IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

PERFORMANCE EVALUATION AND DESIGN OF HEAT EXCHANGER USING SIMULATION TOOL WITH VARYING PARAMETERS

[1]Miss. Chaitali N. Gohatre,[2] Dr. Rakesh Kumar,[3]Dr. Nitin Gajanan Kanse
[1]Research Scholar,[2] Guide,[3] Co-Guide
[1]Chemical Engineering,
[1]JJTU, Jhunjhunu, Chudela, Rajasthan, India

Abstract : This thesis covers heat exchanger thermal design basics and methodologies. Thermal engineering data, Shell side design includes tube architecture, baffles, pressure loss, and average temperature difference. Standard formulas determine tube and shell heat transmission and pressure drop. We utilize these connections to develop efficient heat exchangers in this essay. Designing tube bundle heat exchangers. Fluid distribution between shell and tubes, shell reuse, oversizing, and fouling. Kahn's method allows solution iteration. User-set process parameters include hot and cold stream temperatures, mass flow rates, and liquid densities. Users inherit pipe properties. Pressure loss reduces heat exchanger efficiency.

Adjusting settings in manual calculations and the DWSIM simulation program simplified calculations and produced LMTD, NTU, Kern, and Bell-Dellware values, which were compared. Calculate on. Shells, tubes, shell types, etc., have set sizes and shapes. Designers need a fast way to find the most cost-effective heat exchanger arrangement with many possibilities. We will tweak and measure its thermal efficiency now. The cold and hot fluid pressure drops determine a heat exchanger's LMTD, thermal efficiency, and overall efficiency. Then, hand-collected results are compared. This will shape the heat exchanger.

***IndexTerms* – Heat Transfer, DWSIM, Simulation.**

INTRODUCTION

At the heart of food processing technology is the concept of unit operations. All food processes can be decomposed into a planned sequence of unit processes and actions. It isnot very easy, to sum up all procedures in a single kind of food processing facility for all products. There are too many differences between types of materials, types of heat transfer equipment, types of processes involved, and types of products manufactured by a modern processing plant.

In the field of food processing, there are most likely many different types of food processing processes and pieces of equipment that are frequently seen, such as:

- Cleaning
- Screening
- Sorting
- Grading
- Peeling
- Size reduction
- Mixing
- Size enlargement
- Heat transfer
- Mechanical separation
- Mass transfer
- Material handling

Of all operations, single-unit operations are nearly common to all processed foods regarding heat transfer. Almost all processed foods are heated and cooled at some point between the time they arrive at the processing facility and the time they reach the consumer. The development of process machinery for the refrigeration of perishables, pasteurization, sterilization, freezing of milk and fruit juices, varieties of heat exchangers, boilers, and many other related applications all need consideration about the coefficients of heat transmission.

Thus, the overall purpose thesis addresses the basic food engineering heat transfer principles, equipment, applications, and software used for significant food processing operations of commercial importance. Use simulation tools to design processes that lead to safe food products with specific properties and structures—a study of heat exchanger performance using various inlet parameters.

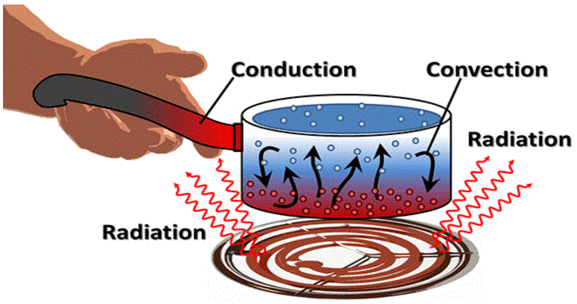


Figure 1.1 Schematic view of modes of heat transfer

Basics/Principles of Heat Exchangers

Heat may be moved from one substance to another using a heat exchanger. Two streams of a process fluid, such as oil, water, steam, gas, or air, are frequently used as these media. Air is another illustration. Generally speaking, one of the fluids must be hotter than the other. Therefore, there are both hot and cold drinks available. Liquid at a higher temperature may transfer heat to a cooler medium. Heat exchanger liquid, which conducts thermal energy over metal walls.

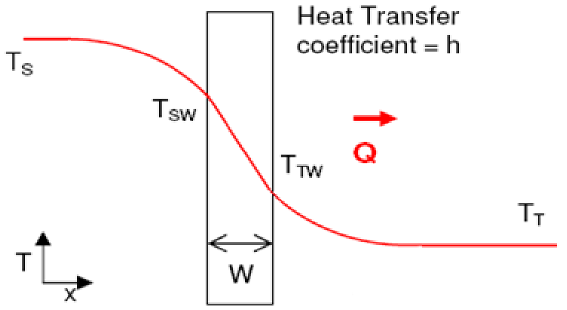


Figure 1.2 Temperature profile for the heat exchanger

NEED OF THE STUDY.

The wide variety of heat exchangers on the market and their context-dependent effectiveness in transmitting heat between fluids inspired this research. Construction of shell-and-tube heat exchangers may be sped up with the use of real-world simulation software. Shell and tube heat exchangers are able to swiftly test a variety of designs to determine which one is the most effective. The goal of this research is to develop a shell-and-tube heat exchanger that is more effective, less expensive, and more compact. Thus, the ideal heat exchanger design, size, and rating rely on many aspects.

Objective of Research Work

This simulation research evaluates heat exchangers in the food processing industry. This study will analyze heat exchanger optimization utilizing two criteria. These goals include improving heat transfer and minimizing system cost for a fluid with a certain mass-flow rate, given intake and output temperatures, and a defined temperature range. The shell and tube sides' maximum pressure drop limits and standard and realistic geometries are considered during optimization.

The research project must cover these topics:
Food industry heat exchangers are investigated.
Second, comprehend heat exchanger development ideas.
Third, to test commercial heat exchangers by choosing an appropriate one.
Simulating a food production heat exchanger.
Consider all input parameters to assess heat exchanger performance.
To achieve goals, determine the heat exchanger's ideal operating parameters.

Scope of the Study

- The heat exchanger is widely used, and it may provide positive feedback to society if it is built appropriately with increased efficiency.
- Since heat exchangers are so useful in many settings, it's fair to say that learning more about them would be a great academic endeavor.
- With the help of simulation tool development, heat exchanger modelling may be completed in a matter of seconds, and the resulting solution can be saved and used in future comparative studies.
- Several adjustable settings on heat exchangers allow for individualized optimization.
- Those in the medical, pharmaceutical, and agricultural professions and those involved in the food, fruit, vegetable, meat, dairy product, baked item, and drink industries may all stand to gain from the heat exchanger's discoveries.
- The development of a simulation tool has proved very useful to scientists. Using the simulation's built-in tool, the configurations may be rapidly located.
- Practical confirmation with simulated tool results requires the rapid construction of an experimental setup.3.1Population and Sample

KSE-100 index is an index of 100 companies selected from 580 companies on the basis of sector leading and market capitalization. It represents almost 80% weight of the total market capitalization of KSE. It reflects different sector company's performance and productivity. It is the performance indicator or benchmark of all listed companies of KSE. So it can be regarded as universe of the study.Non-financial firms listed at KSE-100 Index (74 companies according to the page of KSE visited on 20.5.2015) are treated as universe of the study and the study have selected sample from these companies.

