Comparative Study Between Enhancement of Heat Transfer Between Tube And Tube Heat Exchanger With Insertion of Semispherical Hollow Baffle And Semispherical Solid Baffle

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Abstract- *Different types of heat transfer enhancement techniques are invented by recent researchers like insertion of different shape parts in tube and tube heat exchangers as well as use of different nano particles fluid suspension gives better heat transfer enhancement. These are two successful methods to enhance the heat transfer rate in tube and tube heat exchanger. In this project we studied the behavior of insertion of semispherical hollow baffle of copper material and semispherical solid baffle on heat transfer in tube and tube heat exchanger. Also we have done the comparative study between these two methods for heat transfer enhancement. These works mainly focus on the swirling effect and friction factor due to such arrangement.*

Keywords- Heat exchanger, Heat Enhancement, Semispherical Hollow baffle, Semispherical Solid baffle

I. INTRODUCTION

Heat transfer enhancement techniques reduce thermal resistance in heat exchanger without changing the surface area. Active passive and compound techniques are used to enhance the heat transfer rate in heat exchanger. Active techniques include mechanical aids like magnetic field to change flow pattern with suspended particle. Passive techniques includes treated surface, extended surface and swirl flow devices etc. while compound techniques involve both active and passive techniques. All among different shapes insert in to tube shows heat enhancement result but as compared with other shapes semispherical hollow baffle insertion is effective techniques based on friction factor and power.

Use of different Shapes will change the motion of fluid and swirling pattern that shows enhancement in heat transfer. All of these techniques can be widely used in several engineering process industry.

II. LITERATURE REVIEW

Present Theories and Practices:

Mali S.M [1]performed experiment on insertion of semispherical hollow baffle in tube and tube heat exchanger for counter flow and conclude that heat enhancement is better for insertion as compared with the smooth pipe.

Mali S.M[2] performed on different materials of semispherical hollow baffle for stainless stell and copper material and study give the better heat transfer coefficient for copper material as compared with stainless steel material

Li ya xia WU Jian-Hua,wang hang[3] performed experiment on spiral corrugation and plain helical tube shows increase in heat transfer due to spiral corrugation and predict better result for spiral corrugation.

Aashique alam rezwan.[4] performed on air process heater with semispherical baffle and result shows that ambient temperature vs air temperature ratio decreased up to 0.72 as compared with electrical heater this ratio is 0.9.

P. Dubey [5] carried out experiment with the use of snail shape at entrance of double tube heat exchanger. result shows that heat transfer coefficient increases for snail entrance. He also predicts friction factor decreases as the Reynolds number increases.

T.L. Bergman[6] put theories regarding various heat transfer enhancement techniques and basic concepts regarding heat exchanger and passive techniques

Bodius Salam et.al. [7] have performed experiment on the heat transfer enhancement in a tube with rectangular cut twisted tape insert. And calculated measuring tube side heat transfer coefficient, friction factor, heat transfer enhancement efficiency of water for turbulent flow. At comparable Re, Nu in tube with inserts were enhanced by 2.3 to 2.9 times at the cost of increase in the friction factor by 1.4 to 1.8 times compared to that of smooth tube.

A.H Dhumal et.al.[8] shows that dealing with twisted tapes and wire coils like insertion shapes, are known to be economic heat transfer augmentation tools. behavior of an insert mainly depends on the flow conditions like laminar or turbulent.

III. OBJECTIVE

1) Manufacture the hollow and solid semispherical baffles of material copper and for the counter flow tube and tube heat exchanger
2) To perform on experiment with setup and recording the reading for semispherical hollow baffle and semispherical solid baffle.
3) Comparative study of insert of hollow semispherical baffle and solid semispherical baffle for counter flow and comparison of that two type baffle

Following diagram shows the experimental set-up for caparison of heat transfer enhancement for hollow and solid semispherical baffle of copper material. Holes are made to create semispherical hollow baffle.**fig.2** shows the actual set-up for performance and for analysis of heat enhancement process we estimate following parameter

1) Nusselt Number
2) Prandlt Number
3) Reynolds Number
4) Heat transfer coefficient

