Research Paper Engineering

A Review on Performance Evaluation and CFD Analysis of Double Pipe Heat Exchanger

* H. S. Patel ** R. N. Makadia

* P.G. Student, School of Engineering, RK University, Rajkot, Gujarat, India

** Assistant Professor, School of Engineering, RK University, Rajkot, Gujarat, India.

ABSTRACT

Double pipe heat exchanger is one of simplest type of heat exchanger, generally used for the purpose of sensible heating or cooling. In this paper it describes the different techniques which may help to enhance the heat transfer rate. Heat exchangers are modified in space of annular, also using Nano particle in water and compared with the conventional heat exchanger. Double pipe heat exchanger is practically investigated and results are validated with Ansys CFX software. Results shows that heat transfer rate of modified heat exchanger are higher than the conventional heat exchanger. As Nano particles dispersed in water can significantly enhance heat transfer rate and also heat transfer rate increase with increase of mass flow rate.

Keywords : Heat exchanger, extended surfaces, twisted tape, louvered strips

INTRODUCTION

Double pipe heat exchangers are the simplest device in which heat is transferred from the hot fluid to the cold fluid through a separating cylindrical wall. It consists of concentric pipes separated by mechanical closures. Inexpensive, rugged and easilymaintained, they are primarily adapted to high-temperature, high-pressure applications due to their relatively small diameters. Double pipe heat exchangers have a simple construction. They are fairly cheap, but the amount of space they occupy is generally high compared with the other types. The amount of heat transfer per section is small, that makes the double pipe heat exchangers a suitable heat transfer device in applications where a large heat transfer surface is not required.[1]many engineering techniques have been devised for enhancing the rate of convective heat transfer from the wall surface[2,3]. The use of tabulator elements is a typical example of this application to increase the heat transfer coefficient from the flow surface through an increase in turbulent motion. In general, enhancing the heat transfer can be divided into two groups. One is the passive method, without stimulation by the external power such as a surface coating, rough surfaces, extended surfaces, turbulent/swirl flow devices, the convoluted tube, and additives for liquid and gases. Method, which requires extra external power sources, for example, mechanical aids, surface-fluid vibration, injection and suction of the fluid, jet impingement, and use of electrostatic fields considered as an active method.Those methods are, for instance, the insertion of twisted stripes and tapethe insertion of coil wire and helical wire coil [4,5] and the mounting of turbulent decaying swirl flow devices [6–8] in several heat exchangers. Another concept in augmenting heat transfer rate by using small louvered strip inserts is developed and investigated experimentally. The strips are mounted on the brass wire or core rod, placed inside the inner hot water tube. The strips are expected to induce a rapid mixing and a high turbulent and longitudinal vortex flow like a delta wing, it resulting an excellent rate of heat transfer in the tube.

LITERATURE SURVEY

C.K.Pathi and Dr. Prashant Baredar. (2012)

Presented experimental study on double pipe heat exchanger as performance improvement of double pipe heat exchanger by using tabulator. In this experiment U-bend double pipe heat exchanger is used and reading was taken under three different situations one with inner tube smooth and rest two by using twisted tape inside the tube.

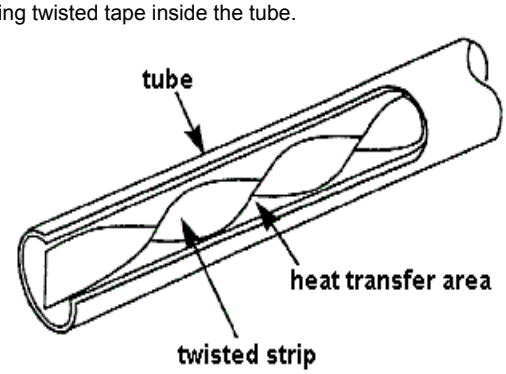


Fig.1 Twisted strip inside tube

First reading was taken for smooth tube under different mass flow rate. And after that smooth tube is removed from heat exchanger and twisted tape is inserted. Here two twisted tape is used and they differs by their twisted ratio. So reading was taken for both twisted tape. And as per the result as compare to conventional heat exchanger the augmented has shown a significant improvement in heat transfer coefficient by 61% for twisted tape 1 and 78% for twisted tape 2. When only heat transfer capacity of heat exchanger is criteria regardless of pressure drop and pumping power twisted tape is more superior as compared to smooth tube. On equal pressure drop and equal pumping power smooth tube is better than twisted tube. Twisted tape of lower twisted ratio gives higher heat transfer coefficient than higher twisted ratio. [9]

M.kannan and S, Ramu et al. (2012)

Presented experimental comparison of different types of heat transfer enhancement techniques in heat exchanger by extended surfaces. They presented four double pipe heat exchangers, one of them is simple heat exchanger and rest three is modified. These three modified heat exchangers are different by their annulus modification.

