THE OPTIMAL AERODYNAMIC SHAPE OF BODIES WITH MINIMAL HEAT TRASFER

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Optimal aerodynamic design of space apparatus is one of the most interesting and promising fields of the applications of the optimal control methods. It is known that spacecraft shape has a great influence on its aerodynamic and heat characteristics. So, one of the efficient methods of solving problem of minimizing the aerodynamic drag and heat fluxes to the apparatus surface is a choice of an optimal body shape.

In addition to improving traditional configurations (axis-symmetric bodies and flat wings) the new shapes of bodies with optimum thermophysical and aerodynamic characteristics are now under investigation. It is known that bodies with circular transversal sections are not optimal with viewpoint of drag minimization. In particular, in [1] it was shown that the drag of star-like bodies is less then the drag of equivalent bodies of the revolution. Note, that identical results take place in the optimal design of three-dimensional bodies with minimal surface heat. In paper [2] the problems of minimization of total radiation heat fluxes along flight trajectory in atmosphere for 3-dimensional bodies were investigated.

However, the review of scientific references on this problem [2] has shown that in spite of wide research of optimization problems of super- and hypersonic aerodynamics many questions connected with the joint influence of heat fluxes and drag on the shape of the 3-dimensional bodies with non-circular transversal sections are not well studied.

This paper presents investigation of a new multi-criterion problem of minimization of the drag and heat fluxes to the surfaces of three-dimensional bodies. In a class of slender bodies possessing homothetic property the initial optimization problem may be reduced to the problem of searching optimal transverse contours. From mathematical point of view this problem is isoperimetric variational one with two cost functionals. The "ideal point"method is applied for solution of such optimization problem.

The investigation of the problem of determining the optimal transversal contour has shown that there exists a class of variational solutions composed of n identical cycles. A distinguishing feature of the suggested approach is that the minimization procedure includes not only a search for each extremal segment but also the number of these segments. This leads to the additional optimizing condition on the number of cycles. Joint integration of the Euler-Lagrange equation and the condition mentioned above has permitted the author to obtain three classes of analytical solutions.

REFERENCES

1. *Theory of optimum aerodynamics shapes.* — Academic Press, New York - London, 1965.
2. Arguchintseva M.A. *Shape optimization problems of 3-dimensional bodies with minimal surface heat.* — Proceedings of the 15th IFAC World Congress, Barcelona, 2002, 2511, pp.1-6.