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Retraction

Retracted: Development of Intelligent CAD Technology for New Longitudinal Shell-Side Heat Exchange Equipment

Wireless Communications and Mobile Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. Wu and F. Zhu, "Development of Intelligent CAD Technology for New Longitudinal Shell-Side Heat Exchange Equipment," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 4228043, 9 pages, 2022.

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Research Article

Development of Intelligent CAD Technology for New Longitudinal Shell-Side Heat Exchange Equipment

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In order to correct the errors of "periodic full-section calculation model" and "unit flow channel model," the author proposes a numerical simulation method of a longitudinal flow shell-side heat exchanger based on CAD. The numerical simulation of the fluid flow and heat transfer characteristics of the three-blade orifice plate heat exchanger is carried out by using FLUENT software, and the "periodic full-section calculation model" and "unit flow channel model" are established, as well as the calculation results of comparative analysis. Experimental results show the following: With the increase of the inner diameter D of the heat exchanger shell, the calculation results of the two models are gradually reached. When $D > 800$ mm, the error of the calculation results of the two models has been reduced to about 10%; at this time, the "unit flow channel model" has practicability and applicability. When $D \leq 800$ mm, the correction algorithm of the "unit flow channel model" is proposed, and the correction correlation formula of the pressure gradient and convective heat transfer coefficient is given. The revised results of the simulation can not only meet the engineering needs but also save computer resources and improve the calculation efficiency, which provides a theoretical basis for the development, improvement, and further industrial application of the "unit flow channel model" of the longitudinal shell-side heat exchanger.

1. Introduction

Shell-and-tube heat exchangers are general-purpose process equipment for heat exchange operations, widely used in chemical, petroleum, petrochemical, electric power, light industry, metallurgy, atomic energy, shipbuilding, aviation, heating, and other industrial sectors, especially in petroleum refining and chemical processing equipment; it occupies an extremely important position. Shell-and-tube heat exchangers always occupy a dominant position of about 70% in heat exchange equipment due to its adaptability to temperature, pressure, medium, durability, and economy [1]. Therefore, the design of shell-and-tube heat exchangers is highly valued by industrialized countries in the world.

In the traditional heat exchanger design process, manual calculation and drawing are used, a large number of charts and repeated calculations are required, the design workload is large, the cycle is long, the efficiency is low, and the design quality is not high. With the development of computer and CAD technology, the use of computer hardware and software technology to automatically design, modify, and output heat exchangers provides a powerful tool for improving the design quality of heat exchangers. In recent years, as more and more manufacturers have passed the ASME certification in my country, the call for a heat exchanger CAD system designed according to the TEMA161 standard is also growing [2]. If you buy this kind of software directly from abroad, the price is quite expensive, and it is difficult for domestic manufacturers to bear it. Figure 1 shows the hierarchical relationship of CAD system development [3]. Faced with this situation, according to the TENIA standard, a replacement system based on the Windows operating system that can cover the whole process of chemical equipment design (structural selection, strength calculation, design specification, material quotation, drawing of parts, and assembly drawings) is developed; a heater CAD

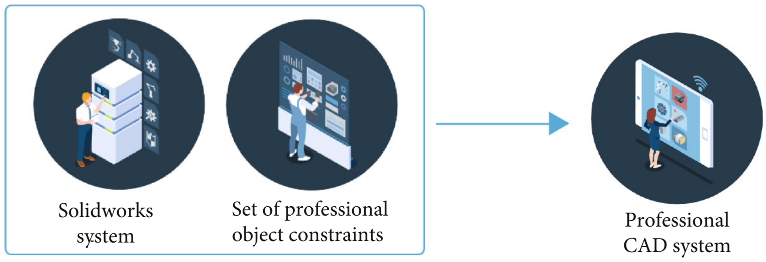

Figure 1: Hierarchical relationship of CAD system development (high end).

system has important practical significance and application value.

