Tohoku Univ. Technology

Knocking prediction method

High precision knocking prediction method reproducing DNS

Overview

Although the knocking phenomenon is a hindrance to the improvement of the thermal efficiency of the engine, the detailed mechanism of the occurrence of knocking has been difficult to fully understand due to the complex interaction of hydrodynamics and chemical reactions.

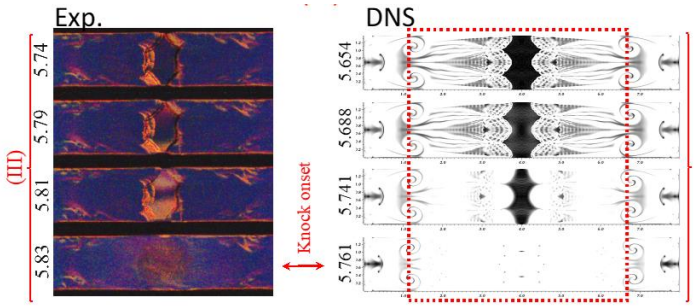
The inventors performed DNS (Direct Numerical Simulation) to calculate the basic equations of a reactive fluid, and confirmed the agreement with experimental data of knocking for the first time in the world [1]. Further, by analyzing the mechanism of the occurrence of knocking in detail, it was found that there was a "critical condition" in which a flame, which is a combustion chemical reaction wave, could not exist as a flame and had to transition to severe overall ignition under extreme conditions. From this, an equivalent theory of ignition and flame was constructed, and the conditions for the occurrence of knocking were successfully derived [2].

The present invention makes it possible to predict the occurrence of knocking accurately and relatively simply, which has been impossible until now.

Product Application

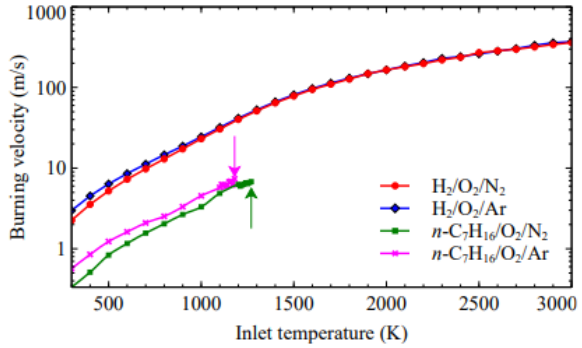
- Engine development
- Knocking sensor

Comparison of experiment and DNS in the occurrence of knocking
* The value on the left is the time (ms).



Features・Outstandings

Relationship between Inlet temperature and Burning velocity



- Fuel with Lewis number lower than 1 (H2) always has flame
- Critical conditions exist for combustion with Lewis number higher than 1 (n-C7 H16).
  ⇒ There is no flame structure at temperatures above sea level.
  ⇒Self-ignition occurs in front of the flame.
  ⇒ Knocking

Related Works

[1] Combustion and Flame Volume 223, January 2021, Pages 330-336
[2] Physics of Fluids 35, 083604 (2023)

IP Data

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