Gasoline, Surrogate, and Single Component Ignition Times for HCCI Conditions

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Motivation

With heightened awareness of the environmental impact of fossil fuel combustion, government regulations of automotive emission of harmful pollutants such CO, NOx, unburned hydrocarbons and particulate matter are becoming more and more stringent. Simultaneously, there has been increased emphasis on improving fuel efficiency, along with a continued demand for enhanced performance capabilities.

Overview

One strategy currently being studied by many investigators is homogeneous charge compression ignition (HCCI), which offers the potential of simultaneously increasing fuel efficiency in internal combustion engines as well as reducing harmful emissions such as NOx and particulate matter. Unlike the familiar Diesel and Otto cycles, HCCI is characterized by a near spatially uniform ignition that allows chemistry to dominate the ignition process—anticipating an ability to simulate the complete combustion process with detailed chemical mechanisms.

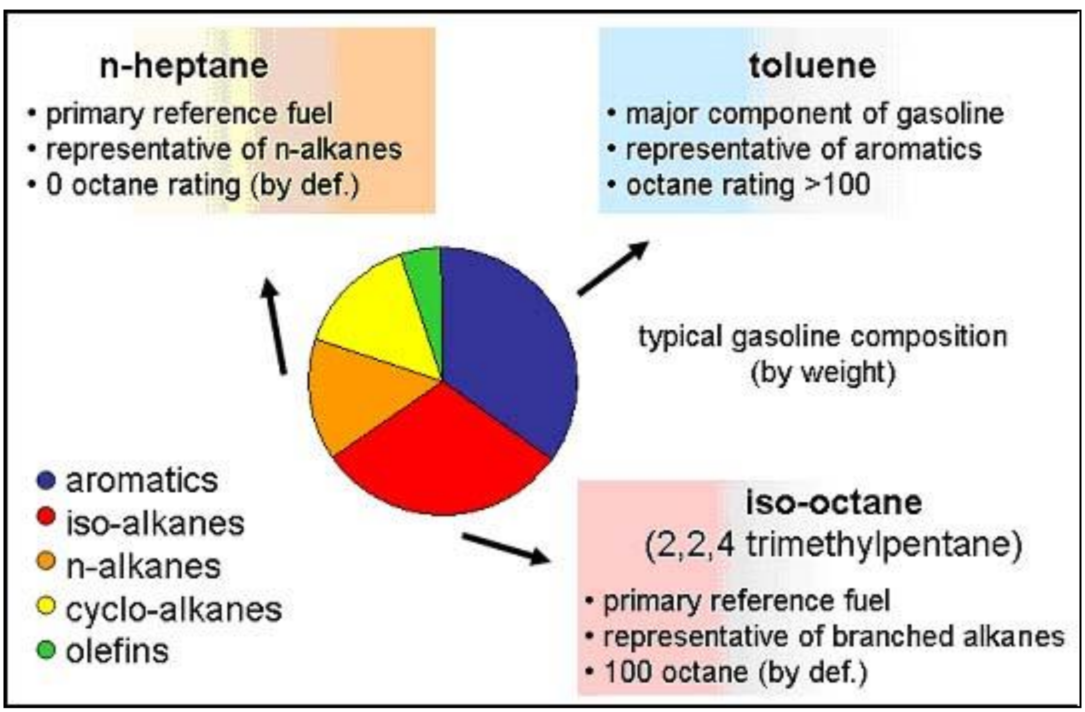

Figure 1: Selection of gasoline surrogate components

Much work has been performed and is currently underway to develop and improve detailed chemical mechanisms suitable for modeling HCCI combustion. To validate and refine these reaction models, detailed kinetic measurements, including ignition times and species concentration time histories, are needed at HCCI-relevant pressures (of order 50 atm) and temperatures (of order 900 K).

With gasoline as a promising HCCI fuel, kinetic data are needed for gasolines, surrogate blends that are to model gasolines, and individual fuel components that make up those blends. Current efforts in our laboratory are aimed at providing useful shock tube ignition data to each of those areas in the form of ignition delay times and detailed time histories of intermediate species and thermodynamic parameters.

