IJARST
International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

A STUDY OF HEAT TRANSFER REVIEW IN CONICAL HEAT EXCHANGERS

CANDIDATE NAME- BHOITE PRASHANT DATTATRAYA
DESIGNATION- RESEARCH SCHOLAR SUNRISE UNIVERSITY ALWAR
GUIDE NAME- DR. NITESH KR. DIXIT
DESIGNATION- Assistant professor SUNRISE UNIVERSITY ALWAR

ABSTRACT

The purpose of this research is to give a systematic overview of the relevant literature by comparing and contrasting different elements of heat transfer performance in conical heat exchangers. The effective transfer of heat from one fluid to another is essential to many manufacturing processes, and heat exchangers play a key role in this. Due to their distinct geometric form, conical heat exchangers may be superior to more conventional heat exchanger designs in terms of heat transfer efficiency. An extensive literature assessment, including both experimental and computational investigations of conical heat exchangers, forms the basis for the comparative analysis. The main concern is how well these exchangers function in contrast to their more traditional equivalents in terms of heat transfer efficiency, pressure drop, and overall performance. The effect of variables such fluid flow rates, shape, material qualities, and operating circumstances on heat transfer performance is investigated.

KEYWORDS: Heat Transfer, Conical Heat Exchangers, manufacturing processes, computational investigations.

INTRODUCTION

Refrigeration and air conditioning, steam power plants, nuclear reactors, the chemical and food processing industries, and medical equipment are only a few examples of the many industrial uses for heat exchangers. The efficiency of a heat exchanger may be increased, and the amount of surface area needed for heat transmission can be decreased, by increasing the heat transfer coefficient. In order to improve heat transmission, several methods are documented. These methods of improving heat transport may be classified into three broad categories: active, passive, and compound.

PASSIVE TECHNIQUES

Passive methods are those that can function without direct application of energy from an outside source. These methods take use of the pressure drop inside the system to generate electricity. Inserts and other devices are often used in passive approaches to bring about a change in geometry or the flow surface. These modify the current flow pattern to boost heat transfer coefficients. The following are examples of such methods:

1. *Tubes in coiled form*: The secondary flow created by the tube's curvature aids in the heat transmission process. These setups find widespread use in both single-phase and boiling (phase-change) environments. Shell and tube heat exchangers are among the most space-efficient options available.
2. Surface treatment refers to the process of imparting a chemical or physical change to a surface, often in the form of a coating. The surface coating or treatment might be uniformly applied or spotty. Condensation and boiling are two common applications of these methods.

3. rough surfaces: in single-phase flows, turbulence increases as a result of surface alterations. There is no change in the heat transmission surface area. The rough surfaces, which may range from a sand particle variety to distinct protuberances, are developed using a number of different techniques.
4. you should use expanded surfaces, since doing so effectively improves heat transmission. The advent of new types of extended surfaces has led to altered flow patterns. The heat transfer coefficient is improved by the fins, which modify the flow field by increasing the surface area available for heat transmission. Heat transfer coefficients have been enhanced by the use of non-traditional extended surfaces, such as integrated inner and outer finned tubing.
5. Fifth, in constrained settings of forced convection flow, utilize displacement augmentation devices, which are various sorts of inserts. In order to improve heat transmission, these devices divert fluid away from the core flow of the duct, where it would otherwise be heated or cooled.
6. Making use of swirl-flow apparatuses: In the axial flow area, these devices create what is known as swirl flow or recirculation flow like secondary flow. Vortex generators, inserts like twisted-tape, and screw-type axial-core inserts are just a few examples of geometric modifications that may be used to induce rotating and/or secondary flow in a tube. Single-phase and phase-change applications are only two places where these gadgets may shine.
7. Surface wicking and surface grooving are two common examples of surface-tension devices that may be used to increase the surface tension of a fluid. Boiling and condensation are two processes where these surface tension devices shine.
8. In this method, single-phase fluid flow is modified by the introduction of various additives, such as gas bubbles, dissolved particles that can be tracked, and suspended solids. Using these adhesives decreases surface tension, which improves heat transmission in systems that are boiling.
9. Single-phase gas flows may include the addition of solid particles or liquid droplets in the form of a dilute (gas in solid suspensions) or dense (fluidized bed systems) phase.

