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TWO-PHASE, MULTICOMPONENT HYDROGEN PEROXIDE BLOWDOWN INJECTOR MODELLING AND TESTS COMPARISONS

Abstract

A blowdown liquid fuelled rocket engine (LRE) survey, propelled by commercial hydrogen peroxide (HTP) and automotive ethanol, is presented. The main objective of this engine is to have a low-cost technology demonstrator to be used in a prototype of a training rocket for the Alcantara Launch Center. During this survey, many challenges regarding the catalytic bed and the oxidizer injector modelling were identified. The injector is an essential component of a LRE since it is responsible for providing an efficient atomization and a stable burning in the combustion chamber, which may be designed for a two-phase and multicomponent flow.

The complete decomposition of the HTP produces gaseous oxygen and water vapor. In this case, the commercial HTP is a 50% HTP/50% H2O mixture. As there is much water in this mixture, a great part of the decomposition heat is absorbed by the water that remains after the catalytic bed. A crossover occurs at 63-64%, where rapid, accelerated decomposition becomes self-sustaining.

Different methods to model two-phase flow on a horizontal pipe have been studied. Wallis, 1969, proposed the homogeneous model, which, in a general fashion, the liquid and gas move at the same velocity. The separated flow model (SFM) developed by Lockhart and Martinelli, 1949, considers that both phases flow separately in the pipes. And there's the dimensional and similitude analysis by Dukler, *et al*, 1964.

As the studied component is an injector (almost isentropic) composed by different subcomponents, the SFM is used. The same approach proposed by Bazarov; Yang; Puri, 2004 is used to create the model, considering the mixture of a liquid jet injector and a gaseous jet injector. The sum of the area occupied by each of the phases must be the internal area of the injector, which are determined by the hydraulic diameter of each one (DL and DG) and the ratios (αL and αG) of the actual cross-section area of flow to the area of the hydraulic diameters. Furthermore, due to the all-transient characteristic of the blowdown, these diameters are also variable in time.

In order to test and validate this LRE, a bench test was built with COTS low-cost equipment compatible with the oxidizer. In addition, pressure transducers and a thermocouple were installed, on the tanks and on the exit of the injector, respectively, to measure relevant data regarding the engine burning.

This work describes the hydrogen peroxide blowdown injector modelling and test comparisons.