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THE PRELIMINARY STUDY OF SEVERITY LEVEL OF STRUCTURAL DISCONTINUITIES IN PARAFFIN GRAIN OF HYBRID PROPELLANT ROCKET

Abstract

Paraffin is one of the potential fuels under investigation at present time for application in hybrid propellant rockets due to some important advantages. However, paraffin is characterized by low mechanical properties and brittle behavior even at normal temperatures. Addition of various modifiers and admixtures to paraffin in small quantities increases several times both strength and stiffness respectively; but absolute values of mechanical properties still remain small. Because of brittle behavior, some sorts of paraffin may crack at negative temperatures. For hybrid propellant rockets operating in conditions of low temperature, such as those launched from high altitudes (balloon launch, air launch) or applied in upper stages of the launch vehicles (space tugs, orbital transfer vehicles) this effect may essentially prejudice the structural behavior of the grain. At the same time, it is remarked in literature that hybrids are insensitive to cracks, since cracking in a hybrid propellant rocket does not lead to catastrophic consequences like in a solid propellant rocket. Some other structural discontinuities in grains, such as air bubbles, may affect the combustion characteristics of hybrid propellant systems, but there are no information about disastrous consequences. The paper addresses experimental characterization of instant shape of paraffin grain with predefined structural discontinuity in process of combustion and its possible influence on structural integrity of hybrid propellant motor. The one-port paraffin grains with and without artificial crack were subjected to combustion in a hybrid propellant test-motor and considerable discrepancies of temperature on surface of the non-cracked and cracked grains were detected. Elevated temperature on the surface of cracked grain was caused by fast evolution of the crack in the direction of motor's case during combustion process. The preliminary qualitative assessment of the severity level of grain's structural defects in hybrid propellant rockets is given.