CAD System Design of Horizontal Condenser

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Abstract. In order to meet the market demand for new high-efficiency heat exchange equipment and the development trend of complexity and high efficiency. The efficiency of heat exchanger design has a considerable impact on energy savings and the economic efficiency of industrial output. The proposed work presents a horizontal condenser design that overcomes several technical challenges that emerge during the automated compilation of instructions and the development of pipe schematics. It provides a feasible scheme, a solid system structure, and reusable modules for the heat exchanger CAD system. The author relies on the "horizontal condenser system development" project, aiming at the above shortcomings of the horizontal condenser, a horizontal condenser system integrating thermodynamic calculation and mechanical design was developed. On the basis of the traditional design method, the author considers the influence of the internal heat transfer mechanism of the horizontal condenser on its performance, through the numerical simulation method, the performance of the horizontal condenser is analyzed to make the design scheme more reasonable, the final optimal solution can save 11.2% of the total cost compared to other solutions. It can meet the market demand for new high-efficiency heat exchange equipment, can significantly improve the design efficiency and design quality of the horizontal condenser, free engineers and technicians from heavy repetitive work, and has good practicability.

Keywords: Horizontal condenser; numerical simulation; CAD; anti-shock plate; economic calculation; object-oriented.
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1 INTRODUCTION

As the main heat exchanger, heat exchangers are widely used in chemical, energy, pharmaceutical, metallurgical and other engineering fields [1]. Heat exchangers are devices that transfer heat from one medium to another. These media can take the shape of a gas, a liquid, or a combination of the two. To avoid mixing, the material might be separated by just a solid wall or in direct contact [2, 3]. Heat exchangers improve a program's energy efficiency by transporting heat from where it's not needed to where it is. Waste heat from a steam turbine, for example, may be transferred to boil water and drive a steam turbine to generate more energy via a heating element (this is the basis for Combined Cycle Gas Turbine technology) [4, 5].

According to the different processes of heat exchange, heat exchangers can be generally divided into three types: hybrid, regenerative and split. Shell heat exchangers are the most common partition heat exchangers. Their low cost, simple structure, and widespread use advantages make shell and tube heat exchangers account for about 37 percent of the global heat exchanger market. Shell and tube heat exchangers are used in a wide range of industrial processes because they are capable of extracting process heat and preheating supply water. It also allows for the cooling of hydraulic and lubricant oil. Evaporators, condensers, and coolers for gas scrubbing are also used in petrochemical plants for a variety of purposes in the refining process. These heat exchangers can efficiently heat or cool things while using very little energy. Shell and tube exchangers are becoming increasingly popular due to their ability to give operational flexibility while also contributing to overall plant efficiency. This shows that the design of shell and tube heat exchangers has an important impact on saving energy and increasing economic efficiency of industrial production in our country.

According to theoretical research and practical design experience, there are often a variety of structural design schemes for heat exchangers that meet a certain heat exchange requirement, how to find the optimal solution from a variety of design solutions is a problem that engineers and technicians should think about. The author will take the design scheme obtained by CAD design software as the research object, and take the economic calculation method of heat exchanger summed up in engineering practice as the evaluation basis, the application of the economic evaluation method in the optimization of the heat exchanger design scheme is verified, and the basis and reference for the future heat exchanger optimization design are provided [6].

Heat exchanger efficiency is defined as the ratio of heat transferred in the real heat exchanger to heat transferred in the perfect heat exchanger [7, 8]. The concept of heat exchanger efficiency brings a fresh method to the design and analysis of heat exchangers and heat exchanger networks. When such features are taken into consideration in industrial calculations, plate heat exchangers remain the most efficient of all heat exchangers. In most cases, they might attain efficiency rates at about 90% [9, 10]. Heat exchanger efficiency and cost-effectiveness have become essential components of the industry's total profitability. CAD assists in component design as well as the simulation of various environments and stresses on a prototype. They can evaluate the performance of a component or piece of equipment in difficult environments or under extreme stress. Heat exchanger designers can also use the application to generate appropriate specifications and deliver exactly what is needed. The horizontal condenser CAD is realized by the unified modeling language (UML) combined with the object-oriented software design method. In the horizontal position, the tube's thickness is smaller than in the vertical position (as the vertical height in case of horizontal position will be less). As a result, the high heat transfer coefficient in the horizontal position will be greater. It improves the thermal efficiency of the power plant. The cost of water to supply the boiler is lowered since the condensate is returned to the boiler.