2. Literature Review

Many scholars at home and abroad have done a lot of research on the auxiliary design of heat exchangers. Mizukami et al. carried out software development on the design of shell-and-tube heat exchangers, but only limited to the process calculation stage [4]; Zhao et al. based their research on the automatic design of shell-and-tube heat exchangers and realized the automatic pipe layout design of shell-and-tube heat exchangers [5]; and Wang et al. developed a three-dimensional modeling system for heat exchange equipment components in a harmonious environment and realized related functions such as automatic assembly [6]. In recent years, many advanced heat exchanger optimization design methods have appeared. The optimal design of the heat exchanger is to make the designed heat exchanger meet certain requirements; one or several indicators can reach the best. Due to the different designs and use backgrounds of heat exchangers, different performance indicators are involved, such as minimum initial investment, minimum operating cost, minimum production cost, minimum volume or heat transfer surface area, and minimum average temperature difference. When a minimum or maximum performance index is qualitatively defined during the design, it is called the "objective function" in the optimization design. Pikina et al. analyzed and introduced the evaluation criteria, entropy, and exergy of heat exchangers based on the second law of thermodynamics and studied their applications and connections [7]. Rajeswari et al. proposed a thermal design method based on the optimization of the comprehensive performance of the heat exchanger, which fully considered the structure, size, performance of the heat exchange process of the heat exchanger, and the optimal relationship between them; a heat exchanger with low structural cost, low operating cost, and good heat transfer performance was obtained [8]. The entropy production reflects the understanding of the irreversible dissipation of the heat transfer process. Espinoza et al. proposed a dimensionless method for the entropy production and defined the entropy production number, thus obtaining the minimum production method, in order to optimize the design of the heat exchanger [9]. Rasheed et al. analyzed the entropy production of the heat transfer process of the heat exchanger and discussed the optimal design of the heat exchanger from this perspective [10].

Although "periodic full-section calculation model" and "unit flow channel model," to a certain extent, can effectively reflect the flow and heat transfer characteristics in the shell side of the heat exchanger, however, since the premise of establishing the "unit flow channel model" is to ignore the influence of the heat exchanger shell wall and the mutual influence between each unit flow channel, the "periodic full-section calculation model" comprehensively considers the above factors; it is closer to the real value than the "unit flow channel model," so there must be some errors in the calculation results of the two models [11]. The author establishes the above two numerical models for the three-blade orifice heat exchanger and conducts a comparative study, the error between the calculation results of the two numerical models and the reasons for the error when the inner diameter of the shell is different is analyzed, the scope of application of the three-blade orifice plate heat exchanger is proposed, the correction algorithm of the "periodic full-section calculation model" for the "unit flow channel model" of the three-blade orifice heat exchanger is proposed, and the correction correlation formula of the convective heat transfer coefficient and the pressure gradient is given.

3. Research Methods

3.1. Brief Introduction of Three-Leaf Orifice Plate Heat Exchanger. The three-blade orifice heat exchanger is one of the new types of heat exchange equipment commonly used in nuclear power plants and plays an important role in nuclear auxiliary systems (such as unit cooling water systems). The three-blade orifice heat exchanger is a type of longitudinal flow shell-side heat exchanger.

Compared with the traditional arcuate baffle support for nuclear power, this support structure changes the shell-side fluid from the transversely swept tube bundle to the longitudinally swept tube bundle, which can effectively reduce the flow dead zone and reduce the vibration induced by the tube bundle. And due to the fluid jet generated in the hole of the support plate, the deposition of chemical substances, corrosive substances, etc., on the wall of the heat exchange tube can be reduced, so that the heat transfer and corrosion conditions in the area near the wall of the heat exchange tube are greatly improved; the probability of heat exchanger failure is reduced [12].

3.2. Implementation of Intelligent CAD System (IHECAD) for Heat Exchange Equipment. Due to the particularity and diversity of heat exchange equipment functions, the complexity of the structure, the nonstandardization of components, and the diversity of medium operating conditions, it is determined that the design process of heat exchange equipment is a complex process of analysis and synthesis, which requires the use of multidisciplinary knowledge and experience to repeatedly build models, solve, and evaluate; establishing an expert system can undoubtedly better solve the analysis and design in this field and then realize the intelligent design of heat exchange equipment CAD.

Based on the comprehensive reasoning model IHECAD system, a concept of modular design is proposed; by combining the advantages of example-based and model-based design methods, a user-oriented, top-down design approach is realized [13]. The basic idea is as follows: the device design model (module and instance model) and design instances are stored simultaneously in the device model library and the instance library, respectively, according to the design requirements, the case-based reasoning strategy is applied first, the function and performance requirements of the new design are mapped into the index pointer of the retrospective related design, and the related instances that meet the function or performance requirements of the new design can be directly traced back from the design instance library. Since the model (class definition) of the relevant instance provides a method for improvement, when some performance indicators of the backtracked instance cannot meet certain requirements, the corresponding mechanism is triggered by the message; the original design instance is revised by changing the attribute parameters, so that the revised instance can meet the requirements of the new design. When the related design cannot be backtracked, or the improved design still cannot meet the new design requirements, the design problem decomposition and subproblem solution are adopted, and the model-based design method is applied, comprehensively producing heat exchange equipment with different structures. In short, the proposed design process is first based on the retrospective and improvement of relevant cases and then the synthesis of heat exchange equipment with different structures based on the model. Thanks to object-oriented programming and knowledge composition, knowledge growth (model extension and instance growth) does not break the consistency of the system. As far as the IHECAD system is concerned, the end user is only the correct description of the design tasks and constraints, and the IHECAD system (or human-computer interaction) proposes the final solution or relevant suggestions.