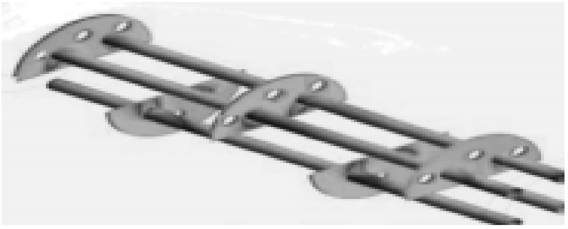


Fig.1 Semispherical Baffle

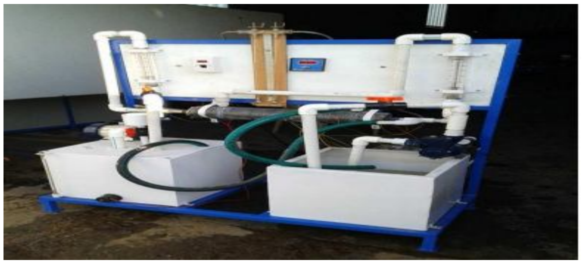


Fig.2 Actual Set-up for performance of experiment

IV. TEST METHODOLOGY AND FORMULAE USE

Heat added to water is calculated by

$$Q = mc_p(Tout - Tin)$$

Heat transfer coefficient was calculated from,

$$h=q/(Tw_i-T_b)$$

Heat flux

$$q=Q/a$$

Where,a = πdiL

Bulk mean temperature = (Tin +Tout)/2

Experimentally Nusselt number was calculated from,

$$Nu = hd_i/k$$

Theoretically Nusselt number was calculated from Gnielinski 1976 correlation

$$Nu_{th} = ((f/8)(Re-1000)Pr)/ 1+12.7(f/8)^{1/2}(Pr^{2/3}-1)$$

Theoretically friction factor was calculated from Petukhov 1970,

$f_{th} = (0.790\ln Re - 1.64)^{-2}$

$Re = \rho U_m di/\mu$

$Pr = \mu Cp/ k$

Mean water velocity was obtained from

$Um = m/A_f$

$A_f = 3.14/4(d_i)^2$

$f_{exp} = \Delta p / (L/di)(\rho Um^2)$

Nomencleture:

A	Area of the heated region of tube, m^2
Af	Flow area, m^2
Cp	Specific heat of water, J/kg.K
d	Tube diameter, m
t	thickness of copper tube, m
h	Heat transfer coefficient, W/m^2K

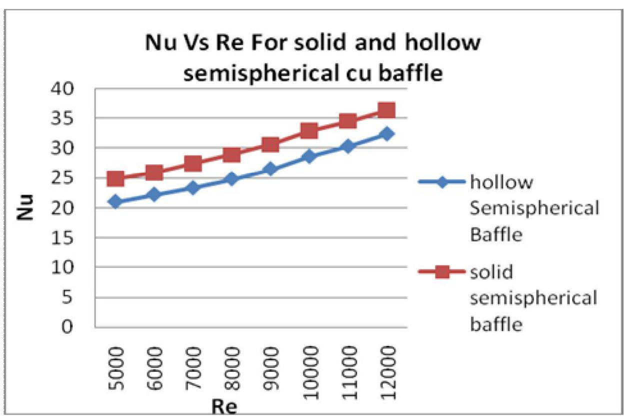
k	Thermal conductivity of water, W/m.K
kw	Thermal conductivity of tube material, W/m.K
L	Effective tube length, m
m	Mass flow rate of water, Kg/s
Q	Heat transfer rate, W
q	Heat flux, W/m^2
Nu	Nusselt Number
f	Friction factor
P_r	Prandtl number

V. RESULT AND DISCUSSION

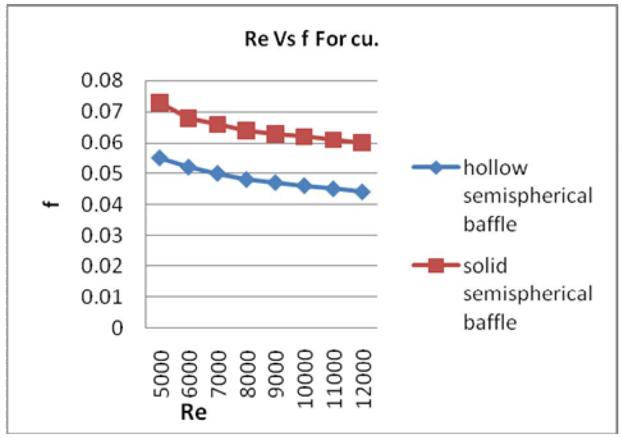
For the logical and systematic comparison, the results are compared on the basis of graphs mainly plotting of

1) Reynolds number property versus nusselt number
2) Reynolds number versus friction factor

For insertation of hollow semi spherical baffle and solid semi spherical baffle



From above graph we conclude that nusselt number for solid semispherical baffle is higher as compared with hollow semispherical baffle for same Reynolds number. Nusselt number slightly increases up to significant level.



Above graph plotted as Reynolds number versus friction factor for both hollow semispherical baffle and solid semispherical baffle. from above graph we conclude that friction factor for solid semispherical baffle is slightly higher than hollow semispherical baffle. but at high Reynolds number this value goes on reducing.

VI. CONCLUSION

1) Nusselt number for solid semispherical baffle is slightly higher than the hollow semispherical baffle
2) Friction factor is slightly more for solid semispherical baffle than hollow semispherical baffle due to more resistance to flow.
3) Swirling motion is slightly higher in solid semispherical baffle so heat transfer rate in solid semispherical baffle is slightly more.
4) Heat transfer rate is slightly higher in solid semispherical baffle but pumping power is also required more

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