The study comprised of non-financial companies listed at KSE-100 Index and 30 actively traded companies are selected on the bases of market capitalization.And 2015 is taken as base year for KSE-100 index.

RESEARCH METHODOLOGY

A heat exchanger transfers energy from one solid surface to another to transfer heat between fluids. Conduction and convection are considered during heat exchanger research and design. Unless the heat exchanger is insulated and its outside surface is heated to very high temperatures, there is often only a minimum amount of radiative transmission that occurs between the heat exchanger and the environment that surrounds it.

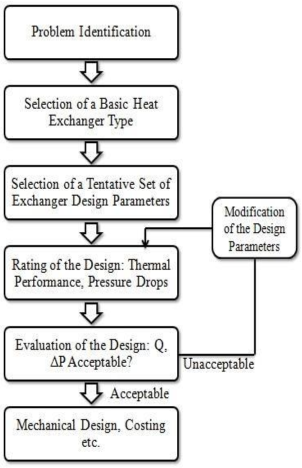


Fig. 3.1 Common Logical Structure for food processing heat exchanger design

Knowing TEMA specifications for shell & tube exchangers

The TEMA Standards not only describe the architecture of heat exchangers but also the tolerances that need to be adhered to while machining and putting the parts together. On the basis of the functions that they carry out, they may be broken up into the three basic categories that are as follows:

- In this context, TEMA B refers to "Chemical Service," TEMA R to "Refinery Service," and TEMA C to "General Service."
- The demanding requirements of processing petroleum fall within the purview of Class R, which in general covers the majority of large-scale processing applications. Class C for any usage in a business environment, regardless of the kind. Class S for any application in a scientific environment. The necessary level of service for chemical activities is known as Class B service.
- Class B allows for lighter (metal that is thinner) construction for noncritical sections due to the fact that heat exchangers are often built of stainless steel or high alloys. However, the structural elements that are required for Class R vehicles must be heavier and more conservative. The Standards for the three different courses have very few points of differentiation between them.
- Expansion joints, fixed or floating tube sheets, fixed or detachable tube bundles, and fixed or floating tube sheets are only some of the parts that go into making a shell-and-tube system a functional heat exchanger. Learn more about the TEMA categories in order to make better choices.

Methods of heat exchanger design:

A. Kern Method

After doing study and carrying out tests with heat exchangers seen in commercial and industrial settings, D. Q. Kern developed this approach. It's straightforward but yet showing impressive focus on detail. Accurate approximations of the pressure drop and heat transfer coefficient may be obtained using this technique. This follows naturally from the current predicament. Incorporating a Relative Housing Diameter Metric. Calculating this length involves factoring in both the outside boundary of the wetting tube and the intertube flow region.

B. Bell-Delaware Method

In 1947, the University of Delaware's Department of Chemical Engineering began a comprehensive study of the shell-side design of shell-and-tube heat exchangers. This work is still going on today. In 1963, after years of hard work, the Delaware Project was finished and given its current name. Standard Oil Development Company, Tubular Exchanger Manufacturers Association, American Petroleum Institute, Andale Company, Downingtown Iron Works, Davis Engineering Co. & Company, and York Corporation all contributed to the project's start in 1947. Mechanics' professional organization ASME oversaw the project. Research for this work was primarily undertaken by Olaf Bergelin and Alan Colburn, two academics at the University of Delaware.

C. Logarithmic Mean Temperature Difference (LMTD) Method

The coefficient of heat transfer may be affected by the temperature differential between two different fluids, as shown by the study of Frank et al. (2011). This is due to the fact that the fluids' temperatures will vary as they go through the heat exchanger, based on their relative locations inside the device.

When developing and assessing a particular heat exchange device, LMTD is used when the liquid's entrance temperature, the liquid's flow rate, and the liquid's target exit temperature are all known. When calculating the exit temperature from a given input temperature, an iterative technique may be used to evaluate how well the calculation performed.

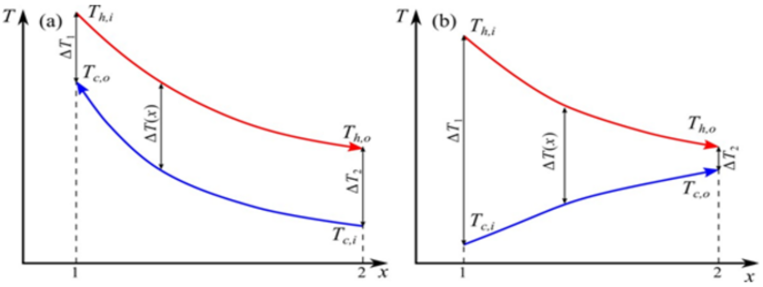


Figure 3.3. Temperature profiles in single pass heat exchangers with (a) counter flow and (b) parallel flow.

Table 3.1 Correlations for heat exchanger effectiveness

Flow geometry	**Relation**
Concentric tube heat exchanger Co-current flow Counter-current flow Counter-current flow at Cr = 1.0 Shell & tube heat exchangers Single shell-pass,2,4,6, tube- pass All heat exchangers with Cr = 0	$\varepsilon = \frac{1 - \exp *\{1 - NTU * (1 + Cr)\}}{1 + Cr}$ $\varepsilon = \frac{1 - \exp *\{-NTU * (1 - Cr)\}}{1 - Cr * exp * \{-NTU(1 - Cr)\}}$ $\varepsilon = \frac{NTU}{1 + NTU}$ $\varepsilon = 2\{1 + Cr + (1 + Cr)^{0.5}[\frac{1 + \exp *\{-NTU(1 + Cr^2)\}^{0.5}}{1 - exp * \{-NTU(1 + Cr^2)\}^{0.5}}]$ $\varepsilon = 1 - e^{-NTU}$

Table 3.2: Total Transfer of heat coefficients in heat exchangers with tubes and shells can range in value

Heat transfer fluids	Overall heat transfer coefficient, U(w/m^{2}k)
Water to water	1140-1700
Water to organic liquids	570-1140
Water to brine	570-1140
Water to condensing steam	1420-2270
Water to gasoline	340-570
Water to gas oil	140-340
Gas oil to gas oil	110-285
Steam to boiling water	1420-2270
Water to air	110-230
Light-organics to light-organics	230-425

Heavy-organics to heavy-organics	55-230

Need for Simulation

The usage of simulation is powerful and has an enormous amount of significance. It provides a mechanism for assessing various designs, methods, and policies without testing the system itself (thus, without the expense of field testing, prototypes, etc.). It is possible to do this by using sensitivity analysis. It is an effective instrument for deciding whether or not a system may be enhanced in some way. In light of this fact, you will not be required to put the system in issue through its paces in order to provide a solution to the "What if?" question.

Types of Simulation

Simulators are a collective term for the many types of software and hardware used in simulation. To categorize instruments that may be used for a variety of purposes, some of the major categories that can be employed are as follows:

A. Discrete Event Simulators

The method of building system representations that is taken by these modeling tools is known as transaction flow. A model is constructed up of its individual components, which include entities, resources, and controls. The primary purpose of discrete simulators is to mimic processes such as call centers, factories, and shipping facilities, in which the materials or information being simulated may be represented as flowing in discrete steps or packets. Discrete simulators may also be used to model other types of operations. In settings like this, discrete simulators are often used as a standard practice.