The design of heat exchange equipment is based on the design method, with its own accumulated experience, following national norms, and considering many factors such as user needs, functional requirements, and process conditions, through analysis, comparison, judgment and evaluation, and finally the process of expressing the design results of the product with graphics and text data. According to the comprehensive reasoning model of the expert system and the functional requirements of the IHECAD system, an expert system is constructed as the core, taking the design of the part drawing and assembly drawing of the heat exchange equipment as the main body, including the structural model of the checking and checking module of the key components [14].

(1) *HECAD interface*: the HECAD interface is composed of the HECAD task master control module and the design task management module, which completes the scheduling and information exchange between tasks. Its main functions are as follows: input and management of initial design information; human-computer interaction and control modules cooperate to make the structure user-oriented; and selection of work tasks and different functional modules. The HECAD task master control module is based on AutoCAD, and the system-specific menu options are embedded in the AutoCAD menu

(2) *Overall control module*: the most important thing in the module is to introduce the inference engine as a class method into the general control module. In addition, the class attributes also encapsulate the attributes of the feature description of the parts and the general algorithms for the parts. Through the rules stored in the knowledge base, the process results are derived and fed back to the user, and explanations are given at the same time

(3) *Database management system*: the HECAD knowledge base system includes knowledge base, graphic base, and database; the HECAD system uses database technology to manage fact base and knowledge base; the knowledge in the expert system can be managed and represented by the database structure and processing method after certain processing [15]

(4) *Scheme design*: according to the resources in the public database, the scheme design calls out the assembly schematic diagram of the heat exchange equipment to be designed from the assembly instance library. From the assembly diagram, you can see the basic structure of each part of the heat exchanger; if you are not satisfied, return to the menu of the design task management module and select it again; if you are satisfied, you can carry out the integrated design from the process design to component structure

(5) *Process design*: according to the patented technology of the center, we use our process design method to design; the designers input the original design information such as user requirements and design process parameters into the computer through the system human-computer interaction interface and automatically enter the public database of the control structure; the reasoning process which is a rule-based reasoning mechanism is employed

(6) *Structural design*: the structural design of the parts of the HECAD system adopts the CBR method. According to the parameters proposed by the user in the control structure, the part design first extracts the data of the corresponding instance from the part instance database; at the same time, from the part

instance library, select the corresponding instance graphic function with data; the schematic diagram of the part instance structure can be obtained

(7) *Dimensions are driven*: the schematic diagram of the part instance structure obtained by CBR; if the user's requirements cannot be met, the parametric design that is carried out is dimension-driven, and the schematic diagram of the part with the topological relationship with the part instance that the user wants to obtain can be obtained. Then, the part drawing design information file and assembly drawing information file are formed

(8) *Drawing of engineering drawings*: by reading part drawings and assembly drawing design information files, the corresponding parametric graphics function is called from the basic graphics library, and the part drawing and assembly drawing can be automatically generated

(9) *Object-oriented development technology*: the establishment of object-oriented heat exchanger class; object-oriented technology is used to abstract data with classes, and the operations on the abstract data are encapsulated in classes. C/C++ uses a variety of development methods to implement object-oriented technology, such as virtual functions, constructors, destructors, class inheritance, derivation, encapsulation, and message triggering. For a specific heat exchange equipment expert system, first, according to the group technology, each type of parts and components is characterized, including geometric features and process parameters, such as diameter, material, pressure, and temperature. At the same time, the calculation method is encapsulated in the information model of the component to form an object class [16]. Using C/C++ class definition can well implement the above design idea, because attributes, methods, and events are encapsulated in C/C++ classes; it can be mapped to each part of the component object class by mapping methods: feature abstraction and feature classification judgment of attribute storage components; the method corresponds to an inference engine based on algorithms and rules based on basic principle knowledge, wherein the inference engine encapsulated in a class method can trigger calculation and design reasoning through the message of the instantiated structural object. The following is a brief description of the establishment method of heat exchange equipment

3.3. Physical Model and Calculation Method

3.3.1. Physical Model. For the three-leaf orifice heat exchanger arranged in an equilateral triangle, its structure is symmetrical. In the fully developed section of the three-blade orifice heat exchanger, the fluid flow is periodic; after a certain simplification of the shell-side structure of the three-blade orifice heat exchanger, a "periodic full-section calculation model" can be established, due to the symmetry of the shell side structure of the heat exchanger; therefore, when modeling, take a symmetrical half of the solid. If the influence of the shell wall on flow and heat transfer is ignored, the fluid flow space enclosed by the three tubes can be taken as a unit flow channel; therefore, a "unit runner model" is established. The main structural dimensions of the heat exchanger are shown in Table 1 [17].

