Experimental Study on Enhanced Heat Transfer In Gasketed Plate Heat Exchanger

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Abstract- *Heat transfer is the predominant phenomenon in the engineering fields. It has created the huge challenge for dissipating the heat from one substance to another. Many researchers have found the different methodologies for increasing the heat transfer rate with the application of various research. In this paper we have proposed a methodology for the heat exchanger in various aspects the present work deals with experimental heat transfer data performed on gasketed plate type heat exchanger. We have proposed the changes in the base fluids of Nano fluids as the base fluids play an important role in the characteristics of Nano fluid. Based on the experimental data, we will estimate the Nusselt number, Reynolds number, Prandtl number and the outputs obtained are convective heat transfer coefficient, overall heat transfer coefficient and also our article shows the result of the overall heat transfer co-efficient between water and Nano fluids.*

Keywords- Heat Exchanger, Gasketed Plate, Nano fluids, overall heat transfer co-efficient

I. INTRODUCTION

A device could also be a tool used to transfer heat between a solid object and a fluid, or between two or more fluids. The fluids could also be separated by a solid wall to stop mixing or they'll be in direct contact. The classic example of an instrument is found in an internal combustion engine, in which a fluid referred to as engine coolant flows through the radiator coils and the air flows through the coils, which cools the coolant and heats the incoming air. Another example is that the conductor, which may be a passive device that transfers the warmth generated by an electronic or a robot to a fluid medium, often air or a liquid coolant. These exchangers are often classified in various ways. We will classify them consistent with transfer processes, number of fluids, and warmth transfer mechanisms. Conventional heat exchangers are compatible with construction type and flow arrangements. This classification develops because the type of kit, application fields, and elegant techniques are generally different. Heat exchangers also can be classified as consistent with the method function.

II. GASKETED PLATE HEAT EXCHANGERS

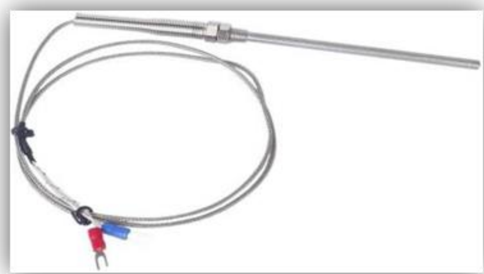
A plate-and-frame or gasket plate heat exchanger (PHE) is a thin rectangular metal plate that is enclosed by gaskets around the edges and held together by a frame. The frame is usually fitted with a fixed nozzle and a movable end card (pressure plate, follower). In the frame, the plates are suspended from the top carrying bar and guided to the bottom carrying bar. To ensure proper alignment. For this purpose, each plate is marked at the center of its top and bottom edges. The fixed and movable end covers with the tray pack are fastened together by long bolts, thus compressing the gaskets and creating a seal. For discussion later, L pack as a palette of design length. The carrying bars are longer than the compressed layer, so when the movable end cover is removed, the plates can be inspected and cleaned to support bars. Each plate is made of sheet metal in the form of a corrugated (or wavy) surface.

III. INSTRUMENTS USED

PACKED PLATE:It is made by stainless steel, copper and titanium, nickel alloy, it enhanced the package of corrugated plate

MANOMETER: A manometer is a device for measuring pressures, a typical simple manometer has a U-shaped glass tube filled with some liquid, and is usually mercury with a high density of the liquid.

THERMOCOUPLE: A Thermocouple is an electrical device that generates an electrical junction with two different conductors. A thermocouple generates a temperature-dependent voltage as a result of the thermoelectric effect, and this voltage can be explained to measure the temperature.



ROTOMETER: A rotometer is a device that measures the flow rate of fluid in a closed tube, belonging to a class of meters called variable area meters, which measures the flow rate by allowing the fluid to cross the cross-sectional area, thus measuring the effect.

FLOWCONTROLVALVE:A flow control valve controls the flow or pressure of a fluid, and control valves typically respond to signals generated by independent devices such as flow meters or temperature gauges.

IV. METHODOLOGY

The first thing is the allowance of hot and cold fluids Parallel to the Gasketed plate heat exchanger unit through pumps via flowmeters, here are two flowmeters is available in this units which is used for flow measurements of hot and cold fluids. And this unit contains a couple of monometers. Which is used for pressure measurement of fluids which is connected from inlet and outlet of the exchanger unit to monometer tube. And also, which contains four thermocouples. Which is connected on the Inlet and outlet of the cold tubes and inlet and outlet of the hot tubes.These thermocouples are connected to the digital display meter for knowing the temperature of hot and cold fluids. And finally we have to taken the measurement of Temperature, Pressure and Flow of hot and cold fluids for estimating the Nusselt number as a function of Reynolds number, Prandtl number and chevron angle and to find the outputs of convective heat transfer coefficient, overall heat transfer coefficient, and exchanger effectiveness. Simillarly we have to Flow the Hot water and Ethylene glycol.

