A Review on use of turbulator for the enhancement of Heat exchanger performance

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***Abstract*: Heat exchanger is a device which is mainly use to transfer heat in between two fluids with are separate from each other. For increase the performance of heat exchangers baffles and turbulators are used. Turbulators are mainly used to create turbulence inside the heat exchanger. It is mainly used to increase the turbulence intensity inside the heat exchanger. So for the betterment and to improve the performance of heat exchanger, design of turbulator play an important role. Here in this work, a complete review on turbulator used in heat exchanger was done.**

1. Introduction

A Heat Exchanger may be stated as a device which transfers energy from a hot fluid to a cold fluid, either maximum or minimum rate within least investment as well as operating cost. In this process never two fluids mixed with each other. Heat exchanger is the main unit in action that gives the efficiency as well as security to numerous of the processes. In such type of job we have to estimate the enactment of the heat exchangers of different types that is tubular, plate and shell & tube. All these heat exchangers may be functioned in both parallel as well as counter flow arrangements. The heat exchanger is accomplished amongst hot and cold water. This device offers a thermal energy flow among two or more fluids at some temperatures. Shell and tube heat exchangers are most useful type of heat exchanger likewise utilized in an extensive range of industrial uses like power generation, heat recovery in wastage system, engineering firms, cooling and refrigeration, space applications, petrochemical activities and many different areas. The foremost attentions regarding the effectiveness of shell tube heat exchanger are comes in a region of turbulence, drop in pressure, coefficient of heat exchanger, fouling, as well as percentage or aggregate of stream rates on tube to shell side, length of heat exchanger as well as turbulator types. By increasing the turbulence power level, conflict to the flow also extended, which advanced the heat exchanger effectively. Heat exchanger rate may be developed with huge loss of pressure though it stimulates to increase in power consumption, which is its real downside.

2. Types of heat exchanger and turbulators

In order to meet the extensively ranged application, numerous type of heat exchangers is been established which are categorized on the basis of behaviors of heat exchanger process, relative path of fluid motion, design and constructional structures, and bodily state of fluids. Can be defined by the fundamentals of conduction, convection, radiation and evaporation or condensation.

