Study of Plate Cheravon Heat Exchangers by CFD Analysis

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Abstract - Plate heat exchangers phes are used in a variety of chemical, process, and power industries over a broad range of temperatures due to their compactness, ease of maintenance, flexibility, and favorable thermal-hydraulic characteristics. We designed the PHE's by elivating the angle of grooves to 30 degrees and 60 degrees. The grooves will make on the heat exchangers by changing the L-angle. The analysis done by using the catiaand ANSYS(FLUENT module) softwares. To analyze the velocity counters and path lines and the pressure variations and the temperature variation all along the plate to achieve the required temperature difference.

keywords: cfd anlysis , plate heat exchangers, h-plate.

I. INTRODUCTION

Heat exchangers are mainly used in refrigerators, turbines, boilers. These are of many types. Among them plate heat exchanger is mainly used.Plate heat exchanger is used for reduce the temperature of hot fluid in system. By passing the cold fluid around the tubes the temperature will be reduced. The efficiency will be based on heat transfer rate, temperatures of fluids. CFD (Conjugated Fluid Dynamics) analysis on plate heat exchanger is done by making the "grooves" on the plate. The analysis of heat exchangers is done for decreasing the velocity of fluid flow in the exchanger. The plate heat exchangers are prepared by using aluminum and steel.

II. METHODOLOGY

ANALYSIS

There are 2 types of analysis mainly, --Real type analysis
Software analysis

3D modeling, constraints, meshing, parameters, result.

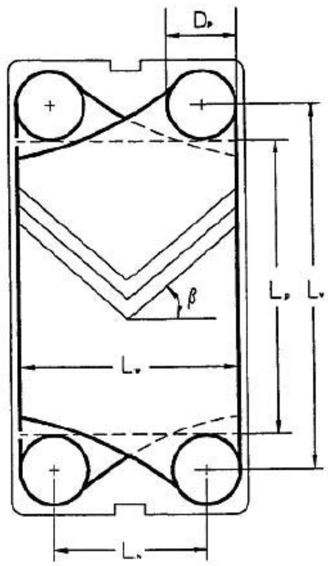
PARAMETERS

Flow rate of fluid, temperature, diameter of tube, density of fluid, length, specific heat of fluid, mass flow rate, pressure, velocity.

PROPERTIES OF FLUID

Mostly in heat exchangers water is used as a fluid.
Density of fluid (water) -1000kg/cu.m
Room temperature - 27 0c
Boiling point - 100 0c
Freezing point - 0 0c

Thermal conductivity - 0.58 W/m-K
Viscosity - 1 cp (20 0c)
Specific heat -4.187kj/kg k



L=156mm

W=127mm

λ=2.5mm

β = 60° or 30°

Here
L=Length of the plate
W=width of the plate
t= plate thickness
β=plate corrugation inclination angle

