Phosphorus Impact on Soot Formation in Flames of Condensed Phase Fuels

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Phosphorus plays a very important role in flame retardancy and its mechanism in flames is not well understood. Bench-scale fire tests indicate that phosphorus directly promotes soot formation. The soot radiant energy, a function of fire temperature and soot concentration, contributes about 40% of energy loss to the walls of the Ohio State University (OSU) fire calorimeter during the burning of large area cabin materials. This research develops a liquid fuel delivery system that accommodates flame retardant chemicals and generate a steady laminar diffusion flame. The pyrometry technique is implemented to measure the full field of flame temperature and soot volume fraction in flames, impacted by the phosphorus type flame-retardant material. This research also outlines a new procedure to simultaneously calibrate and characterize the camera's detector using a blackbody furnace. The flame-retardant material is found to promote soot formation and suppress soot oxidation in the post flame region. The increased net soot concentration cools the flame, resulting in incomplete combustion.