OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

SIZING AND EXPERIMENTAL PERFORMANCE ANALYSIS OF FLOATING HEAD MULTI STREAM HEAT EXCHANGER

Mateen Ahmad[1], Khaqan Javed[2], Muhammad Usama[3]

Department of Chemical Engineering, Institute of Chemical Engineering and Technology, University of the Punjab, Lahore, Pakistan.[1]

Lecturer at Sharif College of Engineering and Technology Lahore, Pakistan Faculty of Chemical Engineering and Technology Department.[2]

Department of Chemical Engineering University of Engineering and Technology, Lahore Pakistan.[3]

Abstract: **Heat transfer between two streams is common, well established and perfectly commercialized, in some industrial applications in all production unit where more than one reactant is to be preheated or pre-cooled for chemical reaction and same as post heating and post cooling required of multiple streams at same or different temperatures required, To overcome this problem, we need more than one heat sinks with one or more than one heat source that will minimize the covered volume per unit heat transfer area by increasing thermal efficiency, to overcome this problem we need to move towards Multi Stream Heat Exchanger for handling multiple streams at once for the exchange of heat. Multi stream heat exchanger is opening of a new class of heat transfer equipment which deals more than two different streams for heat exchange, with a little bit increase in complexity the operational cost will decrease and improve the thermal efficiency of heat transfer equipment, which minimize thermal losses and maximize the heat utilization which directly decrease the equipment size and capital cost. The present study involves the designing of Floating Head Multi Stream Heat Exchanger and where two cold streams flow through the inner and outer pipe and one hot stream is flow through central pipe at same flow rates and its performance analysis is carried out where we calculate experimentally the heat duties of both hot and cold fluids, effectiveness by using Floating Head Multi-Stream Heat Exchanger.**

Keywords *– Sizing, Floating Head Multi Stream Heat Exchanger, Effectiveness, Heat duty Qh and Qc*

---∴∴∴---

I INTRODUCTION

A heat exchanger is a device used for the transference of heat between two fluids while transferring the heat it should be at maximum rate and minimal capital cost [1]. The fluid may be single phase or two phase it depends upon the type of exchanger and its form it may be separated or in contact. A heat exchanger is used for the transmission of enthalpy between the fluids. Heat exchanger have been classified in several ways, according to heat transfer mechanism, according to the flow arrangements i.e. parallel, counter or cross flow [2-4]. Transference of heat between two streams is very common and most of the industries are operating such equipment there has been a frequent approach towards improvement in heat exchanger devices so that lesser heat energy would be lost to the surrounding and achieve a high efficient and effective heat exchanger device. So, there is a need to move towards multi stream heat exchanger to ensure heat transfer among three different streams in minimum time, minimum volume and minimum cost to resolve this problem a new class of heat exchanger was introduced i.e. Floating head Multi-Stream heat exchanger [5].

Floating head Multi-Stream heat exchanger is a different class of heat exchangers designed to improve thermal efficiency of exchangers by minimizing time and space. The ability of an exchanger to either heat more than one cold source simultaneously or cool more than one hot

source simultaneously makes it effective for use in industries. Multi stream exchanger is a revolutionary addition in heat transfer equipment because they can operate with great efficiency under the right configuration. With the little bit increase in complexity the operational cost will decrease and improve the thermal efficiency of heat transfer equipment, which minimize the thermal losses and maximize the heat utilization which directly decrease the equipment size and capital cost.

II MATERIALS AND METHODS

2.1-Methodology

For performance analysis of Floating Head Multi Stream Heat Exchanger following methodology was adopted.

- Sizing of Floating Head Multi Stream Heat Exchanger
- Experimentation on Floating Head Multi Stream Heat Exchanger
- Performance analysis of Floating Head Multi Stream Heat Exchanger.

2.2-Sizing of Floating Head Multi Stream Heat Exchanger

For Performance Analysis of Floating Head Multi Stream Heat Exchanger, Floating Head Multi Stream Heat Exchanger is needed. Thus, Floating head Multi-Stream heat exchangers is constructed by three concentric tubes of the same length which are connected with floating head. Floating head Multi-Stream heat exchangers have some advantages as in the floating head it is easy to remove tubes for cleaning and this floating head exchanger have the advantage of low maintenance cost. For this purpose, the whole apparatus is specially designed.