ACTIVE TECHNIQUES

Active methods are those that need some kind of external power source in order to improve heat transmission.

These methods include the use of external power to enable the desired change of the flow. These methods improve the rate of heat transmission. The following are examples of methods:

1. *Use of mechanical aids:* In order to ensure thorough mixing, several tools are utilized, such as spinning surfaces or mechanical techniques. Examples of such methods are scraped surface and rotating surface tube heat and mass exchangers.
2. Low- and high-frequency surface vibration improves heat transmission by altering the flow field. These methods are often used in single-phase flows with the goal of maximizing heat transfer.

3. fluid vibration, in which particle vibrations are used to modify the flow field. Heat transport is improved by this modification to the flow field. These heat exchangers use vibrations to transfer heat from one medium to another.
4. The fourth kind of enhancement strategy involves the use of electrostatic fields (dc or ac) to alter the flow field in a way that benefits the enhancement process. Heat exchangers are a common use of electric and magnetic fields. Increased bulk mixing and/or induced convection (by electromagnetic pumping) improve heat transmission.
5. Injection is used to feed gas to liquid via a porous heat transfer surface or to inject the same kind of fluid upstream of the heat transfer section. Liquid surface degassing is similar to gas injection in that it results in an improvement.
6. The sixth technique is the use of suction, where liquid is pulled from a single-phase flow via a heated porous surface, or vapor is taken from a nucleate or film boiling application through a heated porous surface.
7. The degree of improvement achieved via the use of jet impingement is determined by whether the flow of the heating or cooling fluid is perpendicular or oblique to the heat transfer surface.

COMPOUND TECHNIQUES

Compound approach refers to the employment of two or more enhancement methods in conjunction to increase heat transfer. The combined effect of the two methods is greater than the sum of their separate contributions. Similar restrictions are placed on the compound procedures due to the difficulty they entail.

Researchers have shown again and again the usefulness of various heat transfer improvement strategies across a wide range of industrial settings. Researchers pay a lot of attention to passive approaches because to their self-improving qualities and low maintenance needs in practical implementations.

The secondary fluid motion in a coiled or curved tube is caused by the constant curvature of the tube, which alters the flow's direction. This causes a localized reduction in fluid flow speed. Reportedly providing a greater heat transfer coefficient with a compact form, helical coil tube heat exchangers are becoming popular. Secondary flow is formed in a helical coiled tube owing to centrifugal force, and this has been documented by several researchers. When fluid particles in the tube's core move at a faster rate than those near the tube's inner wall, a secondary flow develops. Particles in the fluid closest to the tube wall experience a boundary layer with lower axial velocity and less centrifugal force than those further from the wall. To establish the secondaries in the tube, the fluids must be pushed toward the tube wall, where the velocity is lowest, where the centrifugal force is greatest.

Many researchers have shown that helical coil tube heat exchangers perform better than their straight tube counterparts when it comes to transferring heat. Because of the secondary flow created in the fluid, the heat transfer rate is improved as it travels down the curved tube. These byproducts arise from the centrifugal force exerted on particles of the fluid as it moves around a curve. In particular, the laminar flow regime is where the benefits of the flow phenomena are maximized. Jeschke [10] found that the heat transfer coefficient for coiled tubes was significantly different from that for straight tubes. It was suggested that the factor basis parameter on curvature ratio () should be as follows:

$$Nu_c = Nu_s[1 + 3.5(r/R)] \qquad \text{------ 1}$$

He demonstrates that this factor, i.e. (1 + 3.5 (r / R)), is inaccurate and that further improvement may be gained in the heat transfer coefficient in the sequential research by Seban and McLaughlin.

The coiled tube form has been identified in the literature as a significant passive heat transfer augmentation approach. Coiled tube topologies are often used in heat transfer devices due to their many benefits.