3.3.2. Calculation Method and Boundary Conditions. The Gambit software is used for modeling, and the grid is divided into blocks, the grids in the model are all regular hexahedral grids with good quality, and the grid sizes are checked independently. The shell-side medium adopts constant water. The heat exchange tube wall is of constant wall temperature, and the shell wall and support plate are impermeable, adiabatic, and nonslip boundary conditions. The standard $k-\varepsilon$ turbulence model is used, and the steady-state implicit scheme is used to solve the problem; the coupling method of pressure and velocity adopts the SIMPLE algorithm [18].

4. Result Analysis

4.1. Comparison of the Calculation Results of the Two Models. The author used the "periodic full-section calculation model" and "unit flow channel model" to conduct heat exchangers with support plate spacings of 150 mm, 300 mm, and 600 mm and shell inner diameters of 200 mm, 300 mm, 400 mm, 500 mm, 600 mm, and 800 mm. With regard to numerical simulation studies, when the average fluid velocity is the same, the calculation results of the two models are compared. When calculating, take the flow velocity as 0.28 m/s, 0.47 m/s, 0.7 m/s, and 0.93 m/s. If the equivalent diameter is calculated according to $d_e = (4\sqrt{3}l^2/2 - \pi d_0^2/4)/(\pi d_0)$ (l is the tube spacing, d_0 is the outer diameter of the heat exchange tube), the corresponding the equivalents are 6000, 10000, 15000, and 20000. When the inner diameter of the shell is small, the convective heat transfer coefficient and pressure gradient calculated by the "periodic full-section calculation model" and the "unit flow channel model" have a large difference; as the inner diameter of the shell increases, the calculation results of the two models are gradually approached. This is because the premise of the "unit flow channel model" is to ignore the influence of the shell wall on the fluid flow and the mutual influence between the flow channels of each unit, while the "periodic full-section calculation model" takes into account the above two factors. When the inner diameter of the shell is small, the area near the inner wall of the shell accounts for a larger proportion of the total fluid flow area, and the shell wall has a greater impact on the fluid flow, resulting in a large difference between the calculation results of the two models. As the inner diameter of the shell increases, the influence of the shell wall gradually decreases, and the calculation results of the two models gradually approach [19].

Figures 2 and 3 show the errors of the convective heat transfer coefficient and pressure gradient calculated by the "unit flow channel model" relative to the "periodic full-

Table 1: Main geometric dimensions of the calculation model.

Heat exchange tube model	Heat exchange tube center distance (mm)	Pipe layout	Clover hole height (mm)	Support plate thickness (mm)	Support plate spacing (mm)
$\phi 14 \times 1$	19	Equilateral triangle	2.3	10	300, 600

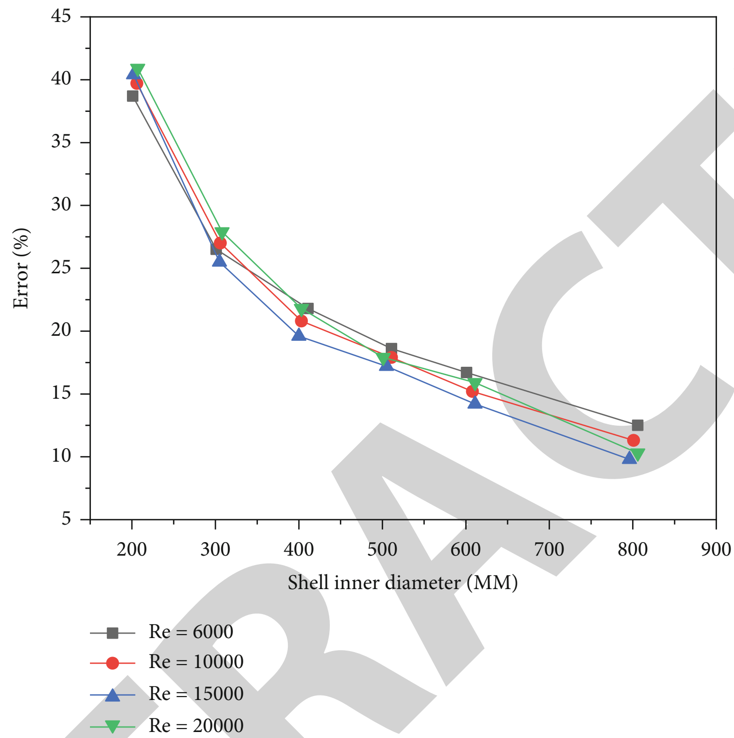

Figure 2: Convective heat transfer coefficient error.

section model," respectively. It can be seen that when the inner diameter of the shell is 800 mm, the error of the convective heat transfer coefficient is about 10%, and the error of the pressure gradient is less than 10%, which meets the engineering needs; therefore, when the inner diameter of the shell is greater than 800 mm, the "unit flow channel model" can be used to replace the "periodic full-section calculation model" to predict the fluid flow and heat transfer performance of the heat exchanger shell side.

