

LOW-TEMPERATURE IGNITION PHENOMENA AND CONTROL FOR THE INTERNAL COMBUSTION ENGINE APPLICATIONS

To be devoted to the Jubilee of Professor Zbigniew Smalko with honor and pleasure

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Autoignition timing of the premixed cylinder charge is still in the God's will, however, it should be controlled to be the optimum artificially in the real engines. Basic studies on physico-chemical characteristics of low-temperature flames: cool and blue flames, using a rapid-compression machine, a motored engine, shock tubes and a flat-flame Powling burner have been of great assistance to understand the in-cylinder ignition phenomena and to develop the ignition-control procedures in engines. In the first half, the properties of low-temperature flames will be shown, and then some examples of application will be presented. The following is an example.

We proposed two kinds of ignition-timing control procedures. The first one: the high/ low-octane two-fuel premixed compression-ignition would make it easy to achieve the best ignition timing. By changing the ratio of fuel amount between high- and low-octane fuels in intake charge, both output torque and ignition timing can be controlled, as well as achieving a high thermal efficiency and clean exhaust. The role of the low-octane fuels is a promoter for the high-octane main fuel ignition. The second one: a small amount of formaldehyde is supplied, not as a fuel but as an additive, into the premixed intake charge of fuel and air. The formaldehyde addition would show a strong promoting effect for the mixture ignition of natural gas. A certain amount of formaldehyde to be added into the intake fuel/air mixture can be chosen for the adequate ignition occurrence near the top dead center depending on the mixture strength. The reasons of low-NO_x / high-HC emission characteristics were also explored and explained.

- The amount of formaldehyde added to the fuel/air mixture becomes a sole controlling factor to the ignition timing. The effect of formaldehyde addition is inhibitory for the mixtures with advanced hot-flame ignition timings as contrasted with a promoting effect to the mixtures with retarded ignition timings.
- The day-by-day ignition-characteristic fluctuation of the fuel gases can be eliminated by using a small amount of formaldehyde.

Formaldehyde is efficacious as an ignition controlling medium for the hydrocarbon/air mixtures in engine cylinders. The effect leading to the ignition would be an inhibitory event for the cool-flame generating constituent and a promoting event of the preflame reaction of the non-cool-flame generating constituent in the fuel gases.

Neither secondary fuel nor additives, i.e. the in-cylinder transformation of the charge to be ready for autoignition would be the near-future subjects for the engines of all kinds, especially for the premixed compression-ignition engines.