The author conducts comprehensive research on the design characteristics, demand analysis and problems that enterprises need to solve in the design of horizontal condensers, solve the various technical problems encountered in the process of automatic preparation of instructions and automatic generation of piping diagrams, it provides a feasible scheme, a good system framework and reusable modules for the heat exchanger CAD system [11, 12]. Mokhov A. et al. thermal conductivity properties of forced convection condensation of air-containing vapors in horizontal pipes were studied experimentally, and the effect of air content and gas flow rate on the local heat transfer coefficient was analyzed. The results show that as the percentage of air mass increases, the heat transfer coefficient of the local condensate decreases, and the inhibitory effect of air on the heat transfer of the condensate decreases as the gas flow rate increases. There is a difference between flow and wave flow. As the difference decreases as the air content increases, the axial change in the local heat transfer coefficient in the heat exchange tube tends to be constant [13.

In a heat exchanger, heat is transferred between hot and cold fluids via a solid wall. The fluids might be process streams or independent heat sources like fluids or refrigerators [14, 15]. Heat transmission can be reduced over time due to corrosion, reaction product deposits, and organic growths. These effects are quantitatively accounted for by fouling resistances. Combining various film coefficients into an overall coefficient of heat transfer allows for the consideration of a broader variety of scenarios and should result in a more accurate estimate [16, 17]. Oh M. et al. conducted an experimental study of the heat transfer of condensed condensation forced by a small amount of water vapor outside a horizontal three-dimensional finned pipe, and found that the heat transfer coefficient of the condensed condensate of a finned tube was 1.72-3 times higher.

The latter has a higher coefficient of thermal conductivity of the condensing regulating the reverse current when the water vapor content is low. When the water vapor content is high, the heat transfer coefficient of the current condensate is higher. It is important to clearly orient the horizontal pipe bundles to the lateral arrangement of the shell under different water vapor concentrations [18]. The heat exchanger designed in the given work analyzes the situation thoroughly and is effective in a variety of situations. It achieves the benefits of ambient cooling. Furthermore, it is intended to reuse the electrical waste heat collected by the system by transferring it to other processes such as wastewater treatment.

2 RESEARCH METHODS

2.1 Overall Structure of Horizontal Condenser CAD System Design and Performance Analysis

The authors investigate the impact of the internal heat transfer mechanism of the horizontal condenser on its performance using the numerical simulation approach, based on the traditional design method. However, there are a range of structural design schemes for heat exchangers that fulfills a certain heat exchange need, and this technique has been used to determine the best answer from a variety of design alternatives. The author developed a horizontal condenser CAD system based on UG, which greatly improved the efficiency of horizontal condenser design. The horizontal condenser CAD system solves the problems of thermodynamic calculation and mechanical design in the design of horizontal condenser. Upon completion of the CAD system of horizontal capacitors, the performance of the horizontal capacitor is analyzed by numerical simulation, so that the designer plays a very important role in clearly observing and optimizing the microscopic field of the horizontal capacitor [19]. The design of heat exchangers involves various quantitative analyses and qualitative decisions based on experience. Figure 1 can be used to illustrate the general process and content of heat exchanger design. Figure 1 illustrates general layout for thermodynamic design of heat exchanger. Various parameters are considered for efficient working and to maintain the performance of the horizontal condenser. Design calculations are made to ensure the good practical applicability.

Evaluation criteria are physical and chemical parameters that can be measured by weight, external volume, injection fluid consumption, initial investment, and service life. Based on the analysis and research of the above parties, it is possible to provide the final design of the optimal heat exchange to the owner or to develop several other models [20- 22].