1. *High heat transfer coefficient:* The secondary flow within the tube is responsible for the effective mixing of the fluid on the tube's inner and outer walls, and it is also responsible for the reduction of the laminar boundary layer that forms on the tube's inner surface as a result of the high heat transfer coefficient.
2. Size reduction: As the heat transfer coefficient rises, the heat exchanger may be made smaller and the whole system can be made more compact.
3. High-temperature operations become feasible when coils are manufactured in a single continuous tube. Extreme temperature differences and thermal shocks are no match for them.
4. Since just one seamless tube is utilized in their construction, induced stresses are minimized, and the coil design allows for plenty of room for thermal expansion.
5. Fewer or no expansion joints are needed since thermal expansion of the tube may be readily handled by the coils themselves.
6. Coils are constructed with a single continuous tube, making it possible to readily manage high pressure.
7. By increasing the turbulence in the tube when secondary flows emerge in a coiled shape, the fouling tendency of the tube is decreased and its cleaning tendency is enhanced.
8. As individual modules will be created for each coil, the design must be modular. It offers the benefits that come with a modular structure.

The helical coil design is widely used in reactors and heat exchangers because to the high heat transfer coefficients and limited residence times that may be accommodated in relatively small volumes. Heat transfer, pressure drop, and flow pattern information is necessary due to the widespread use of helical and spiral coiled heat exchangers.

HELICAL AND SPIRAL COIL HEAT EXCHANGERS

In a shell and coiled tube heat exchanger (Fig. 1), the helical and spiral coiled tube arrangement is the most common. High heat transfer coefficients, a small footprint, less of a propensity to foul, and a flexible, modular design are just a few of the reasons why coiled tube topologies are so popular.

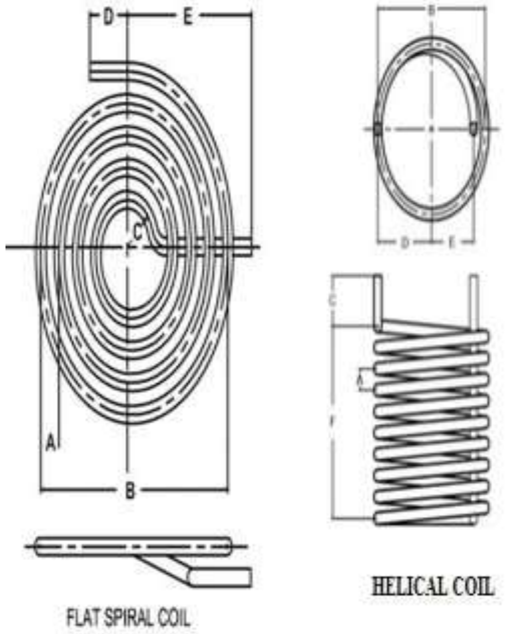

Figure 1 Spiral and helical coiled tubes for heat exchanger

Because secondary flows form within the coiled tube, its heat transfer coefficient is improved. Centrifugal forces acting on the moving fluid cause the secondary flow pattern to emerge perpendicular to the main axis (Figure 2). Two vortices form as a result of this secondary flow pattern. The fluid follows the vortices as they travel from the tube's inner wall through the tube's center to the outside wall. When the fluid reaches the outside wall, it returns to the inner wall by following the wall. As the fluid is carried by the secondary flow over the temperature gradient, heat transfer rates rise. Since the flow is perpendicular to the axial flow, the typical process in straight tube heat exchangers (apart from buoyancy forces) is supplemented by convective heat transfer.

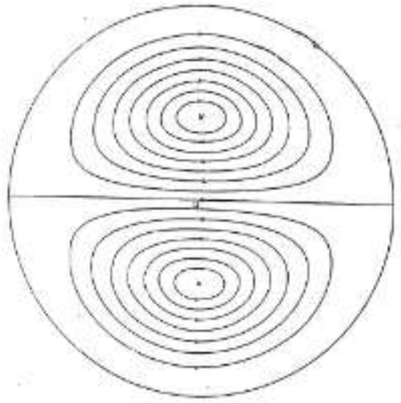

Figure 2 Secondary flow developed in the curved tube

Both the coil diameter (D) and the tube diameter (d) have a role in the strength of the secondary flow that develops in the curved tube. In the laminar flow region, this phenomena is quite useful. The produced secondary intensities are large in relation to the tiny coils and tube diameters. At the same flow rate, the heat transfer coefficient (hi) is increased due to the enhanced mixing of the fluid. Because the strength of the secondary effects diminishes with increasing coil diameter, the heat transfer coefficient (hi) also decreases.

