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DESIGN AND HEAT TRANSFER PERFORMANCE OF SHELL AND ELLIPTICAL TUBE HEAT EXCHANGER BY USING NANO FLUIDS

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A B S T R A C T

Heat exchanger is a device used to transfer heat between one or more fluids. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. These exchangers provide true counter-current flow and are especially suitable for extreme temperature crossing, high pressure, high temperature, and low to moderate surface area requirements.In this thesis, different nano fluids mixed with base fluid water are analyzed for their performance in the shell and elliptical tube heat exchanger. The nano fluids are Aluminum Oxide, Silicon Oxide and Titanium carbide for two volume fractions 0.7, 0.8. Theoretical calculations are done determine the properties for nano fluids and those properties are used as inputs for analysis.3D model of the shell and elliptical tube heat exchanger is done in CREO. CFD analysis is done on the shell and elliptical tube heat exchanger for all nano fluids and volume fraction and thermal analysis is done in Ansys for two materials Aluminum and Copper for better fluid at better volume fraction from CFD analysis

Key words: Waste heat boiler, CFD analysis, CREOsoftware, Ansys Workbench, etc.

INTRODUCTION

INTRODUCTION OF HEAT EXCHANGER

Heat exchangers are one of the mostly used equipment in the process industries. Heat Exchangers are used to transfer heat between two process streams. One can realize their usage that any process which involve cooling, heating, condensation, boiling or evaporation will require a heat exchanger for these purpose. Process fluids, usually are heated or cooled before the process or undergo a phase

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change. Different heat exchangers are named according to their application. For example, heat exchangers being used to condense is known as condensers, similarly heat exchanger for boiling purposes are called boilers. Performance and efficiency of heat exchangers are measured through the amount of heat transfer using least area of heat transfer and pressure drop. A better presentation of its efficiency is done by calculating over all heat transfer coefficient. Pressure drop and area required for a certain amount of heat transfer, provides an insight about the capital cost and power requirements (Running cost) of a heat exchanger. Usually, there is lots of literature and theories to design a heat exchanger according to the requirements.

Factors Affecting the Performance of Shell and Tube Heat Exchanger

For a given shell geometry, the ideal configuration depends on the baffle cut, the baffle spacing, and baffle inclination angle. Even after fixing the right baffle cut and baffles space the performance can be still improved by varying baffle inclination angle. Having lower inclination angle, increases heat transfer at the cost of increased shell side pressure drop. On the other hand increasing angle beyond value might result in reduced pressure drop but with lesser heat transfer. So it is very important to have an optimum baffle angle to give minimum pressure drop with maximum heat transfer. Also determining effective baffle spacing and tube diameter for optimum baffle inclination

Plate Heat Exchangers

In plate heat exchangers fluids flow alternately between stacked plain or cross-corrugated Plates that can be sealed and held together in two different ways. Either gasket are placed Near the plate edges as shown in Figure 1.3 and the stack is held together by a frame or The plates are brazed or welded thus forming a single element. Spiral heat exchangers, being fundamentally identical, generally contain only two coiled plates.

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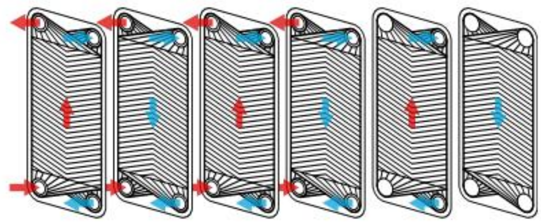

LITERATURE REVIEW

Design and Thermal Performance Analysis of Shell and Tube Heat Exchanger by Using CFD-A Review

This paper is concerned with the study of shell and tube heat exchanger. Also the factors affecting the performance of shell and tube heat exchanger is studied and its details discussion is given. this paper focuses on the designing of small shell and tube heat exchanger with counter flow arrangement. Thermal analysis is carried out considering various parameters such as baffle spacing, baffle inclination, flow rates of hot and cold fluids, tube diameter etc. by using CFD. Some research papers are studied in details and then review from those papers is described in the paper.

RESEARCH GAP & PROBLEM DESCRIPTION

The shell and tube heat exchanger is taken in the water with various temperatures. In this thesis, along with water Aluminum Al_2O_3, silicon oxide and titanium carbide nanofluid at different volume fractions (0.7 and 0.8) of the shell and tube heat exchanger is analyzed for heat transfer properties, temperature, pressure, velocity and mass flow rates in CFD analysis. In thermal analysis, two materials Copper and Aluminum are considered for heat exchanger. Modeling is done in Pro/Engineer, Thermal analysis and CFD analysis is done in Ansys. The boundary conditions for thermal analysis are temperatures, for CFD analysis is pressure, velocity and temperature.