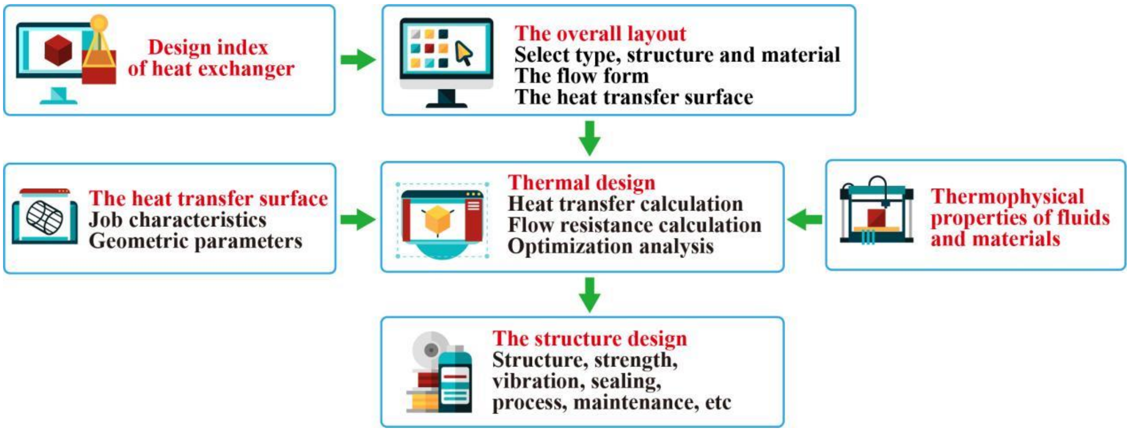

Figure 1: Thermodynamic Design Subsystem Business Process.

2.2 Overall Structure of Horizontal Condenser CAD System Design and Performance Analysis

2.2.1 Design process of horizontal condenser CAD system design and performance analysis

According to the analysis of the design process of the horizontal condenser, the author has improved the design process of the horizontal condenser, as shown in Figure 2:

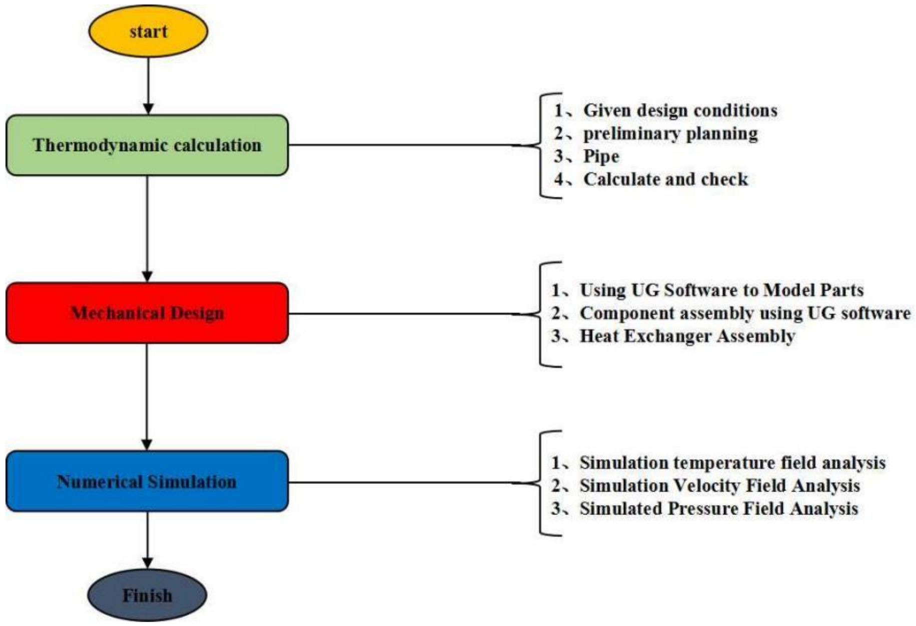

Figure 2: Design process of horizontal condenser CAD system design and performance analysis.

The two modules of thermodynamic calculation and mechanical design constitute the horizontal condenser CAD system, the function of the numerical simulation module is that after the horizontal condenser CAD system completes the horizontal condenser design, the FLUEND software is used to analyze the flow field, so as to propose improvement suggestions for the design [23, 24].

The use case diagram of the horizontal condenser CAD system is shown in Figure 3
The active person in the system is the designer. The designer realizes the functions of thermodynamic calculation and mechanical design module respectively by calling USE CASE 0, USE CASE 1 and other use cases [25].