4.2. Influence on the Error of the Calculation Results of the Two Models. Taking the model with the support plate spacing of 150 mm and the inner diameter of the shell 300 mm as an example, when it is 6000-50000, two different models are calculated, and the relationship between the ratio (α'/α) of the convective heat transfer coefficient and the ratio ($\Delta p'/\Delta p$) of the pressure gradient calculated by the "periodic full-section calculation model" and the "unit flow channel model" with the same Reynolds number is analyzed, as shown in Figure 4. As can be seen, when Re changes between 6000 and 50000, the minimum value of α'/α is 1.36, the maximum value is 1.41, the minimum value of $\Delta p'/\Delta p$ is 1.76, the maximum value is 1.81, and the variation range is very small. And with the increase of Re, the values of α'/α and $\Delta p'/\Delta p$ fluctuate up and down, and there is no obvious change trend [20]. Therefore, it can be considered that when the structural size of the heat exchanger is constant, α'/α and $\Delta p'/\Delta p$ do not change with the change of Re.

4.3. Correction of "Unit Flow Channel Model" of Three-Leaf Orifice Heat Exchanger. When the inner diameter of the shell is greater than 800 mm, the calculation result of the "unit flow channel model" is relatively close to the actual value, but when the inner diameter of the shell is less than or equal to 800 mm, there is still a large error with the actual value [21, 22]. In order to further improve and develop the "unit flow channel model," when the inner diameter of the shell is less than or equal to 800 mm, the calculation results of the "periodic full-section calculation model" and the "unit flow channel model" of different structures are compared, and the former is used to correct the latter, and using the principle of least squares method and multiple linear regression to fit the calculation results, the corrected correlations of the convective heat transfer coefficient and pressure

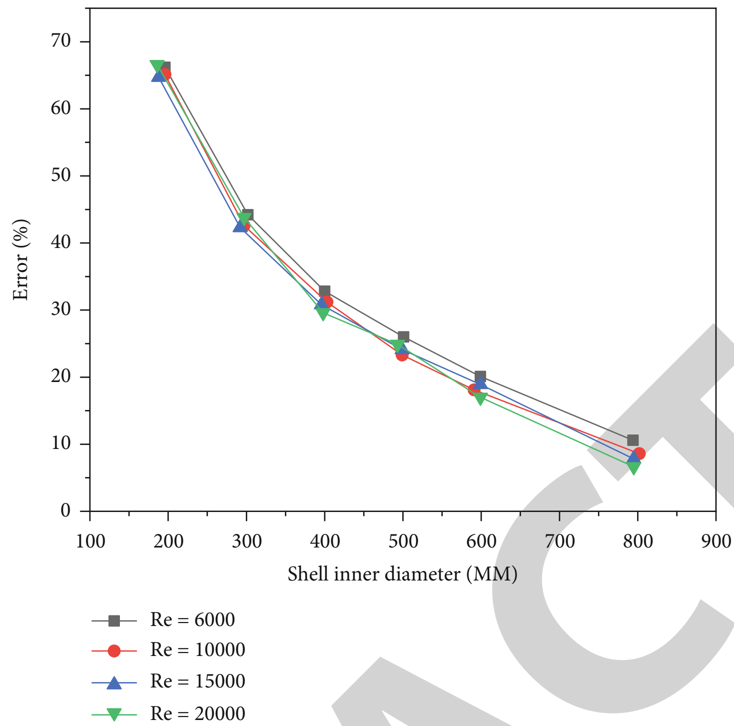

Figure 3: Pressure gradient error.

