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OPTIMIZATION OF COOLING CHANNELS OF LIQUID ROCKET ENGINES USING A DIFFERENTIAL HEAT TRANSFER MODEL

The ***subject matter*** *of this study is the thermophysical processes occurring in the cooling channels of liquid-propellant rocket engines. The* ***goal*** *of this research is to create an algorithm for optimizing cooling channels. The* ***tasks*** *include formulating the optimization problem and performing test calculations. The problems were solved using applied mathematics and optimization theory* ***methods****. The following* ***results*** *were obtained in the course of addressing the research objectives. The problem formulation was developed based on a literature review, and the structural mass was selected as the objective function. Changes in the geometric parameters of the cooling channels also influence the required pressure of the corresponding pump and, consequently, its mass. The objective function was defined as the total mass of the cooling channels and the coolant pump. The primary function of the cooling circuit is to keep the chamber wall temperature within acceptable limits. To ensure the operability of the optimized geometry, a constraint was implemented through the penalty function method. Furthermore, an optimization algorithm was developed based on the previously derived differential model of the cooling channels. Test calculations were performed using the proposed algorithm. The RD-111 engine's gas generator and the RD-119 engine's thrust chamber, for which data were obtained from open sources, were used as test cases. The calculations resulted in a new optimal channel geometry. In the case of the RD-119 engine chamber, the system mass was reduced by 5%.* ***Conclusions****. The scientific novelty of the obtained results consists of the development and verification of a new approach to optimizing cooling channels in liquid-propellant rocket engines. This approach is based on a previously proposed differential heat transfer model. The developed optimization algorithm simplifies the cooling system design process, thereby reducing both the time and cost of liquid-propellant rocket engine design.*

Keywords*: liquid-propellant rocket engine; cooling channels; differential heat transfer model; optimization algorithm; channel geometric parameters; mass minimization.*

Introduction

Designing cooling system for liquid-propellant rocket engines is a complex and labor-intensive process. One of the main challenges is that the geometric parameters of the cooling channels must be determined for a large number of cross-sections, taking into account variations in the chamber radius, local heat flux, coolant temperature, thermophysical properties and other factors. It is also important to recognize that a change in geometry at one cross-section can affect the flow parameters in the upstream regions of the channels.

Furthermore, the task is complicated by the fact that the parameters of the cooling system, such as pressure drop, directly influence other components of the rocket engine. This effect is particularly significant for the coolant pump. As the coolant velocity increases, the heat transfer coefficient also rises, resulting in lower wall temperatures and improved cooling reliability. How-ever, this simultaneously causes higher pressure losses in the system, which requires greater pump pressure and consequently increases both the pump's weight and drive power.

It should also be noted that an increase in coolant velocity can be achieved in several ways – for example, by reducing the channel height or by increasing the helical angle, which decreases the channel width. Therefore, effective design requires the ability to determine the most efficient ratio of geometric parameters across all cross-sections of the chamber.

Motivation

A logical step in advancing the efficient design of cooling systems is the optimization of the cooling channels. It is well known that during the period of rapid development in heat transfer modeling, computing technologies were unable to meet engineering requirements. As a result, the mathematical models developed at that time were deliberately simplified to reduce computational complexity [1]. The same applies to the methods proposed then for optimizing the geometric parameters of cooling channels [2]. Most of these approaches were reduced to simple analytical correlations or graphical representations of final results, subject to significant assumptions and simplifications.

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However, the computational resources available today make it possible to perform multiparameter optimization within acceptable time limits.

Furthermore, modern approaches to modeling heat transfer in liquid-propellant rocket engine cooling channels can be effectively utilized for optimization purposes. As shown in [3, 4], the application of advanced mathematical models significantly improves the accuracy and reliability of the obtained results.

Therefore, the development of an approach to cooling channels optimization remains a relevant and important task.

State of the art

To identify current trends in cooling channels optimization, a review of recent research was conducted. For instance, studies [5, 6] performed parametric heat transfer calculations that demonstrated the influence of various geometric parameters of the cooling channels on its efficiency. However, the procedures used to determine optimal values are not formalized and do not guarantee the identification of a global optimum.

