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Author: Mr. Sangwoo Jung
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, jsw747@kaist.ac.kr

Mr. Seonuk Heo
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, seonukheo@kaist.ac.kr
Prof. Sejin Kwon
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, trumpet@kaist.ac.kr

PREDICTION AND VALIDATION OF THE CATALYTIC DECOMPOSITION OF HYDROGEN PEROXIDE IN DUAL-CATALYTIC BED

Abstract

Hydrogen Peroxide is one of the green propellants that are being considered as alternatives to the high toxic propellants such as hydrazine and its derivatives. Dual-catalytic bed using different grain sizes and catalyst types have been widely adopted in hydrazine monopropellant thruster's catalyst beds. Usually, the small catalyst grains are placed in the upper bed, whereas the larger catalyst grains are placed in the lower bed. The Dual-catalytic bed which uses two different grain sizes has several advantages for thruster performances. As a thrust level becomes higher, it causes the high-pressure drop across the catalyst bed. For this reason, we adopted dual-catalytic bed for 2500 N class hydrogen peroxide bi-propellant thruster to solve the high-pressure drop. The high-pressure drop was successfully decreased, but this attempt was not optimized. If a catalyst bed model is adopted to design dual-catalytic bed, it would be useful to optimize the design. In this study, Pasini et al.'s catalyst bed model was adopted and modified for design optimization of dual-catalytic bed. And then, the dual-catalytic bed model was validated using real thruster firing testes. We adopted the Pasini et al.'s 1-D catalyst bed modeling which uses hydrogen peroxide as a reacting flow. The model can predict flow temperature, pressure drop and propellant decomposition ratio along the axis. We modified the model to consider dual-catalytic bed and the effect of catalyst particle size to reaction performance. Heo et al.'s result of dual-catalytic bed thruster firing tests was used to validate the model. The volume ratio of two different grain sizes in packed bed and propellant mass flux were controlled. $MnO_2/PbO/Al_2O_3$ catalysts were used. The catalyst bed was composed of 10-16 mesh grain and 1/8 inch pellet. Pressure and temperature in the bed to validate the model were measured 5 points and 3 points each along the axis. As a result of validation, comparisons have been made under various conditions between the model and experimental data. Pressure and temperature estimations from the model were well correlated to the experimental results at low mass flux and a large portion of small grain conditions. But as a mass flux and portion of large pellets gets higher, pressure and temperature estimations deviated slightly. In conclusion, dual-catalytic bed model was validated and temperature and pressure estimations were well correlated to the experimental results. As a plan, a parametric study will be conducted to optimize the dual-catalytic bed using the validated model.