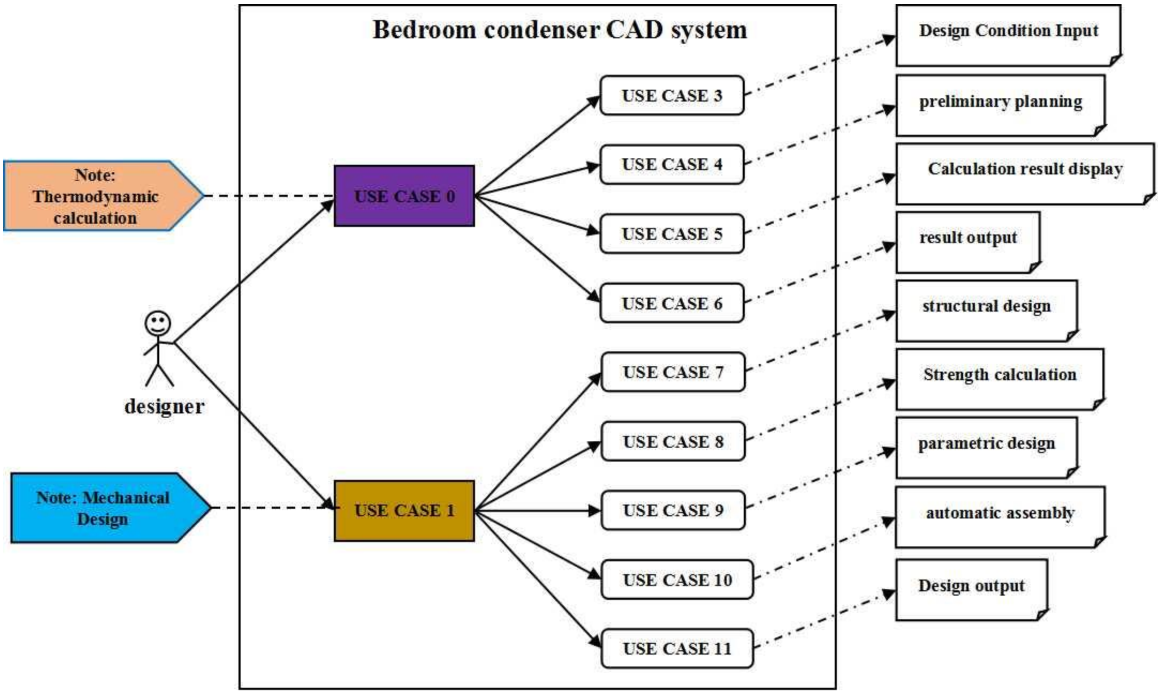

Figure 3: System Use Case.

2.2.2 Analysis of functional modules

The horizontal condenser CAD system provides enterprises with a fast product design technology that is closely integrated with UG NX software, on this basis; numerical simulation can make the design more reasonable [26]. From the overall point of view, each module is refined, and the module function model shown in Figure 4 is constructed.
A brief introduction to each module and its functions is as follows:

2.2.2.1 Thermodynamic calculation module

Thermodynamic Calculation Module, it mainly completes the thermodynamic design calculation part in the design process of the horizontal condenser. First, input the basic working parameters and basic requirements for the horizontal condenser, and make a preliminary plan for the horizontal condenser, some basic structural parameters of the horizontal condenser are determined by thermodynamic calculation, the thermodynamic calculation and verification of the preliminary planning results are carried out, after the verification meets the requirements, the thermodynamic calculation of the horizontal condenser is completed, keep the intermediate results of the calculation process to the parameter library, as a condition for future retrieval and comparison [27]. Finally, the calculation results are output as thermodynamic calculation instructions.

