IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.301

Volume 3, Issue 16, May 2023

Optimization of Design Parameters in Shell and Tube Heat Exchanger using Aspen HYSYS

Vivekanandan R[1], Dr. Stalin N[2], Kaviya M[3], Allwin Jaya Sundaram D[4]

Assistant Professor Department of Chemical Engineering[1]

Assistant Professor, Department of Chemical Engineering[2]

UG Scholar, Department of Chemical Engineering[3,4]

Anjalai Ammal Mahalingam Engineering College, Kovilvenni, India[1,3,4]

Anna University-BIT Campus, Tiruchirappalli, India[2]

Abstract: *This journal documents the process of designing a shell and tube heat exchanger using Aspen HYSYS, powerful process simulation software. The objective of this design project is to optimize the heat transfer performance of the heat exchanger while meeting specific temperature specifications and constraints. Through a combination of theoretical understanding, engineering principles, and software simulation, this journal captures the journey of exploring heat transfer mechanisms, configuring the heat exchanger model, and analysing simulation results. The journal begins with defining the design objectives, including desired heat transfer rates and temperature specifications. The process flow diagram is then established in Aspen HYSYS, with careful consideration given to fluid streams entering and leaving the heat exchanger, their properties, flow rates, and temperatures. The shell and tube heat exchanger model is chosen for its suitability to the design requirements. Key design parameters, such as the number of tubes, tube dimensions, tube layout, and shell specifications, are determined to create an effective heat exchanger design. The selection of the heat transfer mechanism, such as parallel or counter flow, is thoroughly analysed to optimize the overall performance and efficiency of the heat exchanger.*

Keywords: Shell and tube heat exchanger, Kerosene, Simulation, design

I. INTRODUCTION

Heat exchangers are important in many industries as they help transfer heat between different fluids. Aspen HYSYS is software that helps engineers simulate and optimize heat exchanger designs. In this journal, explore the process of designing a heat exchanger and use Aspen HYSYS to bring your design to life. By documenting the experiences, reflections, and insights, this journal will help the better understand the design process. Using Aspen HYSYS, create a diagram of your heat exchanger system, specifying the fluids, their properties, and conditions. Throughout the process, make important decisions, like choosing the right shell and tube heat exchanger model. This choice will impact the efficiency of design. Aspen HYSYS will allow you to experiment with different design options and optimize your heat exchanger performance.

This design process will understanding of heat transfer principles and practical engineering. So, let's begin this exciting adventure together. Through theory, software simulation, and your own creativity.To develop an efficient and cost-effective shell and tube heat exchanger using simulation software (Aspen HYSYS). The results obtained from the simulation and calculations demonstrated that the designed heat exchanger not only met the necessary performance criteria but also exhibited high efficiency. Overall, this project showcases the potential of software-based engineering design in optimizing heat exchanger performance and reducing fuel consumption.

II. INTRODUCTION TO SUPERIOR KEROSENE

Superior Kerosene is a type of kerosene that is refined to meet higher standards of quality and purity compared to regular kerosene. It is a low-sulphur fuel that is primarily used for household and small-scale industrial applications, such as cooking, heating, and lighting. Superior Kerosene has a higher flash point than regular kerosene, which makes it less volatile and safer to handle. It also has a lower carbon content, which reduces its environmental impact and makes

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 16, May 2023

it an eco-friendlier fuel option. Superior Kerosene is often marketed under various brand names, and it is widely used in many countries around the world.

PROPERTY	VALUE
Appearance	Clear and bright
Color	Colorless to light yellow
Odour	Characteristic kerosene odour
Density	0.78-0.85 g/cm³ at 15°C
Boiling point	150-300°C
Flash point	>38°C
Freezing point	-40°C
Viscosity	2-3 cP at 20°C
Chemical formula	$C_{12}H_{23}$
Molecular weight	167.32 g/mol
Refractive index	1.4
Octane number	20-30
Sulfur content	<0.05% by weight
Carbon Content	85-90% by weight
Hydrogen Content	10-15% by weight

