Speciation of C5-C11 Hydrocarbons Generated by the HCCI Gasoline Exhaust Gas Engine

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1. Introduction – In terms of emissions, hydrocarbon speciation is a powerful tool to understand the complex reactions happening inside the cylinder during the combustion process and to observe the effects of varying the fuel composition, fuel additives, and emission control system. Using speciation data enables researchers and scientists to evaluate the relative reactivity of the exhaust and evaporative emissions. Different hydrocarbons in urban air form from differing levels of ozone (smog) which depend on the reactivity of these chemical compounds. To evaluate hydrocarbon impact on ozone formation, HC speciation is required which will also help to determine the presence of toxic emissions from the exhaust tailpipe. Using speciation data has helped researchers to make a number of non-proprietary observations about the relationships between fuel property modifications and automotive emissions [1-2]

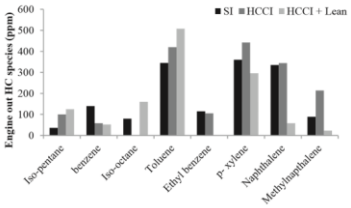


Image 1. Individual HC species

2. Experimental - The hydrocarbon speciation of C_5-C_{11} was carried out using an on- line GC-MS. A Fisons 8000 series GC equipped with direct injector was connected to a Fisons MD 800 mass spectrometer, used as a detector. The gas samples were introduced via a heated line into a six-port Valco valve fitted with a 0.1 ml sample loop.

3. Results and Discussion - In general terms, the engine output emission concentration for all the studied species were higher for HCCI combustion with the exception of benzene, ethyl-benzene and iso-octane imege 1 .The higher unburned hydrocarbon emissions under HCC combustion are due to the lower incylinder temperature and available energy to drive the complete oxidation reactions of the hydrocarbons part of the fuel and to also reduce hydrocarbon oxidation post combustion. On the other hand, the lower concentration of the rest of species under HCCI conditions can be attributed to i) the conversion of iso-octane to methane ii) a higher formation rate of toluene, p-xylene, naphthalene, methyl-naphthalene or any other compounds derived from benzene due to the higher presence of hydrocarbon to react with, and iii) the breakdown of the already formed toluene and p-xylene during SI combustion process producing benzene and ethylbenzene [3].

4. Conclusions - Exhaust hydrocarbons have been speciated, Species such as iso-octane, benzene, and ethyl-benzene are mainly found in the engine exhaust during SI engine operation, while heavier species such as naphthalene and methylnaphthalene are present in higher concentrations under stoichiometric HCCI engine operation

5. References

[1] Hasan, A.O., Leung, P., Tsolakis, A., Golunski, S.E., Xu, H.M., Wyszynski, M.L., Richardson, S., 2011. Effect of composite aftertreatment catalyst on alkane, alkene and monocyclic aromatic emissions from an HCCI/SI gasoline engine. Fuel 90 (4), 1457-1464.

[2] Kaiser, E.W., Maricq, M., Xu, N., Yang, J., 2005. Detailed hydrocarbon species and particulate emissions from a HCCI engine as a function of airefuel ratio. SAE, 2005-01-3749.

[3] Tian, W., Xue, W., Zeng, Z., Shao, J., 2009. Kinetics of 2-methyl-6-acetyl-naphthalene liquid phase catalytic oxidation. Chin. J. Chem. Eng. 17 (1), 72-77.