In [7], a simplified model of the cooling channel was developed and employed to determine optimal geometric parameters. During the optimization, the average temperature, temperature non-uniformity and pressure drop were minimized simultaneously. Although this approach allows for a more comprehensive consideration of the operational aspects of cooling systems, it intro-duces uncertainties in the selection of the primary determining parameter.

A novel approach to modeling a cooling system with spiral channels was proposed in [8]. This method was applied to optimize the channel parameters, with the wall temperature serving as the objective function. The approach is particularly suitable for designing channels in the critical sections of the chamber, where temperatures are highest. However, for other regions of the engine chamber, where thermal loads are considerably lower, its application may be excessive and could result in an unnecessarily high pressure drop in the channels.

In [9], two variants of the objective function were considered. In the first case, thermal resistance was minimized, resulting in a lower wall temperature for a given pressure drop. A limitation of this approach is the requirement to specify the pressure drop in advance, which is typically deter-mined during the chamber design process. The second objective function minimizes the pressure drop in the channels while ensuring that the wall temperature remains below the allowable limit. This approach better reflects the practical considerations encountered in engine chamber design. However, minimizing pressure losses without additional constraints can lead to a substantial increase in the channels' flow area and consequently, to larger chamber dimensions and increased mass, which are undesirable.

A similar limitation is observed in [10], which also focuses on minimizing pressure losses.

In contrast, [11] considers the engine chamber mass as the objective function, with the wall temperature treated as a constraint and is not affected by this drawback. However, this approach does not account for changes in pressure losses as the channels geometry is varied. As a result, such optimization can lead to an overestimation of the required pump pressure and, consequently, a reduction in the overall performance of the engine.

Objectives and tasks

The goal of this work is to develop an algorithm for optimizing the cooling channels of a liquid-propellant rocket engine based on a differential model. The proposed algorithm enables the formalization of the cooling channels design problem, which in turn accelerates the design process and reduces the likelihood of human error.

To achieve the research goal, the following tasks were undertaken:

- formulate the optimization problem;
- select appropriate optimization methods and develop the algorithm;
- conduct test calculations.

1. Materials and methods of research

The present study focuses on the thermal and hydraulic processes occurring in the cooling channels of liquid-propellant rocket engines. These processes were modeled using a mathematical model previously developed by the authors [12]. The model is based on a system of ordinary differential equations:

$$\begin{cases} \dfrac{d(\rho f u)}{dx} = 0; \\ \dfrac{d\left((f/n)\left(p+\rho u^2\right)\right)}{dx} = \\ = p\dfrac{d(f/n)}{dx} - \dfrac{\lambda(d_h)}{8}\rho u^2\sqrt{\Pi^2 - \left(\dfrac{d(f/n)}{dx}\right)^2} - f\xi\dfrac{\rho u^2}{2}\delta(x-x_0); \\ \dfrac{d\left((f/n)\left(p+\rho Tc+\dfrac{\rho u^2}{2}\right)\right)}{dx} + (\rho u)\dfrac{d(f/n)}{dx} = \\ = \dfrac{\lambda(d_h)}{8}\rho u^3\sqrt{\Pi^2 - \left(\dfrac{d(f/n)}{dx}\right)^2} + f\xi\dfrac{\rho u^3}{2}\delta(x-x_0) + q(a+\delta_f); \\ \dfrac{d(\ln(\rho))}{dx} = -\beta\dfrac{dT}{dx}; \end{cases}$$

and the corresponding boundary conditions:

$$p(0)=p_0;T(0)=T_0;\rho(0)=\rho_0;$$
$$\rho(0)u(0)f(0)=\dot{m},$$

where x is the longitudinal coordinate along the channel axis, with the origin located at the coolant supply point;

ρ is the coolant density;

f is the channel cross-sectional area;

n is the number of cooling channels;

u is the coolant velocity;

p is the static pressure;

d_h is the hydraulic diameter of the channel;

$\lambda(d_h)$ is the empirical relationship between the friction loss coefficient and hydraulic diameter;

Π is the channel perimeter;

c is the heat capacity of the coolant;

T is the coolant temperature;

β is the temperature dependence of the volumetric expansion coefficient;

δ is the Dirac delta function;

q is the specific heat flux. Here u, p, T and ρ are functions of the x-coordinate.