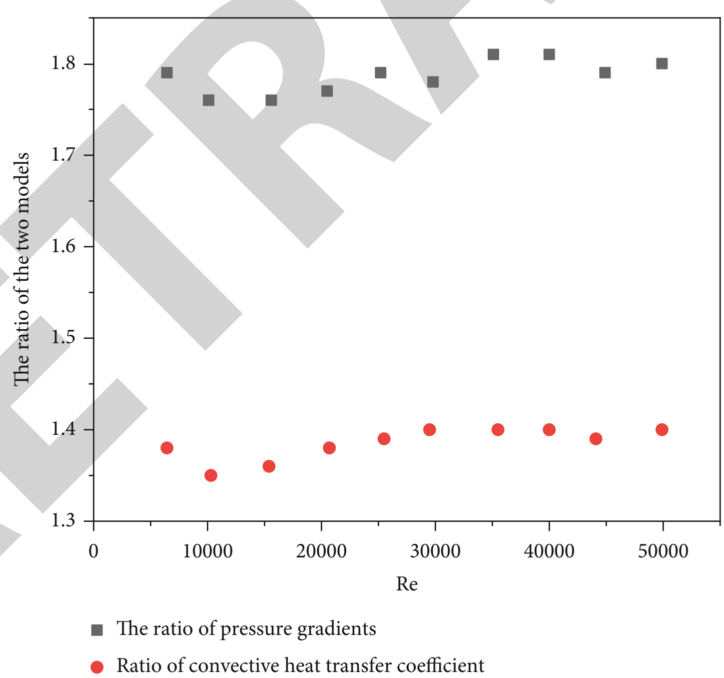

Figure 4: The relationship between α'/α and $\Delta p'/\Delta p$ and Re.

gradient of the "unit flow channel model" are obtained as follows:

$$P_h = \frac{\alpha'}{\alpha} = 4.144\left(\frac{D}{d_e}\right)^{-0.278}\left(\frac{L_b}{d_e}\right)^{-0.095}, \quad (1)$$

$$P_{\Delta p} = \frac{\Delta p'}{\Delta p} = 15.09\left(\frac{D}{d_e}\right)^{-0.706}\left(\frac{L_b}{d_e}\right)^{0.032}. \quad (2)$$

In the formula, P_h is the convection heat transfer coefficient correction factor; α' and α are the convective heat transfer coefficients of the "periodic full-section calculation

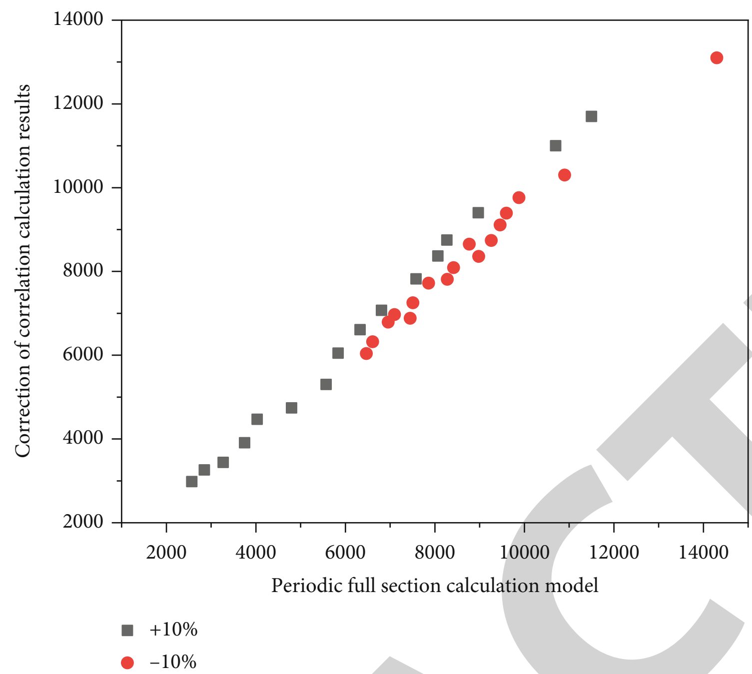

FIGURE 5: Error of correction value of convective heat transfer coefficient.

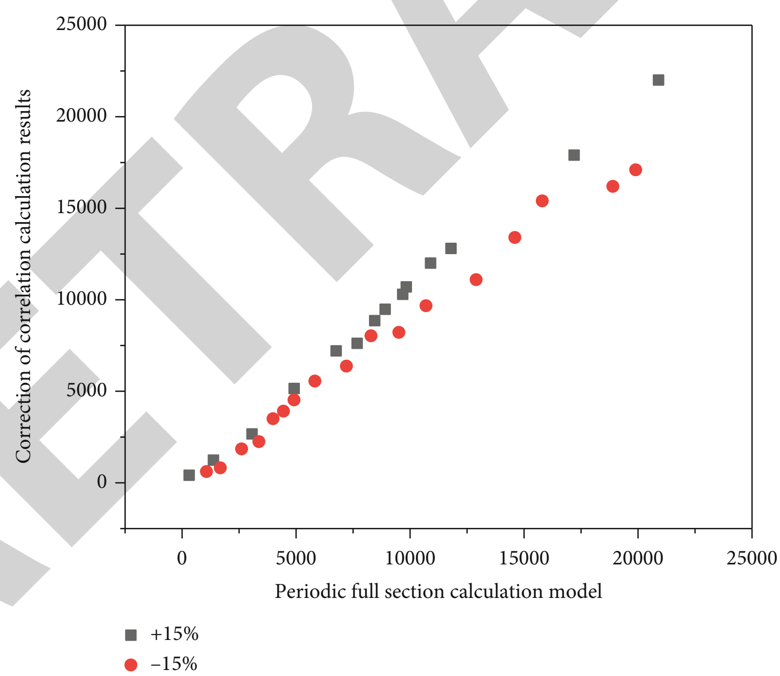

FIGURE 6: Pressure gradient correction value error.

