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# Design, Analysis and Optimization of Shell and Tube Heat Exchanger

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***Abstract:*** **In present day shell and tube heat exchangers are most common type of heat exchanger widely used in oil refineries and other large chemical process plants since it suits high pressure applications. The objective of the project is to design a heat exchanger with a different baffle and study the flow and temperature field inside the shell using solid works flow simulation software tool and as well as to design, fabricate two shell and tube heat exchangers one with higher heat transfer rate and other with lower heat transfer rate and to compare the results of both experimental values with results of Flow Simulations.**

## 1. INTRODUCTION

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

Different heat exchangers are named according to their applications. For example, heat exchangers being used to condense are known as condensers, similarly heat exchangers for boiling purposes are called boilers. Performance and efficiency of heat exchangers are measured through the amount of heat transferred 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. A good design is referred to a heat exchanger with least possible area and pressure drop to fulfil the heat transfer requirements.

## 2. COMPONENT DESIGN

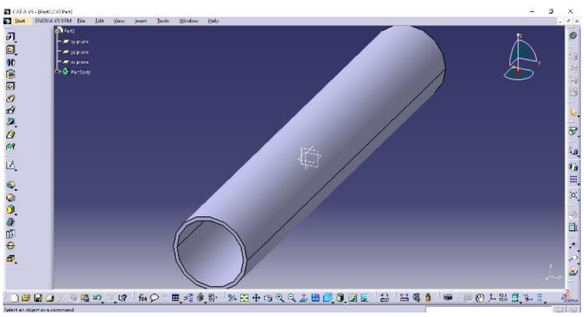

Fig 2.1 Shell

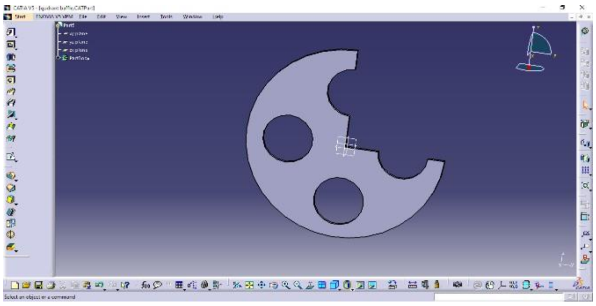

Fig 2.2 Baffle

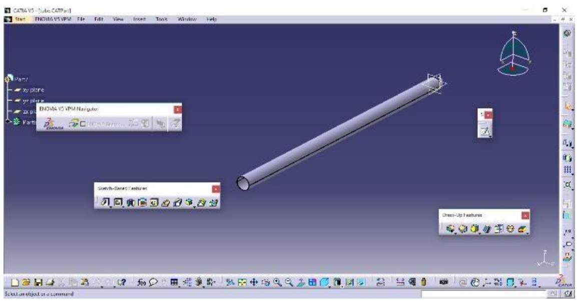

Fig 2.3 Tube

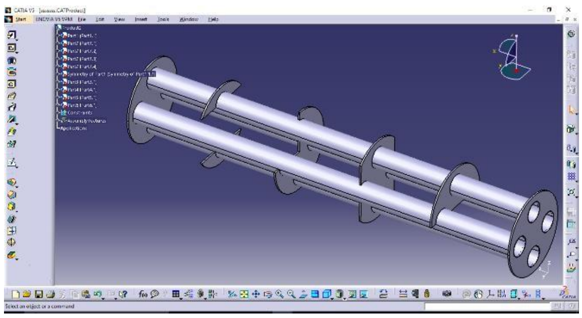

Fig 2.4 Assembled View

## 3. ANALYSIS REPORT

*Temperature Distribution and Surface Parameter over the shell with simple baffle:*

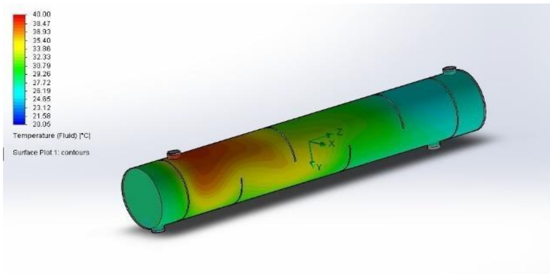


Fig 3.1

| Parameter | Average | Surface Area [m^2] |
|---|---|---|
| Pressure [Pa] | 101325.51 | 0.204385463 |
| Heat Transfer Coefficient [W/m$^2$/K] | 8.9682062 | 0.204385463 |
| Specific Heat (Cp) [J/(kgK)] | 4180.2859 | 0.204385463 |
| Prandtl Number [ Pr] | 5.3838108 | 0.204385463 |
| Temperature (Fluid) [°C] | 30.541389 | 0.204385463 |

