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Retraction

Retracted: Innovative Sensor Design Method of Industrial Ceramic Product Modeling Based on Immune Optimization Algorithm

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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] C. Gu, "Innovative Sensor Design Method of Industrial Ceramic Product Modeling Based on Immune Optimization Algorithm," *Journal of Sensors*, vol. 2022, Article ID 4300643, 7 pages, 2022.

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Research Article

Innovative Sensor Design Method of Industrial Ceramic Product Modeling Based on Immune Optimization Algorithm

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A new method based on immune optimization algorithm was proposed for modeling and design of industrial ceramic products. Based on the joint coding of fuzzy rules and membership function parameters, an improved immune optimization algorithm was used to realize the synchronous optimization of industrial ceramic product modeling. A superheated steam temperature control system is taken as an example to carry out simulation tests. The results show that the ratio of the unit volume to the side length is between 0 and 1, which is called the mass of the grid element. Zero is the worst quality and one is the best. Element aspect ratio and distortion degree are also basic inspection indexes. The average mass of vacuum glass is 0.86, the aspect ratio is 1.71, and the element distortion degree is 0.13, indicating that the grid quality is well divided. It is proved that using the improved immune genetic algorithm to optimize fuzzy control can overcome the defects of the traditional genetic algorithm and ensure the faster and more stable search for the optimal rule base and membership function.

1. Introduction

Today's advanced industrial ceramic product design often refers to a design group. All the members of the group design around a design platform. The design platform is a computer generated digital 3D product model. The designers work together to get the best design for the product. The rapid development of science and technology has provided a wide range of design space for designers and scientific and technical personnel [1]. In particular, the emergence of excellent computer industrial design software makes it possible to give full play to their imagination in the process of product design and design excellent industrial ceramic products. Design is a kind of creative activity, the essence of design is creation and innovation. Innovation is the soul of design, and innovative design is the fundamental way for products to have and maintain competitive advantages. At present, the research on innovation design mainly focuses on the following aspects: (1) study the application of various innovation techniques such as analogy, decomposition, combination, and exploration in the process of innovation design; (2) based on the expert system technology in the field of artificial intelligence, research the innovative design method based on intelligent design expert system; (3) research on innovative design based on innovative design theories such as invention problem-solving theory (TRIZ); (4) carry out relevant researches on how to inspire innovative thinking to facilitate innovative design schemes, such as the establishment and application of various forms of design knowledge base, such as scientific effect base and product gene base, and product innovative design based on natural semantics; (5) research and application of product evolutionary innovation design method based on evolutionary design; (6) product innovation design method based on function; and (7) innovative technical methods for product conceptual design [2]. Structural health monitoring refers to the use of on-site, nondestructive, real-time acquisition of structural and environmental information, analysis of various characteristics of structural response, and acquisition of structural changes caused by environmental factors, damage, or degradation. A good sensor layout scheme should meet the following requirements: (1) in a noisy environment,

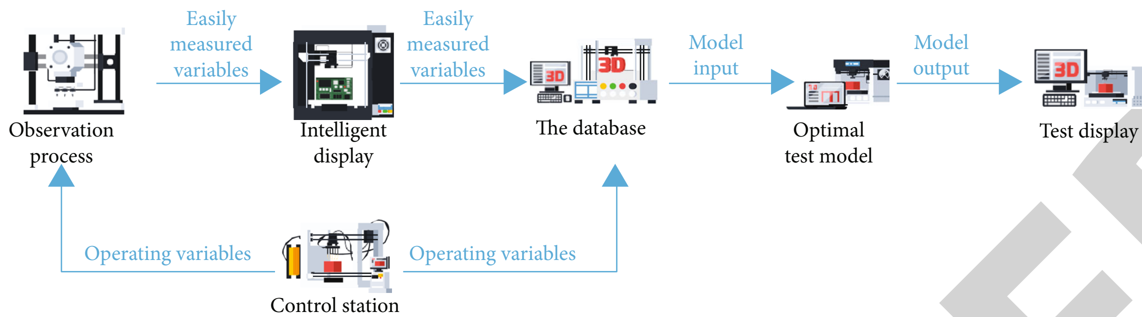

Figure 1: Immune optimization algorithm.

comprehensive and accurate structural response information can be obtained by using as few sensors as possible. (2) The measured structural response information should be able to correspond with the results of numerical analysis. (3) Focus on collecting the vibration response data of interest. (4) The monitoring results have good visibility and robustness. (5) The cost of equipment input, data transmission, and result processing of the monitoring system can be minimized.