Fig.2 Methods of extended surfaces

Fig.2 shows the modification of inner tube of outer surface by providing fin, spiral rod, annular. The results of this experiment are simulated by the Fluent. As per the results of heat transfer rate minimum heat transfer covered by a heat exchanger without modification.

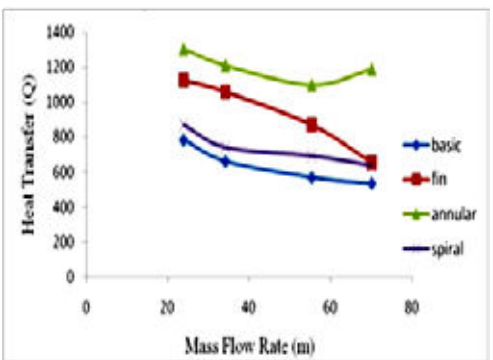
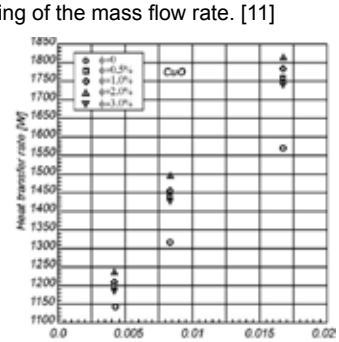


Fig.3 Average heat transfer v/s mass flow rate

As compared to simple heat exchanger modified heat exchanger gave greater heat transfer. As per the graph shown in fig.3 mass flow rate v/s heat transfer, the maximum heat transfer obtains by the annulur method than the fin and spiral rod. [10]

Gabriela Huminic and Angel Huminic. (2011)
Presented heat transfer characteristics of double-tube helical heat exchangers using Nano fluids under laminar flow conditions. CuO and TiO2 nanoparticles with the diameter of 24nm dispersed in water with volume concentration level of 0.5-3% are used as the working fluid. The effect of particle concentration level on the heat transfer characteristics of Nano fluids and water are determined Fig.4 shows the Heat transfer rate for nanofluids at different particle concentration level. And fig.5 shows Heat transfer rate for water at different mass flow rate. From the results of it was found out that the use of CuO and TiO2 nanoparticles as the dispersed in water can significantly enhance the convective heat transfer. Also, outlet water temperature increases with increasing particle concentration level from the inner tube. Convective heat transfer coefficients of the Nano fluids and water increased with increasing of the mass flow rate. [11]



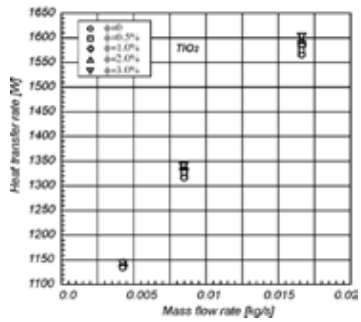


Fig. 4 Heat transfer rate for Nano fluids at different particle concentration level.

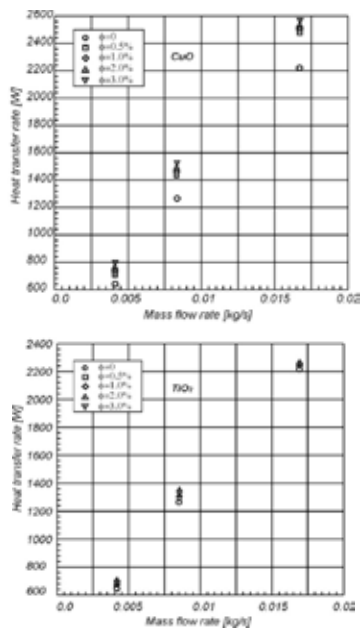


Fig. 5 Heat transfer rate for water at different mass flow rate.

Smith Eiamsa-ard and Somsak Pethkool et al. (2007)

In this work, heat transfer and friction characteristics were experimentally investigated, employing louvered strips inserted in a concentric tube heat exchanger. The louvered strip was inserted into the tube to generate turbulent flow which helped to increase the heat transfer rate of the tube. The flow rate of the tube was in a range of Reynolds number between 6000 and 42,000. The turbulent flow devices were consisted of (1) the louvered strips with forward or backward arrangements, and (2) the louvered strip with various inclined angles (θ=15°, 25° and 30°), inserted in the inner tube of the heat exchanger.

