講演番号	088

Effect of RON and Cycle-to-Cycle Variation on Knocking Phenomena

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KEY WORDS: **Heat engine, Spark ignition engine, Combustion analysis,** Knocking, Research octane number [A1]

According to the authors' previous paper, whenever unburned-zone autoignition occurs at 15 degrees after TDC, ignition delay time at the timing is the period of crank angles of about 10 degrees, regardless of engine speed. As autoignition advances, the period shortens exponentially from several-ten degrees to several degrees. As engine speed increases, the period of time shortens inversely-proportionally for the same period of crank angles. Unburned-zone temperature has to increase with the advance in autoignition, and with the increase in engine speed, to activate unburned-zone reactions. In the present study, a spark-ignition engine is operated for different knock-limit spark-ignition timings with PRF85, PRF90, PRF100, ethanol, toluene, propane, ethane, and methane. Combustion phase advances with the increase in RON and varies in cycle-to-cycle variation. Effects of combustions phase on unburned-zone autoignition timing, unburned energy at the timing, and knock intensity are investigated for a discussion of similarities and differences between knocking phenomena with different combustion phases. Figure 1 shows the relationships between autoignition timing and knock intensity. With a low RON, the advance in cycle-to-cycle increases knock intensity. With a high RON, however, it does not necessarily increase knock intensity. As shown in Figure 2, heat release rate decreases rapidly after unburned-zone autoignition. The maximum decrease rate of heat release rate can be an effective indicator for detecting autoignition occurrence. Figure 3 shows the relationship between the maximum decrease rate of heat release divided by in-cylinder volume at the timing, and knock intensity. The maximum rate of heat release rate divided by the in-cylinder volume, can be a universal indicator for estimating autoignition intensity.

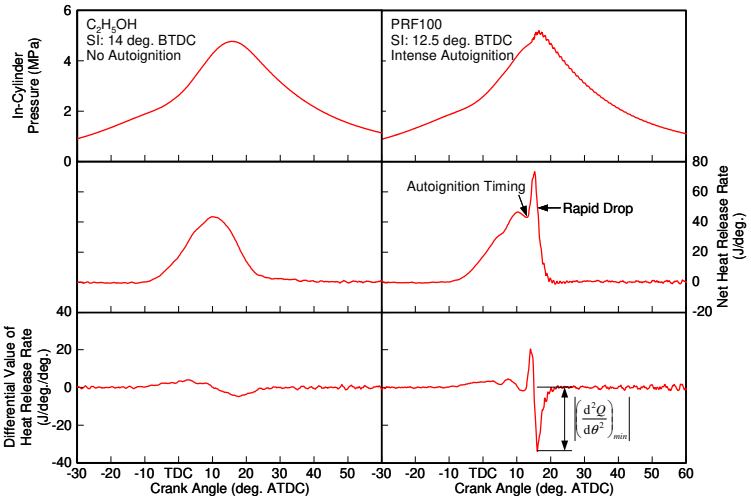

Fig. 2 Histories of Heat Release Rate in Typical Cycles with No and Intense Autoignition

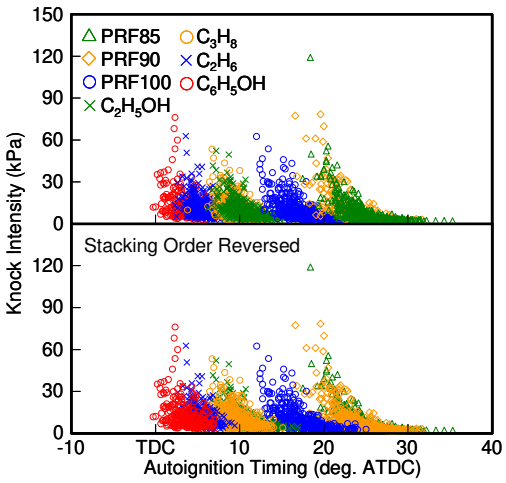

Fig. 1 Relationships between Autoignition Timing and Knock Intensity with Knock-Limit Spark-Ignition Timings

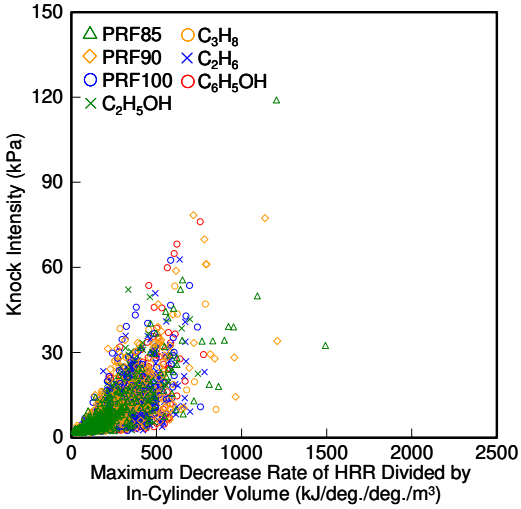

Fig. 3 Relationships between Maximum Decrease Rate of HRR Divided by In-Cylinder Volume, and Knock Intensity