Sensor optimal layout is a typical knapsack problem, whose computation increases exponentially with the increase of variables, and its solution is still the direction of many scholars. In recent years, some stochastic intelligent optimization algorithms, such as simulated annealing, genetic algorithm, ant colony algorithm, and particle swarm optimization algorithm, have gradually emerged. Because they can better solve the constraints of combinatorial optimization problems and are not easy to fall into local optimal characteristics, they have achieved rapid development in the field of sensor optimization layout, as shown in Figure 1.

With the continuous development of network and computer field, intelligent algorithm has been gradually discovered by researchers, including neural network technology, genetic algorithm, fuzzy algorithm, DNA calculation, and artificial immune algorithm. Similar to neural network, immune system is a method inspired by the structure mapping of computer framework, which provides a driving force for the sustainable development of intelligent design of products [3]. Currently, the immune system is involved in many fields, including artificial intelligence, computer science, adaptive systems, control theory, and biological computing. In product design, an efficient method is urgently needed to improve the efficiency and accuracy of design. Li et al. established the user demand model by analyzing the functional hierarchy model of the product and combining the conceptual design process. After mastering the major factors such as quality, performance, and price, they established the UGNX platform and realized the simulation development of the product [4]. Nanda and Garg established an analysis model of users' potential needs by analyzing the theory of product innovation design. After screening, induction and evolution, the model finally determines users' potential needs and provides theoretical guidance for product innovation design [5]. Wan, faced with the rapid development of manufacturing industry, further rooted the concept of green design in actual engineering production, established a more perfect theoretical system of green product innovation design, and further developed an enterprise innovation design software system for green manufacturing. This method was verified by taking the design of washing machine as an example [6]. Liu, X. Q. proposed a standard additive SAM (additive model) fuzzy system from the perspective of mapping [7]. The parameters of the fuzzy model are adjusted step by step to make the model more accurate. Therefore, a new method based on immune optimization algorithm is proposed in this paper. Based on the joint coding of fuzzy rules and membership function parameters, an improved immune optimization algorithm was used to realize the synchronous optimization of industrial ceramic product modeling. Taking the superheated steam temperature control system as an example, the simulation experiment proves that using the improved immune genetic algorithm to optimize the fuzzy control can overcome the defects of the traditional genetic algorithm and ensure the faster and more stable search for the optimal rule base and membership function.

2. Product Innovation Design Framework Based on Immune Algorithm

A product innovation design framework based on artificial immune system is constructed. The AIS product innovation design framework is composed of four layers: supporting theory, method, and technology (basic layer); immune innovation computing model (computing layer); immune innovation design method (method layer); and application of immune innovation design (application layer).

2.1. Supporting Theories, Methods, and Technologies. Supporting theory, method, and technology are composed of AIS principle and technology, innovative computing theory, and innovative design theory and method, which constitute the basic layer of product innovation design framework based on AIS. The principle and technology of AIS mainly refer to the biomimetic mechanism of AIS and various AIS solving algorithms mapped from the biomimetic mechanism of AIS. The theory of innovative computing is a general and general computing theory and method about innovation, which mainly includes the psychological and cognitive theory of innovation, the model of innovative computing, and the evaluation criteria of innovative computing. The theory and method of innovative design mainly include two aspects: one is the general and general theory and method of innovation represented by innovative psychology, creative thinking, creative principles, and innovative techniques. The other aspect is various theories and methods about innovative design, such as TRIZ theory and evolutionary innovative design method [6, 8].

2.2. AIS-Based Product Design Model. Immune algorithm is the improved method of genetic algorithm; in the simulation of the immune system by existing in the process of antibodies to generate new, there is a memory mechanism: namely, algorithm in after completion of solving a problem keeps a certain number of the optimal solution, and the algorithm that accepts the same problem can will retain a solution as the initial solution, thus improving the computation efficiency of the algorithm. In the iterative process, the global convergence can be achieved under the premise of retaining the best individuals of the previous generation. Therefore, it has a good advantage in product design [9].