model" and "unit flow channel model", W/(m^2·K); $P_{\Delta p}$ is the pressure gradient correction factor; $\Delta p'$ and Δp are the pressure gradient of the "periodic full-section calculation model" and "unit flow channel model", Pa/m; D is the inner diameter of the heat exchanger shell, mm; L_b is the spacing between support plates, mm; and d_e is the equivalent diameter, mm.

Comparing the revised results of the "unit flow channel model" with the calculation results of the "periodic full-section calculation model," the results are shown in Figures 5 and 6. As can be seen from the figures, the error between the corrected convective heat transfer coefficient and the calculation result of the "periodic full-section calculation model" does not exceed 10%, and the error of the pressure gradient does not exceed 15%, which meets the engineering needs [23]. Therefore, when the inner diameter of the heat exchanger shell is less than 800 mm, the "unit flow channel model" can be established and the results of equations (1) and (2) can be corrected, obtaining the convective heat transfer coefficient and pressure gradient on the shell side of the heat exchanger, in order to save computer resources and improve computing efficiency [24, 25].

5. Conclusion

The error of the calculation result of the "unit runner model" relative to the "periodic full-section calculation model" decreases with the increase of the inner diameter of the shell, and the "periodic full-section calculation model" and the "unit runner model" calculate the ratio of the heat transfer coefficient (α'/α) to the ratio of the pressure gradient ($\Delta p'/\Delta p$); it does not change with the change of Re. When the inner diameter of the heat exchanger shell is greater than or equal to 800 mm, the error of the calculation result of the "unit flow channel model" relative to the "periodic full-section calculation model" has been reduced to about 10%; within the allowable range of the project, the "unit flow channel model" can be used to obtain the fluid flow and heat transfer performance of the heat exchanger shell side. When the inner diameter of the heat exchanger shell is less than 800 mm, the "unit flow channel model" can no longer accurately reflect the fluid flow and heat transfer characteristics of the heat exchanger shell side; the author proposes a correction algorithm for the "unit flow channel model" using the "periodic full-section calculation model"; after correcting the calculation results of the "unit flow channel model" using the modified correlation formula, it can not only meet the needs of the project but also save computer resources and improve the calculation efficiency. It provides a theoretical basis for the development and improvement of the unit channel model of the longitudinal flow shell side heat exchanger and its further industrial application.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] Y. D. Burda, A. V. Kosygina, I. O. Volkova, M. V. Gorgisheli, A. Y. Yakovleva, and K. V. Suslov, "Development of electric power systems based on the use of intelligent technologies," *IOP Conference Series: Materials Science and Engineering*, vol. 1064, no. 1, p. 012007, 2021.

[2] N. Bessghaier, A. Ouni, and M. W. Mkaouer, "A longitudinal exploratory study on code smells in server side web applications," *Software Quality Journal*, vol. 29, no. 4, pp. 901–941, 2021.

[3] G. Triscari, M. Santovito, M. Bressan, and D. Papurello, "Experimental and model validation of a phase change material heat exchanger integrated into a real building," *International Journal of Energy Research*, vol. 45, no. 12, pp. 18222–18236, 2021.

[4] H. Mizukami, Y. Shirai, and S. Hiraki, "Initially solidified shell growth of hypo-peritectic carbon steel in continuous casting mold," *ISIJ International*, vol. 60, no. 9, pp. 1968–1977, 2020.

[5] D. Zhao, S. Ni, and D. Guan, "Nonlinear thermoacoustic instability investigation on ammonia-hydrogen combustion in a longitudinal combustor with double-ring inlets," *The Journal of the Acoustical Society of America*, vol. 149, no. 4, pp. A121–A121, 2021.

[6] Z. Wang, Y. Bian, S. E. Shladover, G. Wu, S. E. Li, and M. J. Barth, "A survey on cooperative longitudinal motion control of multiple connected and automated vehicles," *IEEE Intelligent Transportation Systems Magazine*, vol. 12, no. 1, pp. 4–24, 2020.

[7] G. A. Pikina, T. S. Nguyen, and F. F. Pashchenko, "A combined discrete-and-continuous multipoint model of a countercurrent heat exchanger," *Thermal Engineering*, vol. 67, no. 1, pp. 52–59, 2020.

