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Recent understanding with flames under external electric fields

Abstract

In this presentation, recent investigations showing the true effects of electric fields on flame behaviors will be summarized. The primary impact of electric fields on flames is the separation of ions and electrons from the origin (reaction zone), letting them migrate toward electrodes—positive ions to a cathode, and electrons and negative ions to an anode. The separation of these charged species imposes electrical charges on the flow volume, ending neutrality in the flame zone such that the electric body force on the flow volume creates a bulk flow motion, i.e., ionic wind, blowing from the flame toward both electrodes. Here, based on two important features of flames — i) negative charges are mostly carried by electrons due to the small amounts of negative ions and neutrality, and ii) the electrons' mobility is three orders of magnitude greater than that of the ions—the electric field results in a unique and intriguing flow modification. Because of the significantly higher mobility of electrons than ions, the migration of electrons to an anode is much faster than that of positive ions to a cathode, such that the charge density in the region between the flame and the anode is significantly smaller than the corresponding region between the flame and the cathode, since electron density is proportional to the mobility ratio multiplied by positive-ion density. This indicates an asymmetric field intensity, which is caused by the significantly different charge densities. Therefore, the response of the ion current in a flame to an electric field is significantly different depending on polarity, particularly when the flame is closer to one of the electrodes. Based on various experimental, theoretical, numerical studies, resulted effects of electric fields will be discussed depending on flame conditions and electrical configurations.

Short CV

Dr. Min Suk Cha: He was born in Seoul, Korea in 1970. He received BS in mechanical engineering from POSTECH in 1993, and MS and PhD in mechanical engineering from Seoul National University in 1995 and 1999, respectively, specializing in Combustion Science. He worked at the Korea Institute of Machinery & Materials (KIMM), where he obtained a plasma background, as a Principal Research Scientist from 2000 to 2010. Currently, he is associate professor at King Abdullah University of Science and Technology (KAUST). His current research interests include plasma (and electrically) assisted combustion, plasma-based electric-to-chemical conversion, nanomaterial synthesis via combustion and plasma, and in-liquid plasma generations.