V. TABULATIONS

S. No	Flow Rate		Temperature			
	Hot Fluid	**Cold Fluid**	**Cold In**	**Cold Out**	**Hot In**	**Hot Out**
	LPM	LPM	T_{ci} (^{0}c)	T_{co} (^{0}c)	T_{hi} (^{0}c)	T_{ho} (^{0}c)
1	2.45	1.33	40.3	42.55	44.4	42.6
2	2.45	5.8	40.9	42.25	44.5	42.5
3	2.45	7.5	41.3	42.45	44.6	42.8

Temperature Measurement(Water-Water system)

S. No	Flow Rate		Temperature			
	Hot Fluid	Cold Fluid	Cold In	Cold Out	Hot In	Hot Out
	LPM	LPM	T_{ci} (^{0}c)	T_{co} (^{0}c)	T_{hi} (^{0}c)	T_{ho} (^{0}c)
1	2.45	1.41	39.5	44.15	44.4	40.16
2	2.45	5.14	40.16	44.65	44.5	40.65
3	2.45	6.98	40.11	44.35	44.6	40.82

Temperature Measurement(Water- Ethylene Glycol system)

VI. CALCULATION

Hot fluid:

$T_{avg} = (T_{hi}+T_{ho})/2$

$= \frac{44.4+42.6}{2}$

$T_{avg}= 43.5^0c$

Properties of hot fluid

ρ =978.17 kg/m^3

ν =0.411×E^{-6} m^2/sec

C_p =4182.07 j/kg. k

K =0.65957 w/m. k

μ =0.000403kg/ms

$u = m_h/ \{\ell A\}$

$= \frac{40}{978.17\times4\times.112}$

u = 0.092m/s

Reynolds number, Re = u.d$_i$/ν

$= \frac{0.092\times25.4\times e-3}{0.411\times e-6}$

Re =5685.6

Prandtl number, Pr = $\frac{Cp}{K}$

$= \frac{4182.07\times0.00043}{0.65957}$

Pr =2.555

Nu = 0.023Re$^{0.8}$ Pr$^{0.4}$

= 0.023× (5185.6)$^{0.8}$× (2.555)$^{0.4}$

Nu= 33.77

Nusselt number, Nu = h.d$_i$/k

$33.77= \frac{h\times25.4\times e-3}{0.65957}$

h_i=876.92

For cold fluid:

$T_{avg} = (T_{ci}+T_{co})/2$

$= \frac{40.3+42.55}{2}$

T_{avg} = 41.43

Properties of cold fluid

ρ=994.10 kg/m^3

ν =7.23×E^{-6} m^2/sec

C_p =4169.54 j/kg. k

K =0.61992 w/m. k

μ =0.000719 kg/ms

u = m$_c$/ {ρ$_c$A}

$= \frac{22}{994.1\times4\times.112}$

u= 0.05m/s

Re = u.d$_o$/ ν

$= \frac{0.05\times25.4\times e-3}{7.23\times e-6}$

Re = 175.65

Pr = $\frac{Cp}{K}$

Pr =4.845

Nu = 0.023Re$^{0.8}$ Pr$^{0.4}$

= 0.023× (175.65)$^{0.8}$×(4.845)$^{0.4}$

Nu= 2.7

Nu = h.d$_o$/k

$2.7= \frac{h\times25.4\times e-3}{0.61992}$

h_0=65.9

$1/U = [1/h_i+1/h_o]^{-1}$

$= \frac{1}{876.92} + \frac{1}{65.9}$

1/U = 0.0163

U = 61.27

Q = UA ΔT_m

$\Delta T_m= \frac{(T_{hi}-T_{co}) - (T_{ho}-T_{ci})}{\ln\{(T_{hi}-T_{co})/(T_{ho}-T_{ci})\}}$

$= \frac{(44.4-42.55)-(42.6-40.3)}{\ln\{(44.4-42.55)/(42.6-40.3)\}}$

$\Delta T_m = 2.1^0c$

Q = UA ΔT_m

= 61.27×8×0.112×2.1

Heat transfer rate (WATER-WATER SYSTEM)

Q = 115.3 W.

Similarly**, For (Water- Ethylene Glycol system)**

Heat transfer rate Q =153.21

VII. ADVANTAGES

They can be easily taken as their separate components for cleaning, inspection, and maintenance

The heat transfer surface area can be easily modified or rearranged for other tasks or for expected dynamic loads, such as plate size, corrugated shapes, and pass arrangements.

High shear rates and shear stresses, secondary flow, high turbulence, and mixing due to plate corrosion patterns reduce heat loss from 10 to 25% in the shell-and-tube exchanger and improve heat transfer.

VIII. APPLICATION

Plate heat exchangers for milk pasteurization applications were introduced in 1930, and now find important applications in liquid-liquid (viscosity up to 10 Pa) heat transfer duties.
They are very common in the dairy, juice, beverage, alcohol, general food processing, and pharmaceutical industries, where they are ideal for cleaning and heat control for purification/pasteurization.

They are also used in the synthetic rubber industry, heating, coolers, and closed-circuit cooling systems of paper mills and major petrochemical and power plants. Here the heat rejection of seawater or brine is common in many applications, and then the use of titanium plates.

IX. PHOTOGRAPHY

X. CONCLUSION

By using the above work, we can conclude that we can apply the plate heat exchanger setup in various heat transfer applications for different fluids in various industry such as sugar mill, paper industry, cement industry for preheating of oil in furnace applications, extracting heat from hot oil for various gearbox industry. where oil is preheating due to reduce the viscosity of oil. Also, plate heat exchanger having 3or more times more than heat transfer co-efficient then shell and tube heat exchanger. This approach is suitable and simple tool for use in the determination of overall heat transfer co-efficient and heat transfer rate.

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