B. Agent-based Simulator

This is a subclass of what is known as discrete event simulators, and the mobile units that are included in them are referred to as agents.

C. Continuous Simulators

The skills that we cover in this session may be used to solve differential equations, which are used to describe the development of systems by using continuity equations. These simulators function the best to mimic the simulated phenomena when the simulated material or information can be represented as growing or flowing smoothly and continuously rather than in frequent discrete stages or packets. This is because smooth and continuous development and flow are more difficult to model than discrete steps. One common kind of continuous simulator is called system dynamics, and it's becoming more popular.

Advantages of simulation

- The findings of simulation research contribute to our advancement in comprehending how the system works.
- It is feasible to evaluate new rules, operating procedures, information flows, and so on without creating any interruption to the actual system's operation in any way, and this is something that should be done.
- Critical Thinking: One of the many advantages of simulation is that it enables participants to debate all aspects of the process.
- Communication tools, such as animation and visualization software. I am able to convey my argument to others in a way that is understandable.
- Capable of exhibiting not just the revenue but also the behavior of the system (that is, how the system changes over the course of time).
- The core principle behind the simulation is straightforward, which makes it straightforward to perfect and straightforward to explain to customers.
- Placing a greater focus on the real qualities of the system under investigation is made possible by using a reduced number of simplifying assumptions.

Disadvantages of the simulation process

- The value of an inquiry is inversely related to both the precision of the model and the level of expertise of the modeler.
- The process of collecting reliable input data is one that may be both time-consuming and sometimes costly.
- Simulation models are not intended to provide optimal solutions; rather, they are instruments for analyzing how a system responds to particular circumstances that the experimenter defines.
- The modeling and analysis of simulations both require a significant amount of time and may be quite costly.

History of DWSIM

Daniel Medeiros was the first individual to develop his DWSIM software on July 9, 2008; this program now serves as the basis for the project. The software for Windows, Linux, macOS, iOS, and Android was then modified on October 5, 2018, to match the standards that users had demanded. This was done in response to user requests. Visual Basic.NET and the programming language C# were used during the development of this application. The DWSIM software is cross-platform and may be run on Windows, Linux, macOS, Android, and iOS. The.NET and Mono software platforms are the ones that are being used.

Step to simulation

i. To begin a new simulation, you may click the button that is labeled "Create new static simulation," which is located in the welcome box. After the simulation has been properly constructed, a window for configuring the parameters will appear. Tabbed panels make up the user interface for the simulation settings, which are presented to the user.
ii. Make modifications to the utilities for Simulation and Petroleum Fractions (Pseudo Components) by adding new connections or removing connections that are already in place.

iii. The procedure of putting up a property package could include choosing phase-balanced flash algorithms and other such things. Arrangement of components in a complex thermodynamic model.
iv. Management of the unit system.
v. Information on the simulation, including the title, author, and description, as well as the parameters for how numbers should be formatted and how passwords should be stored.

