LAMINAR BURNING VELOCITIES OF C5 METHYL ESTERS

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Introduction

Since methyl esters are main constituents of biodiesel there is currently a significant research interest in understanding their combustion properties. Biodiesels are fuels already in use as replacement for fossil fuel diesel, and are expected to become increasingly important. The bulk of the research concerning methyl ester combustion has been conducted during the last half decade [1].

A methyl ester that has been extensively studied and commonly named the simplest biodiesel surrogate is the straight chain saturated compound methyl butanoate (MB), with the formula $C_5H_{10}O_2$. Laminar burning velocities of MB have been determined using counterflow and spherical flame methods [2-4]. In addition to the saturated straight chained esters like MB, biodiesel also has branched and unsaturated constituents. An unsaturated methyl ester that has been studied to some extent is methyl crotonate (MC), $C_5H_8O_2$, a straight chained unsaturated ester. The laminar burning velocity for MC has been determined using the counterflow method [3]. A branched and unsaturated ester that is an isomer to MC is methyl methacrylate (MM), $C_5H_8O_2$.

In the present work laminar burning velocities of MB, MC and MM have been determined using the heat flux method. For MM these are the first determinations of laminar burning velocity and for MB and MC the results of this study significantly extend the temperature range compared to previous studies.
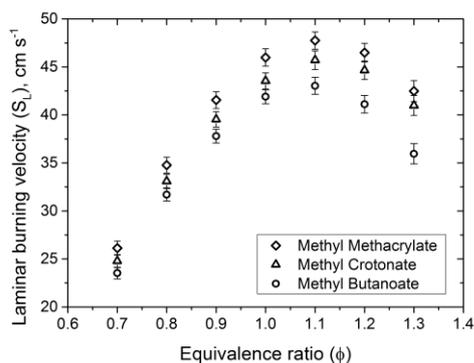
Experimental

Laminar burning velocities were determined using a heat flux setup at Lund University. This particular setup has previously been described in detail [5]. Initial gas mixture temperatures were 298, 318, 338 and 358 K, except that for MC: the lowest temperature was not accessible due to condensation. The range of equivalence ratios investigated were ϕ=0.7-1.3, limited by instability of the flame at lower and cellular flame structure at higher ϕ.

Uncertainties in laminar burning velocities were evaluated based on uncertainties in flow of gases and temperature scatter of the thermocouples in the burner plate.

Results

The figure shows laminar burning velocities of the three C5 esters at initial gas mixture temperature of 338 K. From the laminar burning velocities the temperature dependence of the laminar burning velocities have been determined, using empirical correlation $S_L = S_{L0} (T/T_0)^{\alpha}$. Within the experimental uncertainty the power exponent α is identical for the three esters over the investigated range of ϕ.

Conclusions

The trend in laminar burning velocity for the C5 methyl esters is $S_L(MM) > S_L(MC) > S_L(MB)$, the saturated unbranched burn slowest, unsaturation increase the laminar burning velocity and branching increase it even more.

Acknowledgements

References

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