Figure 1: Internal View of Floating Head Multi Stream Heat Exchanger

Figure 2: Floating Head Multi Stream Heat Exchanger

2.3-Floating Head Multi Stream Heat Exchanger Setup

Performance Analysis is carried out in the Floating Head Multi Stream Heat Exchanger by keeping hot water flow rate constant and cold-water flow at same value, the flow rates of hot & cold water are controlled by using the rotameters

- For hot water flow rates are selected as 1.2 LPM, 3.5 LPM, 6.6 LPM, 8.5 LPM
- For cold water flow rates are also kept 1.2 LPM, 3.5 LPM, 6.6 LPM, 8.5 LPM.
- After achieving steady state various temperature are recorded and according to the various procedures effectiveness Qc and Qh.

2.4-Consideration for the Experimentation

The major considerations made for the experimentation of multi stream heat exchanger are as follows:

- Two cold fluids flow through the inner and outer tube in same direction.
- Hot water flow through the Central tube
- Heat transfer from hot fluid to cold fluid streams takes place without phase transformation.
- Heat exchanger is well insulated against atmosphere
- Two cold streams are entering at same flow rate
- One hot stream is entering at same flow rate as we kept for cold stream
- There is no fouling in Multi stream heat exchanger
- Flow is continuous, uniform and steady.

Figure 3: Experimental Setup of Floating Head Multi Stream Heat Exchanger

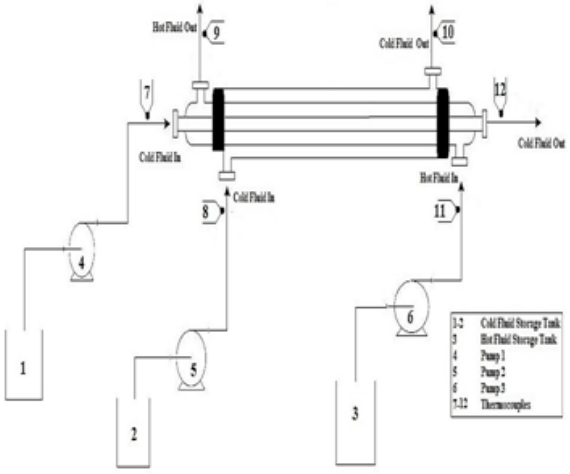

Figure 4: Schematic Process Diagram

III RESULTS AND DISCUSSION

3.1-Heat Duty of Hot Fluid (Qh) of Hot Fluid Across Various Flow Rates

Table 1: Data for Qh at different Flow rates

Sr No	Flow Rate (LPM)	Heat Duty Qh (KW)
1	1.2	0.8360
2	3.54	1.72634
3	6.6	3.6784
4	8.5	4.73733

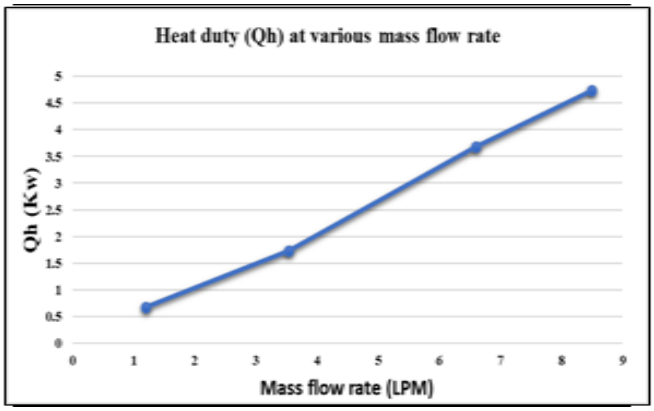

Figure 5: Heat duty (Qh) at different Flow rates

At different flow rates heat duty Qh i.e. amount of heat that is transfer by hot fluid have different values as we see as the flow rate of hot and cold fluids increases duty is also increases and more transference of heat is taking place.