Table.1.Properties of Superior Kerosene

III. METHODS

- **Simulation-Based Approach:** Aspen HYSYS allows you to simulate the heat exchanger performance with different design parameters. By running multiple simulations and analysing the results, you can iteratively optimize the design. Adjust variables such as tube dimensions, number of tubes, and shell specifications to identify the most efficient configuration.
- **Heat Exchanger Sizing:** Utilize Aspen HYSYS to determine the appropriate size of the heat exchanger components, such as tube length, diameter, and pitch. This involves considering factors like fluid properties, flow rates, and heat transfer requirements. The software can provide guidance on sizing criteria and help ensure the design meets the desired performance criteria.
- **Heat Transfer Enhancement Techniques:** Explore the use of various heat transfer enhancement techniques to improve the efficiency of the heat exchanger. Aspen HYSYS offers options to incorporate features such as extended surfaces, turbulators or enhanced tube geometries, which can enhance heat transfer rates and overall performance.
- **Baffle Design and Configuration:** Baffles play a crucial role in directing fluid flow inside the shell, improving heat transfer efficiency. Aspen HYSYS enables you to optimize baffle design by adjusting parameters such as baffle spacing, cut, and orientation. Experiment with different baffle configurations to enhance heat transfer and minimize pressure drop.
- **Heat Exchanger Network Integration:** Consider integrating the shell and tube heat exchanger into a larger heat exchanger network, if applicable. Aspen HYSYS can help you analyse the interactions between multiple heat exchangers and optimize the overall network performance. This approach can lead to improved energy efficiency and cost-effectiveness.
- **Parametric Studies:** Perform parametric studies by varying different design parameters one at a time or in combination. This allows you to assess the impact of individual parameters or their interactions on heat exchanger performance. Aspen HYSYS enables you to automate these studies, making it easier to evaluate a wide range of design scenarios.
- **Optimization Algorithms:** Aspen HYSYS offers optimization capabilities that can automatically adjust design variables to achieve predefined goals, such as maximizing heat transfer while minimizing pressure drop

or cost. Utilize these optimization algorithms to streamline the design process and identify optimal design configurations efficiently.

- **Heat Transfer Performance:** Start by presenting the key results related to the heat transfer performance of your heat exchanger. Include the temperature profiles of the fluid streams entering and leaving the heat exchanger. Analyse how effectively the heat transfer occurred between the streams. Evaluate the overall heat transfer coefficient achieved in the simulation and compare itwith industry standards or design targets. Discuss any deviations or variations from expected values and potential reasons behind them.
- **Pressure Drop Analysis:** Examine the pressure drop across the heat exchanger and present the relevant results. Discuss the influence of different design parameters, such as the number of tubes, tube dimensions, or baffle configurations, on the pressure drop. Compare the simulated pressure drop with design specifications or standard guidelines to assess the efficiency of your heat exchanger design. Reflect on any trade-offs between heat transfer performance and pressure drop encountered during the simulation.
- **Temperature Approach and Log Mean Temperature Difference (LMTD):** Evaluate the temperature approach achieved in the simulation, which represents the difference in temperature between the hot and cold fluid streams at the end of the heat exchanger. Discuss the impact of design parameters on the temperature approach and how it affects the overall heat transfer efficiency. Calculate and analyse the Log Mean Temperature Difference (LMTD), a critical parameter in heat exchanger design, and its relationship to the heat transfer rate.
- **Sensitivity Analysis:** Perform a sensitivity analysis on key design parameters to evaluate their impact on heat transfer performance and pressure drop. Vary one parameter at a time while keeping others constant and observe the corresponding changes in the simulation results. Discuss the sensitivity of the heat exchanger design to these parameters and identify which ones have the most significant influence. This analysis can provide insights into potential areas for further optimization or trade-offs in the design.
- **Comparison with Design Objectives:** Compare the simulation results with the initial design objectives you established at the beginning of the project. Evaluate how well your design met the specified heat transfer rates, temperature specifications, and other constraints. Identify any areas where improvements are needed or where the design exceeded expectations. Discuss potential modifications or adjustments that can be made to achieve desired design objectives.
- **Limitations and Uncertainties:** Acknowledge any limitations or uncertainties associated with the simulation results and the design process. Discuss factors that might affect the accuracy or representativeness of the simulation, such as assumptions made, simplifications in the model, or variations in real-world operating conditions. Consider the potential impact of these limitations on the interpretation of the results and provide suggestions for further analysis or validation.