This mathematical model was used to optimize the cooling path, whose main geometric dimensions are shown in Figures 1–2.

As is well known, reducing the flow area of a channels increases pressure drop, which consequently increases the pump mass. Therefore, the optimization objective was to minimize the combined mass of the chamber and the pump component responsible for cooling the chamber.

The pump mass can be determined from parametric design calculations for the turbopump unit. During preliminary engine design stages, the pump mass can be estimated using established empirical relationships derived from historical data [13]:

$$m_p=\begin{cases}48\left(P_p\cdot 10^{-6}\right)^{0.53}, & P_p\le 20\cdot 10^6;\\ 95\left(P_p\cdot 10^{-6}\right)^{0.33}, & P_p> 20\cdot 10^6.\end{cases} \quad (1)$$

In this case, the pump power is given by the following expression:

$$P_p=\dot{m}\frac{\Delta p_p}{\eta_p\rho};\Delta p_p=p_{ch}+\Delta p_{cool}+\Delta p_{oth}-p_{in}.$$

where p_{ch} is the chamber pressure;

Δp_{cool} is the pressure drop in the cooling channels;

Δp_{oth} is the other pressure drops;

p_{in} is the inlet pressure;

Accordingly, the pump mass can be expressed as a function of the pressure drop in the cooling system, which is determined using the differential model:

$$m_p=f\left(\Delta p_{cool}\right). \quad (2)$$

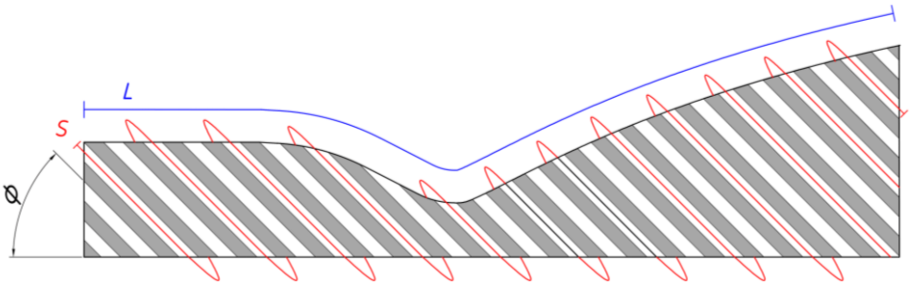

Fig. 1. Main longitudinal dimensions of the cooling system

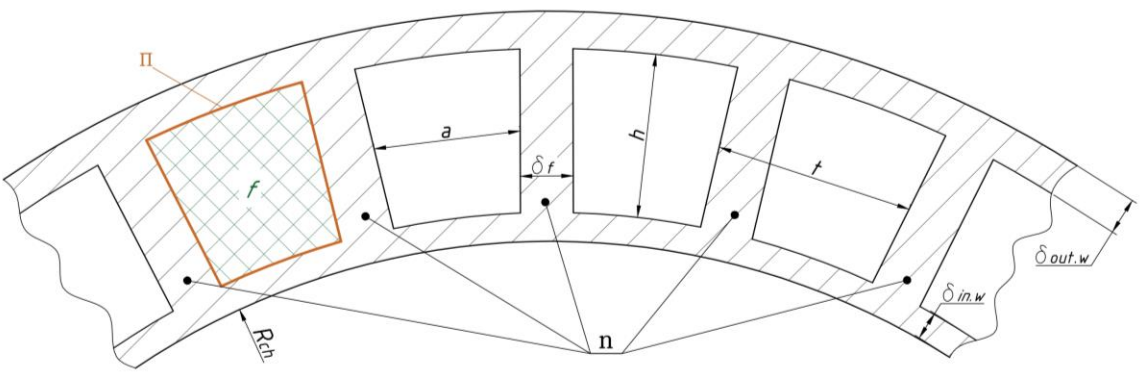

Fig. 2. Key dimensions of the cooling channels in cross-section

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Furthermore, changes in the parameters of the cooling channels also influence the structural strength. Therefore, the optimization algorithm must account for the necessary adjustments in wall thickness when modifying other channels parameters to achieve a minimum mass. To this end, the wall thickness was expressed as a function of the cooling system's geometric and energy parameters, based on established relationships from structural mechanics and the theory of strength of materials [14]. A cylindrical shell model was employed for this purpose, with the cooling jacket of the liquid-propellant rocket engine chamber represented as a wall of effective thickness:

$$\delta_{ef} = \delta_{in.w} + \delta_{out.w} + \psi\delta_f;$$

$$\psi = \frac{t-a}{t}.$$

The pressure-induced stresses in the annular and meridional directions, along with the temperature-induced loads in the annular direction, were included in the analysis:

$$\sigma_\Theta^p = \frac{p_{ef} R_{ch}}{\delta_{ef}}; \sigma_s^p = \frac{p_{ef} R_{ch}}{2\delta_{ef}}; \sigma_\Theta^t = E\frac{\alpha_t \Delta T}{R_{ch}} h,$$

where p_{ef} is the pressure in the cooling channels;

α_t is the coefficient of thermal expansion of the rib material;

ΔT is the temperature difference across the rib;

E is the Young's modulus.

Equivalent stresses were calculated according to the fourth theory of strength:

$$\sigma_{eq} = \sqrt{(\sigma_\Theta^p + \sigma_\Theta^t)^2 - (\sigma_\Theta^p + \sigma_\Theta^t)\sigma_s^p + (\sigma_s^p)^2}.$$

The wall strength condition was then formulated as:

$$\sigma_{eq} < \sigma_l.$$

The permissible stress values were defined as:

$$\sigma_l = \frac{\sigma_{0.2}(T_w)}{k_{sf}}; (k_{sf} = 1.3-1.5),$$

where $\sigma_{0.2}$ is the yield strength;

T_w is the wall temperature;

k_{sf} is the safety factor.

The wall thickness was selected to be as small as possible while satisfying this constraint. Accordingly, the wall thickness was expressed as a function of the following form:

$$\delta_{out.w} = f(t, a, \delta_f, h, R_{ch}, p_{ef}, T), \tag{3}$$

The temperatures and pressures used in this relationship were determined from the differential model described earlier.

2. Results and Discussion

2.1. Formulation of the optimization problem

As noted earlier, the system mass (chamber plus coolant pump) was chosen as the objective function. It is evident that pressure variations also influence other system parameters, such as pipeline mass, specific impulse in open-cycle engines and so on. However, due to the complexity of accurately determining these parameters at the preliminary stage of engine design, they were not considered in this study. Consequently, the objective function can be expressed as follows:

$$m(X) = m_p(\Delta p_{cool}) + m_{ch} \to \min,$$

where the pump mass can be estimated using the previously proposed correlation (1, 2) and the chamber mass is calculated as the sum of the masses of the outer and inner walls, along with the mass of the ribs:

$$m_{ch} = \int_0^L (\delta_{in.w}(l) + \delta_{in.w}(l))dl + \int_0^S (\delta_{if}(s) n(s) h(s))ds.$$

where n is the number of fins;

To ensure that the wall temperature remains within acceptable limits, a penalty function was incorporated into the formulation:

$$P(X) = \max(T_w - T_{max}, 0)^2,$$

where T_{max} is the maximum permissible temperature of the inner wall material.

Finally, the minimization function can be expressed as:

$$F(x) = m(x) + \mu P(X) \to \min,$$

where μ is the penalty coefficient, chosen based on the stability of the calculations and the required strictness of constraint enforcement.

The vector of unknown parameters in this formulation of the optimization problem is:

$$X = \{a, h, \varphi, \delta_{out.w}, \delta_f, n\}.$$

However, equality-constraints allow for a reduction in the problem's dimensionality. In this formulation, two equality-constraints can be identified: the previously mentioned dependence of the outer wall thickness on the other fin parameters (3) and the relationship between the geometric parameters of the channel:

$$a = f(\delta_f, R_{ch}, n, \varphi),$$

which, in the case of rectangular channels, takes the form:

$$a + \delta_f = \frac{2\pi R_{ch}}{n}\cos(\varphi) \rightarrow a = \frac{2\pi R_{ch}}{n}\cos(\varphi) - \delta_f.$$

