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Analysis of the electric currents in 1D premixed flames under applied voltages JIE HAN, MEMDOUH BELHI, FABRIZIO BISETTI, Clean Combustion Research Center, KAUST, TIERNAN CASEY , Combustion Modeling Laboratory, Univ. of California, Berkeley, HONG G. IM, Clean Combustion Research Center, KAUST, JYH-YUAN CHEN, Combustion Modeling Laboratory, Univ. of California, Berkeley — Studying electric currents in flames has practical aspects such as the determination of the ionic structure of a flame, the analysis of the flame behavior under an electric field and the use of flame electric properties for combustion diagnostics. This study proposes a simplified model to compute the electric currents in lean-to-stoichiometric 1D premixed flames under applied voltages. The Navier-Stokes equations coupled with transport equations for neutral and charged species along with a Poisson equation for the electric potential are solved. The model reproduces qualitatively the voltage-current characteristic found experimentally. The sensitivity of the electric currents to the applied voltage, equivalence ratio, and pressure is studied and the key parameters affecting the saturation current are determined. Results show that the saturation current is controlled by the amount of charged species created by the chemi-ionization reaction. We found that the recombination rate of electrons with cations and transport coefficients of charged species are the most important parameters affecting the voltage at witch saturation occurs. Analytical formulas for the voltage-current characteristic and the potential of saturation are developed and used to explain the obtained results.

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