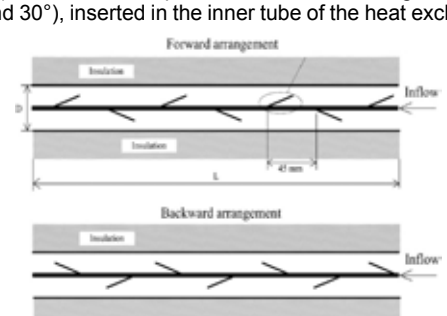


Fig. 6 Louverd strips with forward and backward arrangement

Louvered strip insertions can be used efficiently to augment heat transfer rate because the turbulence intensity induced could enhance the heat transfer. The highest heat transfer rate was achieved for the backward inclined angle of 30°

due to the increase of strong turbulence intensityAll inclined louvered strip arrangements would significantly enhance the heat transfer in comparison with the plain tube.The use of the louvered strip with backward arrangement leaded to better overall enhancement ratio than that of forward arrangement around 9% to 24% for all inclined angles. The mean overall enhancement ratio was around 1.17 to 1.98 for backward arrangement, and 1.11 to 1.8, for forward arrangement. [12]

CONCLUSION

From the above literature survey it may conclude that heat transfer augmentation techniques is successful to increase heat transfer performance of double pipe heat exchanger. Heat exchanger with the modification of extended surfaces, twisted tape, and louvered strips are resulted greater heat transfer rate as compared to heat exchanger without modification. As Nanoparticles dispersed in water can significantly enhance the convective heat transfer and heat transfer rate increases with the increase of mass flow rate.

REFERENCES

[1] M A Mehrabian, S H Mansouri and G A Sheikhzadeh, "The Overall Heat Transfer Characteristics of A Double Pipe Heat Exchanger: Comparison of Experimental Data with Predictions of Standard Correlations" IJE Transactions B: Applications, 395-406, Vol. 15, No. 4, December 2002 | [2] R.L. Webb, Advances in modeling enhanced heat transfer surfaces, Proceeding 10th International Heat Transfer Conference, vol. 1, Hemisphere, Washington, DC, 1994, pp. 445–459. | [3] A.E. Bergles, Heat transfer enhancement-the encouragement and accommodation of high heat fluxes, Transaction ASME, Journal Heat Transfer119 (1995) 8–19. | [4] K. Yakut, B. Sahin, The effects of vortex characteristics on performance of coiled wire turbulators used for heat transfer augmentation, Applied Thermal Engineering 24 (2004) 2427–2438. | [5] R. Sethumadhavan, M.R. Rao, Turbulent flow heat transfer and fluid friction in helical-wire-coil-inserted tubes, International Journal of Heat and Mass Transfer 26 (1983) 1833–1845. | [6] M. Yilmaz, O. Comakli, S. Yapici, Enhancement of heat transfer by turbulent decaying swirl flow, Energy Conversion and Management 40 (1999) 1365–1376. | [7] M. Yilmaz, O. Comakli, S. Yapici, O. Nuri Sara, Heat transfer and friction characteristics in decaying swirl flow generated by different radial guide vane swirl generators, Energy Conversion and Management 44 (2003) 283–300. | [8] Aydin Durmus, Ayla Durmus, M. Esen, Investigation of heat transfer and pressure drop in a concentric heat exchanger with snail entrance, Applied Thermal Engineering 22 (2002) 321–332. | [9] "Performance improvement of double pipe heat exchanger by using tabulator" C.K.Pardhi, Dr. Prashant Baredar, IJESET, vol-2, issue-4, 881-885 | [10] "Experimental and Analytical comparison of heat transfer in double pipe heat exchanger"M.Kannan, S.Ramu, S.Santhanakrishnan, G.Arunkumar, Vivek.M Vol-03, issue-03, 2012(2249-6564) | [11] "Heat transfer characteristics in double tube helical heat exchangers using nanofluid"Gabriela Huminic and Angel Huminic, 2011(4280-4287) | [12] Smith Eiamsa-ard, Somsak Pethkool , Chinaruk Thianpong , Pongjet Promvonge, 2007 "Turbulent flow heat transfer and pressure loss in a double pipe heat exchanger with louvered strip inserts" 0735-1933, doi:10.1016/j.icheatmasstransfer.2007.07.003