Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 4, April-2017

EXPRIMENTAL ANALYSIS OF SPIRAL HEAT EXCHANGER

Sunykumar Mistry [1], Sagar Patel[2], Jaykumar Shah [3], Snehal Patel [4], Professor Ketan Jambu [5]

[1]*Mechanical engineer, BITS EDU Campus,*
[2]*Mechanical engineer, BITS EDU Campus,*
[3]*Mechanical engineer, BITS EDU Campus,*
[4]*Mechanical engineer, BITS EDU Campus,*
[5]*Mechanical engineer, BITS EDU Campus,*

Abstract* — Correct selection of heat exchanger is very important factor for industries, Spiral heat exchangers are known as excellent heat exchanger because of compact structure and high heat transfer efficiency because of less fouling, easier cleaning and high heat transfer coefficient, Spiral heat exchanger is a good alternative to the other types of heat exchangers, especially when it's going to handle high fouling flow or high viscous fluid, Low fouling rate of heat exchanger, reduce the need of cleaning therefore out of service will be decreased. A new arrangement for flow of hot and cold fluids is employed for design, hot fluid flows in axial path while the cold fluid flows in a spiral path. To measure the performance of the spiral tube heat exchanger, its model is suitably designed and fabricated so as to perform experimental tests, With the help of some modification of plate in spiral heat exchanger, contact surface area for hot and cold fluid might have change therefore performance of spiral heat exchanger is also change by comparing with current heat exchanger we can get actual result.

***Keywords*- Spiral Heat Exchanger, Fins, Sand, Plate Type, LMTD.**

I. INTRODUCTION

The heat exchanger is the best application of heat transfer and Heat exchangers are devices application to transfer heat between dual or more fluid streams at different temperatures. A greater number of production facilities in industries use processes in which heat is transferred between different Medias. The basic principle of heat transfer is two fluids at different temperatures are placed in contact with a conductive wall, heat transfer begin from hot fluid to the cold fluid until both fluid reach the equal temperature level.

The driving force for heat transfer is the temperature difference levels between the hot & cold fluids, the greater the difference the higher the rate at which the heat will flow between hot and cold fluid. With complex processing sequences, designer must optimize the temperature levels at each stage to enhance the total rate of heat flow.

A second factor controlling the heat transfer is the area provided of the conductive wall for heat flow. The greater area the larger the amount of heat that should flow in a given duration with given temperature difference. The designer has to be minimize this area to provide cost effective solutions to his client with skill. The amount of area can be minimized and configured to reduce the ascendancy volume and overall cost.

The third and most crucial factor controlling the heat transfer is the rate at which the heat flows into and out from individual of the fluids. A high resistance is heat flow in either fluid will produce a slow overall rate of transfer. The level of resistance to heat flow determine from many different factors including the thermal characteristics of the fluids but can be affected by the designer in a very positive way through the generation of turbulence within the fluids to resist the creation of a thermally resistant static "boundary layer" of fluid in contact with the heat transfer surface.

The fourth factor also under the control of the designer, is the flow of heat through the conductive barrier between the fluids. The material selection has to be compatible with the fluids of the process, it will not corrode or contaminate food product, it must have an adaptable level of mechanical strength to prevail against working temperature and pressure it must have a lower resistance to heat flow so that it should not become the overriding factor in the heat transfer process. The basic examples of heat exchangers are boiler, condensers, radiators, electronics cooling, etc.

