

FGM Modeling of Hydrogen Boundary Layer Flashback in a Turbulent Channel

Stijn N.J. Schepers^{1*}, Jorrit J.A. Rijk¹, Jeroen A. van Oijen¹

*Lead presenter: s.n.j.schepers@tue.nl

¹ Eindhoven University of Technology, Eindhoven, the Netherlands

Due to hydrogen's high reactivity, most premixed combustion systems are sensitive to flame flashback. Endres et al. [1] investigated flashback limits numerically in a turbulent channel, using an implicit LES approach with detailed chemistry, comparing their outcomes to the experimental results of Eichler et al. [2]. In this work, the flashback limits at two Reynolds numbers are determined using the Flamelet Generated Manifold (FGM) approach to model the chemistry, enabling a significant reduction in simulation time. The FGM model is able to capture heat losses and the strong preferential diffusion effects related to lean premixed hydrogen flames. A flame is stabilized on a heated wall and the inlet hydrogen content, i.e., equivalence ratio ϕ_{in} is increased until flashback occurs. The left image of Figure 1 shows the flame front at flashback for 20 m/s inlet velocity and $\phi_{in} = 0.55$. This equivalence ratio is added to the right image of Figure 1 and there appears to be a close match with both the experimental [2] and numerical results [1], but at a significantly lower computational cost. The authors plan to extend the analysis further to the full range of inlet velocities investigated by Eichler et al. [2], while incorporating a model for the sub-grid scale turbulence-chemistry interaction.

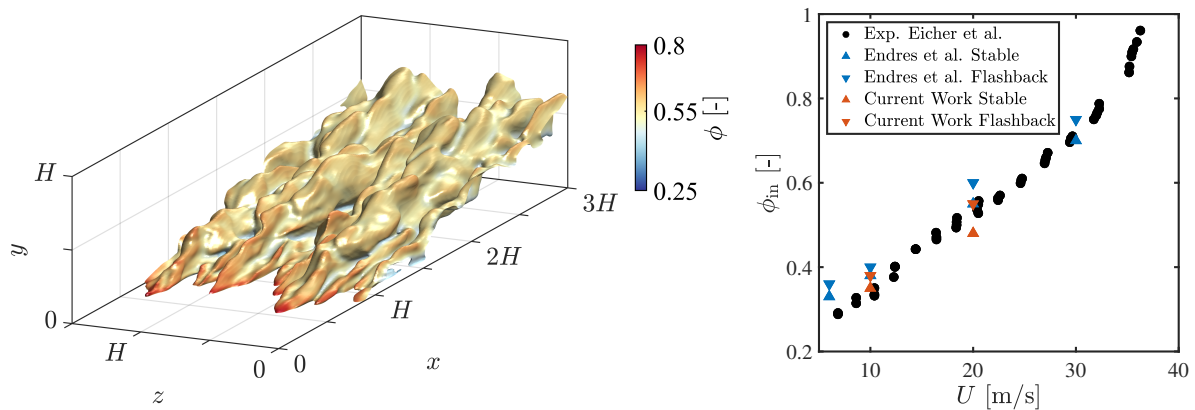


Figure 1: Snap shot of the flame front at flashback ($U = 20$ m/s, $\phi_{in} = 0.55$) colored with equivalence ratio (left), and flashback limits from literature [1, 2] and the current work (right).

References

- [1] Endres, A. and Sattelmayer, T. "Large Eddy Simulation of confined turbulent boundary layer flashback of premixed hydrogen-air flames," *International Journal of Heat and Fluid Flow*. Vol. 72, 2018, pp. 151-160.
- [2] Eichler, C., Baumgartner, G., and Satterlmayer, T., "Experimental investigation of turbulent boundary layer flashback limits for premixed hydrogen-air flames confined in ducts," *Journal of Engineering for Gas Turbines and Power*. Vol. 134, No. 1, 2012.