Additionally, the problem formulation is supplemented by inequality-constraints, which arise from technological limitations in manufacturing and practical considerations:

$$\delta_f \ge \delta_{f_{m.l}};\delta_{out.w} \ge \delta_{out.w_{m.l}};$$

$$a \ge a_{m.l}; h \ge h_{m.l}; 90^\circ \ge \varphi \ge 0^\circ; n \ge 1.$$

2.2. Development of the optimization algorithm

An optimization algorithm was then developed and implemented for the resulting problem formulation. The input data for the optimization are the same as those used in the heat transfer calculations, including the cooling channels geometry, cooling scheme, properties of the combustion products, coolant and wall material. In addition, constraints related to manufacturing technology and the maximum allowable wall temperature are specified. This temperature depends on the material properties, engine operating conditions and other relevant factors.

The algorithm is based on the previously described differential model of the cooling channels. The values obtained from calculations using this model provide all the parameters required for optimization, including wall temperatures, variations in the required pump pressure and others.

Gradient descent was employed as the optimization method due to its simplicity, low computational cost and stable performance with sufficiently smooth objective functions. While evolutionary or stochastic methods might provide improved results, they require a significantly higher number of iterations, rendering their use impractical. Since gradient descent relies on the calculation of gradients, the algorithm used a finite-difference approximation computed from the differential model. The final version of the algorithm is presented as a flowchart in Figure 3.

2.3. Performing test simulations

To validate the developed optimization algorithm, test calculations were performed. The cylindrical section of the RD-111 engine’s gas generator was chosen as the object of optimization. Before performing the optimization, the heat transfer calculation results obtained from the differential model were verified to be consistent with data from the literature [15].

The optimization results yielded the optimal flow path parameters and the existence of a global minimum was confirmed (Fig. 4).

