A PRELIMINARY STUDY ON THE ORIGIN OF OXYGEN BONDED IN SOOT PARTICLES IN ETHANOL/ETHYLENE PREMIXED FLAME

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Abstract
The objective of this study is to elucidate the source of oxygen incorporation into soot particles generated during ethanol combustion. The composition of carbon particulate matter (PM) and flame structure were investigated in fuel-rich premixed flames of ethylene and ethylene blended with ethanol (20% of total carbon fed) at atmospheric pressure. Analysis of the composition of gaseous species, conducted through probe sampling and gas chromatographic techniques, revealed that ethanol had a minor influence on the production of carbon monoxide (CO) and carbon dioxide (CO_2), while also delaying the formation of hydrocarbons. Carbon particulate matter (PM) and its fractions were subjected to laser desorption ionization-time of flight mass spectrometry (LDI-TOFMS) analysis to investigate the origin of oxygen integration: a fraction encompassing species smaller than 20 nm to isolate organic carbon and primary particles; a fraction soluble in dichloromethane; and a fraction soluble in acetonitrile, aimed at isolating organic carbon and its lighter fraction enriched in polycyclic aromatic hydrocarbons (PAHs), respectively. Fourier-transform mass spectrometry (FFT) analysis revealed mass discrepancies indicative of oxygen presence in ethanol-derived samples, particularly in the total particulate matter and small particle fractions, with negligible oxygen content in the soluble fractions. This finding challenges the traditional assumption regarding the role of oxy-PAHs in particle oxygenation. Consequently, attention was redirected toward small hydrocarbons such as aldehydes, with acetaldehyde emerging as a potential candidate for oxygen incorporation into particles. Acetaldehyde was found to be more prevalent in ethanol flames, supporting this hypothesis. Strategies aimed at reducing the formation of specific aldehydes, like acetaldehyde, could provide insights for mitigating particle oxygen content levels and their effects on human health.