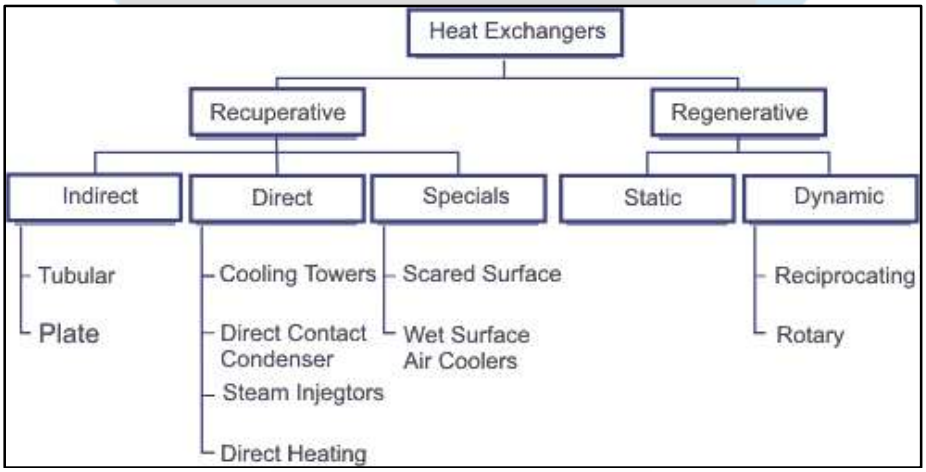

Fig. Heat exchanger classifications

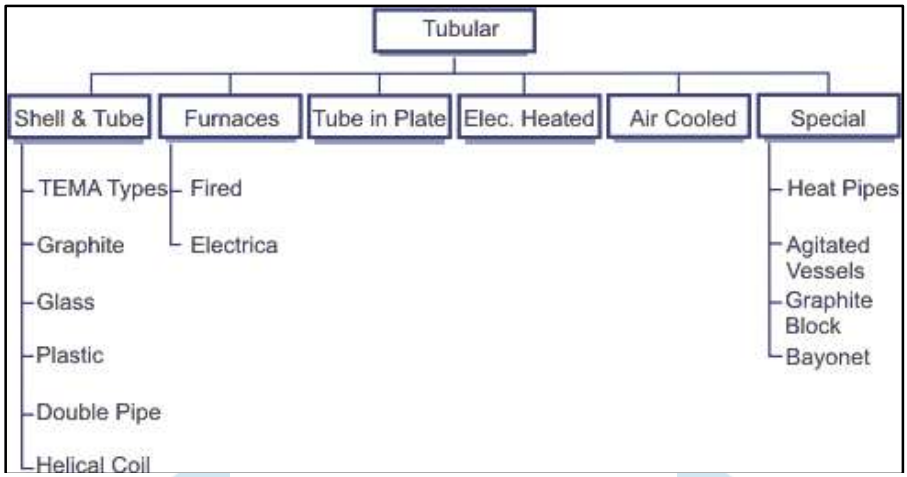

Fig. Tabular heat exchanger classification

3. Turbulator

Turbulator are flow leading or impeding blades or pieces utilized in some industrial process vessels (tanks), such as shell tube heat exchangers, chemical reactors, and static mixers. Turbulator are an essential portion of the shell tube heat exchanger intention. A turbulator is analyzed to maintain tube packs as well as straight the stream of fluids for maximum efficiency. Turbulator analysis and forbearances for heat exchangers are conversed in the ideals of the Tubular Exchanger Manufacturers Association. Shell roundness is significant to attain effective fastening alongside unnecessary bypass. Turbulator must be prepared from a range of resources well-matched with the shell side liquid. They can be perforated or machined. Some of the turbulator are prepared by a press which offers a lip nearby the tube hole to give extra surfaces alongside the tube as well to remove tube wall cutting from the turbulator verge.

Fig 1.6 [Ref. 7] Discontinuous helical turbulators (a) typical, (b) Perforated; (c) Samples of helical turbulator

The persistence of longitudinal turbulator is to maintain the complete stream track of the shell fluid such that a preferred overall flow pattern of the two fluid flows being accomplished. For example, two-pass shell through longitudinal turbulator, split flow, double split flow. Transverse turbulators have been categorized as plate turbulators and grid. Plate turbulators are solo segmental, double-segmental, and triple-segmental, non-tubes-in-window segmental turbulator and disk-and-doughnut turbulator.

4. Introduction

Many of the researchers have work on heat exchanger to increase the performance of heat exchanger using different methods. Many of the researchers use different type of turbulators to increase the performance of heat exchanger.

Sheikholeslami et.al [1] (2018) Impact of distinctive and perforated uneven helical turbulators on flow and in transfer of heat in an air to water double pipe heat exchanger are practically analysed. According to the practical facts, relationships among Nusselt number, friction factor and performance of thermal parameter are accessed as functions of distinct constraints. Non-dominated Sorting Genetic Algorithm II is in action to get the maximum high efficiency of designed heat exchanger. Practical steps are being showed to examine flow to be turbulent and transfer of heat in an air to water heat exchanger prepared with usual and perforated intermittent helical turbulators. Impacts of the Reynolds number, ratio of open area and ratio of pitch on loss in pressure and transfer of heat enhancement are observed. Relationships among Darcy factor, Nusselt number and performance of thermal parameters are obtained.

Zhouhang Li et.al [2] (2017) Helical coils have gained ever more interest in the area of carbon dioxide of supercritical range with Rankine cycles through the past era due to the dense assembly and great rate of heat transfer. Previous analyses basically concentrated on influence of operational conditions and with the gravitational upthrust, and are not satisfactory to properly comprehend the behaviour of supercritical carbon dioxide gas heaters with helically coiled. Impact of few different main elements, such as the alignments of coil and roughness of inner wall, on full enactment that's been rarely stated and is still uncertain to date.

In this work we filled such opening with a solid to fluid conjugate model of heat transfer where supercritical turbulence flow is explained by the Shear Stress Transport k-u functions. Impact of coil alignments and inner rib roughness on transfer of heat of supercritical carbon dioxide which have been inspected in helical coiled tubes with different dimensionless curvature.

Ali et.al (2017) [3] This paper defines the thermal analysis of reclined parallel to surface of the ground and upright at right angle to surface of the ground, slinky horizontal ground heat exchangers wit ground about the sprawled horizontal ground heat exchangers due to extraction of heat, as well as the influence of deviation in temperature of ground on reclined horizontal ground heat exchangers performance. The thermal performance improvements by intermittent operations of ground heat exchangers are also discussed. Moreover, the allocations of temperature of the unobstructed ground and temperature of the environs are also taking into account. The evaluated unobstructed temperature of ground data delivers a useful needle of the installation of ground heat exchangers at an appropriate deepness for heating as well as cooling purposes.h changed water rates of mass flow in the reheating manner of constant and discontinuous actions.

Pawar et.al (2016) [4] In past few eras many of the mechanical, practical and mathematical models are being existed on shell with tube in combination tube heat exchanger by several scholars. In the firms where shell and tube heat exchangers are utilized for various applications example for heat recovery waste, oil refineries and so on. This analysis concentrated on the practical research of shell and tube heat exchanger with distinguished type of turbulators. The shell and tube heat exchanger with segmental turbulators and flower turbulators are calculated, made-up and verified. In a shell and tube heat exchanger associated to segmental and helical turbulator, flower turbulator provides recovered thermal as well as hydraulic performance. Also production of flower turbulators is liberal as comparable to helical turbulator.

Murthy et.al (2016) [5] Improving surfaces of heat transfer are utilized in many engineering functions such as, air conditioning equipment, heat exchangers and many more areas. Both active and inactive methods that is being examined on improvement of heat transfer. Passive heat transfer method is one of the utmost important methods that are utilized. In the zone of heat transfer, studies have been made out over numerous of years for the growth of convective heat transfer improvement methods. The additives used in the base fluid as water or ethylene glycol is one of the methods functioned to expand the heat transfer. In the current studies an effort being made to represent a perilous analysis on inactive methods which are utilized in order to develop the performance of heat transfer.