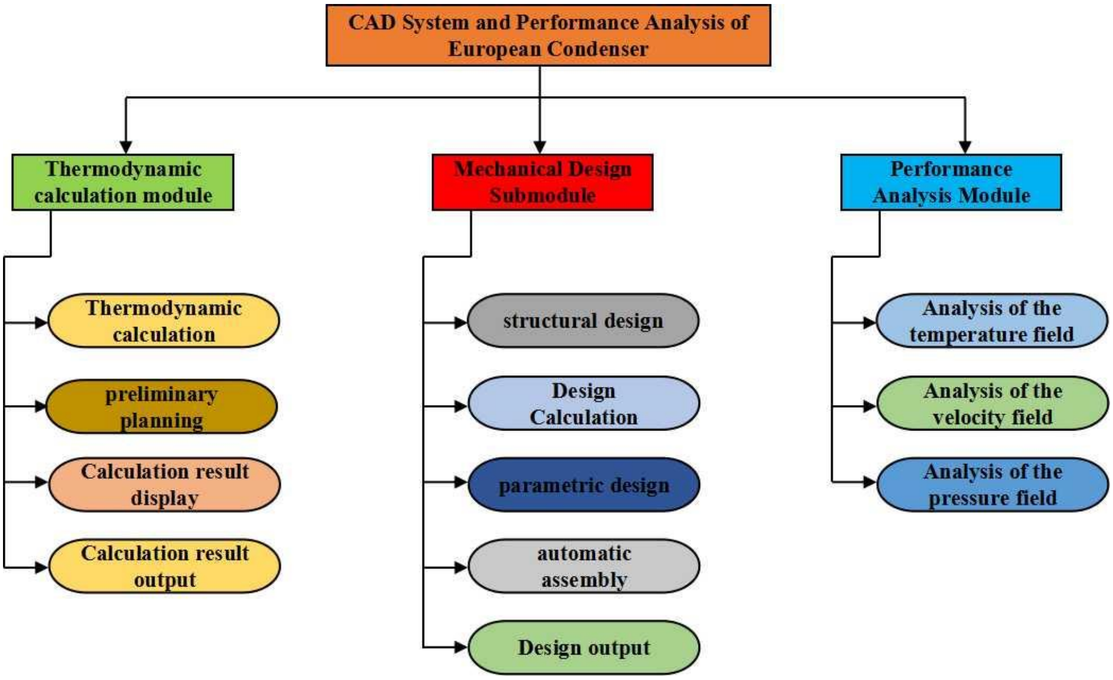

Figure 4: Functional model of horizontal condenser CAD system design and performance analysis.

The thermodynamic calculation module consists of four sub-modules, design condition input, preliminary planning, calculation result display and calculation result output. The above components are explained as follows:

- **Design condition input:** The function of this part is to complete the input of the initial conditions in the design of the horizontal condenser, mainly to determine the project information in the horizontal condenser design project, the basic information of the horizontal condenser and the basic working condition parameters, in order to facilitate the preliminary planning of the horizontal condenser.
- **Preliminary planning:** The function of this part is input into the module according to the design conditions, determine the various basic information of the horizontal condenser and the specific requirements of the designer, through thermodynamics, some basic planning for the horizontal condenser is calculated and completed, mainly including the planning of heat exchange tubes, the pipe spacing, the height of the anti-wash plate and the limit circle diameter of the pipe layout, etc., and the planning of other horizontal condenser structures, such as the thickness of the tube sheet and the support plate, etc. Thus, the design calculation of the horizontal condenser is completed.
- **Calculation result display:** The function of this part is to display the preliminary planning results. During this process, various thermodynamic data can be displayed, if the verification result of the thermodynamic calculation result is qualified, then the following design can be continued, otherwise, the preliminary planning should be carried out again.
- **Calculation result output:** The function of this part is to check the thermodynamic calculation results that meet the requirements. Designers can choose a concise format or a detailed format according to their needs, and output the thermodynamic calculation process and results in the current project as a thermodynamic calculation manual in Word format.

2.2.2.2 Mechanical design module

The main function of the mechanical design module is to complete the mechanical design in the horizontal condenser design process [28]. Including the composition structure of the horizontal condenser and the design of the properties of its components, the strength check of the components of the horizontal condenser, the parameterization to generate the three-dimensional model of the components of the horizontal condenser, the horizontal condenser Assembly of three-dimensional models of condensers and their components and output of 2D drawings of horizontal condensers. The module is composed of five sub-modules: structure design module, design calculation module, part parameterized design module, automatic assembly module, and design output module.

- **Structure design:** The structural design is mainly to select the overall structure of the horizontal condenser, configure the composition of the horizontal condenser, and determine the specific structure of the components of the horizontal condenser. The structural design module reads the preliminary planning data from the document storing the thermodynamic calculation results, and selects the specific structure of the horizontal condenser according to the preliminary planning results, select the specific structural form of the components, and store the structural design results in a formatted document.
- **Design calculation:** Through the SW6-98 software, the strength of some pressure parts of the horizontal condenser is checked, so as to determine the key dimensions of these pressure parts. The author designed the interface program to read the strength calculation book of SW6-98, and output the format strength calculation book from SW6-98, extract the strength check results and the critical dimensions of the compressed parts, and write the extracted data as recommended values into the structural design XML document generated by the "structural design module".
- **Parametric design of parts:** Through the above functional modules, the structure and main size parameters of the horizontal condenser are basically determined, the part parameterization module will extract the structure, composition, size and other data of the horizontal condenser from documents and databases, and extract the three-dimensional template file of the horizontal condenser from the template library, the 3D template is parametrically designed through the secondary development interface of UG, and the 3D model file of the components of the horizontal condenser is obtained.
- **Automatic assembly:** After parametric modeling of all the components of the horizontal condenser, it is necessary to realize the function of assembling these parts together. The automatic assembly module passes the UG secondary development program. It realizes the automatic assembly of components according to assembly rules.
- **Design output:** This module mainly outputs the three-dimensional model of the horizontal condenser designed above in the form of two-dimensional engineering drawings, and mainly outputs part drawings, component drawings and general assembly drawings. The part drawing includes the title block; the technical requirements assembly drawing includes the title block, detailed list, technical requirements and so on.