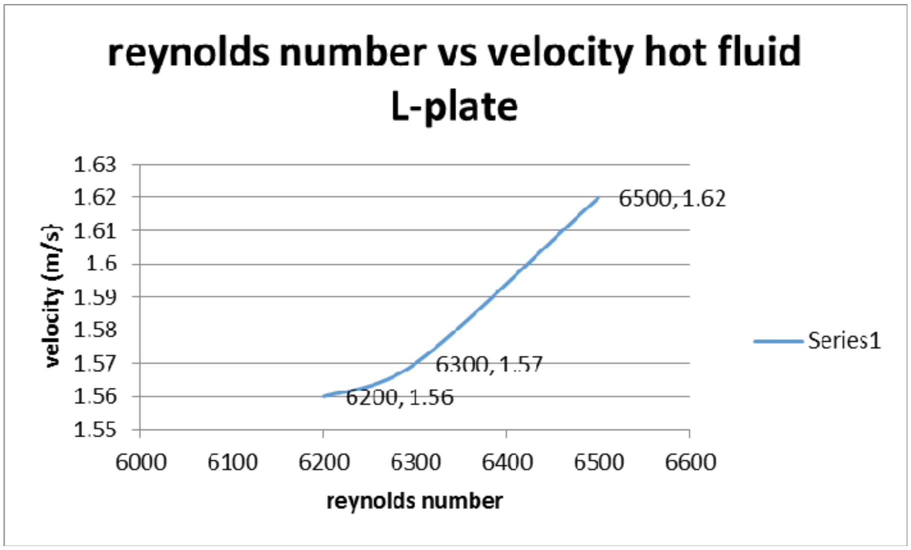
III. CALCULATIONS

$$\mathrm{Re} = \frac{\text{inertial forces}}{\text{viscous forces}} = \frac{\rho \mathbf{v} L}{\mu} = \frac{\mathbf{v} L}{\nu}$$

Reynolds number,
Diameter of tube = 4mm
Dynamic Viscosity (water) = $1.002x10^{-3}$ Kg/M-sec

FOR HOT WATER

For Re= 6100
Velocity V= $(1.002x10^{-3}$ x6100)/4
V= 1.528 M/s
Similarly Re= 6200 , then V= 1.56
Re= 6300 , then V= 1.578
Re= 6500 , then V= 1.628



FOR COLD WATER

For Re= 1800

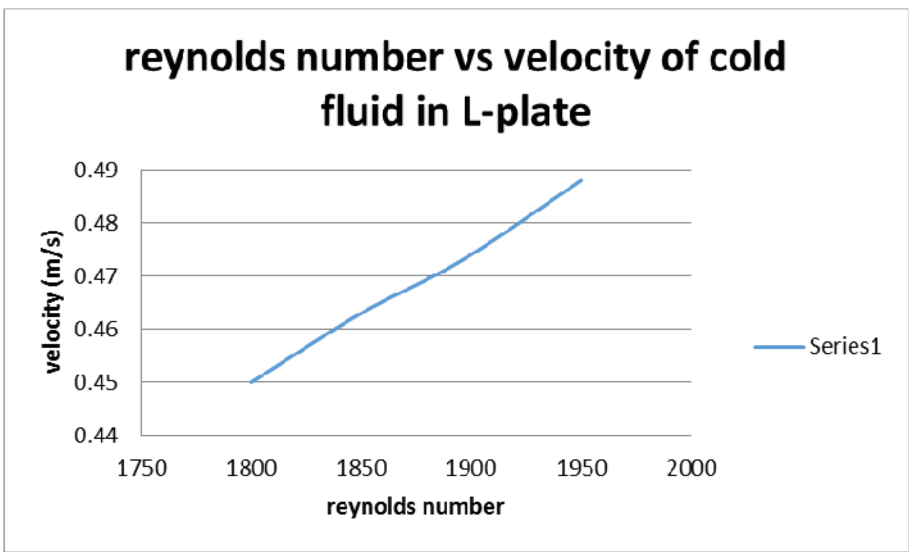
V = $(1.002\text{x}10^{-3}\text{ x}1800)/4$

Velocity V= 0.45

Similarly Re= 1850 ,then V= 0.463

Re= 1896 ,then V= 0.474

Re= 1950 ,then V= 0.488



PECLET NUMBER (Pe)

Pe= convective flux/ conductive flux

$$P_e = \frac{uD_h}{\alpha} \quad , \alpha = \frac{k}{\rho c_p}$$

For water μ = $1.002\text{x}10^{-3}$

K = 0.58 W/M-K
Sp Heat= 4.187 Kj/Kg-K
Density (water)= 1000Kg/cu.m

Now, α = 0.58/ (1000x4.187x1000)
= 1.385×10^{-7}
Pe = $(1.002 \times 10^{-3} \times 4 \times 10^{-3})/1.385 \times 10^{-7}$
Pe = 0.0289

