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APPLICATION OF MULTIDISCIPLINARY DESIGN OPTIMIZATION METHOD IN LIQUID ROCKET ENGINE DESIGN

Abstract

Liquid rocket engine design is a complex process in which the search of the best performance at the less cost is essential. This process takes account of many disciplines which have to be well handled in order to obtain the optimal design of liquid rocket engine. These disciplines, which often have conflicting objectives, require adapted design tools that allow to integrate the constrains inherent to each discipline and to facilitate the compromise search. It is obvious that the liquid rocket engine design process is multidisciplinary, multi-parameters, multi-objects, and multi-peak values. The traditional way to solve the liquid rocket engine design problem is a sequential method in which each discipline solves its own optimization problems and aims to be consistent with the other ones. This method is built on the designer expertise and does not necessarily ensure the global optimality.

The multidisciplinary design optimization (MDO) is a set of engineering systems design methods which is very suitable for designing complex engineering systems such as liquid rocket engine. The MDO methods aim to take advantages of the couplings and synergisms between the different disciplines in order to reach the global optimal design. However, the interdisciplinary nature of problems makes them challenging from both a computational and an organizational perspective. The paper focuses on the analysis and application of the different MDO methods in the liquid rocket engine design problems. First, the precision and applicability of several approximate methods are discussed. Second, some characteristics of MDO algorithms such as the robustness, the calculation costs, the flexibility, the convergence speed or the implementation difficulty are considered in order to determine the MDO method which is most appropriated in the liquid rocket engine design framework. The successful applications in the regenerative cooled thrust chamber and gas-generator body of liquid rocket engine show the feasibility and practicability of MDO.