2.2.1. Antigen Coding Pattern. The antibody and antigen codes in the algorithm include binary, character, and real number codes. Here, the first code is used to encode antibodies and antigens, with $y_i = \{k_1, k_2, \cdots k_n\}, y_i \in Y, Y = \{y_1, y_2, \cdots y_n\}$ antibody population and k_j allele [10]. The Hemming distance between antibodies is

$$D = \sqrt{\sum_{i=1}^{n}\sum_{j=1} \left(y_i - y_j\right)^2 (i \neq j)}. \tag{1}$$

According to informatics theory, information $T_j(\alpha)$of the JTH gene is

$$T_j(\alpha) = \sum_{i=1}^{\alpha} - P_{ij} \lg P_{ij},$$
$$P_{ij} \frac{\text{The number of times the isogene of gene } J \text{ appears}}{\alpha}. \tag{2}$$

Suppose the immune system is composed of antibody N with M genes [11].

The average information entropy (amount) of all antibody diversity is

$$T(\alpha) = \frac{1}{m}\sum_{j=1}^{M} T_j(\alpha). \tag{3}$$

2.2.2. Affinity Calculation of Antibody and Antigen. Take $\alpha = 2$ and obtain from the concept of information entropy: the affinity of any two antibodies V and W is

$$ay_{V,W} = \frac{1}{1 + H(2)}. \tag{4}$$

2.2.3. In General Algorithms. Effective antibodies are divided into memory cells at the end of the search process, and only one optimal solution is obtained when applied to optimization problems. The improved immune algorithm uses the concept of concentration to calculate the differentiation of memory cells and inhibitory cells, realizes cell differentiation during the search process, simulates the antibody production mechanism of the immune system, and calculates the promotion and inhibition of antibody production by using expected value [12]. This method can be used to solve multiobjective optimization problems. The flow chart of the improved immune algorithm is shown in Figure 2.

The specific process of the algorithm is shown in Algorithm 1.

3. Numerical Verification of Products Based on Immune Optimization Algorithm

After the optimization design is completed, it is still necessary to test whether the energy saving of the product meets the needs of customers. The method of numerical simulation can greatly shorten the test cycle of the product, so the method of numerical simulation is adopted to verify the energy-saving property of vacuum glass, that is, the insulation performance. Data show that the annual energy consumption of the construction industry accounts for 30% of the total energy consumption of the whole society. Because of the rich expression of glass materials in architecture, it has been widely developed by the promotion of architecture. Vacuum glass is a product developed on the basis of insulating glass. Compared with ordinary glass, vacuum glass has more excellent thermal insulation, anticondensation, frost, sound insulation, and other properties. Green energy saving is the development trend of vacuum glass industry.

Meshing is the most important part of finite element method. The mesh preprocessing software of ANSYS WORKBENCH can deal with mesh generation operation well, so the existing model can be mesh-generated through this module.

The number of grids will directly affect the size of the calculation scale and the accuracy of the calculation results. With the increase of the number of grids, the accuracy of the calculation results will be improved, and the calculation scale will also increase, thus increasing the load. Therefore, the scale and precision should be considered when determining the number of grids.

3.1. Transformation Extension Method. If the object to be divided is a surface and the shape comparison is regular, the transformation extension method can be used. The transformation extension method starts from nodes, expands to line elements, and then extends to two-dimensional elements of the plane and then from two-dimensional to three-dimensional elements. The resulting grid is of high quality and fast speed.

3.2. Delaunay Triangle Method. This method can be used if the object is a connected region consisting of a closed curve. This method uses equilateral triangles for discretization, which can ensure that the small geometric features of the object are not lost, and is suitable for local optimization processing