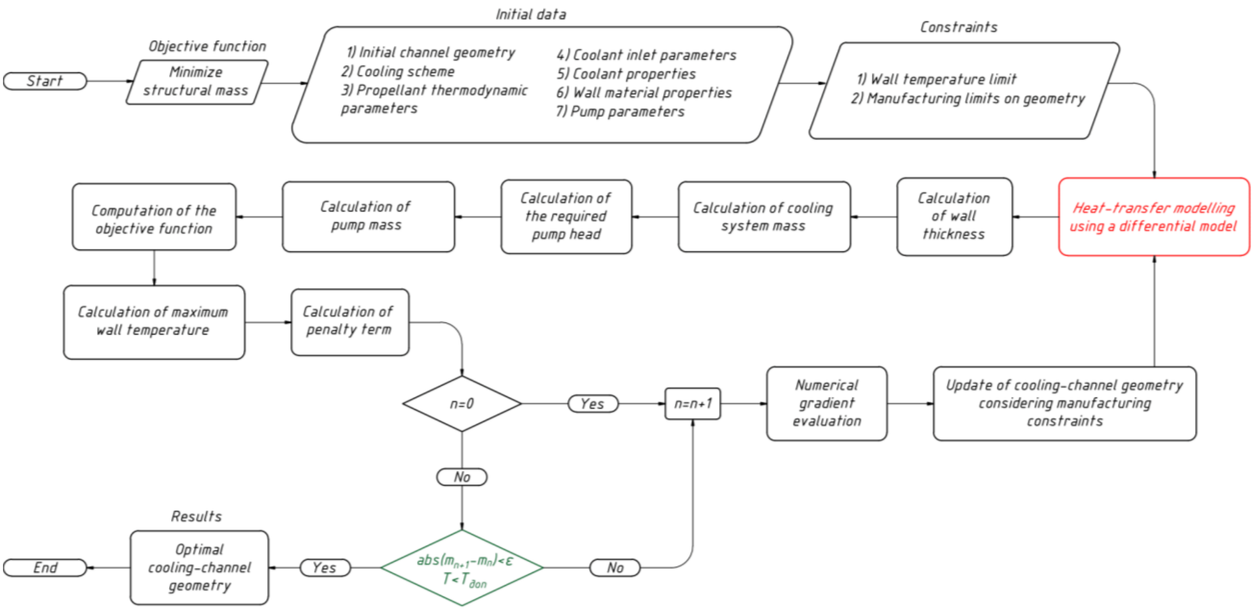

Fig. 3. Flowchart of the optimization algorithm

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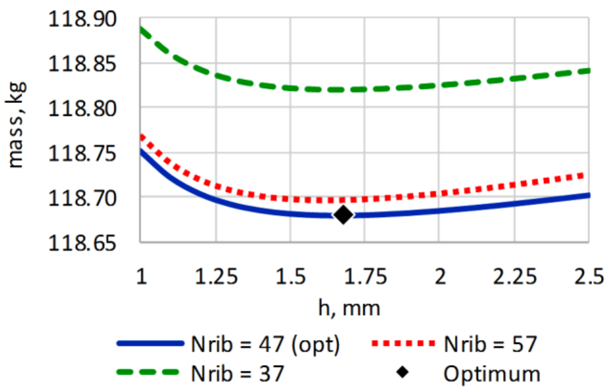

Fig. 4. Variation of the objective function with channel height for different fin thicknesses

The results shown in the graph confirm that the geometric parameters obtained during the optimization process correspond to a minimal system mass: deviations in fin height or the number of fins from the optimized values lead to an increase in system mass. This verification was performed for all optimization parameters.

The optimization algorithm was subsequently applied to the middle section of the RD-119 engine chamber [15]. Figure 5 provides a visualization of the convergence of the optimization process.

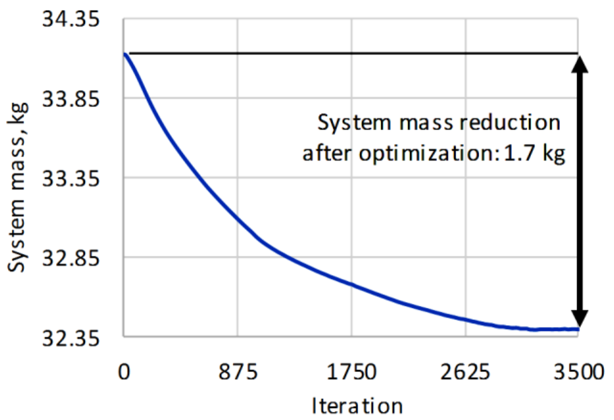

Fig. 5. Convergence of the optimization process

The calculation results indicate that the system mass was reduced by 1.7 kg, corresponding to approximately 5% of the total system mass. Moreover, the optimized channel geometry ensured that the wall temperature remained within the specified range (Fig. 6).

These results confirm the correct operation of the optimization algorithm.

Conclusions

In this work, an optimization problem for the cooling channels of a liquid propellant rocket engine was formulated. The problem formulation includes the

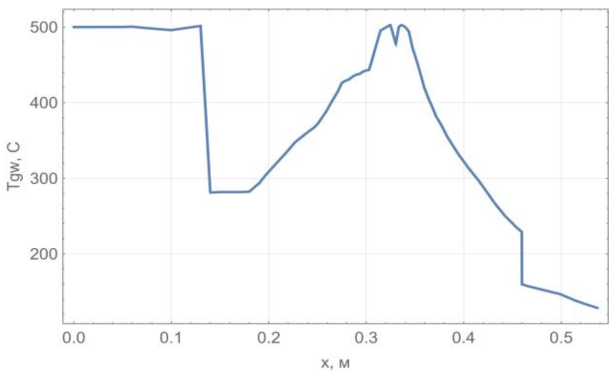

Fig. 6. Hot-gas side wall temperature

following elements: the objective function minimizes system mass, the penalty function maintains temperature within a specified range, the vector of unknown parameters comprises the geometric dimensions of the channels, inequality-constraints ensure compliance with manufacturing requirements and equality-constraints derive from the physical nature of the problem and enable dimensionality reduction.

2. Next, an optimization algorithm was developed and implemented based on the previously obtained mathematical models. Gradient descent was employed as the optimization method. A penalty function method was used to maintain wall temperature within the specified range. Gradients were determined using finite-difference approximations of the derivatives.