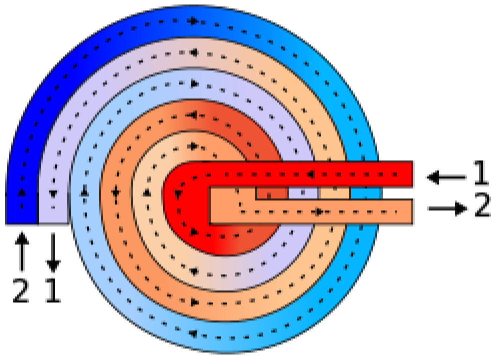


Fig. 1 Spiral Plate Type Heat Exchanger

1.1 Spiral Plate Heat Exchanger

The spiral plate heat exchanger is made by rolling two long metal plates around a center core to form two concentric spiral passages, one for each fluid. The plate edges are welded shut so that each fluid stays within its own passage and there is no flow bypassing or intermixing. Spacing within the passages is maintained by welded spacer studs although some designs do not require them. Due to its inherent circular design and large surface area to volume ratio, the spiral heat exchanger offers unique advantages over other types of heat exchangers like the shell and tube. Single and long curving flow passages with a uniform rectangular cross-section ensure superior flow distribution, intense turbulence, and high heat transfer coefficients (50-100% greater than shell & tubes). The spiral's single-flow passages induce high shear rates that scrub away deposits as they form. This self-cleaning effect reduces fouling and makes spiral heat exchangers ideal for handling tough fluids such as process slurries, sludge, and media with suspended solids or fibers. Spiral heat exchangers normally operate in true countercurrent flow for close approaches and temperature crosses. Occasionally a co-current flow design has major benefits, especially in cooling or heating fluids prone to gelation, burn-on, freezing or similar skin temperature related fouling. The spiral heat exchanger is compact and requires minimal space for installation and servicing. Removable covers provide easy access to interior heat transfer surfaces for field inspections, routine maintenance, or manual cleaning if required.

II. LITRATURE SURVEY

Ganesh Patil, Prof. (Dr.) C.H.Bhosale, Prof. N.N.Shinde, Prof.M.M.Wagh (2015) developed the phase change material based heat exchanger using organic and inorganic material.

Fig. 2 Experimental set up

Pitambar Gadhve and Shambhu Kumar (2012) expounded use such a surface dimple surface to enhance forced convection heat transfer. Heat transfer improvement is based on principle of scrubbing action of cooling fluid inside the dimple which serves turbulent mixing in flow and enhance heat transfer. An experimental set up has been designed and fabricated to study reaction of dimpled surface on heat transfer in rectangular duct. Results compared with flat surface tube and found heat transfer enhancement over the later one.

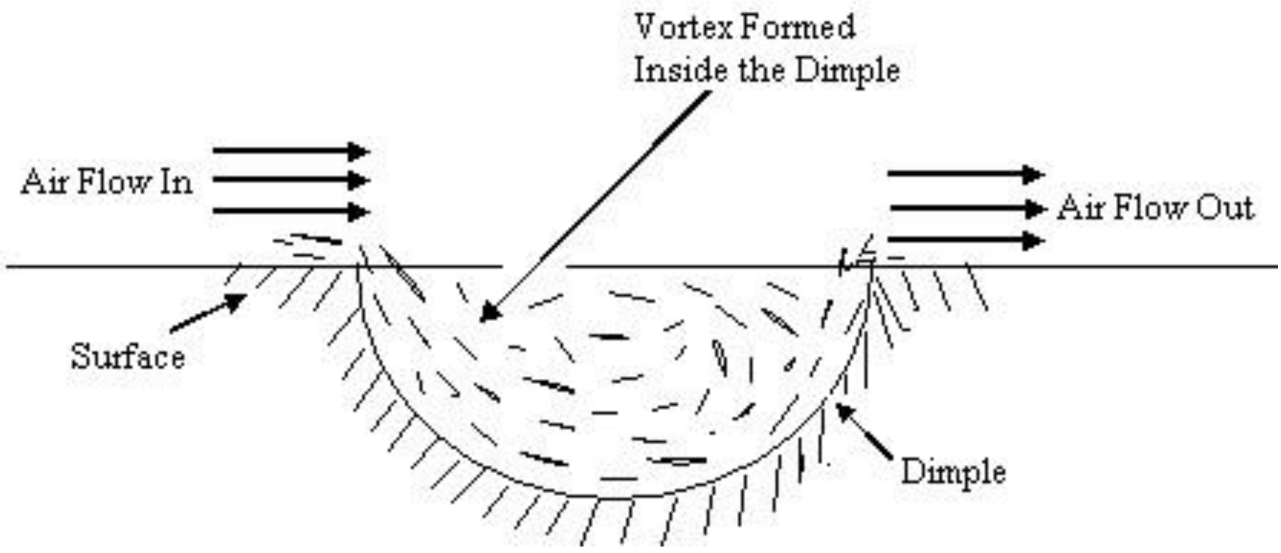


Fig. 3 Vortex heat transfer enhancement Mechanism

J.P. HARTNETT & W.J. MINKOWYCZ They were found the average in tube heat transfer co-efficient in spiral coil heat exchanger. The test section is spiral coil heat exchanger which have six layer of concentric spiral coil tube. They achieve the experiment result of tube heat transfer coefficient in spiral coil heat exchanger under dehumidifying conditions. They give the experimental equation and compare with the current correlation and obtain new correlation.