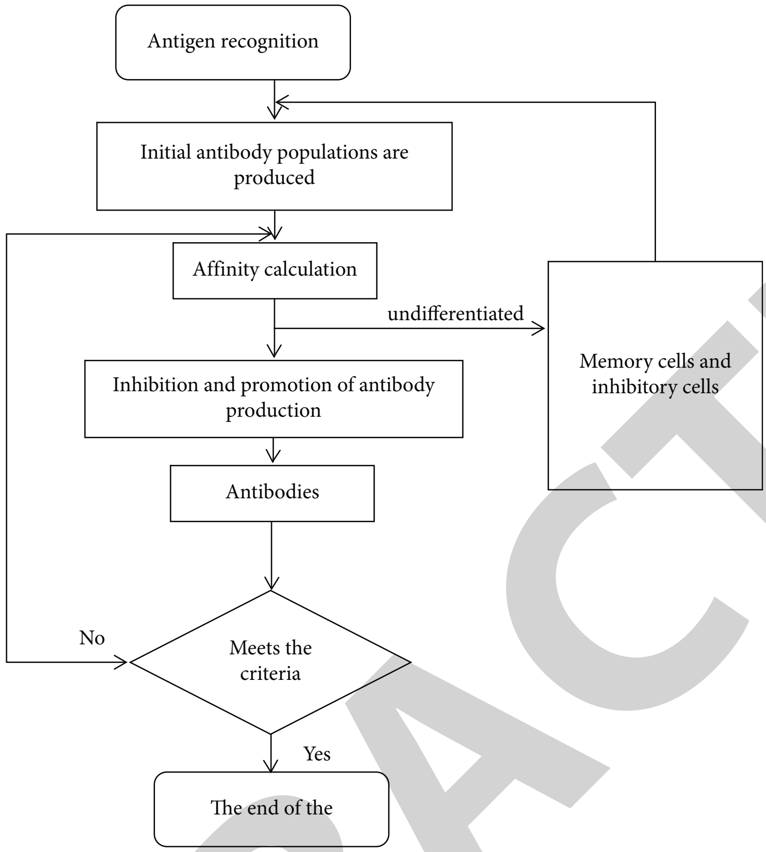

Figure 2: Flowchart of improved immune algorithm.

3.3. Coverage Method. If the computed object is a complete cropped surface and the boundary is a trimmed curve, the covering method can be used. The covering method mainly uses quadrilateral elements for meshing.

3.4. Frontier Method. The front edge method is suitable for dividing surfaces, both quadrilateral and triangular elements can be used. It is mainly achieved by transforming the surface isoparameter into two dimensional space and then mapping the two dimensional space into three dimensional space.

3.5. Hexahedral Method. This method is suitable for meshing objects with simple structure, regular shape, and no complex cavity, hole, or hole structure.

The hexahedral partition method has the advantages of neat structure, suitable for simple geometry, and good flexibility. The shape of customized product vacuum glass is simple and regular, so the hexahedral partition method is used here. At the end of meshing, quality check is required. The ratio of the cell volume to the side length, between 0 and 1, is called the mass of the grid cell. Zero is the worst quality and one is the best. Element aspect ratio and distortion degree are also basic inspection indexes. The mesh quality corresponding to the element distortion degree is shown in Table 1.

As can be seen from Table 1, the average mass of vacuum glass is 0.86, the aspect ratio is 1.71, and the element distortion degree is 0.13, indicating that the grid quality is well divided.

4. Results and Analysis

The optimal layout of sensors has two aspects: one is the optimization of the number of sensors, and one is the optimization of the sensor position; this paper is only the optimization of the position.

The boundary conditions of heat conduction of the fully tempered vacuum glass model are set in accordance with the national standard GB/T34337-2017. The parameters of the applied boundary conditions are shown in Table 2 and Figure 3.

The thermal conductivity of vacuum glass components is shown in Figure 4.

Firstly, the central unit is analyzed. The emissivity of the glass interior side is set as 0.04, and that of the outdoor side is set as 0.84.

The heat flux of vacuum glass central unit is $7.2807\,\mathrm{Wm^{-2}}$.

By definition,

$$K_{\mathrm{ccn}} = \frac{q_{\mathrm{ccn}}}{\Delta T} = 0.26\mathrm{Wm^{-2}K^{-1}}, \tag{5}$$

Step 1: antigen recognition

In immune algorithms, the antigen is the engineering problem to be solved. Firstly, binary genetic coding is carried out for the characteristics of the input engineering problems. $X = \{x_1, x_2, \cdots x_n\}$ represents the set of problems to be solved, where $x_i (1 \le i \le n)$ represents product characteristic parameters and is regarded as the problems to be solved [13, 14].

