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EFFECT OF THE ELECTRODE SHAPE ON THE COMBUSTION CHARACTERISTICS OF ELECTRICALLY CONTROLLED SOLID PROPELLANT

Abstract

Electrically Controlled Solid Propellant (ECSP) is a novel propellant of which the ignition, extinguishment and re-ignition is enabled by controlling the electric energy. Furthermore, it is known to be safe even if the flame is applied to the propellant directly, and it is not deflagrated nor detonated. The first ECSP was developed in the DSSP, United States. They used the Hydroxylammonium Nitrate (HAN) and Poly-Vinyl Alcohol (PVA) as an oxidizer and binder, respectively. This composition is easy to produce from lab-scale to plant scale due to low viscosity. They also revealed that HAN provides the electrical properties so that the electrically controlled combustion of the ECSP is enabled. Now days, many researchers focus on the ionic characteristic of HAN that consists of hydroxylammonium cation and nitrate anion and is ionized easily in solution state. Thereby, Lithium Perchlorate, Ammonium Perchlorate, and Ammonium nitrate, etc., are utilized as an alternative of HAN, while electrically conductive polar polymers, such as Polyethylene oxide, are used as an alternative of PVA. However, the ECSP requires further understandings in terms of electrical ignition and combustion mechanism. Especially, the electrode shape affects to the combustion characteristics. Therefore, the combustion effects using various types of the electrode shape on ECSP was conducted in this research. The electrode used in this research was stainless steel and configurated into plate, mesh, foam types to control the current density under atmospheric condition. The applied electricity was limited to 4 A at 200 V. In case of using plate electrode, the applied electricity to the propellant was 0.3 A at 200 V, and the regression rate at 0.1 atm was 0.14 mm/s. In case of using mesh and foam, the applied voltage and current was 180 V and 4 A. The regression rate for mesh and foam was 0.48 and 0.52 mm/s, respectively. These results indicated that the regression rate increased with the current density. The throttling performance was also investigated. When the voltage and current limit increased to 400 V and 8 A, and the plate electrode was used, the regression rate increased 2.8 times and the measured voltage and current were 400 V and 0.8 A, respectively. On the other hand, when using the mesh and foam types electrode with same electrical condition, there was no significant changes on the regression rate though the voltage and current increased up to 300 V, 8 A, respectively.