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TOOLKIT FOR LIQUID ROCKET PROPULSION SYSTEM DESIGN

Abstract

The overall scheme of liquid rocket engine systems involving the general thrust chamber and expected performance characteristics together with selection of the propellant feed system and gas generator configurations and their analyses and initial sizing of the tanks for the propellant components is commonly known as the pneumohydraulic scheme. Due to involvement of numerous major components and their interrelated constitutive elements, the preliminary design of pneumohydraulic schemes is a highly hierarchical, complex and time consuming procedure which consists of various design phases. Each of these phases involves complicated mathematical models the manual numerical analysis of which results in reduction of the computational efficiency and growth of the time consumption. In order to reduce the time consumption and increase the computational efficiency it would undoubtedly be more convenient to automate each constitutive design phase. The current paper considers development of a computer application the primary purpose of which is to automate the design of pneumohydraulic schemes of liquid rocket engine systems. Since the preliminary chemical equilibrium analysis is the most extensive and decisive stage, the application is mainly concentrated on refined combustion analysis. Based on an appropriate output of the preliminary chemical equilibrium analysis, determination of the main thermal and structural characteristics of the thrust chamber is considered. Furthermore, once the chemical equilibrium analysis and thrust chamber design are complete, depending on the engine scheme, the sizing and analysis of the propellant feed system, gas generator and tanks for the propellant components are also conducted. However, despite the convenience of the direct numerical analyses in the individual operations, the data ports of the minor engine components may not coincide in various cases. In order to merge numerous minor engine components and preserve the port data continuity, the junction algorithms have also been developed and implemented in the application. As the ultimate output of the application the pneumohydraulic scheme of a system involving the overall thermal, performance and geometrical characteristics is obtained. The reliability and functionality of the application is eventually demonstrated through the design of the pneumohydraulic scheme of a liquid rocket engine system operating based on liquid methane and liquid oxygen.