Since the helical coil heat exchanger's coil diameter is constant throughout its length, so too is the intensity of the secondaries it generates. For a coiled tube of a particular diameter, the total effect is always hi. The local hi varies from the innermost to the outermost segment of a coil in a spiral design because to the continual change in coil diameter. Hi is much greater near the core of the spiral than it is at its periphery.

The pressure difference (P) across a coil is affected by secondary currents created inside the coil. The pressure drop rises with the strength of the secondary flow. Changes in the flow pattern in the tube as a result of stronger secondary flow diminish the establishment of a laminar boundary layer in the coiled tube, leading to a greater pressure drop. Due to the helical coil's constant coil diameter and the spiral coil's variable coil diameter, the helical coil configuration exhibits less pressure drop than the spiral coil arrangement for the same mean coil diameter. Helically wound coils perform better than spirally wound ones in terms of heat transmission and shell side pressure drop, but spiral coils have the upper hand when it comes to space savings and the bypass factor.

CONCLUSION

Conical coils with five different cone angles (0 degrees, 45 degrees, 90 degrees, 135 degrees, and 180 degrees) and three different tube diameters (8 mm, 10 mm, and 12 mm) were built and utilized to investigate heat transmission and pressure drop. In order to produce data for coil heat exchangers, both hot water (on the tube side) and cold water (on the shell side) are used.

REFERENCES

1. Abdalla, M.A., “A four-region, moving-boundary model of a once through, helical coil steam generator”, *Annals of Nuclear Energy*, Volume 21(9), (1994), pp. 541-562.
2. Berger, S.A., Talbot, L, Yao, L.S., “Flow in curved pipes”, *Ann. Rev. Fluid Mech.*, Volume 15, (1983), pp. 461-512.
3. Bai, B., L. Guo, Z. Feng, X. Chen, “Turbulent heat transfer in a horizontally coiled tube”, *Heat Transfer-Asian Research*, Volume 28(5), (1999), pp. 395403.
4. Rao, B.K., “Turbulent heat transfer to power law fluid in helical passage”, *International Journal of Heat and Mass Transfer*, Volume 15(2), (1994), pp. 142-148.
5. Sandeep, K.P., Palazoglu, T.K., “Secondary flow in coiled tubes”, Presented at the *1999 ASAE, Annual International Meeting. Paper No. 996148. ASAE, 2950*, Niles Rd., St. Joseph, MI 49085-9659 USA, (1999).
6. Genssle, A, Stephan. K, “Analysis of the process characteristics of an absorption heat transformer with compact heat exchangers and the mixture”, TFEE181, *International Journal of Thermal Sciences*, Volume 39, (2000), pp. 30-38.
7. Bergles, A.E., “Handbook of Heat Transfer”, McGraw-Hill, New York, NY, USA, 3rd edition (1998).
8. Bergles, A.E., “The implications and challenges of enhanced heat transfer for the chemical process industries”, *Chemical Engineering Research and Design*, Volume 79, no. 4, (1998), pp. 437–444.
9. Diwan, A., Mahanta, P., Sumitra Raju, K., Suresh Kuamr, P., “Review of passive heat transfer augmentation techniques”, *Proc. Instn. Mech. Engineerss,* Vol. 218, Part A, (2004), pp. 509-527.
10. Jeschke, D, “Heat transfer and pressure loss in coiled pipes”. *Ergaenzungsheft* Z. Ver. Disch. Ing., Volume 68, (1925), pp. 24-28.
11. Seban, R.A., McLaughlin, E.F, “Heat transfer in tube coils with laminar and turbulent flow”, *International Journal of Heat and Mass Transfer*, Volume 6, (1963), pp. 387-395.

12. James, R., Lines, “Helical Coiled heat exchangers Advantages”, *Bulletin by Grahams Manufacturing Co. Inc., Batavia,* NY, (2004).