Table 3.1

*Temperature Distribution and Surface Parameter over the Baffles with simple baffle:*

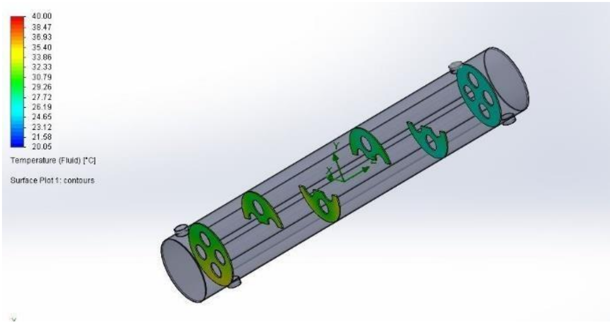


Fig 3.2

| Parameter | Average | Surface Area [m^2] |
|---|---|---|
| Pressure [Pa] | 101325.543 | 0.049095362 |
| Heat Transfer Coefficient [W/m$^2$/K] | 18.9930451 | 0.049095362 |
| Specific Heat (Cp) [J/(kg*K)] | 4180.43517 | 0.049095362 |
| Prandtl Number [ Pr] | 5.52649235 | 0.049095362 |
| Temperature (Fluid) [°C] | 29.340583 | 0.049095362 |

Table 3.2

*Temperature Distribution and Surface Parameter over the Copper Tubes with simple baffle:*

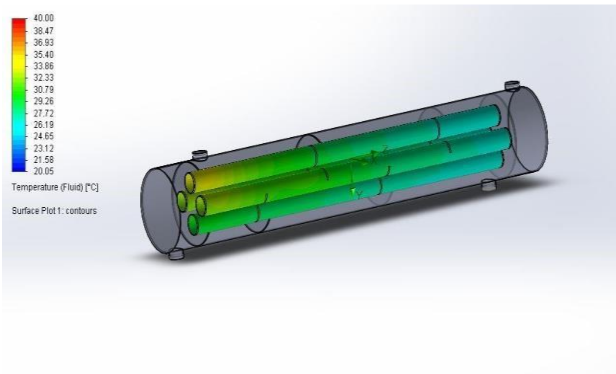


Fig 3.3

| Parameter | Average | Surface Area [m^2] |
|---|---|---|
| Pressure [Pa] | 101325.964 | 0.303691439 |
| Heat Transfer Coefficient [W/m$^2$/K] | 40.475341 | 0.303691439 |
| Specific Heat (Cp) [J/(kg*K)] | 4180.49305 | 0.303691439 |
| Prandtl Number [ Pr] | 5.57457055 | 0.303691439 |
| Temperature (Fluid) [°C] | 28.9457988 | 0.303691439 |

Table 3.3

*Temperature distribution and surface parameters of the outer shell with modified baffle:*

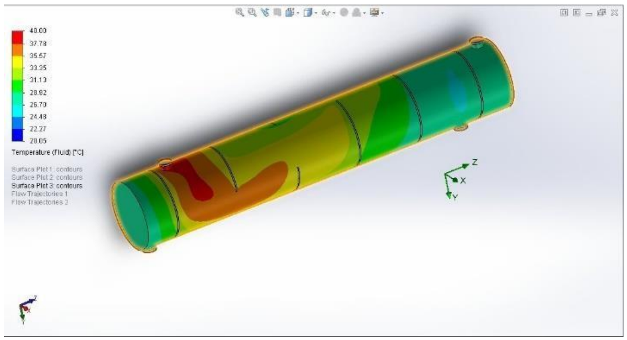

Fig 3.4

| Parameter | Average | Surface Area [m^2] |
|---|---|---|
| Pressure [Pa] | 101325.601 | 0.203746379 |
| Heat Transfer Coefficient [W/m$^2$/K] | 8.07375509 | 0.203746379 |
| Specific Heat (Cp) [J/(kg*K)] | 4180.20439 | 0.203746379 |
| Prandtl Number [Pr] | 5.34132832 | 0.203746379 |
| Temperature (Fluid) [°C] | 30.8493843 | 0.203746379 |