Link 2: produces the initial antibody

The algorithm detects the problem in the previous link and determines whether the problem is the first invasion. If it is not the first identification, the system will directly call corresponding cells from the existing memory cell bank for immune response. If the antigen is the first invasion, the system performs genetic manipulation on the recognized antigen, differentiates the corresponding memory cells, and eliminates the antigen to obtain the corresponding design scheme [15].

Link 3: affinity calculation

According to formula (4), the affinity between the current antibody population and the antigen is obtained, and the antibody with $ax_{\varepsilon,\delta}$ better combination of antigen and antibody in A is selected, and the selected antibody is taken as the alternative antigen scheme. In the selection process of affinity values, in order to improve the retrieval efficiency and accuracy of the existing design database, a threshold value $ax_{\varepsilon,\delta}$ is set for affinity T_c. When $ax_{\varepsilon,\delta} \ge T_c$, the antibody with the largest affinity matching with the antigen is the product design scheme that most meets the requirements [16].

Link 4: cell differentiation and regeneration

Antibodies with affinity higher than the set threshold in link 3 were added to memory cells. Due to the limit of total number of cells, when the total number reached the upper limit, memory cells with antibody information with the greatest affinity would replace cells with lower affinity [17].

Step 5: antibody promotion and inhibition

In biological systems, antibodies have a feedback effect. When stimulated by an antigen, the concentration of this antibody changes accordingly. This mechanism ensures antibody diversity and avoids immature convergence. High affinity antibodies are promoted and high density antibodies are suppressed. Here, cell differentiation is represented by the concept of concentration [18].

Definition 3: antibody concentration is c_V

$$c_V = \sum_{w=1}^{N} \frac{ac_{V,W}}{N},$$

$$ac_{V,W} = \begin{cases} 1, ay_{V,W} \ge Tac_1, \\ 0, \text{other}, \end{cases}$$

where Tac_1 is A set affinity threshold.

Definition 4: expected value of antibody calculation

$$E_V = \frac{ax_V \prod_{W=1}^{N} (1 - ar_{V,W})}{c_V \sum_{S=1}^{N} ax_s},$$

$$ar_{V,W} = \begin{cases} ar_{V,W}, ar_{V,W} \ge Tac_2, \\ 0, other, \end{cases}$$

where Tac_2 is A set threshold value.

Link 6: antibodies are produced

New antibodies are produced by randomly determining genes that replace the antibodies eliminated in link 4. After selection, crossover, and mutation, superior antibodies are produced, renewing the antibody population. And determine whether the expected conditions are met. If not, continue to step 3 until the final conditions are met. When the traditional genetic algorithm is applied to the optimization problem, only one optimal solution can be obtained, and it has some disadvantages, such as precocious, neglecting its prior knowledge and low efficiency. By calculating the concentration mechanism, the artificial immune algorithm can effectively avoid the disadvantage of local premature convergence, which is applicable to the problem of strong constraint optimization. At the same time, the vaccine can be extracted from the prior knowledge, so as to make use of the unconsidered prior knowledge, so as to get the solution of the problem more accurately. When dealing with the same or similar problems, the artificial immune algorithm can call up the previous solutions from the memory bank and search on this basis, which can greatly reduce the time needed to solve this kind of problems and effectively improve the computational efficiency. The improved immune algorithm can be applied to the cost decision of engineering product structure design and research and development, and the rapid and accurate immune response can avoid the local premature convergence of the algorithm, enhance the global convergence, and get the satisfactory global optimal value, that is, the optimal matching solution.

Algorithm 1

Table 1: Unit distortion corresponds to grid quality.

Element distortion	0~0.25	0.25~0.50	0.50~0.80	0.80~0.95	0.95~0.98	0.98~1.00
Mesh quality level	Good	Good	Medium	Appropriate	Poor	Invalid

Table 2: Numerical quasiboundary conditions for convective heat transfer in vacuum glass.

