SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CM1404
STSM title: Determination of laminar flame velocities of alternative fuels using HFM
STSM start and end date: 24/03/2019 to 07/04/2019
Grantee name: Mr. Márton Kovács

PURPOSE OF THE STSM:

There is an ongoing consultation between the group of Professor Konnov at the Lund University and our research group at the ELTE about the implementation of the technical details of the heat flux method in our data format specification (ReSpecTh Kinetic Data Format (http://respecth.hu)). Besides this, the simulations of laminar burning velocities, and also the simulations of the heat flux measurements have several possible difficulties and my participation in a heat flux measurement could help me to understand some of the issues of the simulations. The main purpose of my STSM was to get experimental experience with the heat flux method, learn the technical details and get better understanding of its simulations. A further aim of the STSM was to continue the discussion about the implementation of the technical details of the heat flux method to the ReSpecTh dataformat and to discuss some further aspects of the simulations.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSM:

During my STSM, I could join to an experimental project using the heat flux method in the group of Professor Konnov at the Lund University. The subject of this project was to measure the laminar burning velocities of methane/ammonia/air flames at various compositions. The main motivation behind this experimental project was the increasing scientific and industrial interest of ammonia as an alternative fuel.

When I arrived, the experimental setup had been completed and ready to use. However, I could participate in some of the preparations for the measurements. During this, I got a brief overview about the method and its technical details. The preparations included the calibrations of the mass flow controllers and the rewiring of the thermocouples.

For the validation of the equipment, we first measured the laminar burning velocities of neat methane/air flames in the range of fuel/oxidizer equivalence ratio $\varphi = 0.7 – 1.4$. Then, we investigated the effect of adding ammonia to the fuel. We measured the laminar burning velocities with 20% ammonia in the fuel in the range of $\varphi = 0.7 – 1.4$, and with 40% ammonia in the fuel in the range of $\varphi = 0.7 – 1.3$. We planned to do more measurements with 40% ammonia at $\varphi = 1.4$ and with 60% or more ammonia but for these conditions the satisfactory stabilization of the flame was not possible. We also measured the laminar burning velocities of stoichiometric flames at the ammonia content of 0 – 60% stepping by 10%. In all, 26 laminar burning velocities of flames with various compositions were measured.

We also carried out the simulations of these data with the mechanisms Glarborg-2018, Okafor-2018, POLIMI-2019 and Tian-2009 with the program *FlameMaster 4.0* and the simulation framework of our group *Optima++*. We also did the sensitivity analysis of these experimental conditions with the mechanism Okafor-2018.

We discussed the actual state and tasks of the implementation of the technical details of the method to the ReSpecTh and also some more aspects of the simulations.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The main results of my STSM were the 26 measured laminar burning velocities described above and the simulations of them with 4 mechanisms and carrying out sensitivity analysis. We summarized our results on a poster entitled as “Laminar Burning Velocities of Premixed Methane/Ammonia/Air Flames at Standard Conditions” and we presented it on the SMARTCAT workshop “Ammonia for Fueling Future Energy“ in Lisbon on April 13–14. The poster included the 26 measured laminar burning velocities and the simulation results with the mechanisms Glarborg-2018, Okafor-2018 and POLIMI-2019. The simulation results with the Tian-2009 meachnism and the sensitivity analysis results were not presented on the poster due to the necessity of further investigations. Another result of my STSM was the successful discussion on the implementation of the technical details of the heat flux method to the ReSpecTh specification.

FUTURE COLLABORATIONS (if applicable)

Due to the success of this collaboration we expect to continue the measurements in the near future or start a similar new project.
We will also continue the discussions about the ReSpecTh data specification.