

## Ignition Quality Tester (IQT): An Alternative for Characterizing Combustion Kinetics of Low Volatility Fuels

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The Ignition Quality Tester (IQT) (cf. Figure 1) is a constant volume spray combustion system that can be heated and pressurized to conditions that are similar to a diesel engine at top dead center. The IQT can be viewed as a bridge between engine studies and traditional methods for characterizing combustion kinetics. Because there are no moving parts (e.g. piston) inside the combustion chamber the system is much easier to model than an engine. Also, since the fuel is injected into the chamber as a liquid, studies can be performed on low volatility fuels that are difficult to study with other types of experiments (e.g. shock tubes or rapid compression machines).

By comparing experimental data with model predictions, the IQT can be used to validate kinetic models of ignition. CFD modeling of the IQT using KIVA-3V (using a 42 species mechanism<sup>2</sup>) was used to predict ignition of n-heptane accurately between temperatures of 600-900 K at 15 and 21 bar. While the spray physics effects can affect the ignition results, operating the IQT in a regime where the chemical kinetics dominates allows for the characterization of fuel kinetics. Combustion pressure traces of three isomers of heptane in the IQT are shown in Figure 2. As the heptane isomers become more branched, the boiling point and heat of vaporization decreases causing faster evaporation. This should lead to faster ignition if the evaporation were rate-limiting. Instead, the observed ignition delay increases as the isomers become more branched, indicating that the chemical kinetic effects are dominant.

### References

- (1) Bogin, G.E.; DeFilippo, A.; Chen, J.Y.; Chin, G.; Luecke, J.; Ratcliff, M. A.; Zigler, B. A.; Dean, A. M. *Energy & Fuels*. **2011**, 25 (12), 5562-5572.
- (2) Ra, Y.; Reitz, R. D. *Combust. Flame*, **2008**, 155, 713–738.

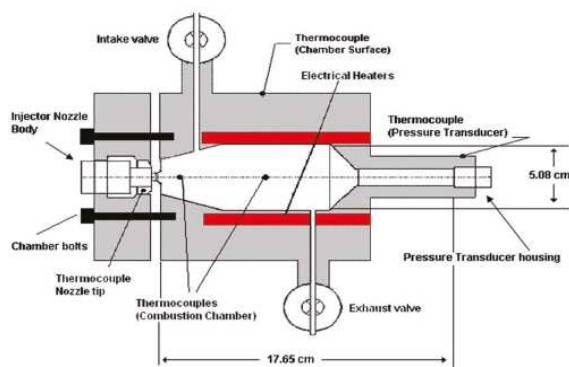


Figure 1. Schematic of IQT combustion chamber<sup>1</sup>

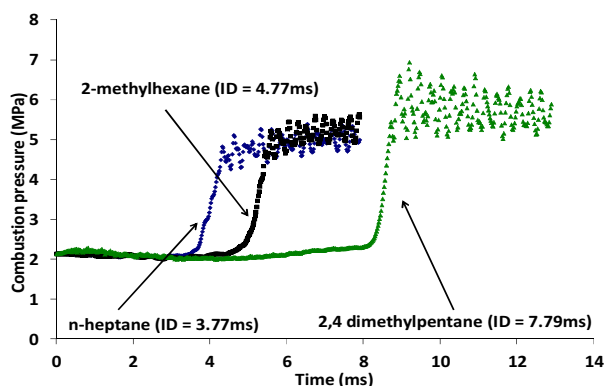


Figure 2. Combustion pressure traces for heptane 2-methylhexane, and 2,4-dimethylpentane:  $P_{\text{air}} = 2.1 \text{ MPa}$ ,  $T_{\text{air}} = 855 \text{ K}$ , averaged over 10 injections<sup>1</sup>