2.2.2.3 Performance analysis module

The main function of the performance analysis module is to complete the mechanical design of the horizontal condenser, microscopic analysis of the overall performance of the horizontal condenser, thereby; the performance of the horizontal condenser can be improved. It includes numerical simulation analysis of the temperature field, velocity field and pressure field of the horizontal condenser. Through the study of numerical simulation, the internal heat transfer mechanism of the horizontal condenser can be more clearly understood, and the necessary theoretical basis for the optimal design of the horizontal condenser can be provided.

- **Analysis of temperature field:** Temperature field analysis is mainly based on the horizontal condenser inlet temperature, outlet temperature, condensing temperature, and ambient design, and the internal temperature distribution field is obtained using software that mimics the horizontal condenser temperature field. From this, it is possible to clearly see the thermal conductivity performance of the horizontal capacitor in order to implement the thermodynamic calculations and structural improvements of the horizontal capacitor.

- **Analysis of velocity field:** The analysis of the velocity field is mainly based on the design of the horizontal condenser inlet velocity, inlet temperature, outlet temperature, condensation temperature and medium and other parameters, using software to simulate the velocity field of the horizontal condenser, thus, the internal velocity distribution field of the horizontal condenser is obtained, it can be seen from this that the high-speed zone, low-speed zone and fluid velocity inside the horizontal condenser, will they have a greater impact on the heat exchange tube or other components of the horizontal condenser, analyze whether the distribution of its high-speed zone and low-speed zone is reasonable, so as to realize the improvement of the structure of the horizontal condenser.
- **Analysis of pressure field:** The analysis of the pressure field is mainly based on parameters such as the design inlet velocity, inlet pressure and medium of the horizontal condenser, use the software to simulate the pressure field of the horizontal condenser, thereby, the internal pressure distribution field of the horizontal condenser is obtained, from which we can see whether the internal fluid pressure of the horizontal condenser will pose a threat to the heat exchange tubes or other components of the horizontal condenser, and can analyze whether the pressure drop is qualified, so as to achieve the improvement of the horizontal condenser structure.

3 RESULTS ANALYSIS

The horizontal condenser system provides designers with a very convenient tool for thermodynamic calculation and parametric design of horizontal condensers, greatly improve the work efficiency, the horizontal condenser system itself is very large, involving many aspects of knowledge, the author only analyzes the structural characteristics of the horizontal condenser, analyzes the needs of the enterprise, and studies the technical problems raised by the enterprise, only for the problems to be solved by the enterprise, finally completed the design of the horizontal condenser system. The performance analysis of the horizontal condenser is to optimize the design of the horizontal condenser through the numerical simulation method, so that the performance of the horizontal condenser can be optimized, and the designers can better understand the heat transfer mechanism of the horizontal condenser.

3.1 Thermal Resistance Analysis of Horizontal Condenser

Generally, there are two main measures to strengthen heat transfer, namely, increasing heat transfer temperature difference and reducing heat transfer thermal resistance. Due to the limitations of process, environment, materials and other factors, the heat transfer temperature in industrial equipment generally cannot be changed at will, moreover, increasing the heat transfer temperature difference will increase the irreversible loss, so in most cases, the method of reducing the heat transfer thermal resistance is adopted. The horizontal condenser belongs to the partition heat exchanger, and its heat exchange sequence is that the latent heat released by the refrigerant condenses and transfers to the outer wall of the heat exchange tube, the outer wall surface of the heat exchange tube is transferred to the inner wall surface through heat conduction, and finally transferred to the cooling water in the tube from the inner wall surface. The thermal resistance consists of multiple series links, according to the thermal resistance separation formula (3.1); formula (3.2) reduces the thermal resistance of the largest link. It has the most significant effect on improving the heat transfer coefficient. Table 1 shows the experimental measurement values of the inlet and outlet of the condenser under standard conditions, the thermal resistance of each part in the heat exchange is calculated, and the thermal resistance distribution is shown in Figure 5.

$$r = \frac{1}{h_i}\frac{d_0}{d_i} + \frac{\delta}{\lambda}\frac{d_0}{d_m} + \frac{1}{h_0} + r_s \quad (3.1)$$

$$d_m = \frac{d_0 - d_i}{ln(d_0/d_i)} \quad (3.2)$$

In the formula: The heat transfer area is based on the outer wall of the heat exchange tube.