Table 3.4

*Temperature distribution and surface parameters of the Baffles with modified baffle:*

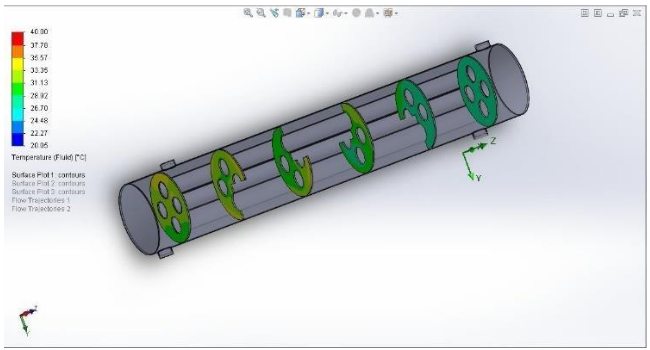

Fig 3.5

| Parameter | Average | Surface Area [m^2] |
|---|---|---|
| Pressure [Pa] | 101325.53 | 0.061282976 |
| Heat Transfer Coefficient $[W/m^2/K]$ | 21.3377011 | 0.061282976 |
| Specific Heat (Cp) [J/(kg*K)] | 4180.25156 | 0.061282976 |
| Prandtl Number [Pr] | 5.41812553 | 0.061282976 |
| Temperature (Fluid) [°C] | 30.1582706 | 0.061282976 |

Table 3.5

*Temperature distribution and surface parameters of the Copper Tubes with modified baffle:*

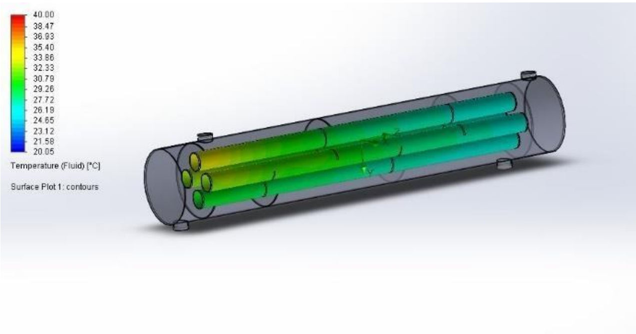


Fig 3.6

| Parameter | Average | Surface Area [m^2] |
|---|---|---|
| Pressure [Pa] | 101325.53 | 0.061282976 |
| Heat Transfer Coefficient $[W/m^2/K]$ | 21.3377011 | 0.061282976 |
| Specific Heat (Cp) [J/(kg*K)] | 4180.25156 | 0.061282976 |
| Prandtl Number [Pr] | 5.41812553 | 0.061282976 |
| Temperature (Fluid) [°C] | 30.1582706 | 0.061282976 |

Table 3.6

## 4. CONCLUSION

The heat transfer and flow distribution are discussed in detail and proposed model is compared with simple design. Thus, the model has been improved. The assumption of changing the baffle design worked well. If hot water is raised to higher temperature, it might be help to get better heat transfer and to get better temperature difference between inlet and outlet. Moreover, the model has provided the reliable results by increase in heat transfer rate by 100%. Thus, this model can also be improved by using any other baffle design, and a software with higher computational theory. The heat transfer coefficient is poor because the temperature of the inlet hot fluid is very low. Thus, a better heater can be used for better heat transfer. And some other ways to obtain better heat transfer is to decrease the cold-water temperature to a lower level and also by using wolverine copper tubes. A SOLIDWORKS package (FLOW SIMULATION) was used for the numerical study of heat transfer characteristics of a modified baffle heat exchanger for counter flow and the results were then compared with that of simple baffle. The FLOW SIMULATION results when compared with the experimental results from different studies were well within the error limits. The study showed that there is much difference in the heat transfer performances of the typical and modified heat exchangers in the same Counter-flow configuration.

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