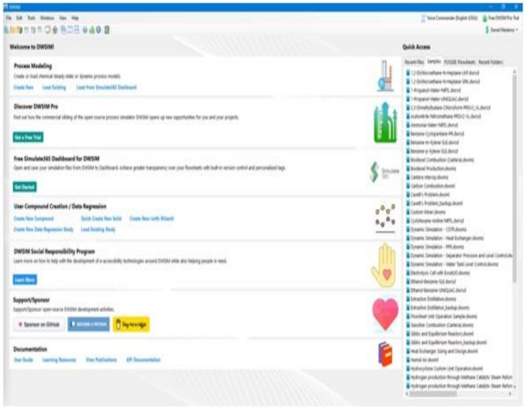


Fig.3.28 Welcome Screen

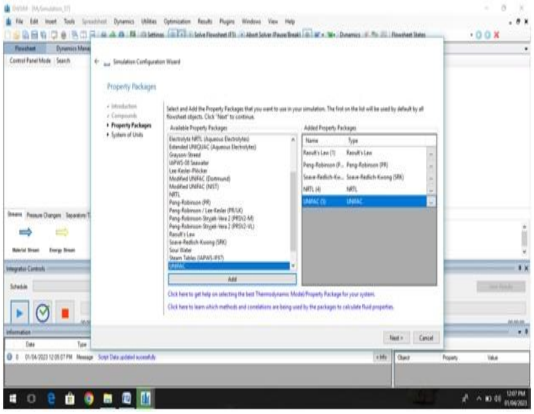


Fig. 3.31 Property Package Configuration Interface

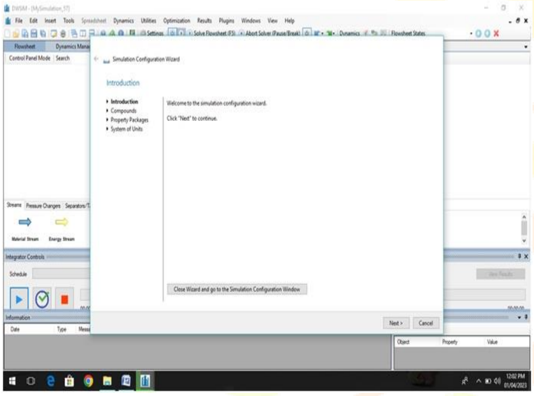


Fig.3.29 Simulation Configuration

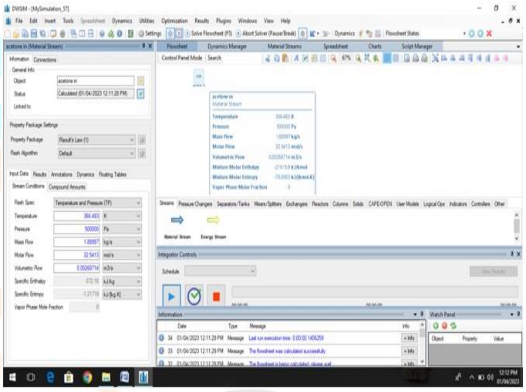


Fig.3.33 Specifying Streams Information

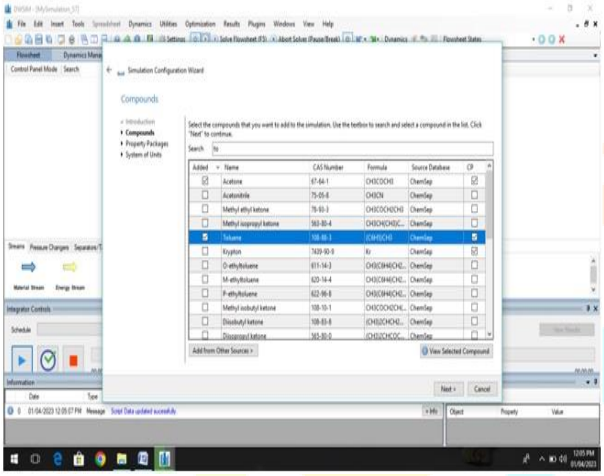


Fig.3.30 Select Component

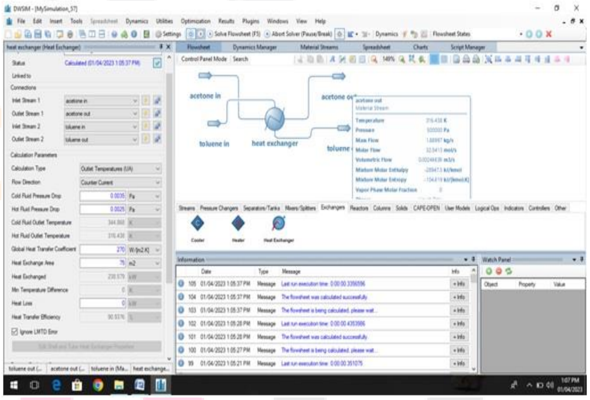


Fig.3.34 Adding material Streams To The heat exchanger

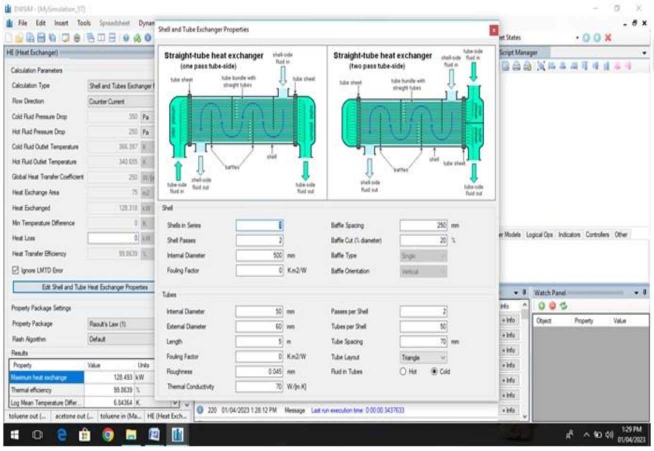
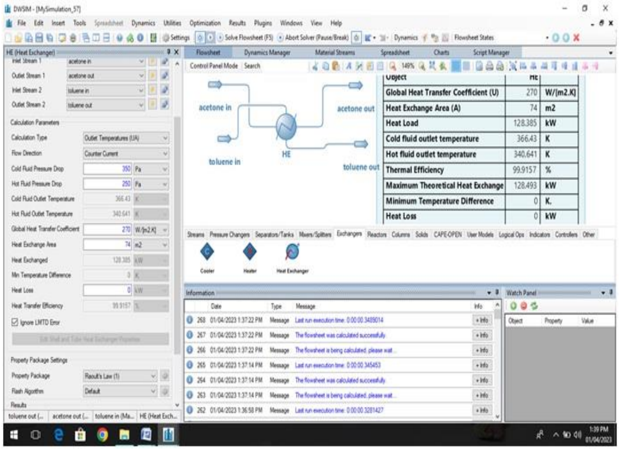


Fig.3.36 Heat Exchanger Calculated

Fig.3.35 Specifying shell &tube Geometry for heat exchanger’s



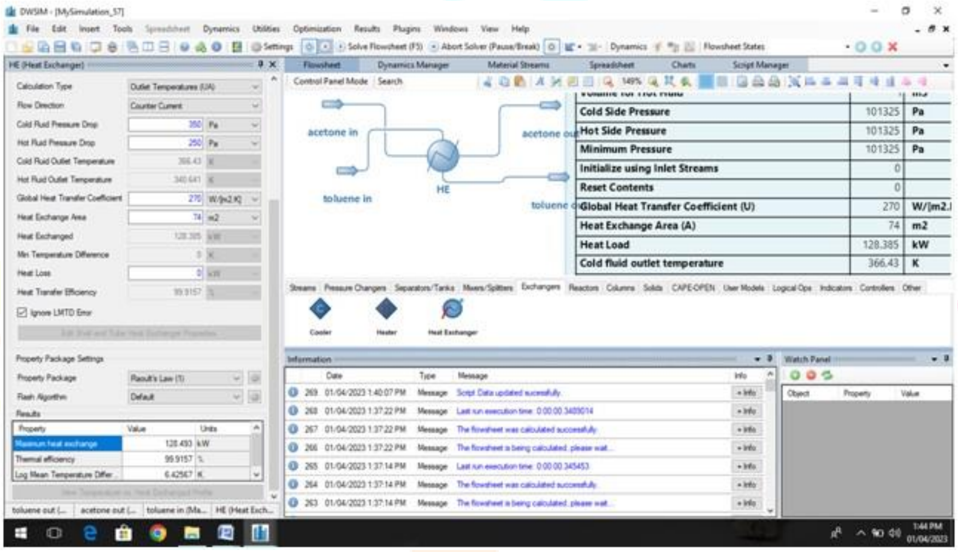
Inlet Stream 1: acetone in
Outlet Stream 1: acetone out
Inlet Stream 2: toluene in
Outlet Stream 2: toluene out

Calculation Parameters
Calculation Type: Outlet Temperatures (UA)
Flow Direction: Counter Current
Cold Fluid Pressure Drop: 350 Pa
Hot Fluid Pressure Drop: 250 Pa
Cold Fluid Outlet Temperature: 366.43 K
Hot Fluid Outlet Temperature: 340.641 K
Global Heat Transfer Coefficient: 270 W/[m2.K]
Heat Exchange Area: 74 m2
Heat Exchanged: 128.385 kW
Min Temperature Difference: 0 K
Heat Loss: 0 kW
Heat Transfer Efficiency: 99.9157 %
☑ Ignore LMTD Error
Edit Shell and Tube Heat Exchanger Properties

Property Package Settings
Property Package: Raoult's Law (1)
Flash Algorithm: Default
Results

Object	HE	
Global Heat Transfer Coefficient (U)	270	W/[m2.K]
Heat Exchange Area (A)	74	m2
Heat Load	128.385	kW
Cold fluid outlet temperature	366.43	K
Hot fluid outlet temperature	340.641	K
Thermal Efficiency	99.9157	%
Maximum Theoretical Heat Exchange	128.493	kW
Minimum Temperature Difference	0	K.
Heat Loss	0	kW

```
    Date                    Type     Message                                     Info
268 01/04/2023 1:37:22 PM  Message  Last run execution time: 0:00:00.3489014     +Info
267 01/04/2023 1:37:22 PM  Message  The flowsheet was calculated successfully.   +Info
266 01/04/2023 1:37:22 PM  Message  The flowsheet is being calculated, please wait...  +Info
265 01/04/2023 1:37:14 PM  Message  Last run execution time: 0:00:00.345453      +Info
264 01/04/2023 1:37:14 PM  Message  The flowsheet was calculated successfully.   +Info
263 01/04/2023 1:37:14 PM  Message  The flowsheet is being calculated, please wait...  +Info
262 01/04/2023 1:36:58 PM  Message  Last run execution time: 0:00:00.3281427     +Info
```



Calculation Type: Outlet Temperatures (UA)
Flow Direction: Counter Current
Cold Fluid Pressure Drop: 350 Pa
Hot Fluid Pressure Drop: 250 Pa
Cold Fluid Outlet Temperature: 366.43 K
Hot Fluid Outlet Temperature: 340.641 K
Global Heat Transfer Coefficient: 270 W/[m2.K]
Heat Exchange Area: 74 m2
Heat Exchanged: 128.385 kW
Min Temperature Difference: 0 K
Heat Loss: 0 kW
Heat Transfer Efficiency: 99.9157 %
☑ Ignore LMTD Error

