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STUDY ON THE EFFECT OF THE GAP BETWEEN GRAIN AND CASE ON THE STRUCTURAL INTEGRITY OF SOLID PROPELLANT

Abstract

The structural integrity of solid propellant is one of the core factors that determines the normal operation of the solid rocket motor (SRM). New configurations of grains with high performance face more stringent structural integrity requirements. Focusing on a high loading integrated grain, we used finite element method to numerically study the stress and strain bearing high pressure gas at the initial stage of SRM operation. The difference between the working condition of with or without gap (or pressure) on the outer surface of the grain was compared. Calculated values were used to evaluate the structural integrity based on the mechanical parameters of the propellant. The result indicates that the maximum stress and strain values locate at the bottom of the inner orifice of the grain when no pressure is applied on the outer surface of the grain. The values far exceed the tensile strength and elongation of ordinary propellants which cannot guarantee the requirements of the structural integrity. When same pressure is applied on the inner orifice and outer surface of the grain, the stress and strain values are all within the allowable range of ordinary propellants. According to the results above we can draw the conclusions that the existence of the gap between grain and case can rapidly balance the pressure difference between the inner and outer surface of the grain. The significant reduction of the stress and strain levels helps to guarantee the safety of SRM during ignition and operation process. It should be mentioned that the gap appears automatically at low temperature (lower than the curing temperature of the propellant). At high temperature the grain expands and the outer surface of the grain is closely fitted to the inner surface of the case and the gap is missing. Therefore, appropriate geometric design needs to be adopted to ensure the presence of the gap when SRM operates at a high temperature.