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PREDICTION ON THE REUSE NUMBER OF LIQUID ROCKET ENGINE BY DEVELOPING A GENERALIZED LIFE MODEL

Abstract

It is critical to developing the reusable liquid rocket engine to make the commercial aerospace as real. However, most of the rocket engine around the world are single use because of the requirement of the safety and the time spent in turnaround of spacecraft. Thus, how to assess the potential reusability of the existing rocket engine becomes a meaningful work. To address this problem, in the current work, a generalized life method of predicting the potential reusability of the expenditure liquid rocket engine is proposed. First, the existence of the generalized life model is analyzed. Because some failure modes of the component are common but the others rare, to reproduce all of them the complete repair hypothesis is proposed. Through this assumption, it qualitatively proves the existence of the generalized life model. Moreover, the true life is distributed on the generalized life curve. Then, a special generalized life distribution, Weibull, is discussed because most of the failure probability can be simulated by this model. To obtain the model parameters from the perspective of safety and reliability, a conservative method is proposed to estimate model parameters. After this, the life distributions of the components are all determined, which lay the foundation for assess the reusability based on the system reliability requirement. Finally, to verify the validity of this method, some experimental tests are carried out on some a propulsion system. The reasonability is proved by comparing the simulated and the experimental results. The current work indicates that: (1) the true life is contained in the generalized model, and the generalized model with two parameters can be determined by considering the reliability of the expenditure system and the examined failure model; (2) based on the generalized life model, the individual component of the propulsion system can be reused 2 5 times in simulation, which is nearly consistent with the experimental result; 3 from the theoretical calculation and the experiment, it is reasonable to take the system reliability after reuse as the assessment criterion, while the component reliability cannot. This study provides a reference for the evaluation of the reusability of the liquid rocket engine.