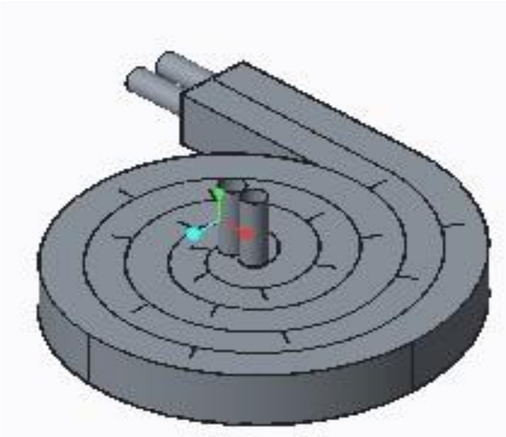
In 1985, Kanchan Chowdhury, Helmut Linkmeyer, M.KhalilBassiouny, Holger Martin have present the analytical studies on the temperature distribution in spiral heat exchangers Straight forward design formulae for efficiency and mean temperature difference. The temperature distribution in SPHE has been calculated numerically to obtain the efficiency and LMTD correction factor F as a function number of transfer units NTU, the number of turns n, and the heat capacity ratio C. It has been found that the LMTD correction factors, when plotted against the number of transfer units per turn NTU/n, fall approximately on a single curve, that curve for balanced counter current operation (C= -1) can be very closely representation of our numerical results it was concluded that a simpler physical model exist to represent the overall behaviour of a SPHE equally well. In fact, a counter current cascade of n concurrent heat exchangers does results exactly in above mentioned formulae for LMTD correction factor. From the model the F-factors for other heat capacity rate ratio C ($-1 < C \leq 0$) can be calculated and they are in sufficient agreement with the numerical results.

In 2007, M. Picon-Nunez, L. Canizalez-Davalos, G. Martinez-Rodriguez and G.T. Polley have present a shortcut design approach for Spiral heat exchanger. The approach consist of an interactive process where physical dimension like plate width and external spiral diameter are given initial value; convergence is achieved until the calculated pressure drop and heat duty meet the required specification of the design problem. The results of the application of the approach are compared with case studies reported in the literature. A numerical study using computational fluid dynamics is performed to the performance of the geometry. The temperature profiles of the exchanger calculated analytically show the same tendency as those obtained numerically; thus, the method provides a good starting point of estimating the dimensions of spiral heat exchangers in single phase applications.

P. Naphon proposed that the heat exchanger consist of a shell and helically coiled tube unit with two different coil diameters. Cold water and hot water are used as a working fluids in shell side and tube side. Mass flow rate of cold and hot water ranging between 0.10 and 0.22 kg/s, and between 0.02 and 0.12 kg/s. He concludes that temperature of Outlet cold water increases with increasing hot water mass flow rate. An average heat transfer rate increases as hot water and cold water mass flow rates increase. The friction factor decreases with increasing hot water mass flow rate. Inlet hot and cold water mass flow rates and inlet hot water temperature have important effect on the heat exchanger effectiveness.

G. E. KONDHALKAR & V. N. KAPATKAT gives the performance analysis of spiral tube heat exchanger over the shell and tube type heat exchanger. They conclude that the cost reduce while using spiral tube heat exchanger is around 15 –20 % as compared to shell and tube type heat exchanger and to establish that advancement in overall heat transfer coefficient as compared to shell and tube type heat exchanger from 400 to 650W/m2K. The process at higher velocity was not suitable. So it is oriented to keep the low velocity with more turbulence which is reduced fouling and increases the heat transfer rate as well as oil will not stick to the inner surface of the tubes.