Project	Shell Side	Tube Side
Working Fluid	R404a	Freshwater
Import Flow/m^3h^{-1}	28.6	20
Inlet Temperature/℃	56	32
output Temperature/℃	37	36
Inlet Pressure/Mpa	1.74	0.3
Outlet Pressure/Mpa	1.69	-/-

Table 1: Experimental measurement values of a certain type of original horizontal condenser.

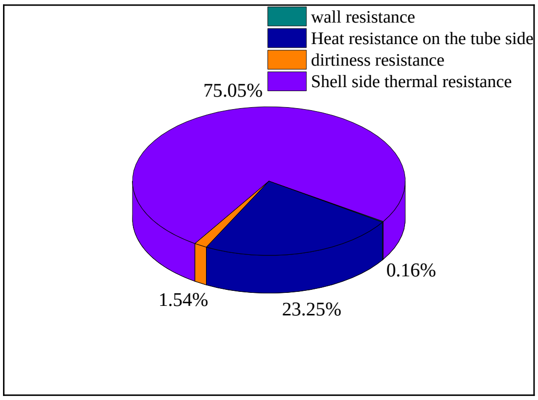

Figure 5: Thermal resistance distribution of the original structure of the horizontal condenser.

As shown in Figure 5, the thermal resistance of the heat exchanger on the side of the casing and on the side of the pipe accounts for 98.3% of the total heat resistance. This is a major factor influencing the heat exchange; contamination and resistance affect. The thermal conductivity of the pipe wall accounts for only 1.7% of the total thermal resistance. The main reason is that the shell-side refrigerant is a clean working fluid, however, the cooling water flow rate on the tube side is higher and it is not easy to scale, so the thermal resistance of the scale is small. In terms of thermal resistance, a set of heat exchange tubes uses copper tubes with a large thermal conductivity. Compared to the thermal resistance of liquid convection, the thermal resistance of the heat transfer medium can be almost neglected. The thermal resistance of the condensate on the shell side is 75% of the total thermal resistance, which is three times the thermal resistance of the convection heat transfer on the cooling water side. This reduces the thermal resistance of the condensate. The transfer side is the key to increasing heat transfer.

3.2 Economic Calculation and Analysis of Heat Exchanger

Heat exchange savings are mainly measured by the sum of the investment costs and operating costs of the heat exchanger, i.e., the total cost of the heat exchanger in formula (3.3):

$$C_{tot} = C_i + C_{oD} \tag{3.3}$$

C_i is the investment cost, which is mainly related to the heat exchange area of the heat exchanger, the actual engineering experience is summarized as the Hall correlation formula (3.4):

$$C_i = a_1 + a_2 A^{a_3} \tag{3.4}$$

Among them: a_1, a_2, a_3 are all constants, when the heat exchange tube material is carbon steel, $a_1 = 7000$, $a_2 = 360$, $a_3 = 0.80$.

C_{oD} is the operating cost, which is related to the energy loss caused by the pump overcoming the frictional resistance; the specific calculation method is as follows in formula (3.5):

$$C_{oD} = \sum_{k=1}^{n} \frac{C_0}{(1+i)^k} \tag{3.5}$$

In the formula: i is the depreciation rate; n is the total number of years of operation; C_o is the annual operating cost, $C_o = P \cdot C_e \cdot H$, where: H is the running time of the heat exchanger, h; C_e is the energy cost of the water pump, $Yuan/kWh$;

P is the pump power, which is calculated according to formula (3.6). The specific calculation method is as follows:

$$P = \frac{1}{\eta}[\frac{m_t}{\rho_t}\Delta P_t + \frac{m_s}{\rho_s}\Delta P_s \tag{3.6}$$

Substitute the design parameters of the three different heat exchangers into the above economic model for calculation, and convert them to Yuan as the cost unit, the investment cost, operating cost and total cost of the three different design schemes can be obtained, as shown in Table 2.

Economic Indicators	*Design Scheme One*	*Design Plan Two*	*Design Scheme Three*
Cost of Investment $C_i/Yuan$	682982.68	671951.14	675150.44
Operating Costs $C_{oD}/Yuan$	228528.41	270661.40	350930.64
Total Cost $C_{tot}/Yuan$	911511.10	942612.55	1026081.11

Table 2: Summary of economic indicators of three different heat exchanger design schemes.