3. Test calculations were then performed. An optimality check was conducted on arbitrary cross-sections, confirming that the minimization problem had a solution and that the optimization algorithm functioned correctly. For the engine chamber, the resulting flow path geometry was shown to maintain wall temperature within the specified limits while reducing structural mass by 5% of the total system mass.

In future work, the optimization problem formulation will be refined, for example, by incorporating changes in the mass of other engine components, such as pipelines, or by accounting for variations in specific impulse during channels optimization.

Conflict of Interest

The author declare that they have no conflict of interest in relation to this research, whether financial, personal, author ship or otherwise, that could affect the research and its results presented in this paper.

Financing

The study was conducted without financial support.

Data Availability

The manuscript has no associated data.

Use of Artificial Intelligence

The author confirm that they did not use artificial intelligence technologies when creating the current work.

The author have read and agreed to the published version of this manuscript.

References

1. Salakhutdinov G. M. *Razvitie metodov teplozashchiti zhidkostnikh raketnikh dvigatelei* [Development of thermal protection methods for liquid rocket engines]. Moscow, Nauka Publ., 1984. 144 p. (In Russian).
2. Zarubin B. C. *Temperaturnie polya v konstruktsii letatelnikh apparatov (Metodi rascheta)* [Temperature fields in aircraft structures (Calculation methods)]. Moscow, Mashinostroenie Publ., 1978, 184 p. (In Russian).
3. Dubrovskiy, I., & Bucharskyi, V. Development of a method of extended cells for the formulation of boundary conditions in numerical integration of gas dynamics equations in the domains of a curvilinear shape. *Eastern-European Journal of Enterprise Technologies*, 2020, vol. 5, no. 7 (107), pp. 74–82. DOI: 10.15587/1729-4061.2020.213795.
4. Bucharskyi, V., Zhang, L.-H., & Wan, Y.-L. Improvement in Time Efficiency in Numerical Simulation for Solid Propellant Rocket Motors (SPRM). *Journal of Propulsion Technology*, 2018, vol. 39, no. 1, pp. 92-99. DOI:10.13675/j.cnki.tjjs.2018.01.010.
5. Leonardi, M., Pizzarelli, M., & Nasuti, F. Analysis of thermal stratification impact on the design of cooling channels for liquid rocket engines. *International Journal of Heat and Mass Transfer*, 2019, vol. 135, pp. 811–821. DOI: 10.1016/j.ijheatmasstransfer.2019.02.028.
6. Desai, R., & Kuzhiveli, B. Integrated modular design and analysis of liquid propellant rocket engine working on liquid methane-oxygen expander cycle. *IOP Conf. Ser.: Mater. Sci. Eng*, 2022, vol. 1240, article no. 012014. DOI: 10.1088/1757-899X/1240/1/012014.
7. Li, X., Wu, S., Zhang, Q., Li, X., & Chen, S. A novel method based on the calculus of variations to optimize the cooling passage configuration in thermal protection structure. *IOP Conference Series: Journal of Physics*, 2024, vol. 2764, article no. 012038. DOI: 10.1088/1742-6596/2764/1/012038.
8. Lv, J., Du, G., Jin, P., & Li, R. Heat Transfer Analysis and Structural Optimization for Spiral Channel Regenerative Cooling Thrust Chamber. *International Journal of Aerospace Engineering*, 2023. DOI: 10.1155/2023/8628107.
9. Atefi, E., & Naraghi, M. Optimization of Regeneratively Cooled Rocket Engines Cooling Channel Dimensions. *AIAA Propulsion and Energy 2019 Forum*, 2019. DOI: 10.2514/6.2019-3938.
10. Ibarra-Lozano, P., & Milo, V. P. Comprehensive Design of the Regenerative Cooling System for a Student-Designed LOx/Ethanol Liquid Rocket Engine. *11th European Conference For Aeronautics And Space Sciences (EUCASS)*, 2025. Available at: https://www.eucass.eu/component/docindexer/?task=download&id=7386. (accessed 12.11.2024).
11. Litvinov, O., Koloskova, H., & Kondratenko, O. Optymizatsiia parametriv okholodzhuvalnoho traktu kamery zghoriannia ridynnoho raketnoh dvyhuna. [Optimization of parameters of the cooling tract of the combustion chamber of a real rocket engine]. *Visnyk Dniprovs'koho universytetu. Seriya: Raketno-kosmichna tekhnika – Journal of Rocket-Space Technology*, 2024. vol. 33, no. 4-28, pp. 38-44. DOI: 10.15421/452422. (In Ukrainian).
12. Sliusariev, V., & Bucharskyi, V. Development of a mathematical model for the cooling channel of a liquid propellant rocket engine's chamber with respect for variations in coolant density. *Eastern-European Journal of Enterprise Technologies*, 2024, vol. 6, no. 1 (132), pp. 14–20. DOI: 10.15587/1729-4061.2024.316236.
13. Tizon, J. M., & Roman, A. A Mass Model for Liquid Propellant Rocket Engines. *53rd AIAA/SAE/ASEE Joint Propulsion Conference*, 2017. DOI: 10.2514/6.2017-5010.
14. Lizin, V. T., & Pyatkin, V. A. *Proektirovanie tonkostennikh konstruktsii* [Design of thin-walled structures]. Moscow, Mashinostroenie Publ., 2003. 448 p. (In Russian).
15. Gakhun, G. G., Alekseev, I. G., Berezanskaya, E. L., Gutkovskii, E. L., & Khovanskii, O. M. *Atlas konstruktsii ZhRD. Opisaniya. Chast 1.* [Atlas of Liquid Propellant Engine Designs. Descriptions. Part 1]. Moscow, MAI, kafedra 203 Publ., 1969. 226 p. (In Russian).