III. 3D DESIGN



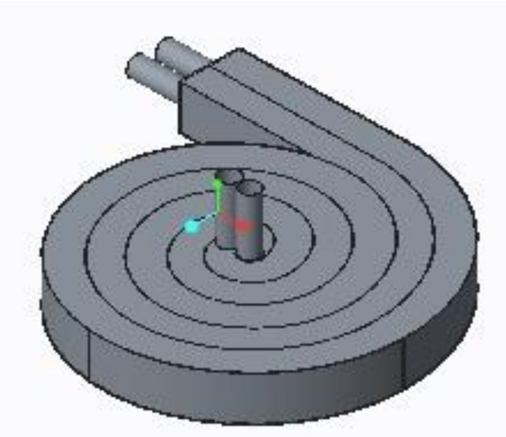


Fig. 4 with Fins Fig. 5 without Fins

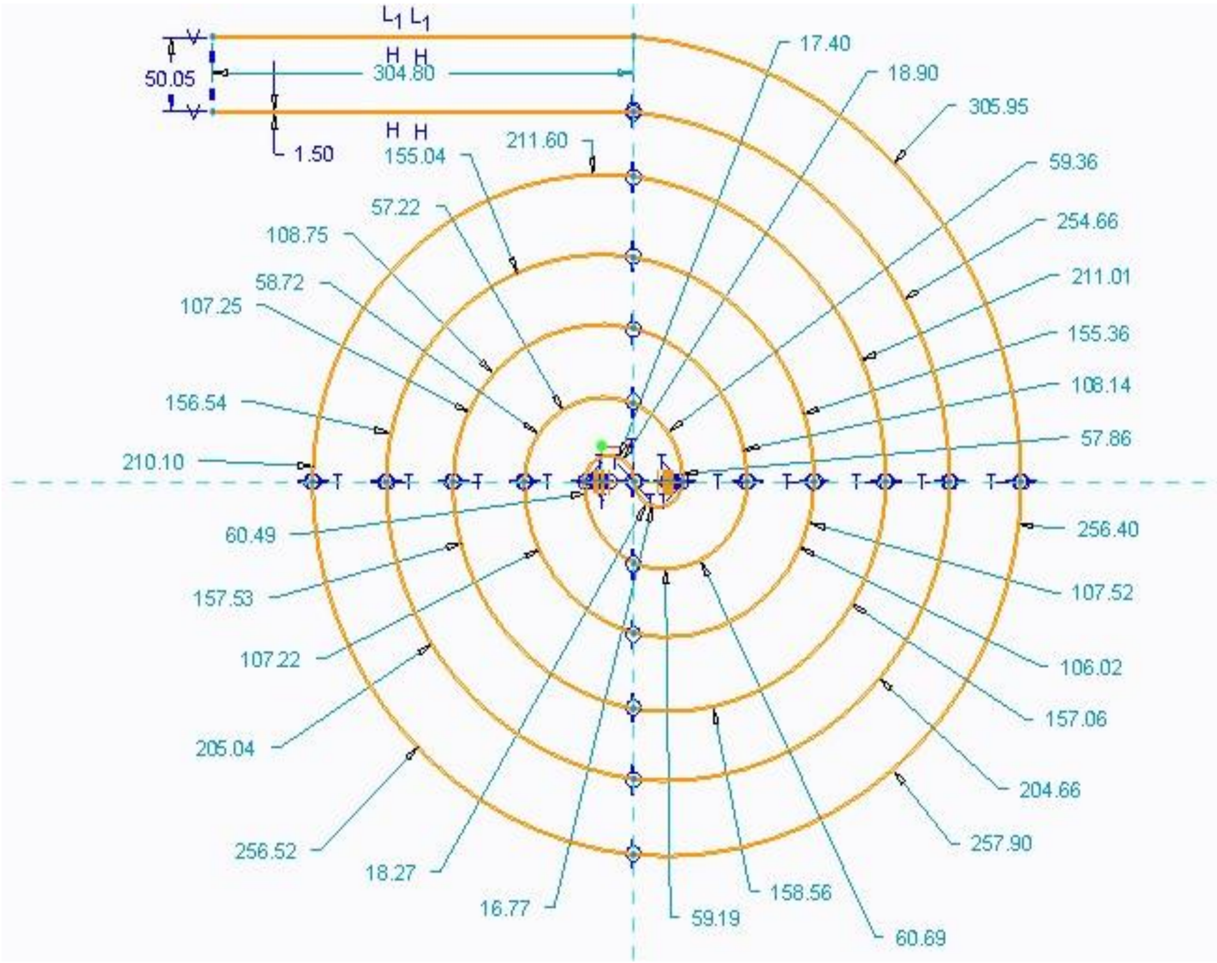


Fig. 6 Dimensions of Heat Exchanger

IV. EQUIPMENT'S FOR PRACTICAL

I. **Storage Tank**: Storage tank is used for storing hot and cold fluid.

Fig. 6 Storage Tanks

II. **Pump:** It is use for supply of water from storage tank to heat exchanger**.**

Fig. 7 Water pump

III. **Thermocouple:** It is measuring device to measure temperature of both hot and cold fluid from both inlet and outlet.

Fig. 8 Thermocouple

V. TEST RESULT

Fluid Type	Type of Heat Exchanger	Inlet(°C)	Outlet(°C)
Cold	With Fins	18.4	41.8
	Without Fins(Sand)	18.5	35.5
Hot	With Fins	60.1	33.1
	Without Fins(Sand)	60.3	44.7

VI. CONCLUSION

The study suggest that due to fins attachments on plates in heat exchanger, surface area is also increases compare to conventional spiral heat exchanger which is filled with sand. Due to Higher Contact Surface between Hot Fluid & Cold Fluid, Overall heat transfer co efficient and effectiveness of heat exchanger is also increases. Hence it could be said that efficiency of fins type spiral plate heat exchanger is greater than conventional heat exchanger.

IV. REFERENCES

[1] Kondhalkar G. E , Kapatkat V. N, " Performance Analysis of Spiral Tube Heat Exchanger used in oil extraction system" International Journal of Modern Engineering Research (IJMER), Vol.2, Issue.3, May-June 2012, pp-930-936.

[2] Dr.M.Thirumarimurugan, Dr.T.Kannadasan, A.Sivalingam, T.S.Krushnathej, Prof.S.Gopalakrishnan, "Experimental and Simulation Studies On SpiralHeat Exchanger for Miscible System Using Matlab" International Journal of Advanced Engineering Technology, Vol.II, Issue IV, OctoberDecember2011, 269-277.