Property Package Settings
Property Package: Raoult's Law (1)
Flash Algorithm: Default
Results

Property	Value	Units
Maximum heat exchange	128.493	kW
Thermal efficiency	99.9157	%
Log Mean Temperature Differ...	6.42567	K

Cold Side Pressure	101325	Pa
Hot Side Pressure	101325	Pa
Minimum Pressure	101325	Pa
Initialize using Inlet Streams	0	
Reset Contents	0	
Global Heat Transfer Coefficient (U)	270	W/[m2.K]
Heat Exchange Area (A)	74	m2
Heat Load	128.385	kW
Cold fluid outlet temperature	366.43	K

```
    Date                    Type     Message                                     Info
269 01/04/2023 1:40:07 PM  Message  Script Data updated sucessfully.             +Info
268 01/04/2023 1:37:22 PM  Message  Last run execution time: 0:00:00.3489014     +Info
267 01/04/2023 1:37:22 PM  Message  The flowsheet was calculated successfully.   +Info
266 01/04/2023 1:37:22 PM  Message  The flowsheet is being calculated, please wait...  +Info
265 01/04/2023 1:37:14 PM  Message  Last run execution time: 0:00:00.345453      +Info
264 01/04/2023 1:37:14 PM  Message  The flowsheet was calculated successfully.   +Info
263 01/04/2023 1:37:14 PM  Message  The flowsheet is being calculated, please wait...  +Info
```

Fig.3.37 Final result for the given case study

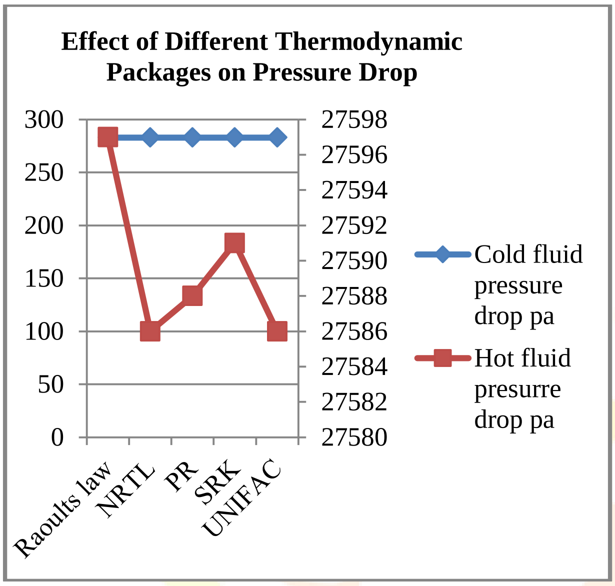
IV. RESULTS AND DISCUSSION

This experiment employed a stationary simulation. To solve intake parameters, DWSIM computed heat exchanger shell and tube exit parameters. This fixed the issue. DWSIM is able to simulate the performance of a shell-and-tube heat exchanger while taking into account the relevant characteristics of the issue. During the course of our inquiry, we looked at a variety of conventional tube-and-shell heat exchanger designs. We made use of a wide variety of thermodynamic property packages, each of which was associated with a unique group of input parameters. An investigation into the performance of shell and tube heat exchangers under a variety of different intake conditions, including comparisons with thermal parameters such as thermal efficiency, tube-shell pressure drop, Reynolds number, LMTD and LMTD correction factors, global coefficients for heat transfer, and resistance heat transfer tube shells. The table below breaks out the recently completed report.

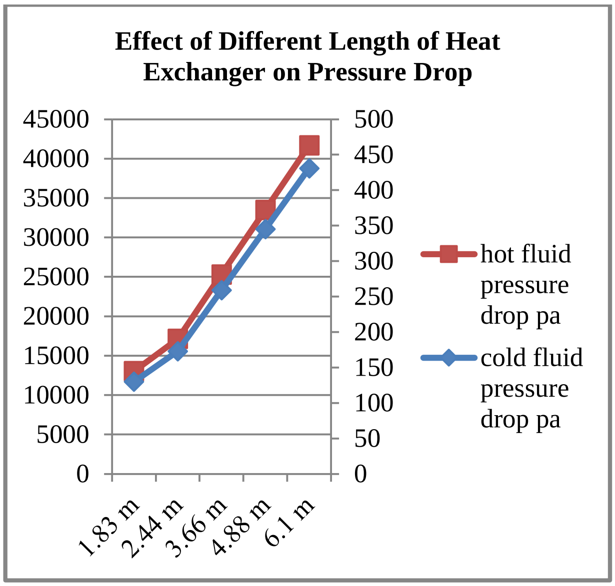
Table 4.1:Effects of Different Numbers of Tube Passes on Heat Exchanger Parameters

Effect of Different Numbers of Tube Passes on Heat Exchanger Parameter					
Parameters	**Units**	**Two-pass**	**Four pass**	**Six pass**	**Eight pass**
Global Heat Transfer Coefficient (U)	W/[m2.K]	269.42	360.356	411.583	445.202
Heat Load	kW	182.341	198.678	204.933	208.235
Cold fluid outlet temperature	K	337.811	340.085	340.955	341.417
Hot fluid outlet temperature	K	329.618	325.984	324.58	323.836
[Shell and Tube] LMTD Correction’s Factor (F)		0.918551	0.864063	0.830659	0.808194
Logarithmic mean temperature difference LMTD	K.	23.3275	20.2017	18.9779	18.323
[Shell and Tube] Resistance heat transfer pipes	K.m2/W	0.002138	0.0012	0.000854	0.00067
[Shell and Tube] Resistance heat transfer shell	K.m2/W	0.00114	0.001142	0.001142	0.001143

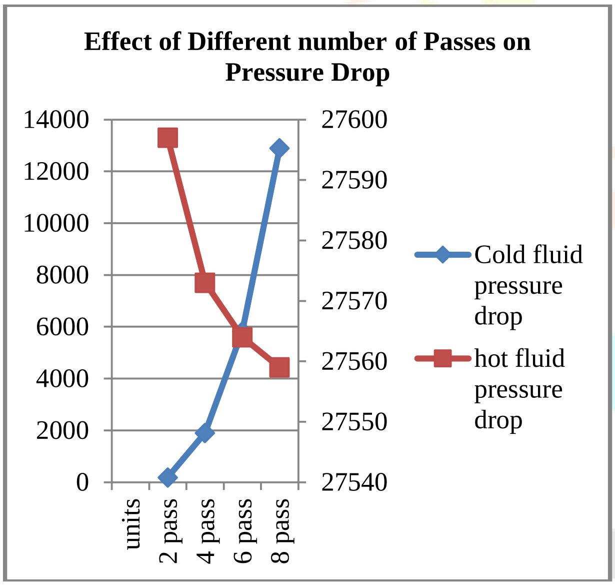
[Shell and Tube] Reynolds number shell		19252.5	19016.8	18925.8	18877.6
[Shell and Tube] Reynolds number tubes		9801.93	19824.8	29864.6	39909.8
Thermal Efficiency	%	69.4842	75.7091	78.0927	79.351
Maximum Theoretical Heat Exchange	kW	262.422	262.423	262.423	262.423
Cold fluid pressure drop		183	1899	5815	12894
hot fluid pressure drop		27597	27573	27564	27559