NUSSELT NUMBER

Nu= 0.26x $Pe^{0.27}$
Nu= 0.26x $0.0289^{0.27}$
Nu= 0.099

HEAT TRANSFER CO-EFFICIENT

$$h = \frac{Nu\ k}{D_h}$$

= $(0.099 \times 0.58)/ 4 \times 10^{-3}$
h = 14.35 W/sq.m-K

TURBULENT FRICTION FACTOR

f = $2.9 \times Pe^{-0.13}$
= $2.9 \times 0.0289^{-0.13}$
f= 4.597

PRESSURE DROP

$$\Delta P = f\left[\frac{LG^2}{2D_h \rho g_c}\right]$$

g= 9.81 Kg/cu.m
G= (density x volume)/ area
= $(1000 \times 156 \times 127 \times 2 \times 10^{-9})/(127 \times 2 \times 10^{-6})$
= 156
Specific mass flow rate (G) = 156 Kg/Sq.m-sec

Δ P= $4.597*[(156*10^{-3}*156^2)/ (2*4*10^{-3}*1000*9.81]$
Therefore pressure drop = 222.376

IV. CFD ANALYSIS ON PLATE HEAT EXCHANGER

plate heat exchangers on l-plate (30 degrees)
velocity path lines

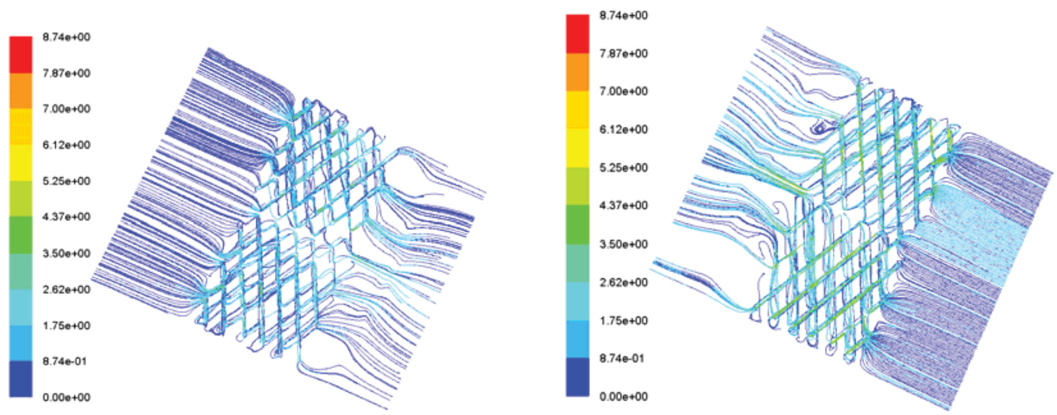


fig a : velocity pathlines of cold and hot side

pressure path lines

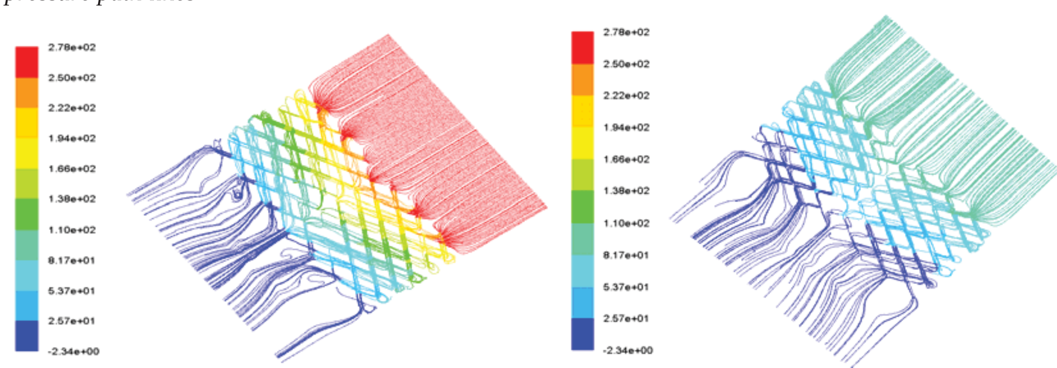


fig b : pressure pathlines on hot and cold water

temperature pathlines

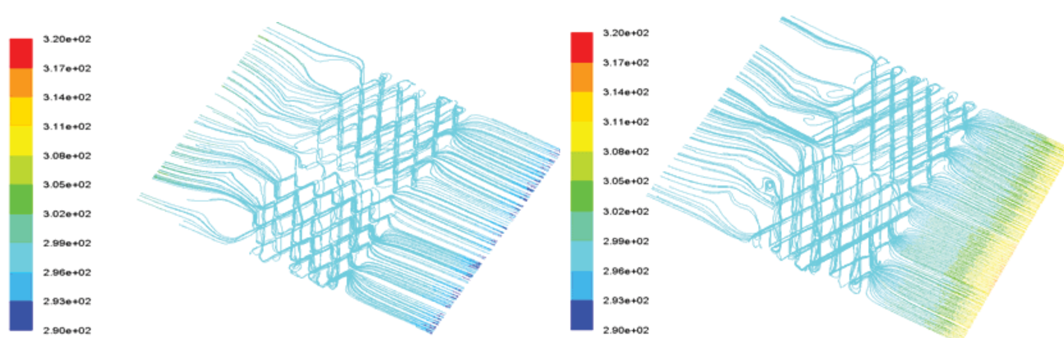


fig c temperature path- lines on hot and cold side

Cfd Analysis On Plate Heat Exchangers Of 60 Degree Plate (H-Plate)