[3] Paisarn Naphon, Somchai Wongwises, "A study of the heat transfer characteristics of a compact spiral coil heat exchanger under wet-surface conditions" Experimental Thermal and Fluid Science" 29, 2005, 511–521.

[4] Dr M A. Hossain, M I. Islam, S A. Ratul, MT U R. Erin, " Comprehensive Study on Heat Transfer Co-efficient and Effectiveness for Water Using Spiral Coil Heat Exchanger" Proceedings of the Global Engineering, Science and Technology Conference 2012, Dhaka, Bangladesh, 28-29 December 2012.

[5] Jay J. Bhavsar, V. K. Matawala, S. Dixit, "Design and Experimental Analysis of Spiral Tube Heat Exchanger, International Journal of Mechanical and Production Engineering, ISSN: 2320-2092, Volume-1, Issue-1, and July-2013.

[6] Rakesh Baghel and Sushant Upadhyaya, "Effect of Coil Diameter on Pressure Drop in Archimedean Spiral Coils" International Journal of Applied Engineering Research.ISSN 0973-4562, Volume 8, Number 18 , (2013), pp. 2151-2156.

[7] R.Rajavel1, K. Saravanan, "An Experimental Study of Spiral PlateHeat Exchanger for Electrolytes" Journal of the University of Chemical Technology and Metallurgy, 43, 2, 2008, 255-260.

[8] S. Ramachandran, P. Kalaichelvi and S. Sundaram, "Heat Transfer Studies in a Spiral Plate Heat Exchanger for Water – Palm Oil two Phase System" Brazilian Journal of Chemical Engineering, July - September, 2008, Vol. 25, No. 03, pp. 483 - 490.

[9] Kaliannan Saravanan,Rangasamy Rajavel, "An Experimental Investigation of Heat Transfer Coefficients for Spiral Plate Heat Exchanger" Modern Applied Science,Vol.2,No.5,September 2008.

[10] A.Mohamed Shabiulla and S.Sivaprakasam, "Experimental Investigation and Neural Modeling of Water-Butanol System in a Spiral Plate Heat Exchanger"International Journal of Application or Innovation in Engineering & Management" Volume 2, Issue 9, September 2013.