Effect of Different Thermodynamic Packages on Pressure Drop

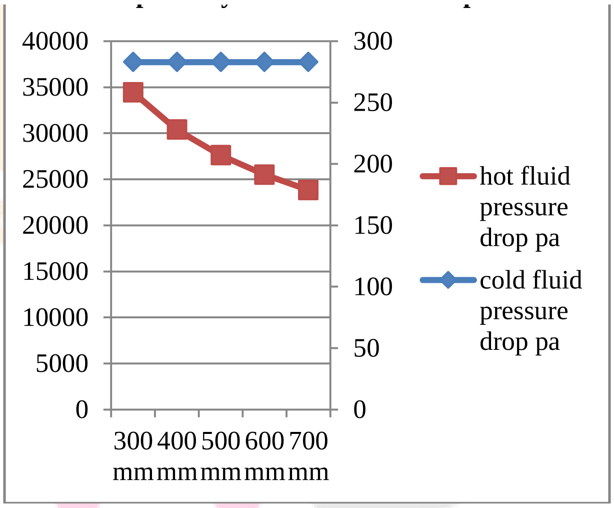
Graph 4.10 Effects of Different Thermodynamic Packages on Pressure Drop


Effect of Different Length of Heat Exchanger on Pressure Drop

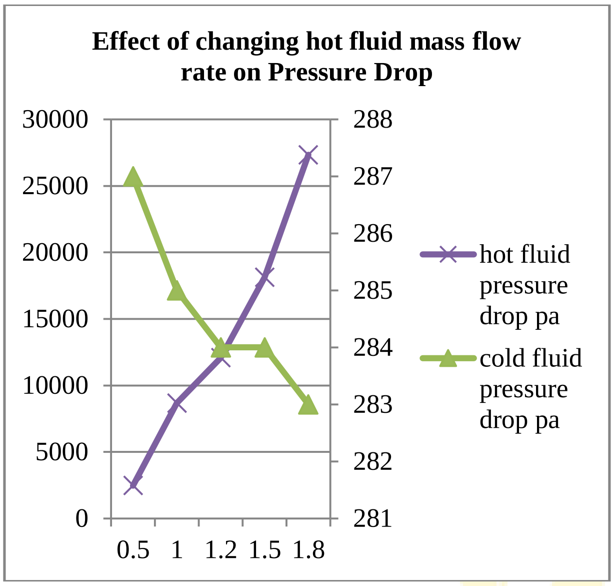
Graph 4.12 Effect of Different Length of Heat Exchanger on Pressure Drop


Effect of Different number of Passes on Pressure Drop

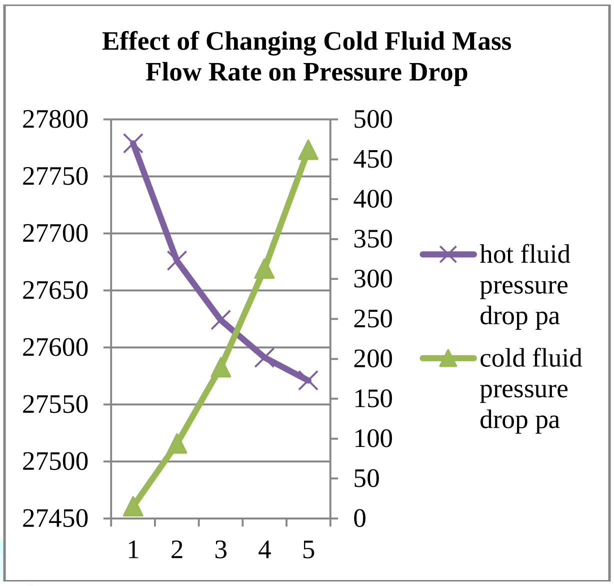
Graph 4.11 Effect of Different number of Passes on Pressure Drop



Graph 4.13 Effect of shell diameter for triangular pitch layout on Pressure Drop

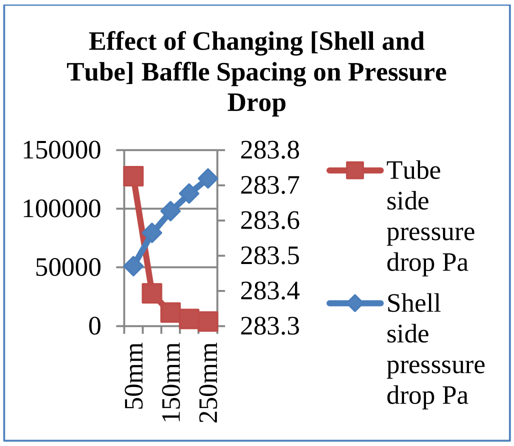


Graph 4.14 Effect of changing hot fluid mass-flow-rate on Pressure Drop

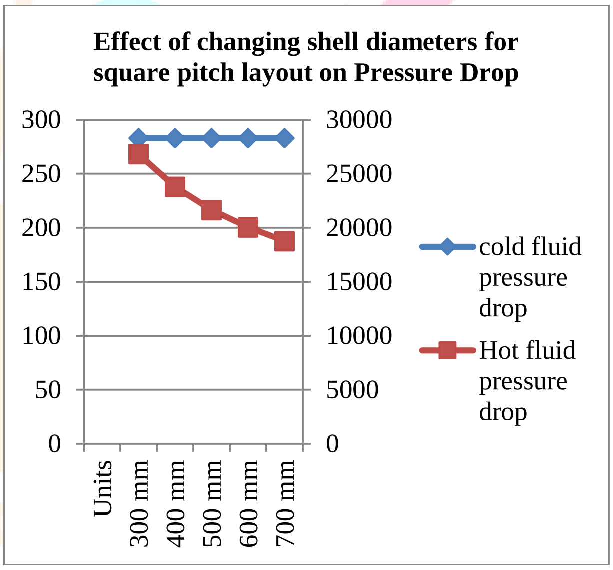


Graph 4.15 Effect of Changing Cold Fluid Mass-Flow-Rate on Pressure Drop

Total pressure on tube and shell sides with different baffle spacings is shown in graphs 4.16 and 4.16. See the graphics below. pressure drop. Because baffle spacing boosts shell fluid mass velocity.



