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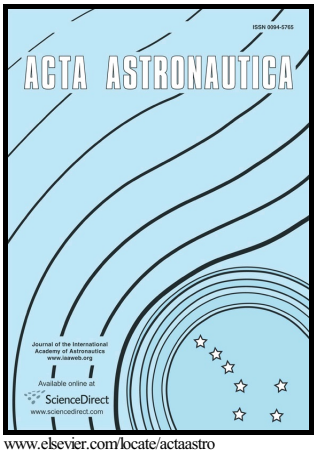


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# Experimental and Numerical investigation on the ignition and combustion stability in solid fuel ramjet with swirling flow

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**Abstract**

The present article investigates experimentally and numerically the ignition and flame stability of high-density polyethylene solid fuel with incoming swirling air through a solid fuel ramjet (SFRJ). A new design of swirler is proposed and used in this work. Experiments on connected pipes test facility were performed for SFRJ with and without swirl. An in-house code has been developed to simulate unsteady, turbulent, reacting, swirling flow in the SFRJ. Four different swirl intensities are utilized to study experimentally and numerically the effect of swirl number on the transient regression, ignition of the solid fuel in a hot-oxidizing flow and combustion phenomenon in the SFRJ. The results showed that using swirl flow decreases the ignition time delay, recirculation zone length, and the distance between the flame and the wall, meanwhile, increases the residence time, heat transfer, regression rate and mixing degree, thus, improving the combustion efficiency and stability.

*Keywords:*
Regression rate; Swirl flow; Solid fuel ramjet; Combustion; Ignition.

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## 1. Introduction

The thermal decomposition and ignition of combustible solid fuels is one of the important issues related to the combustion of solid fuel engines. Solid fuel ramjet (SFRJ) is the most simple and reliable air-breathing engine that contains no moving parts which can be used in both military and civilian applications. It uses cylindrical solid fuel grain as a combustor in which the combustion will take place. Therefore, the dominant process controlling the ignition time is the solid fuel pyrolysis. In general, ignition was classified in the solid phase, heterogeneous, or in the gaseous phase [1], the last one is taking place in solid fuels [2]. Moreover, in terms of the controlling mechanism, ignition is classified into auto-ignition and piloted-ignition depending on the evaporation time, whereas, if the reaction time is much smaller than evaporation time the ignition process is diffusion-controlled (piloted-ignition) and otherwise it is reaction-controlled [3]. Ignition process

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