The boundary types	The environment temperature		Convective heat transfer system	
	Indoor	Outdoor	Indoor	Outdoor
Parameter	20	0	7.7	25

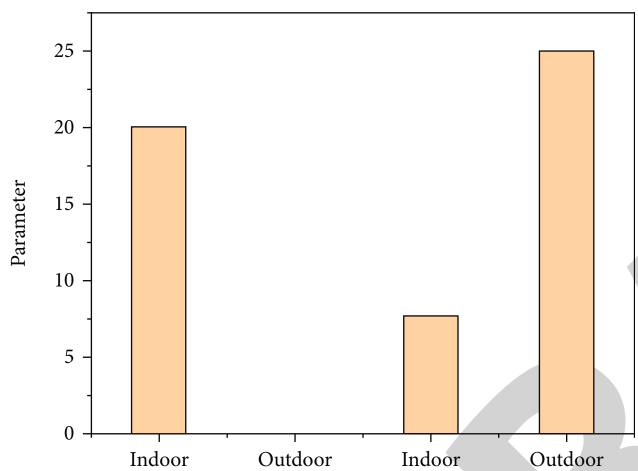

Figure 3: Numerical quasiboundary condition data graph of convective heat transfer in vacuum glass.

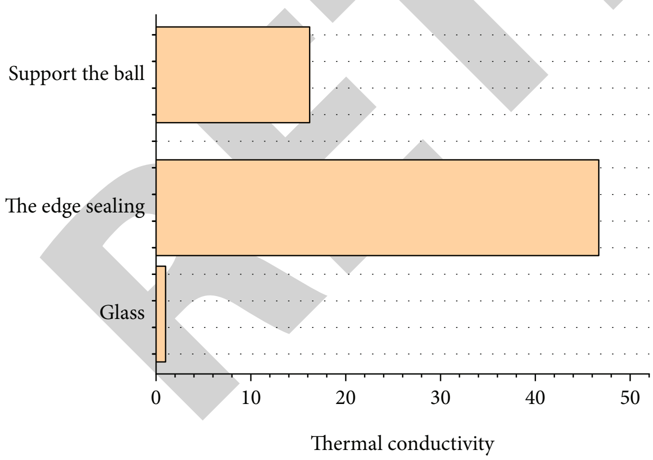

Figure 4: Thermal conductivity of vacuum glass material.

where the heat transfer coefficient of the vacuum glass central unit in the optimized example is 0.26 $Wm^{-2}K^{-1}$. The difference between the coefficients and the results of the optimized function model is not significant, and the overall error is less than 5%, which verifies the accuracy of the central unit heat transfer model. By loading the same boundary conditions on the whole model of vacuum glass, the temperature distribution cloud diagram of the whole model of vacuum glass was obtained.

The heat conduction of vacuum glass mainly depends on the micro support and the edge material, and the temperature transfer at the edge sealing material is rapid.

The total heat flux of vacuum glass model is 18.065 Wm^{-2}.

Similarly, it can be obtained:

$$K_{\text{tot}} = \frac{q_{\text{tot}}}{\Delta T} = 0.84 \text{Wm}^{-2}\text{K}^{-1}. \quad (6)$$

According to the formula, the heat transfer coefficient of the model is 0.84 $Wm^{-2}K^{-}$.

The error between the above results and the calculation results of the mathematical model is within 5%.

$$\frac{f(x_1) - f(x_2)}{f(x_1)} = 4.2\%. \quad (7)$$

The numerical simulation result is 0.84 $Wm^{-2}K^{-1}$. It shows that the optimization example achieves the energy saving of customers for customized products and further verifies the accuracy of the product design model based on the artificial immune system sex. This method can provide reference and guidance for the design of customized model products in small batch production.

5. Conclusion

This paper presents a new method based on immune optimization algorithm. Innovation design can be used to calculate the theory and method; by calculating the way and method to study the implementation, AIS provides a new calculation model or calculate way; it has powerful information processing and problem-solving skills, and many excellent features such as very accord with the requirement of design innovation can provide powerful support for innovative design; firstly, the structure and composition of vacuum glass were analyzed, and the mathematical models of radiation heat transfer, support, residual gas, and edge seal heat transfer of key parts of vacuum glass were established. Through the finite element method, the overall geometric model was established, and the temperature transfer nephogram of the model and the corresponding results of heat flux and heat transfer coefficient were obtained through the operation of CAE software, such as meshing and applying boundary conditions. By comparing the simulation analysis results with the model derived calculation results, it is proved that the error between the theoretical results and the simulation results is within 5%, indicating that the product design model based on AIS can meet the specific needs of customers.

Data Availability

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

Conflicts of Interest

The author declares no conflicts of interest.

Acknowledgments

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