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HIGH POROSITY OPEN CELL METAL FOAM SUPPORTED CATALYSTS FOR DECOMPOSITION OF 98% HYDROGEN PEROXIDE

Abstract

Investigation, described in this manuscript, treats about alternative (for popular ceramics) metal supported catalysts for decomposition of the highest-class hydrogen peroxide: 98%+ (according to MIL-PRF-16005F). The aim for this study is to find a good practical solution for decomposition of 98% hydrogen peroxide, strictly for rocket propulsion. Propulsive application requires stability and durability for long, multi-cycle lifetime.

Ceramic supported catalysts and their parameters are well described in open literature about heterogeneous decomposition of highly concentrated hydrogen peroxide. The authors have been working with ceramic supported manganese oxide catalysts for years. The experience gained, mainly by testing, has revealed multiple drawbacks of ceramics, including: susceptibility to thermal shocks, low mechanical strength, need for special treatment while packing catalyst beds, problems with repeatability between individual packed beds.

High porosity open cell metal foams, commonly used for: filters, batteries and industrial catalysts, have been identified as a structure of great potential as catalyst support for decomposition of hydrogen peroxide. Due to low density (approx. 1.3 kg/L for Ni/Cr/Al, porosity: 85%), good mechanical and thermal properties, availability of various materials and alloys as well as new technologies of manufacturing make metal foam a potential solution for many different propellants, not only hydrogen peroxide.

High porosity (approx 85%) Ni/Cr/Al open cell foam has been processed to prepare several types of catalysts, with different content and dispersion of active phase. Prior cleaning and drying was performed to prepare carriers for further processing: wet impregnation, slow drying and calcination. Deposition of active phases such as: silver (from silver nitrate) and manganese oxides (from sodium and potassium permanganates) have been tested. This process used to be practiced before with ceramic support.

Simple drop tests with 98% hydrogen peroxide have been conducted in order to estimate activities of catalysts, in a simplified scale: low, medium, high. Then, real-environment tests have been performed in a catalyst bed. Temperature, pressure along the bed and propellant mass flow rate were measured while testing. Moreover, mass of the catalyst pack at each step of testing was recorded in order to determine the active phase loss.

The analysis of test results provided the general conclusion that metal foam is a promising catalyst support for decomposition of the highest-class hydrogen peroxide for propulsive application. Future tests will provide more information about the expected lifetime, possibly limited by metal oxidation.