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In-Use Vehicle Hydrocarbon Speciation:

The Impacts of Fuel Types, Driving Cycles and Emission Status on the Reactivity of Vehicle Emissions

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Environmental

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by

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PUBLICATION AND PRESENTATIONS

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ABSTRACT OF THE DISSERTATION

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This project examined the relative significance of three emission factors (fuel, cycle and emission status) on in-use vehicle exhaust reactivity. Nineteen in-use vehicles were tested with randomly assigned seven fuel types and two driving cycles. The specific reactivity was used to compare the exhaust reactivity among tests. For each exhaust speciation profile, three different compound classes were analyzed: lightend HC, midrange HC, and carbonyls. The primary analysis focused on the effects of three emission factors on the total exhaust reactivity. The difference in total exhaust reactivity between the FTP and UC cycles was not statistically significant ($p > 0.05$). However, exhaust reactivity was a strong function of fuel type. On average, for Bag 1 the exhaust

reactivity for California Phase 2 fuel was the lowest (16 % below the highest fuel type). The mean SR for high emitting vehicles was significantly higher than for low emitting vehicles for Bags 2 and 3 (11% and 15% higher than low emitters, respectively). In general, exhaust emissions were the highest in Bag 1 because the catalyst had not reached its optimal operating temperature. Thus, catalyst was critical in reducing the exhaust SR in Bags 2 and 3 for low emitting vehicles. The secondary analysis concentrated on the effects of three emission factors on the three compound classes. The mean SR differences between the FTP and UC cycles for Bag 2 lightend HC and carbonyls were statistically significant ($p < 0.05$). There was a significant fuel effect on the mean SR for the midrange HC ($p < 0.05$), but not for lightend HC and carbonyls ($p > 0.05$). Emission status showed a significant effect on the mean SR for all three compound classes. A further detailed analysis evaluated the effects of three emission factors on the weight percent of individual hydrocarbon species emitted. In general, the weight percent of the exhaust species from the lightend HC and midrange HC fuel fractions were significantly affected by the choice of fuel, while driving cycle and emission status had minimal effects. The weight percents for lightend HC species (non-fuel fraction) from low emitting vehicles were significantly lower than for the high emitting vehicles in Bags 2 and 3 (p-value < 0.05). The results of this research highlight the importance of including exhaust reactivity in current mobile source emission inventory model. This study also has significant implications for assessing the effectiveness of reducing exhaust reactivity through the use of reformulated gasolines and vehicle emission control devices such as catalytic converters.