Graph 4.16 Effect of Changing [Shell and Tube] Baffle Spacing on Pressure Drop

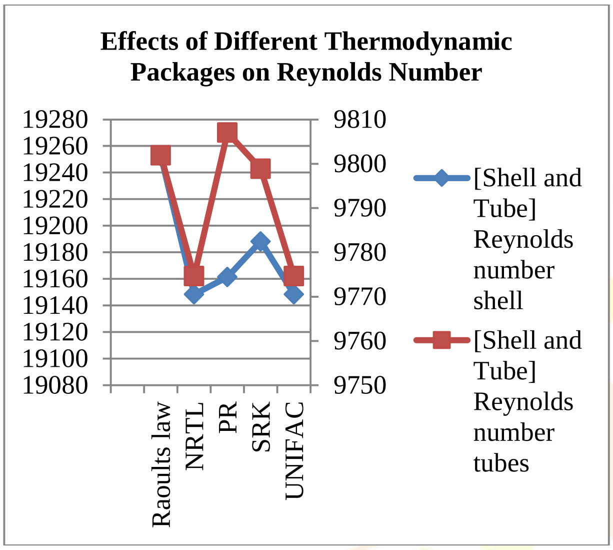


Graph 4.17 Effect of changing shell diameters for square pitch layout on Pressure Drop

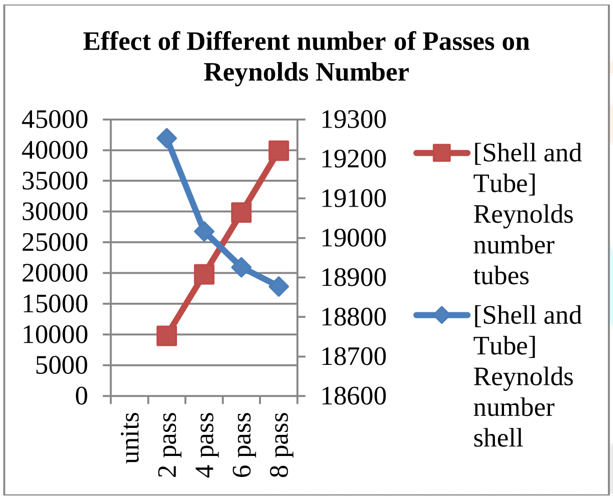
Table 4.2: Effect of Different Lengths of Heat Exchanger on heat exchanger Parameters

Effect of Different Lengths of Heat Exchangers						
Parameters	**units**	**1.83 m**	**2.44 m**	**3.66 m**	**4.88 m**	**6.1 m**
Global Heat Transfer's Coefficient (U)	W/[m2.K]	267.409	268.189	269.224	269.817	270.187
Heat Load	kW	125.895	147.694	176.608	194.083	205.176
Cold fluid outlet temperature	K	329.799	332.876	337.01	339.447	340.987
Hot fluid outlet temperature	K	341.708	337.098	330.882	327.012	324.53
[Shell and Tube] LMTD Correction's Factor (F)		0.982518	0.968773	0.931052	0.883165	0.829234
Logarithmic mean temperature difference LMTD	K.	33.6447	29.7352	24.4067	21.0903	18.933
[Shell and Tube] Resistance heat transfer pipes	K.m2/W	0.002172	0.002159	0.002142	0.002132	0.002126

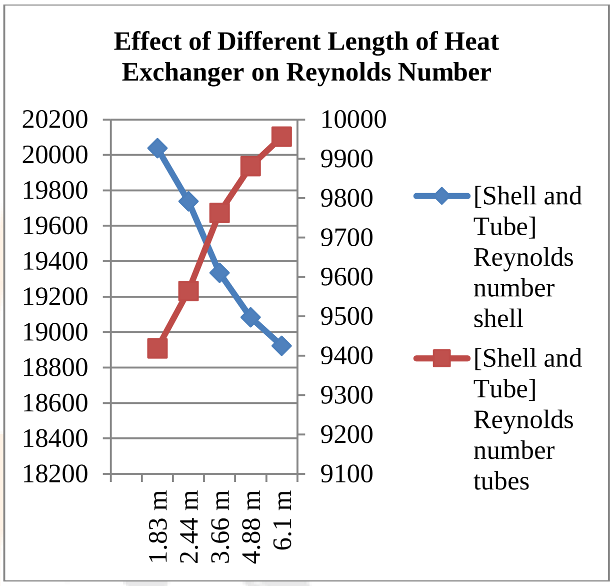
[Shell and Tube] Resistance heat transfer shell	K.m2/W	0.001135	0.001137	0.00114	0.001141	0.001143
[Shell and Tube] Reynolds number shell		20037.4	19737.9	19334.6	19083.5	18922.5
[Shell and Tube] Reynolds number tubes		9418.96	9564.68	9763.2	9881.32	9956.45
Thermal Efficiency	%	47.974	56.2885	67.3056	73.9598	78.1751
Maximum Theoretical Heat Exchange	kW	262.423	262.387	262.397	262.417	262.457
cold fluid pressure drop	pa	130	173	259	345	431
hot fluid pressure drop	pa	13034	17131	25317	33499	41682



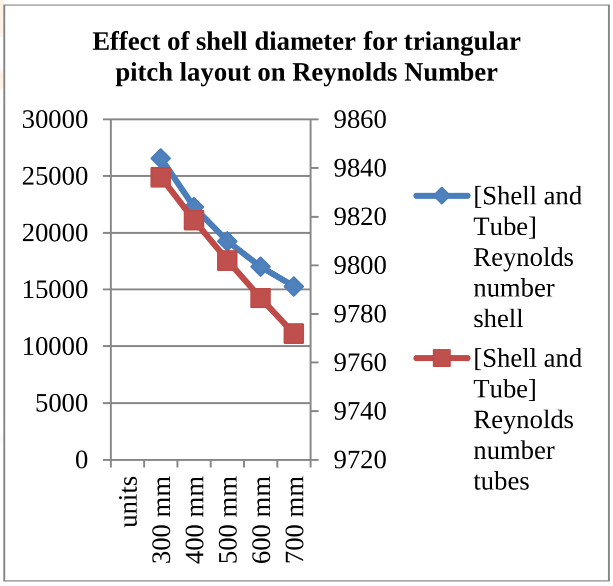
Graph 4.18 Effects of Different Thermodynamic Packages on Reynolds Number



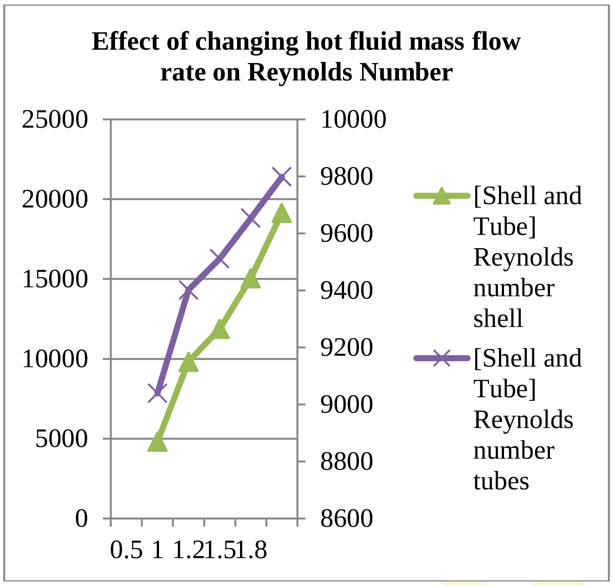
Graph 4.19 Effect of Different number of Passes on Reynolds Number



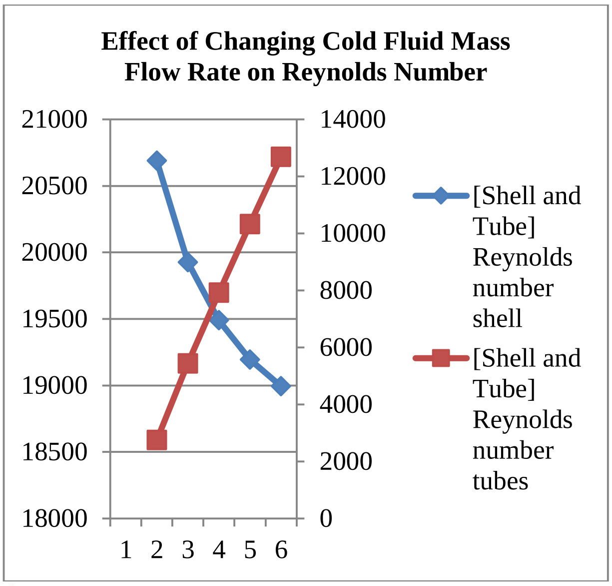
Graph 4.20 Effect of Different Length of Heat Exchanger on Reynolds Number



