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EXPERIMENTAL INVESTIGATION OF THE FEED SYSTEM INSTABILITIES IN HYBRID ROCKET MOTORS

Abstract

Hybrid rocket motors have been experiencing combustion instabilities problems in various projects at different motor scales. Because of the lack of comprehensive theoretical models, research has been focused on explaining the specific ranges of operation instabilities. Special attention is given to the unstable behaviour of the hybrids, characterised by the combustion low frequency instabilities. For that, in most of the experiments rely on gaseous oxidizers with sonic orifices, which decouples the effects of the feed system over the motor performance. Previous researches conducted at University of Brasilia (UnB) and at University of Brussels (ULB) showed that the combustion chamber pressure oscillation was strongly influenced by the injector design, pressure drop between the feed system, the combustion chamber length and the size of the motor pre-chamber. To investigate the instability related to the feed system, a series of tests were carried out using liquid nitrous oxide as the oxidizer in a 1.0 kN hybrid motor. Effects of the feed system on the chamber pressure were verified, and it was confirmed that the instability of the system had a different behaviour related with the TC-coupled instability, which is mainly caused by the boundary layer response time. In the case of the feed system instabilities, the main frequencies were strongly influenced by the residence time of pre-chamber and the flow characteristics. The analysis of the experimental data allow inferring the conditions that hybrid rockets motors are less sensitive to develop combustion instabilities related with liquid oxidizer feed system.