Kinetics of Autoignition

Akira Miyoshi

Dept. Mechanical Science & Engineering
Hiroshima University, 1-4-1 Kagamiyama, Higashi-hiroshima, Japan

The gas-phase autoignition phenomenon of a hydrocarbon-air mixtures is one of the key issue in the technologies of reciprocating internal combustion engines, as it governs the ignition delays in Diesel combustion engines and the knocking in spark-ignition engines. The phenomenon is essentially driven by the branched chain reactions as well as the thermal feedback. In this study, it is shown that, despite the well-known complexity of the oxidation mechanisms of hydrocarbons, the autoignition phenomenon can be simply understood as a behavior of a linear system of ordinary differential equations (ODEs).

Firstly, the well-known chain reactions of H_2-O_2 system will be discussed. outside the second explosion limit, the chemistry in the autoignition induction period can be dominated by three reactions, and simply described by the largest positive eigenvalue of the coefficient matrix of the linear system of ODEs. Then it will be also shown that, even for the complex low-temperature oxidation mechanism, similar simple kinetic behavior can be observed in relatively low-temperature and high-pressure regime under which the autoignition in reciprocated internal combustion engines occurs. Some insight into, and, suggestion for, the technological problems will be also presented.