HEAT TRANSFER ENHANCEMENT OF A TRIPLEX CONCENTRIC TUBE DURING ENERGY STORAGE BY USING PCM

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Abstract

The extremely important of Heat Exchanger (HE) is that without mixing of fluid that carries the heat. Substances that leave or absorb large amount of so-called ‘latent’ heat this type of substances are called phase change materials (PCMs) once they undergo a change in their physical state i.e. from solid to liquid and contrariwise. This paper addresses a CFD analysis of phase change materials in thermal energy storage units dominated by heat condition. The result states that by utilization of PCM, the temperature is increment identified in counterflow whereas compared to parallel flow. The heat transfer rate is nearly 20% increased in counterflow.

Keywords : Triplex concentric tube, Creo 2.0, Heat exchanger, shell and tube heat exchanger, and CFD.

I. Introduction

Energy is one of the most important sources for the productive advancement of all countries. The accelerated commercial increase industrialized advance is mainly depending upon the energy only. Thinking about environmental conservation and also within the situation of great uncertainty on future energy supplies. That's why our foremost attention at the usage of sustainable energy resources and energy conversion techniques. Nowadays the most energy is developed from the thermal power stations only this energy does not stored properly at a particular point Now we are more concentrating on thermal energy storage systems one of the system is solid-liquid phase exchange, which has acquired full-size intrest because of its benefits. Such storage systems stock a considerable amount of energy in a limited size. The results are more prominent flexibility and also denseness of the PCM [III].

Hamada et. al., [XI] worked on the outcome of overall heat transfer rate by applying carbon -fiber chips and carbon brushes as preservative by experimentally and numerically compare. Heat transfer rate increases in PCMs by using the carbon fiber
chips and also adjacent to the heat transfer exterior thermal resistance is higher than that for the carbon brushes. Hosseini. M et. al., [VI] Based on the discovery from the present paper at the liquefying layer section natural convection is largely influenced by heat transfer. The liquefying time drop to 37% by rising the inlet water temperature by the 80°C. Rahimi. M et.al., [V] explains that the time for the melting and solidify is decreased then the increment inflow in a fin and tube heat exchanger is observed. It is more effective for the fin arrangement while compared with the melting time. M. Esapour et. al., [IV] The present analysis on multi-tube heat exchange along with the melting characteristic of R135 as phase change material. liquefying time depletion rate for an HTF temperature rise at low temperature field in between 50°C to 60°C, is largest than the similar rise at higher temperature vary, 60°C to 70°C. Abduljalil A et. al., [I] The present study on experimentation investigated TTHX with exterior and internal fins. Coming to conclusion the HTF water temperature carries an essential result on the liquefying approach measure with the mass flow change. A control planning is normally advised to gain the entire liquefying of the PCM when the power supply depends on sun intensity. Kun Yang et. al., [II] The effect of the liquefying performance of the PCM in a TTHX is studied by the enthalpy method. The most influential parameter for the PCM liquescent process and melting action is accelerated by the higher HTF inlet temperature. Seddegh, S. et. al., [X] In the current study, experimental results are compared and agreed with the estimated results. This indicated that PCM has high thermal behavior when compared with the pure physical phenomenon model. The analyses show that natural convection and conduction plays a dominant role in heat transfer within the PCM in the charging and discharging method. S. Gurulingam et.al., [VII] From this paper, we conclude that for fewer space applications Adoption of PCM in the latent heat energy depot systems gives more energy. Rathod, M. K et.al., [VIII] This paper deals with the time required for the total liquefying/solidifying for shell and tube LHUS along with longfin is invested. 12.5% of liquescent life is shortened when the inlet temperature is 80°C and it is increased by 5°C then 24.52% of melting time is reduced. Approximately 43.6% discount in time is located because of the set up of three longitudinal fins in the course of the solidification manner.

II. Modeling of Heat Exchanger in CREO 2.0

From the Long Jian-you [III] the heat exchanger model is designed in Creo and assembled as per the requirements. The given figure is the drawing of the triplex heat exchanger.

Fig. 1: Counterflow Heat Exchanger
Simulation of the Heat Exchanger

The assembled model in Creo is converted into STEP file and imported to CFD as shown in Fig. 3, in this CFD heat transfer enhancement it is observed as per boundary conditions.

Fig. 3: Imported from the statics, we observed the element size and its quality of the mesh.

In the Fluent, the solid and fluid parts are assigned to the assembled model. To get accurate results in the mesh element size should be minimum. Hexagonal fine mesh is applied to the assembled body as shown in Fig. 4. The cold fluid (water) is entered into the center tube at one end and leaves another end. In the middle tube, pcm is fixed to heat exchange. The outermost of the tube is continuously flow with hot water at different temperatures.

Table 1: Mesh specifications

| Mesh metric | Element quality | Aspect Ratio | Skewness | Orthogonal Quality |
|-------------|----------------|--------------|----------|--------------------|
| Min         | 0.20678        | 1.1402       | 4.126e-5 | 0.1626             |
| Max         | 0.9998         | 8.6137       | 0.8374   | 0.9997             |
| Avg         | 0.83525        | 1.8544       | 0.22324  | 0.7777             |
| Standard Deviation | 9.764e-2 | 0.4688 | 0.11885 | 0.1195 |

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The fluid properties and solid material properties are assigned to the assembles model. By giving different mass flow rates for both hot fluid and cold fluid along with its respective temperatures then the results are noted for all conditions and explained below.

Fig. 4: Meshed body

Fig. 5: Cold fluid inlet

The Fig.4, explains that the temperature contours of the triplex heat exchangers in this the distribution of the temperature is observed at entry of the hot fluid and cold fluid in parallel flow but in counterflow.
It happens when the hot fluid is entered into the tube then the temperature distribution is starts and continuous until the existing of the tube in this counterflow maximum amount of the temperature is distributed.

Fig. 6: Temperature distribution

III. Results and Discussion

The Fig. 7 is representing the temperature difference of cold water from inlet-outlet at different mass flow rates for both parallel flow and counterflow. Universally, know that better heat transfer capacity for counterflow compared to parallel flow. In this work, high-temperature differences occurred for counterflow.

Fig. 7: Temperature difference between cold water inlet-outlet at distinct mass flow charges
The Fig. 8 is explaining the temperature difference of hot fluid from inlet to the outlet at distinct mass flow charges. Here the outlet temperature reduction is more for the counter-flow for all mass flow rate compared to parallel.

**Fig. 9**: Total heat transfer rate comparison for both parallel and counter flow

Heat transfer rate plays a major role in all heat exchangers applications (in automotive, industrial and electronic, etc.). In this work heat-transfer is compared for all mass flow rates for parallel and counterflow. The heat transfer rate is generally increased for an increment of mass flow rate. Nearly 20% increment observed in counterflow.

### IV. Conclusions

By observing the above results. By utilization of PCM, the temperature is increment observed in counterflow while compared to parallel flow. The total heat transfer rate is a 20% increment observed in counterflow. Similarly, the heat transfer coefficient is also observed for both parallel and counter flow of triplex concentric tube heat exchanger.
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