Aerodynamic needle optimization using pSeven and FloEFD software packages

Saratov A.A.[1], Aksenov L.A., Khominich D.S.[1]
[1]DATADVANCE, Moscow
[2]Mentor Graphics, Moscow

The goal of the present work is do define an optimal geometry of aerodynamic needle within the required range of parameters in order to minimize supersonic drag at the different angles of attack.

Aerodynamic needles are used to reduce aerodynamic drag of aircrafts under the supersonics. Both experimental research and simulations are used to study aerodynamic characteristics of such needles. To evaluate aerodynamic drag at the nonzero angles of attack, a 3D modeling of the objects' external supersonic flow is required. This is a complex and resource-consuming computational challenge.

CFD analysis was performed in FloEFD software package, used for CDF and thermal simulations. To solve the problem, mesh convergence was analyzed and optimal FE mesh parameters were set.

In this work, four parameters of needle's geometry were optimized using pSeven – software platform for engineering automation, data analysis and optimization, powered by MACROS algorithmic core. Using surrogate-based optimization algorithm allowed obtaining optimal needle geometry parameters with the minimum solver calls budget. The work demonstrates the process of automating similar problems solution in pSeven.

Optimization problem setup didn't consider thermal effects, which play a big role in the aerodynamic needle geometry selection process in the course of aircraft design. However, ignoring this constraint allowed getting several different geometries with similar aerodynamic efficiency during the global optimum search.

The result of the executed work is a set of optimal geometry parameters of aerodynamic needle to minimize supersonic drag at the different angles of attack.