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HYBRID ROCKET SIMULATION USING CEQUEL FOR THERMOCHEMISTRY CALCULATIONS

Abstract

In hybrid rockets the fuel regression rate is often determined empirically in laboratory scale motors for each fuel type. Thus, the resulting burning rate correlations will have an uncertainty due to measurement uncertainties and data reduction procedures associated with the test motor. An analytic simulation of a connected pipe facility generated “synthetic test data” predictions for pressure transducers, flow meter, thermocouples and other test measurements. The simulation included a lumped parameter internal ballistics model that included factors for combustion efficiency and variation of oxidizer-to-fuel ratio. The formulation simulated was hydroxyl-terminated polybutadiene and the uncertainties in the resulting regression rate and regression rate law based on the “synthetic test data” were estimated. The results show how measurement uncertainties and conceptual biases in the data reduction can impact the uncertainty and accuracy of regression rate laws. The objective is to estimate the effect of test conditions and measurement accuracy on the solid fuel regression rate laws. The scope includes examining all the primary measured parameters in a laboratory-scale test engine, simulating the test operation for assumed fuel brining rate laws, and then analyzing the simulated test operation to determine the fidelity of the “experimentally simulated” test. The baseline test configuration is a center-perforated fuel grain with injection of a heated oxidizer entering at the head end and a choked-flow nozzle and the aft end.