Flammability and Flame Propagation in Aerosols of High Flash Point Hydrocarbons

Accidental release of industrial hydrocarbons can produce flammable aerosols, resulting in fire and explosion hazards. The risks posed by industrial fluids having high flash points and low vapor pressures have not received much attention until recent accidents in the process industry. However, the understandings of aerosol combustion of industrial fluids have been limited by experimental data, thus preventing the development of well-designed accident management program.

For production of monodisperse aerosol droplets, atomization of liquids by electrical force, or electrospray, is carried out using industrial hydrocarbon fluids to investigate factors controlling the aerosol droplet size. Aerosol droplet size by electrospray is mainly controlled by applied voltage, liquid flow rate, conductivity and other physical properties of the liquid. Focusing on equilibrium between the electric field force on the cone-jet surface and the liquid-air surface tension, electrospray is further studied using finite element modeling. Similar effects of electric field force on droplet size were observed between experimental and modeling results. Modeling of electrospray using the finite element method has the potential to provide more knowledge of the process of Taylor's cone formation and appearance of the unstable spraying phenomenon.

Aerosols of heat transfer fluids were ignited to observe some key parameters affecting the flame propagation speed. Droplet size of the aerosols was finely controlled by applying the electrospray method, subsequently; the generated droplet sizes were measured using the laser diffraction technique. Different combustion modes were observed using a high speed camera, the recorded flame propagation velocities and their corresponding flame sizes were investigated using image processing and analysis. Results showed that the flame propagation speed is increased by larger droplet evaporation area. Higher amount of fuel vapor was found to decrease the flame propagation speed by producing larger flame area and heat loss to the surroundings. The proposed study describes a unique approach to understand the aerosol combustion process that may lead to safer handling of flammable aerosols in the process industry.