Graph 4.21 Effect of shell diameter for triangular pitch layout on Reynolds Number



Graph 4.22 Effect of changing hot fluid mass flow rate on Reynolds Number



Graph 4.23 Effect of Changing Cold Fluid Mass Flow Rate on Reynolds Number

Findings and Conclusions

This research examines how various input characteristics affect heat exchanger efficiency. This investigation heavily uses DWSIM, a research method and simulation tool. Numerous studies have examined mass flow rate differences between cold and hot fluids, heat exchanger lengths, baffle distances, shell diameters, baffle pitch arrangements, materials, thermodynamic properties of metals, passage effects, and more. Among the many conclusions: The mass flow rates of fluids vary greatly with temperature.

Heat transfer devices decrease or eliminate germs in food items to make them safe for ingestion and extend shelf life.

Shell and tube heat exchangers are used for high-pressure applications with temperatures more than 260 degrees Celsius and 30 bar. Heat exchangers typically consist of a shell and a series of tubes. These heat exchangers have been designed to have an exceptionally long service life. The maximum heat load and the total heat transfer between heat exchangers are determined using human design calculations and the use of DWSIM software. The range of heat transfer varies depending on which method is used. Therefore, comparison helps remove faults and improves the efficiency of heat exchangers.

The flow rates of both the hot and cold fluids have the greatest influence on the overall efficiency of a type 1 shell and two tube pass heat exchanger. This holds true across a wide variety of shell-and-tube heat exchangers in terms of their thermodynamic setups. Because both the hot and the cold sides of the heat exchanger make use of the same flow fluid.

The heat dissipation of the heat exchanger was significantly enhanced when the fouling factor was calculated. Prevents a decrease in temperature in the heat exchanger.

References

[1] Arjun Sunil (2014), “Design of Shell and Tube Heat Exchanger Using Computational Fluid Dynamics Tools,” Research Gate, DOI: 10.13140/RG.2.2.14939.05924.

[2] Arkadiusz Szpicer, Weronika Bińkowska, Iwona Wojtasik-Kalinowska, Salih Mustafa Salih, Andrzej Półtorak (2023), “Application of computational fluid dynamics simulations in the food industry,” European Food Research and Technology, doi.org/10.1007/s00217-023-04231-y.

[3] Armand Fopah Lele, Thomas Rönnebeck, Christian Rohde, Thomas Schmidt, Frédéric Kuznik, Wolfgang K. L. Ruck (2014), “Modelling of heat exchangers based on thermochemical material for solar heat storage systems,” The 6th International Conference on Applied Energy – ICAE2014, Energy Procedia 61 (2014) pp. 2809 – 2813.

[4] Edreis Edreis and A Petrov (2020), “Types of heat exchangers in industry, their advantages and disadvantages, and the study of their parameters,” IOP Conf. Series: Materials Science and Engineering 963, doi:10.1088/1757-899X/963/1/012027, pp. 1-9.

[5] E. Kayabasi, H. Kurt (2018), “Simulation of heat exchangers and heat exchanger networks with an economic aspect,” Engineering Science and Technology, an International Journal (21), pp. 70-76.

[6] Mohsen Mirzaei, Hassan Hajabdollahi, Hadi Fadakar, (2017), “Multi-objective optimization of a shell-and-tube heat exchanger by constructal theory,” Accepted Manuscript in Applied Thermal Engineering, PII: S1359-4311(16)34360-5, Reference: ATE 10657.

[7] Mr.Santosh K Katarki, Mr. Anandkumar S Malipatil (2017), “CFD Analysis of Shell and Tube Heat Exchanger for Heat Transfer Capabilities,” International Journal of Engineering and Techniques, ISSN: 2395-1303, Volume 3 Issue 6, pp. 102-106.

[8] Mwewa Chikonkolo Mwape, Isaiah Etemo Muchilwa, Zachary Otara Siagi & Francis D. Yamba (2020), “Design and Performance Evaluation of a Hydronic Type Compost Heat Exchanger,” Cogent Engineering, ISSN: 2331-1916, pp. 1-47.

[9] Navickait, Kristina; Penzel, Michael; Bahl, Christian; Engelbrecht, Kurt (2023), “Performance Assessment of Double Corrugated Tubes in a Tube-In-Shell Heat Exchanger,” MDPI, Energies 2021, doi.org/10.3390/en14051343.

[10] Nazni P and Shobana Devi R (2016), “Effect of Processing on the Characteristics Changes in Barnyard and Foxtail Millet,” Journal of Food Processing & Technology, Volume 7 • Issue 3 • 1000566 ISSN: 2157-7110 JFPT, an open access journal.

[11] Nikhil M Gadave, Pramod P Kothmire (2019) “Thermo-Hydraulic Performance Evaluation of Shell & Tube Heat Exchanger with Different Tube Geometries,” International Journal of Engineering and Advanced Technology, ISSN: 2249 – 8958, Volume-9 Issue-1, pp. 2125-2132.

[12] Niyant P. Thakkar, Mithilesh Kumar (2019) “PERFORMANCE ANALYSIS AND OPTIMIZATION OF PLATE TYPE HEAT EXCHANGER IN DAIRY INDUSTRIES,” PDPU Journal of Energy and Management, Vol. 3, No.2, pp 11-20.

[13] Padmakshi Agarwal, Adhirath Sikand and Shanthi V (2014), “Application of Heat Exchangers in Bioprocess Industry: A Review,” International Journal of Pharmacy and Pharmaceutical Sciences, ISSN- 0975-1491, Vol 6, Issue 1, pp. 24-28.

[14] Pavan Vishwakarma, Jitendra Jayant (2017), “ANALYSIS OF MULTIPLE SHELL AND TUBE HEAT EXCHANGER BY VARYING THE INPUT PARAMETERS COMPUTATIONAL FLUID DYNAMICS” INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, ISSN: 2277-9655, pp. 72-83.

[15] Anil Kumar Samal (2013) “SHELL AND TUBE HEAT EXCHANGER DESIGN USING CFD TOOLS” B. Tech. Thesis, Department of Chemical Engineering, NIT Rourkela,769008

[16] Karan Ajitkumar Shah (2021) “Development of decision-makingmodel for cost optimization of the heat exchanger based on spreadsheet programs,” M.S. Thesis, Mechanical Engineering at Rhine-Waal University of Applied Sciences.

[17] Jianchang Huang (2010) “PERFORMANCEANALYSIS OF PLATE HEAT EXCHANGERS USED AS REFRIGERANT EVAPORATORS” Ph.D. Thesis, Faculty of Engineering and the BuiltEnvironment, University of the Witwatersrand, Johannesburg.