3.2-Heat Duty of Cold Fluid (Qc) Across Various Flow Rates

Table 2: Data for Qc at different Flow rates

Sr No	Flow Rate (LPM)	Heat Duty Qc (KW)
1	1.2	0.5852
2	3.54	1.5048
3	6.6	3.2186
4	8.5	3.58226

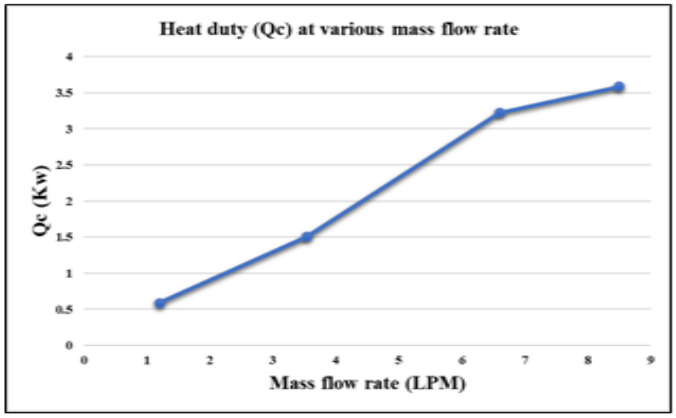

Figure 6: Heat duty (Qc) at different Flow rates

A different flow rates heat duty Qc i.e. amount of heat gain by hot cold fluid have different values as we see that as the flow rate of hot and cold fluids increases Qc is also increases and more heat is gain by cold fluid.

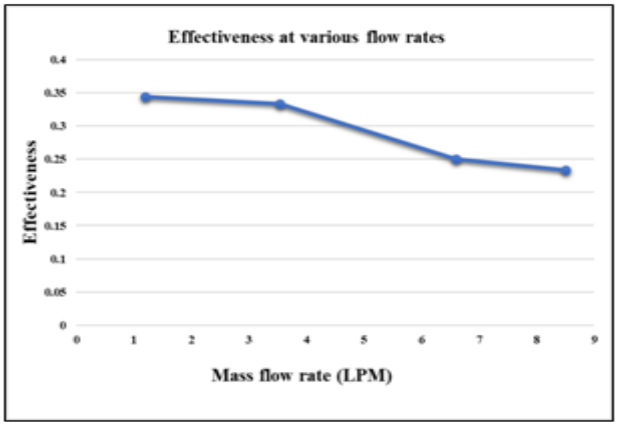

Figure 7: Effectiveness at different flow rates

3.3-Effectiveness at Different Flow Rates

Table 3: Date for Effectiveness at different Flow rates

Sr No	Flow Rate (LPM)	Effectiveness
1	1.2	0.3437
2	3.54	0.3333
3	6.6	0.2535
4	8.5	0.2333

Figures shows that effectiveness of heat exchanger at various flow rates Another aspect exists that at low flow rates of the hot and cold fluid there is higher value of the effectiveness this is mainly because of the at low flow rates the they remain for more time in heat exchanger and exchange of the heat becomes higher.

IV CONCLUSION

Thus, Floating Head Multi-Stream Heat Exchanger provides good heat transfer, the effectiveness of Floating Head Multi-Stream Heat Exchanger is better. Another aspect is that at low flow rates of the hot and cold fluid there is higher value of the effectiveness this is mainly because of the at low flow rates the they remain for more time in heat exchanger and exchange of the heat becomes higher. So, by result we can see that the heat duties, thermal efficiency and effectiveness is better so we can say that is a compact version of heat exchanger where we can deal with more than two different streams for heat Exchange.

REFERENCES

[1] Shah, R.K; Liu, K. Fundamental of heat transfer design, Wiley, New York,2003.

[2] Ediz, B.; Sandeep, K.P. Calculation of overall heat transfer co efficient in triple tube heat exchanger, Heat and Mass transfer, 2005.

[3] Bharat, D.; Omkar, S.G.; Parnal N.I.; Saeed. Experimental determination of effectiveness of triple pipe heat exchanger with dimple tubing, International journal for scientific research and development, Vol 4.

[4] Garcia, V.O. Numerical simulation of triple pipe heat exchanger, International journals of thermal sciences.

[5] Quadir, A.G.; Saqab, S.J.; Jarallah, N.J.; Salman, A.; Irfan, A.B. Numerical investigation of performance of a triple pipe heat exchanger, International journals of Heat and Mass transfer

[6] Saeid, N.H.; Seetharamu, K.N.Finite element analysis for co current and counter current parallel flow of three fluid heat exchangers, International journal of numerical method heat fluid flow.

[7] Krishna, V.; Hedge, P.G.; Subramanian, N.Effect of ambient heat in leak on the performance of three fluid heat exchanger, for cryogenic application using element method, International journals of Heat and Mass transfer.