The Different Modules in CREO

- Sketcher
- Part Design
- Assembly Design

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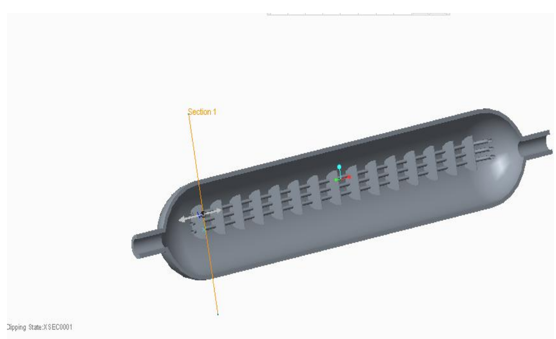
- Drafting
- Sheet metal

Shell and elliptical tube 3d modelling

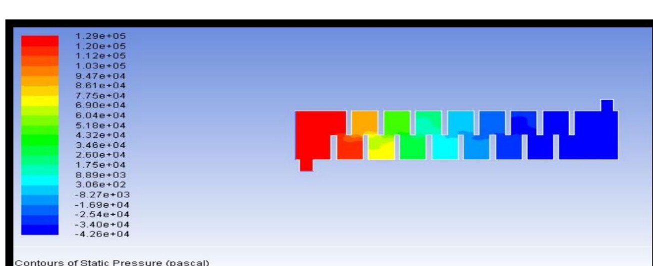
CUT SECTION



CFD ANALYSIS OF SHELL AND ELLIPTICAL TUBE HEAT EXCHANGER

FLUID- WATER

STATIC PRESSURE



VELOCITY MAGNITUDE

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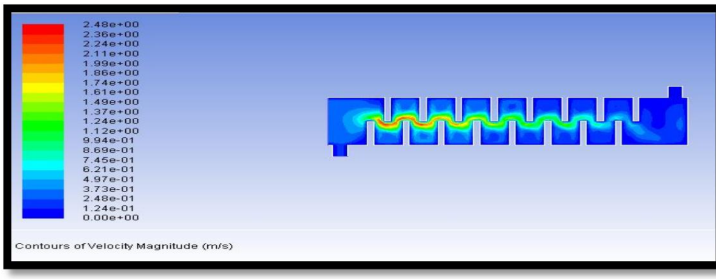
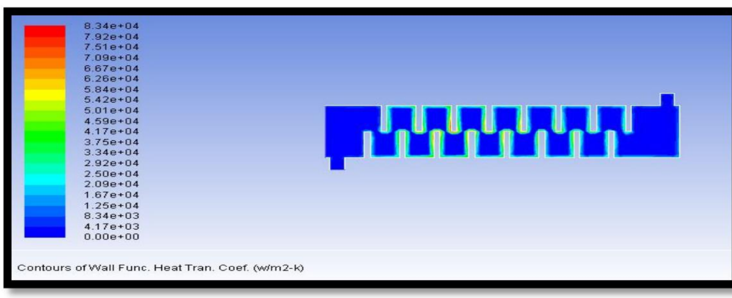


HEAT TRANSFER CO-EFFICIENT



Mass flow rate

Mass Flow Rate	(kg/s)
cold_fluid_outlet	0
cold_inlet	204.02502
hot_fluid_inlet	17.552153
hot_fluid_outlet	0
interior-_trm_srf	1333.6503
wall-_trm_srf	0
Net	221.57718

Heat transfer rate

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```
Total Heat Transfer Rate                    (w)
---------------------------- -------------------
         cold_fluid_outlet                    0
                cold_inlet           -40094.066
           hot_fluid_inlet            1605249.8
          hot_fluid_outlet                    0
             wall-_trm_srf                    0
         ---------------- -------------------
                       Net            1565155.7
```

RESULT TABLES

CFD ANALYSIS RESULTS

NANO fluid	Volume fraction	Pressure (pa)	Velocity (m/s)	Heat transfer coefficient (W/mm²k)	Mass flow rate (Kg/sec)	Heat transfer rate (w)
Aluminum oxide	0.7	9.43e+04	2.33e+00	7.44e+04	167.9008	1569374.7
	0.8	1.03e+05	2.34e+00	9.67e+04	183.91106	1512691.3
Silicon oxide	0.7	6.81e+04	2.36e+00	2.15e+04	119..96034	1453473.3
	0.8	7.34e+04	2.51e+00	2.25e+04	129.18757	1424705.4
water		1.29e+05	2.48e+00	8.34e+04	221.57718	1565155.7

CONCLUSION

In this thesis, different nano fluids mixed with base fluid water are analyzed for their performance in the shell and elliptical tube heat exchanger. The nano fluids are Aluminum Oxide, Silicon Oxide and Titanium carbide for two volume fractions 0.7, 0.8. Theoretical calculations are done determine the properties for NANO fluids and those properties are used as inputs for analysis.3D model of the shell and elliptical tube heat exchanger is done in Pro/Engineer. CFD analysis is done on the shell and elliptical tube heat exchanger for all NANO fluids and volume fraction and thermal analysis is done in

ANSYS for two materials Aluminum and Copper for better fluid at better volume fraction from CFD analysis.By observing the CFD analysis the heat transfer rate increases for aluminum oxide at volume fraction 0.7 when compare with silicon oxide and water.By observing the thermal analysis the heat flux values are more for copper material.So it can be conclude the better performance of shell and elliptical tube heat exchanger, the copper material and aluminum oxide nano fluid at volume fraction 0.7.

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