ABSTRACT

Metal-liquid oxidizer mixtures are attractive for propulsion applications due to their high energy densities. Several particle sizes ranging from micron to nano scales for different metal-liquid oxidizer mixtures have been studied and substantial information regarding this combustion is available from the experiments. Theoretical studies have also been done and analytical expressions for burning rates have been derived but all those studies were done for steady state conditions with a lot of simplifications. A transient study is thus conducted here using basic conservation principles of mass and energy and a bounded region is chosen to mimic the experiments. Layer by layer constant pressure vaporization is assumed to develop the flow field required for combustion. Also, numerical simulation is done using finite volume method for Mg/H_2O mixture and subsequently for Al/H_2O mixture. It was found that for Mg/H_2O mixtures the flame front velocities were overpredicted and thinner vapor and reaction zones were predicted compared to experimental observations. Similar trends were observed for Al/H_2O mixtures. Parametric studies were also done to analyze effects of various parameters on flame front velocities and temperature profiles. It was found that lower thermal diffusivities gave better flame front velocities values but gave poor temperature profiles agreement with experimental data. Burning time was increased to mimic agglomeration and this gave better agreement with experimentally obtained flame front velocities and temperature profiles. However, some disparities in the liquid water zone were observed. Incorporting temperature depending properties and a better boiling model is likely to give better predictions. .