IV. FIGURES AND TABLES

The below figure is related about the simulation diagram for shell and tube exchanger.

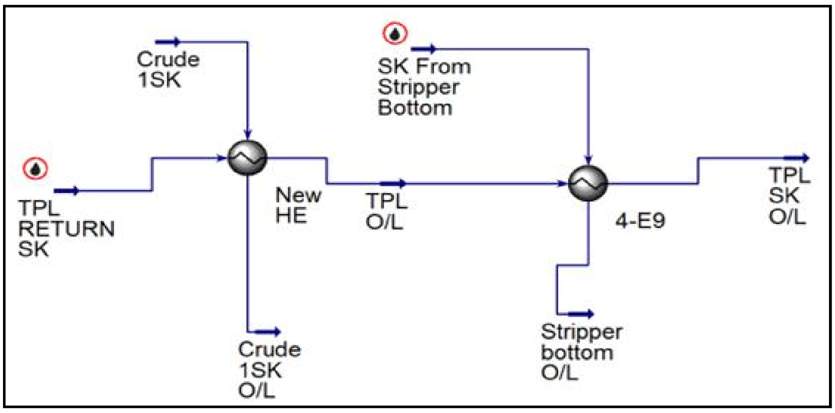

Fig. 1. Simulation diagram of shell and tube heat exchanger design

V. RESULTS AND DISCUSSION

The following result shows that design parameters of shell and tube heat exchanger by using Aspen HYSIS.

S.No.	Design Parameters	Values
1	Tube Passes	2 Pass
2	Shell Passes	1 Pass
3	Flow	Counter flow
4	Shell type	E
5	Overall UA	182300kJ/^{o}C.hr
6	Pressure Drop	98.07kPa
7	Heat Duty	2193000kcal/hr
8	Specific Heat	332kJ/kgmole^{o}C

Table.2. Optimised parameters of shell and heat exchanger

VI. CONCLUSION

The project outcomes provide a valuable contribution to the engineering design of shell and tube heat exchangers for waste heat recovery, which can lead to energy savings and cost reduction in industrial processes. This project highlights the importance of applying theoretical knowledge to practical engineering problems and the usefulness of simulation software in optimizing heat exchanger design. Overall, this project successfully demonstrated the feasibility and effectiveness of using software-based design for shell and tube Heat exchangers, which can be applied to other industrial process.

REFERENCES

[1]. Albadwe,www.unep.org/pcfv/PDF/AlbadweYahaConf.pdf-,2015.
[2]. Aris. A normalization for the Thiele modulus. Ind. Eng. Chem. Fundam, 4:227, 1965.
[3]. David Neil MacKenzie, A Concise Pahlavi Dictionary. Oxford University Press. p. 57. ISBN 978-1-934768-59-4, 1971.
[4]. David S. J. "Stan" Jones & Peter R. Puja, Handbook of Petroleum Processing, University of Illinois at Chicago, USA, http://www.springer.com, 2006.
[5]. James G. Speight, CD&W Inc., The Chemistry and Technology of Petroleum, Wyoming. http://www.taylorandfrancis.com, 2007.
[6]. James H. Gary, Colorado School of Mines & Glenn E. Handwork, Consulting Chemical Engineer, Petroleum Refining Technology and Economic, http://www.dekker.com, 2001.
[7]. ReyadShawabkeh, Dr. Department of Chemical Engineering, King Fahd University of Petroleum & Minerals, e-mail: rshawabk@kfupm.edu.sa 2010.
[8]. Riazi, M.R. Characterization and Properties of Petroleum Fractions, ASTM, 2005.
[9]. Richard L. Myers, The 100 most important chemical compounds /a reference guide/ library of Congress Cataloging-in-Publication Data, 2007.
[10]. Weissermel, K., and Arpe, H.-J. Industrial Organic Chemistry. Verilog Chemise, New York, 1978.