Sheikholeslami et.al (2016) [6] The turbulent hydrothermal study of forced convection in a heat exchanger of double pipe is existed practically. Now perforated turbulators are used in annulus area. Hot water generates the cold air in the outer tube warmer. Different quantities of ratio of pitch, ratio of open area and Reynolds number are deliberated. Relationships for Nusselt number, performance of thermal and darcy factor of friction are tested. Impacts of perforated circular ring on stream type and thermal treatment in a heat exchanger of water to air are observed. The effect of pitch ratio, thermal conductivity Reynolds number on hydrothermal activity are calculated. Relationships of Nusselt number and friction factor have been provided.

Bandos et.al (2016) [7] The method to get the key to the determinate source as cylinder model for the heat exchangers with ground at a distinct concealed depth that are taking into account the capacity of heat inside them and permits random rate of heat changes are obtained. Logical evaluations for the temperature of the ground taking average are justified by integrating the particular results over the cylinder source as depth for vertical and time dependent modifications of the heat rate. Fresh results for mean temperature replies from ground heat exchanger modelled as finite cylinder source of uniform heat flow implanted into the semi-infinite zone on a distance D from its surface being existed in a solo integral pattern.

Sheikholeslami et.al [8] (2016) Effect of perforated and distinctive helical fin on hydrothermal action in water to air heat exchanger is obtained. Water as well as air moving over inner and outer pipes, correspondingly. Influence of ratio of pitch, Reynolds number and ratio of open area are studied. Empirical formulations for performance of thermal parameter, Darcy factor and Nusselt number are achieved. Impacts of perforated fins with helical coil on current type as well as thermally treated water to air heat exchanger are scrutinized. The impacts of Parental number and Reynolds number on hydrothermal behavior are analyzed. Relationships among Nusselt number, friction factor and heat transfer coefficient have been estimated. Results reveal that loss in pressure and Nusselt number reduces with enhance of pitch ratio. The slope of temperature over the hot wall rises with rising in velocity of the inlet air.

Serageldin et.al [9] (2016) In the current paper we analyses the thermal behavior of an Earth-Air Heat Exchanger utilized for heating as well as cooling purposes and is explored under Egyptian weather situations. The soil temperature contours as well as the temperature variation of moving air through horizontal Earth-Air Heat Exchanger is practically examined. Also, a calculated model based on non-uniform, one-dimensional and quasi-state is established for conservation of energy equation while, the standard model is useful to find the turbulence kinetic energy of the moving fluid. The statistically advanced model and computational fluid dynamics calculation conclude the validation against investigational outcomes. In this analysis, the variation in temperature of moving air from side to side horizontal Earth-Air Heat Exchanger practically considered.

Wang et.al [10] (2016) In the analysis of multistream plate-fin heat exchangers, selection of surface and layer pattern maximizing are examined as two self-determining issues and still continue at the experimental phase, that develops an impediment for maximizing the performance. The layer maximization model with eleven constraints for the geometrical space is assembled by utilizing an inherited procedure hybrid with an eccentric search procedure. There are two cases that have been maximized in firms with this model, and the consequences are estimated by three tools.

Vahidifar et.al [11] (2015) This analysis examines characteristics of heat transfer and the drop in pressure of a horizontal double pipe heat exchanger with wire coil enclosures. The magnification of coefficient of heat transfer in the heat exchanger decreases the weight, size and heat exchanger cost. When an article is engaged in a boundary layer, it disturbs the flow pattern and changes the velocity as well as temperature contours. The change is influenced by the development of jets and stirs in the boundary layer as it varies transfer and coefficients of friction on the wall. The current investigational analysis concentrated on the analysis of the transfer of heat and drop in pressure among the wire coil and rings insert in smooth tube with Re=5000-25000 and prandtl number=0.7. The circular cross sectional wire coil as well as rings are implanted in the tube. Wire coil and rings inserts tube

produced amazing rise in both heat transfer and drop in pressure in contrast with the smooth tube comparative to the pitches and wire thickness.

Roslim et.al [12] (2015) This object informs about the inquiry on the things of porous twisted plate as enclosure to improve performance of heat transfer and flow parameter for a single fixed tube. The real fixed tube of the boiler is utilized and implanted with simple and porous twisted plates. The accumulating outcome is associated with the simple tube without any supplement. The final consequences describe that formation of holes changed the flow pattern and then creating secondary flow and forthcoming to turbulence flow. The temperature variation and characteristic of heat transfer of the porous surface twisted plate as inserts in fitted tube are presented in this article. The result obtained was discussed and proved that porous surface twisted plate enhanced the rate of heat transfer inside the tube.

5. Conclusion

It is found that the value of heat transfer depends on different parameters of heat exchanger. Different types of turbulators were used to increase the performance of heat exchanger. Heat transfer rate depends on the mass flow rate of working fluid and it also depends on the temperature of working fluid at the inlet of heat exchanger. Heat transfer also depends on the type of flow behavior of working fluid inside the heat exchanger, different types of turbulators were used to enhance the flow of working fluid so that heat transfer get enhance.

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