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ОПТИМІЗАЦІЯ ТРАКТІВ ОХОЛОДЖЕННЯ РІДИННИХ РАКЕТНИХ ДВИГУНІВ З ВИКОРИСТАННЯМ ДИФЕРЕНЦІАЛЬНОЇ МОДЕЛІ ТЕПЛОПЕРЕДАЧІ

В. В. Слюсарєв

Предметом дослідження в даній роботі є теплофізичні процеси в трактах охолодження рідинних ракетних двигунів (РРД). **Метою** роботи є розробка алгоритму оптимізації тракту охолодження. **Задача** роботи полягає в постановці задачі оптимізації та проведенні тестових розрахунків. Рішення задач проводилося за допомогою **методів** прикладної математики та оптимізації. В ході вирішення задач були отримані наступні **результати**. На основі аналізу літератури була проведена постановка задачі оптимізації. В якості цільової функції була обрана маса конструкції. Враховувалось, що зміна геометричних параметрів тракту охолодження також відобразиться на необхідному напорі відповідного насосу і як наслідок на його масі. У зв'язку із цим в роботі в якості цільової функції розглядалась сума мас: тракту охолодження та насосу охолоджувача. З іншого боку в роботі враховувалось, що прямим призначенням тракту охолодження є підтримання температури стінки в допустимих межах. Для гарантування роботоздатності оптимальної геометрії тракту охолодження в постановку оптимізації було включено обмеження, яке було реалізоване за допомогою методу штрафних функцій. Далі, на основі раніше розробленої диференціальної моделі тракту охолодження був розроблений алгоритм оптимізації. Із застосуванням розробленого алгоритму були проведені тестові розрахунки. В якості об'єктів тестових розрахунків були розглянуті газогенератор двигуна РД-111 та камера двигуна РД-119, дані про яких були отримані з літературних джерел. В результаті розрахунків була отримана нова, оптимальна геометрія тракту. У випадку оптимізації тракту камери двигуна РД-119 маса системи при цьому була знижена на 5%. **Висновки**. Наукова новизна отриманих результатів полягає в наступному: запропоновано та верифіковано новий підхід до оптимізації трактів охолодження в РРД на основі раніше розробленої авторами диференціальної моделі теплообміну. Розроблений алгоритм оптимізації дозволить спростити стадію проектування систем охолодження, що дасть можливість скоротити та здешевити процес розробки РРД.

Ключові слова: рідинний ракетний двигун; тракт охолодження камери двигуна; математична модель теплопередачі; оптимізація тракту охолодження; геометричні параметри каналу; мінімізація маси.

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