

Absolute HCO concentration measurements for validation of methane combustion mechanisms under fuel-rich conditions

Alexey Fomin¹, Tatyana Zavlev¹, Igor Rahinov², Vladimir A. Alekseev³, Alexander A. Konnov³,
and Sergey Cheskis¹

¹*School of Chemistry, Tel Aviv University, Tel Aviv, Israel*

²*Department of Natural Sciences, The Open University of Israel, Raanana, Israel*

³*Division of Combustion Physics, Lund University, Lund, Sweden*

alexeyfo@post.tau.ac

Most of the mechanisms of methane oxidation were developed for high temperature, near stoichiometric or fuel-lean combustion. On the other hand, oxidation under very fuel-rich conditions is of interest as a possible way for the conversion of natural gas to syngas (mixture of CO, H₂ and water). The syngas production can be a first step of the so called Gas-to-Liquid (GTL) process, e.g. the Fischer-Tropsch process [1] or similar where syngas is converted to liquid hydrocarbons. However, the oxidation mechanism at these conditions is still not fully described and understood. In this work, we measure absolute concentration profiles of the HCO radical in the low pressure (30 torr) flat methane/oxygen/nitrogen flames with equivalence ratios in the range between 1.0 and 2.0 and compare the results to the detailed kinetic modeling performed with several reaction schemes. HCO is a key intermediate in methane combustion, since its reactions constitute the main pathway for CO production.

The HCO radical concentration profiles were measured in flames stabilized on a 6 cm McKenna burner. The measurements were conducted using Intracavity Laser Absorption Spectroscopy [2] based on the dye laser. The temperature profiles in these flames were measured by Laser Induced Fluorescence of OH radical. The experimental HCO concentrations are compared to those calculated by using experimental temperature profiles and by solving energy balance equation. The flame front position relative to the burner was controlled by varying the nitrogen dilution of the methane/oxygen mixture.

The differences between the experimental results and the predictions obtained by kinetic modeling are discussed with respect to the accuracy of the measurements and possible uncertainties in the kinetic schemes for the considered conditions.

References

[1] A. Steynberg and M. Dry, eds., Fisher-Tropsch Technology (Elsevier, 2004).

[2] V.A.Lofovsky, S.Cheskis, A. Kachanov, F. Stoeckel, J. Chem. Phys, 106 (1997) 8384 - 8391