[8] J. Rajeswari, J. Raja, and S. Jayashri, "Gradient contouring and texture modelling based cad system for improved tb classification," *Automated Software Engineering*, vol. 29, no. 1, pp. 1–12, 2022.

[9] R. V. Espinoza, K. C. Haatveit, S. W. Grossman, Y. T. Jin, and D. H. Sherman, "Engineering p450 TamI as an iterative biocatalyst for selective late-stage c-h functionalization and epoxidation of tirandamycin antibiotics," *ACS Catalysis*, vol. 11, no. 13, pp. 8304–8316, 2021.

[10] F. Rasheed, M. Rommel, G. C. Marques, W. Wenzel, and J. Aghassi-Hagmann, "Channel geometry scaling effect in printed inorganic electrolyte-gated transistors," *IEEE Transactions on Electron Devices*, vol. 68, no. 4, pp. 1866–1871, 2021.

[11] S. Gao and L. K. Bhagi, "Design and research on CADDCAM system of plane based on NC machining technology," *Computer-Aided Design and Applications*, vol. 19, no. S2, pp. 64–73, 2021.

[12] L. Ignaczak, G. Goldschmidt, C. Costa, and R. Righi, "Text mining in cybersecurity," *ACM Computing Surveys*, vol. 54, no. 7, pp. 1–36, 2022.

[13] P. Cardaliaguet and N. Forcadel, "From heterogeneous microscopic traffic flow models to macroscopic models," *SIAM Journal on Mathematical Analysis*, vol. 53, no. 1, pp. 309–322, 2021.

[14] Y. Liu and W. Zhou, "Numerical modeling to predict seismic performance of the post-tensioned self-centering concrete shear walls," *Bulletin of Earthquake Engineering*, vol. 20, no. 2, pp. 1057–1086, 2022.

[15] J. Lermé, J. Margueritat, and A. Crut, "Vibrations of dimers of mechanically coupled nanostructures: analytical and numerical modeling," *The Journal of Physical Chemistry C*, vol. 125, no. 15, pp. 8339–8348, 2021.

[16] I. Goda and J. Girardot, "Numerical modeling and analysis of the ballistic impact response of ceramic/composite targets and the influence of cohesive material parameters," *International Journal of Damage Mechanics*, vol. 30, no. 7, pp. 1079–1122, 2021.

[17] I. V. Egorov and N. V. Palchekovskaya, "Numerical simulation of the receptivity of a supersonic boundary layer to acoustic

disturbances in compression and rarefaction flows," *Doklady Physics*, vol. 66, no. 3, pp. 76–79, 2021.

[18] J. Cai, G. Du, H. Xia, and C. Sun, "Model test and numerical simulation study on bearing characteristics of pervious concrete pile composite foundation," *KSCE Journal of Civil Engineering*, vol. 25, no. 10, pp. 3679–3690, 2021.

[19] S. K. Sarangi and D. P. Mishra, "Thermo-fluid performance enhancement of a fin-and-tube heat exchanger by rectangular winglets," *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy*, vol. 236, no. 4, pp. 738–751, 2022.

[20] X. Fu, Y. Wang, C. Yu, H. Zhang, and B. Gao, "Investigation on thermal-hydraulic performance prediction of a new parallel-flow shell and tube heat exchanger with different surrogate models," *Open Physics*, vol. 18, no. 1, pp. 1136–1145, 2020.

[21] X. Xu, L. Li, and A. Sharma, "Controlling messy errors in virtual reconstruction of random sports image capture points for complex systems," *International Journal of Systems Assurance Engineering and Management*, vol. 6, 2021.

[22] M. Bradha, N. Balakrishnan, A. Suvitha et al., "Experimental, computational analysis of Butein and Lanceoletin for natural dye-sensitized solar cells and stabilizing efficiency by IoT," *Environment, Development and Sustainability*, vol. 24, no. 6, pp. 8807–8822, 2022.

[23] G. Veselov, A. Tselykh, A. Sharma, and R. Huang, "Special issue on applications of artificial intelligence in evolution of smart cities and societies," *Informatica (Slovenia)*, vol. 45, no. 5, p. 603, 2021.

[24] P. Ajay, B. Nagaraj, R. A. Kumar, R. Huang, and P. Ananthi, "Unsupervised hyperspectral microscopic image segmentation using deep embedded clustering algorithm," *Scanning*, vol. 2022, Article ID 1200860, 9 pages, 2022.

[25] H. Xie, Y. Wang, Z. Gao, B. Ganthia, and C. Truong, "Research on frequency parameter detection of frequency shifted track circuit based on nonlinear algorithm," *Nonlinear Engineering*, vol. 10, no. 1, pp. 592–599, 2021.