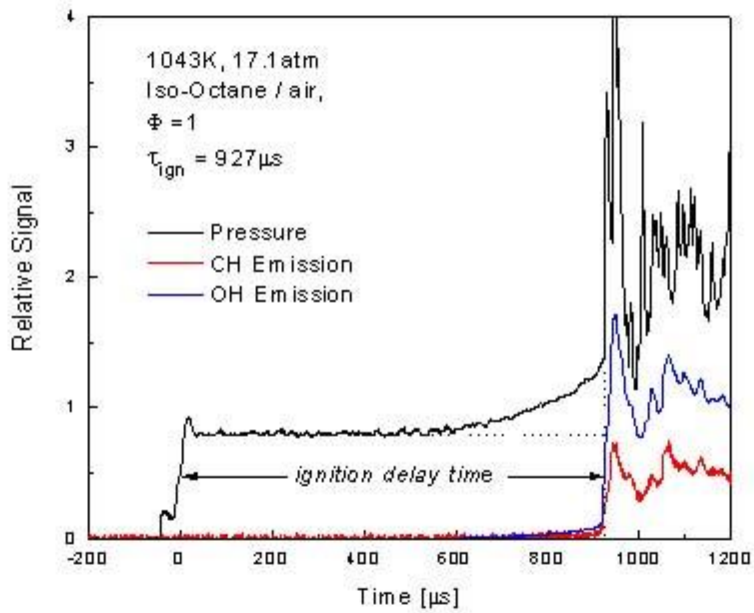

Figure 2: Shock ignition of iso-octane/air, monitoring pressure and emission corresponding to CH* and OH*

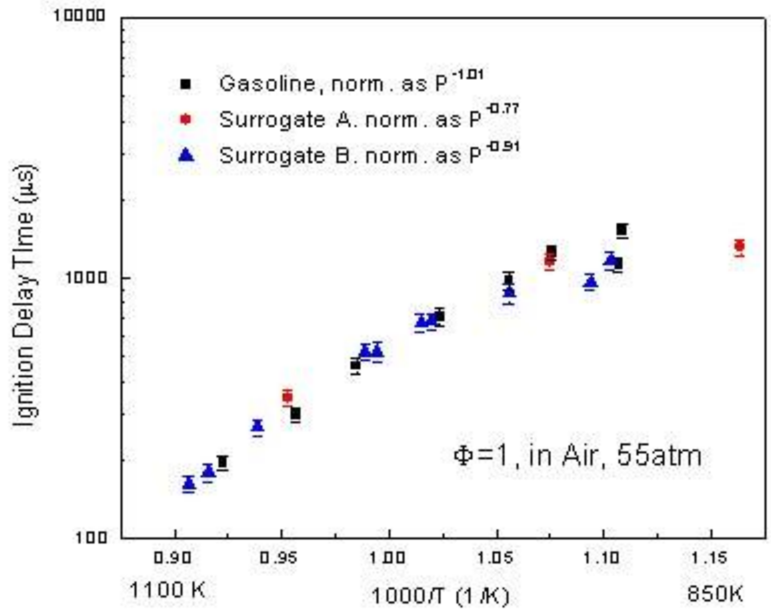

Figure 3: Arrhenius plot of ignition delay times show good agreement between gasoline and surrogate blends

References

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2. B.M. Gauthier, D.F. Davidson, and R.K. Hanson, "Shock Tube Determination of Ignition Delay Times in Full-blend and Surrogate Fuel Mixtures," submitted to Combustion and Flame, Jan. 2004.
3. C.S. Libby, D.F. Davidson, and R.K. Hanson, "A Shock Tube Study of the Oxidation of 1,3-Butadiene," paper AIAA-2004-1322 presented at 42nd Aerospace Sciences Meeting, Reno, NV, Jan. 2004.
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5. B.M. Gauthier, D.F. Davidson, and R.K. Hanson, "A Shock Tube Study of Iso-Octane and Toluene Ignition at High Pressures," paper WSS/CI-03F-26 at Fall 2003 WSS/CI meeting, UCLA, Oct. 2003.