EFFECT OF ALKYLATED AROMATICS ON PARTICLE FORMATION IN DIFFUSION FLAMES

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Aromatic hydrocarbons are the major constituents of real engine fuels and they are used as anti-knock additives to enhance the octane number of the fuels, to suppress auto-ignition and to increase the energy density of transportation fuels. However, they play an important role in the soot formation enhancing the formation of soot precursors such as PAHs.
This paper is an experimental study about the sooting tendency of four C_8H_{10} isomers (ethylbenzene, orto-, meta- and para-xylene) and three C_9H_{12} isomers (iso-propylbenzene, normal-propylbenzene and 1,3,5-trimethylbenzene). The presence of only one aromatic ring allows a simple characterization of the role of alkyl chain that differs for position and number of methyl groups.
Counter-flow diffusion flames with ethylene/ alkyl-aromatic blend as fuel stream have been studied by in-situ spectroscopic techniques, namely laser induced emissions, and then related to ethylene/toluene flame to understand the effect of alkyl chain position and length on the particulate formation. The analysis of spectral emission from the flame allows to distinguish between laser induced fluorescence, associated to small nanoparticles, and laser induced incandescence, associated to large soot aggregates.
The flame configuration chosen for this study better allows the investigation of the nanoparticles and soot profiles along the flame with respect to co-flow flames employed in the earlier studies about the sooting tendency of aromatic hydrocarbons. Also the percentage of aromatic used in this study reaches values as high as 30%, similar to those found in real fuels.
The experimental results show that the effect of the alkyl chain strongly depends on the combustion environment and whether the focus is on nanoparticles or soot the presence of a long side alkyl chain, as in ethylbenzene, iso-propylbenzene and normal-propylbenzene, promotes the nanoparticles formation probably because radicals attack are facilitated with respect to the presence of single methyl groups; also the presence of a two methyl groups in orto- position favours the formation of larger PAHs and thus nanoparticles, by a faster ring closure with respect to meta- and para- configuration. This behaviour is similar in both pyrolytic and oxidative zone of the counter-flow flame.
Looking at the sooting tendency of the investigated hydrocarbons, in the pyrolytic and oxidative region of the flame there are not evident changes in soot production for the C_8H_{10} isomers. When C_9H_{12} isomers are used a stronger effect is found. Also for soot, the presence of a single side chain is more effective with respect to the presence of single methyl groups.

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