velocity path lines

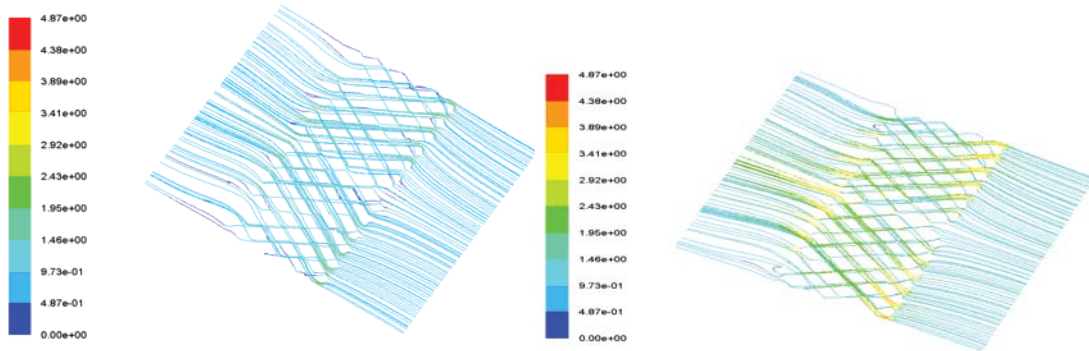


fig d : velocity path lines of cold and hot plate side

pressure path lines

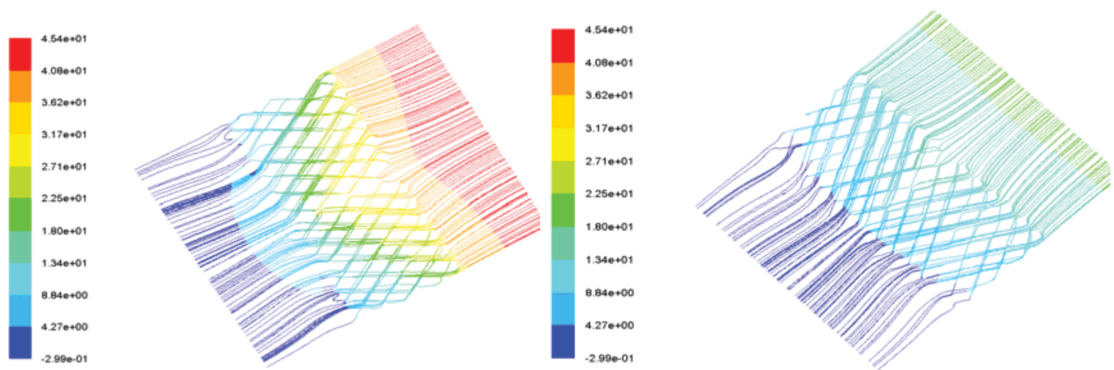


fig e: pressure path lines of hot and cold fluid plate side

temperature pathlines

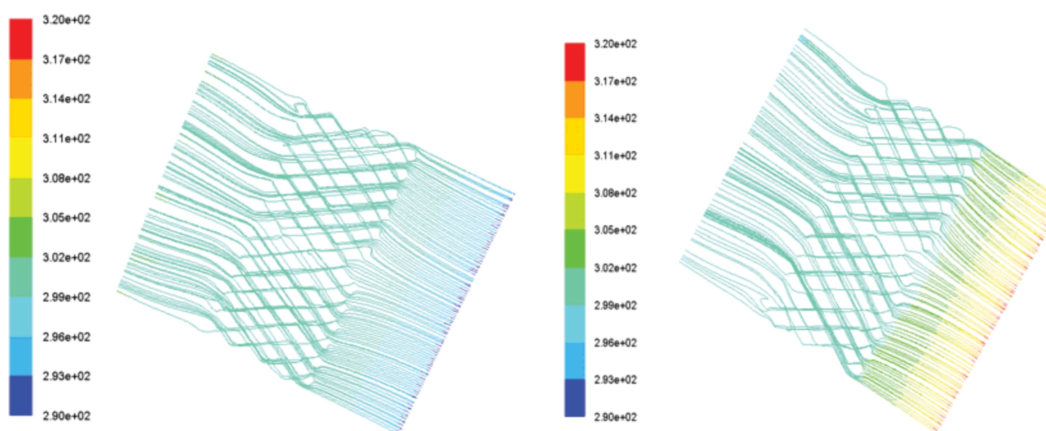


fig f : temperature path lines of cold and hot fluid plate side

V. CONCLUSION

The two plate heat exchangers are considered and the cfd analysis has been done and obtained the velocity pressure and temperature distribution on overall plates are determined and the calculation has done on the l-plate and the h-plate and the variation of the velocity and the pressure results the friction factor high in the l-plate but the heat transfer rate is more occupied and the distributed all along the h- plate which having higher efficiency .

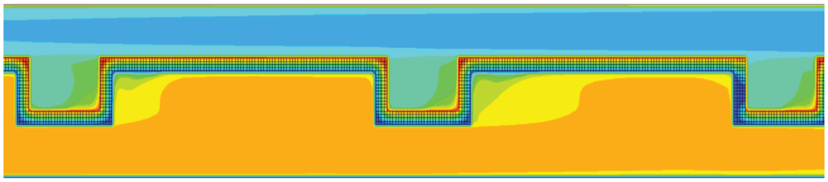


fig : temperature distribution on plate heat exchanger on L-plate

REFERENCES

[1] Weerapun Duangthongsuk and Somchai Wongwises, Heat transfer enhancement and pressure drop characteristics of TiO_2–water nanofluid in a double-tube counter flow heat exchanger, International Journal of Heat and Mass Transfer 52 (2009) 2059–2067.

[2] S.M. Fotukian and M. Nasr Esfahany, Experimental study of turbulent convective heat transfer and pressure drop of dilute CuO/water nanofluid inside a circular tube, International Communications in Heat and Mass Transfer 37 (2010) 214–219.

[3] Shive Dayal Pandey and V.K. Nema, Experimental analysis of heat transfer and friction factor of nanofluid as a coolant in a corrugated plate heat exchanger, Experimental Thermal and Fluid Science 38 (2012) 248–256.

[4] M. Fakoor Pakdaman et.al, An experimental investigation on thermo-physical properties and overall performance of MWCNT/heat transfer oil nanofluid flow inside vertical helically coiled tubes, Experimental Thermal and Fluid Science 40 (2012) 103–111.

[5] D. Ashtiani et.al, An experimental investigation on heat transfer characteristics of multi-walled CNT-heat transfer oil nanofluid flow inside flattened tubes under uniform wall temperature condition, International Communications in Heat and Mass Transfer 39 (2012) 1404–1409

[6] Arun Kumar Tiwari et.al, Performance comparison of the plate heat exchanger using different nanofluids, Experimental Thermal and Fluid Science 49 (2013) 141–151