It can be seen from Table 2 that, in terms of heat exchanger investment cost, option 2 is the most economical, while option 1 has the highest cost, and there is little difference between the options; In terms of operating costs, option 1 is the most economical, option 3 has the highest operating cost, and the options vary greatly. Considering the investment cost and operating cost, the scheme 1 has the least total cost and is the most economical scheme, compared with the scheme 3 with the most total investment, the total cost can be reduced by 11.2%, and the economy is significantly improved.

3.3 Fluid-Solid Wall Treatment Method

When CFX performs the fluid-solid coupling heat transfer calculation, the governing equations of the solid domain and the fluid domain are solved separately, and the coupling between different regions is realized through the continuity condition of the fluid-solid interface, namely in formula (3.7) and (3.8):

- Continuous temperature:

$$T_w I_s = T_w I_f \tag{3.7}$$

- The heat flux density is continuous:

$$q_w I_s = q_w I_f \tag{3.8}$$

For the discrete solution method of the fluid-structure interaction problem, two discrete methods are used, one is the one-to-one correspondence between the grid nodes of the fluid domain and the solid domain interface, at this time, the grid nodes of the fluid-solid interface establish an identity mapping relationship, the temperature and heat flux are directly exchanged, which is simple and stable, but has high requirements for grids, and is suitable for simple geometric models; The other is that the grid nodes of the fluid-solid interface do not correspond, and different grid divisions are adopted, however, the implicit GGI interface algorithm provided by CFX (general interface method) can be used in the case that the interface meshes do not match. The fluid domain calculated by the author does not correspond to the interface mesh node of the solid domain, and the GGI interface is used to realize the data transfer between the fluid-solid interfaces.

3.4 Performance Analysis of Horizontal Condenser

The performance indicators of the horizontal condenser mainly include pressure drop, margin, etc., the smaller the value of the pressure drop and the margin, the better the performance of the horizontal condenser. The main parameters that affect the pressure drop and headroom are the cylinder length, internal layout and flow rate of the horizontal condenser. The longer the length of the cylinder, the more complex the internal layout, the faster the flow rate, the greater the pressure drop, but the margin is reduced, which can make the heat exchange more sufficient, when the length of the cylinder is determined, through the numerical simulation method, a set of internal layouts and flow rates are obtained that make the pressure drop and margin relatively reasonable, so as to achieve the purpose of improving the performance of the horizontal condenser.

In order to simplify the calculation, the following assumptions are made for the working conditions of the horizontal condenser model:

The physical parameters of the liquid and solid walls are all fixed values, that is, the density, viscosity, specific heat capacity, etc. do not change with temperature, pressure and time;

1. The fluid flow is a steady-state flow that is fully developed periodically;
2. Along the main flow direction of the fluid, the fluid is dominated by convection heat transfer;
3. The influence of heat loss and gravity on fluid flow is ignored;
4. The wall of the flow channel is a closed surface, that is, it is not permeable to heat and medium.

4 CONCLUSION

The horizontal condenser system is a powerful and very complex system. Based on actual production and operation experience, the author continuously optimizes the economic model of heat exchanger investment cost and operating cost, incorporating the economic model directly into the heat exchanger design process; further improve the design level of heat exchangers. Limited by time and ability conditions, not all issues have been discussed in detail, many problems and work need to be further studied and improved. In the future, further research and improvement are needed in the following aspects:

1. Further improve the automatic and intelligent theory and application system in the thermodynamic calculation of horizontal condensers. In order to better meet the needs of enterprises, it is necessary to further improve and perfect the thermodynamic calculation and mechanical design subsystems, the connotation of the horizontal condenser system has been continuously deepened and developed, and finally a more perfect parametric design theory and application system of the horizontal condenser has been formed.
2. The author mainly focuses on the horizontal condenser products in the heat exchange equipment, and does not calculate and model other products, therefore, in order to better meet the needs of enterprises, it is necessary to continue to develop numerical simulation methods suitable for heat exchange equipment products such as dry evaporators, and to establish a more complete design resource management system. This horizontal condenser, which is suggested in the study, has demonstrated innovative high-efficiency heat exchange equipment and can considerably increase design efficiency and design quality. It can assist to prevent heavy repetitive labor and is very practical. The entire cost has decreased by 11.2 percent, and the economy has improved dramatically.

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