Y. 2007. Air Side Thermal hydraulic Performance of Offset Strip Fin Heat Exchangers Fin Alumunium Heat Exchangers. Applied Thermal Engineering 27:306-313
[12] Michna J. G., Jacobi A. M. and Burton L. R. 2005. Air Side Thermal- Hydraulic Performance of an Offset Strip Fin Array at Reynolds Number up to 12, 0000. Fifth International Conference on Enhanced Compact and Ultra Compact Heat Exchangers. Science, Engineering and Technology 8-14.

[13] Prabhat Gupta, Atrey M. D. Performance Evaluation Of Counter Flow Heat Exchangers Considering the Heat In Leak and Longitudinal Conduction for Low Temperature applications. Cryogenics Volume 40, issue 7, Pages 469-474.
[14] Barron R. F., Cryogenic Heat Transfer, Taylor and Francis (1999) 311-318.
[15] Shah R. K. and Sekulic D. P. Fundamentals of Heat Exchangers, John Willey & Sons Inc., pp 10-13
[16] Kays W. M. and London A. L. Compact Heat Exchangers. 2nd Edition, McGraw-Hill, New York, 1964
[17] Weiting A. R.1975. Empirical Correlations for Heat Transfer and Flow Friction Characteristics of Rectangular Offset strip Fin Plate Fin Heat Exchangers. Transactions of ASME, Journal of Heat Transfer 97:488-497
[18] Manson S. V. Correlations of Heat Transfer Data and of Friction Data for Interrupted Plane Fins Staggered in successive Rows NACA Technical Note 2237(1950)
[19] Maiti D.K. Heat Transfer and Flow Friction Characteristics of Plate Fin Heat Exchanger Surfaces- A Numerical Study PhD Dissertation Indian Institute of Technology, Kharagpur (2002)
[20] DURMAZ, Gurcan, Experimental and Numerical Analysis of Heat Transfer Performance of Offset Strip Fins, Master of Science thesis, The Graduate School Of Engineering and Science of IZMIR Institute of Technology:2009



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY