



Design and Thermal Analysis of Shell and Tube Heat Exchanger Using CFD

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Abstract

This overview seems with exclusive research on the application of CFD analysis to heat exchangers. A shell and tube heat exchanger is a type of heat exchanger in which liquids exchange heat without mixing. It has a set of tubes through which a liquid flows. These switchgear systems are commonly used in power plants, chemical plants, petrochemical plants, and automobiles. There are several turbulence models used in the popular CFD software, which include the okay-epsilon model, the okay-omega model, and the ok-omega SST version. Various CFD software tools are available, such as CFX and FLUENT. The effects show that CFD is a great way to are expected how heat exchangers work and perform.

Key Words: Shell and tube heat exchanger, CFD, turbulence model, computational modeling, Fluent



1. INTRODUCTION

Heat exchangers are devices used to exchange heat flow. from one liquid to each other. Conventional Heat Exchangers diligent of us in our daily lives are composed of capacitors and evaporators used in air conditioning and refrigerator. Boilers and condensers in thermal power .flora are examples of large industrial heat exchangers. There are heat exchangers in our cars inside the mold of radiators and oil coolers. Heat exchangers are also many in the chemical and technology industries.

There is a wide range of heat exchangers for different styles of makes use of, thus the construction could also be different attachment. However, no matter the range, the maximum temperature exchangers can be classified into a few common types based entirely on some basic layout standards. We want best remember the extra common types here to discuss a few analysis and design methods.

2. SHELL AND TUBE HEAT EXCHANGER

A shell and tube heat exchanger is a class of heat exchange systems. It is the most common type of heat.

exchanger in oil refineries and various large chemicals methods, and is suitable for better compression applications. As the name suggests, this type of heat exchanger includes a shell (a large stress vessel) with a pack of tubes inside it.

A liquid flows through the pipes, and any other fluid flows over the tubes (through the shell) to transport heat between the two fluids. The set of pipes is called a pipe package agreement, and can be composed of many styles of pipes: simple, length-finned, etc.

Shell and tube heat exchanger design is primarily based on correlations between the Kern method and the Bell-Delaware techniques -In Bell's process, the heat transfer coefficient and flow drops are estimated from correlations for flow over complete pipe banks, and the effects of leakage,

Bypass and slip in window quadrant are allowed with the help of making use of editing elements. This technique will yield higher separate predictions of the heat transfer coefficient and pressure drop than Kern's approach; and, as it takes in the explain the consequences of leaks and bypasses, can be used

to investigate the effects of construction tolerances and using sealing strips. The Bell-Delaware method is larger rigorous process and can give certain consequences. In Kern-ear's method based on experimental work with industrial exchangers with wide-ranging tolerances and will deliver a fairly first-class prediction of the heat transfer coefficient for conventional designs. The prediction of pressure drop is much less best because the flow drop is greater laid low with leaks and bypass than heat switch. It

Shell-facet heat transfer and friction element are correlated in a similar way to those for pipe-

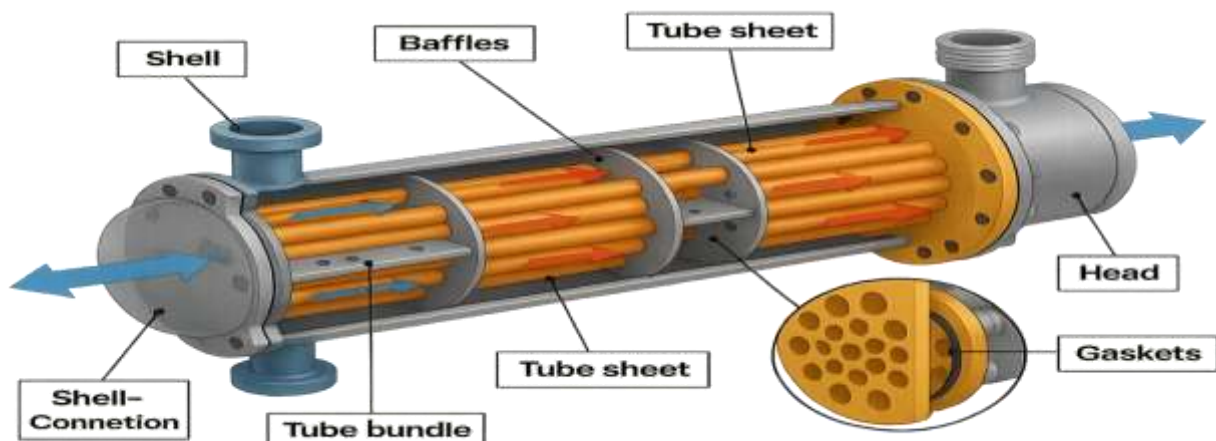


Fig.1: Shell and tube heat exchanger



3.COMPUTATIONAL FLUID DYNAMICS

CFD is useful for analyzing fluid go with the flow, heat transfer; chemical reactions and so on by solving mathematical equations with the help of numerical estimation.CFD improve everything system in small cells and practice controlling equations on these discrete factors to find numerical solutions regarding voltage distribution, temperature gradients. This software program can also create a digital prototype of machine or device before can be practice for real global physics to the model, and the program will offer with images and files that predict how that configuration will take place. More recently, the methods have been applied to internal combustion engine design, combustion chambers of gasoline

5.LITERATURE REVIEW

[1] specialization in the applications of computational fluid dynamics (CFD) in the zone of heat exchangers. It has been observed that CFD rented for fluid fluid misdistribution, dirt,current drop and temperature rating within the setup and optimization part. Various turbulence modes such as trendy, realizable and RNG, $k - \epsilon$, RSM, and SST in order - ϵ with speed-voltage coupling systems along with SIMPLE, SIMPLEC, PISO and and many others. Were accompanied by performing simulations. Common methods used for the installation and improvement of Heat exchangers are expensive. CFD provides cost-effective opportunity, quick solution and get rid of the need for prototype, it is far retarded to Plate, Shell and Tubes, vertical mantle, compact and printed channel Table changers however also bent enough to are expected fluids pass with flow velocity to complete heat exchanger configuration and optimization in the context of a huge range of turbulence models and integrating systems is the $k - \epsilon$ turbulence model at most widely used configuration and optimization .The .

turbines and furnaces, in addition to fluid flows and heat transfer in heat exchanger.

4.TURBULANCE MODEL

Turbulence occurs due to the instability of the drift.Turbulent flows contain a wide range of length, velocity and time scale and solving them all makes the charges of simulations huge. Therefore, several turbulence models had been developed with specific decision intervals.

There are many turbulence models available in CFD software along with the Large Eddy Simulation (LES) and Reynolds Average Navier-Stoke (RANS). There are more RANS models to do with relying on

function of go with the flow, e.g., Standard okey- ϵ model, okey- ϵ RNG model, Realizable ok- ϵ , ok- ω and RSM (Reynolds stress Model) fashions.

simulation results starting from 2% to tens of% with experimental studies. In some sweet cases, it varies

to 36%. [2] Qiuwang Wang et al. has investigated a mixed a pair of shell-vessel shell-and-tube heat exchangers (CMSPSTHX) with non-stop helical vessels in outer shell vessels is invented to improve heat exchange .overall performance and simplification of the manufacturing process. It CMSP-STHX is compared to conventional shell-and-tube heat exchanger with segmental shells (SG-STHX) using method using computational fluid dynamics (CFD) techniques. It the numerical results show that under the same mass slip charge M and general heat transfer charge Q_m , the conventional

normal pressure drop ΔP_m of CMSP-STHX is reduction than it Distribution of the adjacent heat transfer coefficients at each pipe floors are determined and visualized by means of mass transfer measurements. The determination of shell-facet float divisions are allowed with the help of adjacent current measurements. For identical Reynolds field,current drop and normal heat dissipation are improved through increased



shell spacing, which can increase the temperature transfer coefficient within the entire sign space due to the reduction of the percentage of leakage current and due to the higher buoyancy velocity via the shell onset and adjacent heat transfer coefficient distributions for individual pipes is hardly affected by the shell spacing

6. METHODOLOGY

Understanding the methodologies behind shell and tube heat exchangers means grasping their installation, operation and the ideas of heat transfer that govern them. Here's a breakdown:

Core concepts:

Basic Structure:

A shell and tube heat exchanger contains a cylindrical shell containing a package of tubes. One fluid flows via the tubes (tube-aspect fluid), and the alternative flows around the tubes inside the shell (shell-aspect moisture).

Heat transfer:

Heat is transferred between the two fluids via the partitions in the tubes.

The configuration aims to maximize this heat exchange while maintaining a safe separation of the fluids .

Fluid Flow:

The waft relationship (parallel sliding, countercurrent or cross current) significantly affects the performance of the heat exchanger.

Reverse current is usually the most green.

Baffles within the shell direct the shell-side fluid plume, increasing turbulence and improving heat exchange.

Key methodological considerations:

Design considerations:

□ Fluid Properties: Understanding the thermal conductivity, viscosity and density of the fluids is important.

Temperature and pressure: Operating temperature and pressure dictate material selection and structural design.

□ Heat transfer requirements: The desired heat exchange rate determines the dimension and configuration of the heater

bills of exchange. Fouling: Any fouling (accumulation of deposits) should be taken into account as it reduces the temperature transfer effect.

□ Pressure drop: Minimizing flow drop even as maximizing heat exchange is a key design goal

7. CONCLUSIONS:

CFD offers fee efficient option, fast response and eliminate the need for a prototype. The literature assesses knowledge by analysis of many parameters, which have an impact on on the overall performance of STHE. It has been observed that computational modeling is one of the effective techniques to look at those types of temperature factors.

The parameters such as pipe and shell diameter, the area of pipe, pitch and baffle angles are the vital to be worked on. A separate analysis using the CFD simulation could be worth finishing. A heat exchanger used inside the KLTPS Pandro power plant has been taken for likewise survey in the proposed surveys paintings.

An observe be performed on float and heat transfer assessment the use of CFD. The modeling changed to accomplished using Autodesk Inventor .

Professional 2015 and the simulation will be done the use of Autodesk Simulation CFD 2015. Based on experimental

and CFD results it could be concluded as follows:

The heat transfer charge changed to higher this is due to the corrugated copper tubes that had been used to improve the touch floor .

of the tube.

Compared to the opposite types of shell & tube heat exchangers, fouling is very much less this turned out to finish due to

free spaces between the shingles and the PVC pipe as causes of shear stress on the shell wall. This strain reduces dirt.

Low pressure drop and high potential heat exchange rate had been achieved. This was due to the isolation of the segmental barriers .

which was used to adjust the waft of the fluid and they are very easy to replace.

Shell & tube heat exchanger price changed to reduced this changed to due to the design and materials used within the heat exchanger.



REFERENCES

1. Muhammad Mahmood Aslam Bhutta, Nasir Hayat, Muhammad Hassan Bashir, Ahmer Rais Khan, Kanwar Naveed Ahmad, Sarfaraz Khan⁵, CFD Applications In Various Heat Exchangers Design: A Review, Department Of Mechanical Engineering, University Of Engineering & Technology, Applied Thermal Engineering, 2011.
2. Qiuwang Wang, Qiuyang Chen, Guidong Chen, Min Zeng, "Numerical investigation on combined multiple shell-pass shell-and-tube heat exchanger with continuous helical baffles", International Journal of Heat and Mass Transfer 52 (2009).
3. K.Mohammadi, W.Heidemann, H.Muller – Steinhagen “Numerical Investigation Of The Effect Of Baffle Orientation And Baffle Cut On Heat Transfer And Pressure Drop Of A Shell And Tube Heat Exchanger” ResearchGate , august 2006.
4. Hari Haran , Ravindra Reddy and Sreehari “ Thermal Analysis of Shell and Tube Heat Exchanger using C and Ansys” International Journal of Computer Trends and Technology volume 4 issue 7 –July 2013.
5. Huadong Li, Volker Kottke ,” Effect Of Baffle Spacing On Pressure Drop And Local Heat Transfer In Shell-And-Tube Heat Exchangers For Staggered Tube Arrangement”, International Journal of Heat Mass Transfer, Elsevier Science , Germany, 1998.
6. Ender Ozden, Ilker Tari ,"Shell Side CFD Analysis of A Small Shell And Tube Heat Exchanger" ,Middle East Technical University, 2010.
- [7]. Andre L. H. Costa, Eduardo M. Queiroz “Design optimization of shell and tube heat exchangers”, Applied Thermal Engineering, 28,14-15,2008,1798-1805.
- [8]. Priyanka G, M. R. Nagaraj “CFD Analysis of Shell and Tube Heat Exchanger with and without Fins for Waste Heat Recovery Applications”, IJSR, 3,7,2014,1437-1440.
- [9]. Pranita Bichkar, Ojas Dandgaval, Pranita Dalvi, RhushabhGodase and Tapobrata Dey “Study of Shell and Tube Exchanger with the Effects of Types of Baffles”, Procedia Manufacturing, 20,2018,195-200.
- [10]. N Santhisree, M Prashanthkumar, G Priyanka “Thermal analysis of shell and tube heat exchanger”, IJMET, 8,5,2017,596-606.
- [11]. Bansi D. Raja, R. L. Jhala, Vivek Patel “Man-objective optimization of shell and tube heat exchanger”, Thermal science and Engineering progress, 2,2017,87-101.