

# Modeling of H<sub>2</sub>/air flame stabilization regime above coaxial dual swirl injectors - Supplementary material

## 1. Results from TFUP model applied with laminar burning velocity as edge flame speed

In order to further consolidate the choice of the triple flame speed  $s_d$  as an estimation of the edge flame speed  $s_l$ , the same comparisons between the TFUP model predictions and the observed flame transition are realized using the laminar burning velocity  $s_l$ . They are presented and commented in the following.

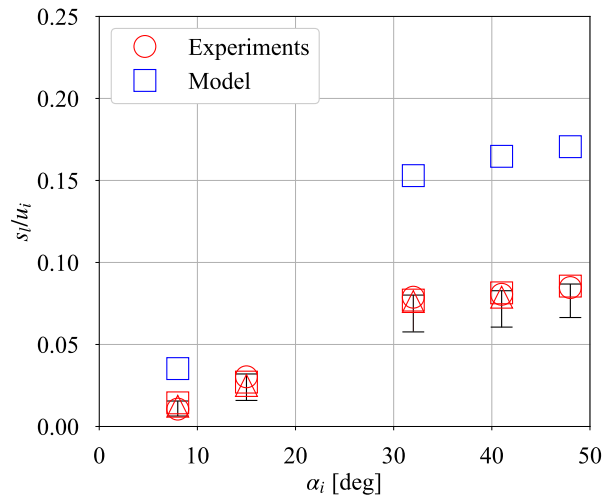


Fig. S1: Comparison of predicted flame re-attachment with experimental observations for cases  $F_2 - S_i - Air + N_2/H_2 + CH_4 + He$  using the laminar burning velocity  $s_l$  as an estimation of the edge flame speed. The burning velocity  $s_l$  is calculated with Cantera. The corresponding central jet angles  $\alpha_i$  and dilution levels  $Y_{H_2}$  and  $Y_{O_2}$  achieved with CH<sub>4</sub>/He for the central tube and N<sub>2</sub> for the annular channel are reported in Table 3 in the manuscript. Flow conditions  $F_2$  (see Table 1 in the manuscript)).

The same comparison as in Fig. 11 in the manuscript between predictions of the TFUP model and experimental observations is now carried out considering the laminar burning velocity  $s_l$  to estimate the speed of the leading edge flame. The results are presented in Fig. S1 for the case  $F_2 - S_i - Air + N_2/H_2 + CH_4 + He$  of Fig. 11 in the manuscript. It is shown that the results are no longer

in good agreement with the experimental observations of the transition from lifted to anchored flame stabilization.

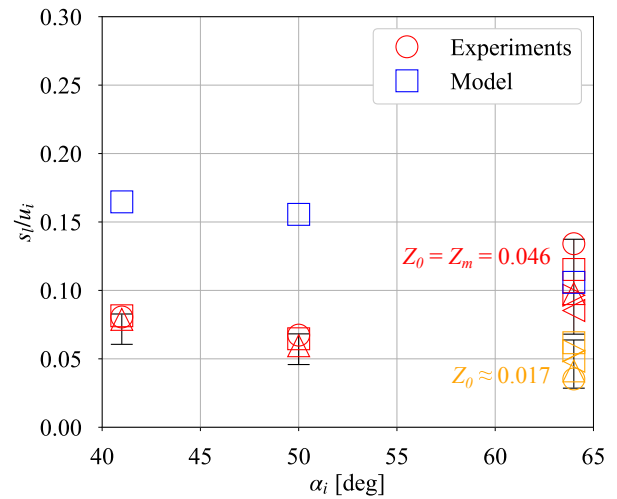


Fig. S2: Comparison of the predicted flame transitions with observations made for diluted cases  $F_1 - 0.6 - Air + N_2/H_2 + CH_4 + He$ ,  $F_2 - 0.6 - Air + N_2/H_2 + CH_4 + He$  and  $F_3 - 0.6 - Air + N_2/H_2 + CH_4 + He$  using the laminar burning velocity  $s_l$  as an estimation of the edge flame speed. Yellow symbols correspond to  $s_l$  values calculated at the highest equivalence ratio measured in the TFUP zone. Red symbols correspond to  $s_l$  values calculated for the maximum laminar burning velocity. The injection velocity changes from  $u_i = 17$  m/s to  $u_i = 45$  m/s in the central channel and is fixed to  $u_e = 28.5$  m/s inside the air channel (see flow conditions  $F_1$  to  $F_3$  in Table 1 in the manuscript). The corresponding central jet angles  $\alpha_i$  and dilution levels  $Y_{H_2}$  and  $Y_{O_2}$  achieved with CH<sub>4</sub>/He for the central tube and N<sub>2</sub> for the annular channel are reported in Table 5 in the manuscript.

The comparison of observed and predicted transitions for different central injection velocities  $u_i$  as in Fig. 13 in the manuscript with the edge flame speed estimated at the triple flame speed  $s_d$  is now presented in Fig. S2 estimating the leading edge flame speed with the laminar burning velocity  $s_l$ . As in Fig. S1, the experimental results are no longer in good agreement with the predictions of the TFUP model, except for the case  $F_1 - 0.6 - Air + N_2/H_2 + CH_4 + He$  ( $\alpha_i = 64^\circ$ ) when

the laminar burning velocity  $s_l$  is estimated at the mixture fraction featuring the higher laminar burning velocity. Looking at the other results when the leading edge flame speed is estimated with the laminar burning velocity  $s_l$ , this case is considered as not relevant and his agreement with the model predictions as a coincidence.

Results from Figs. S1 and S2 consolidate the choice to estimate the speed of the leading edge flame using the expression from Ruetsch *et al.* [1] for the triple flame speed.

- [1] G. R. Ruetsch, L. Vervisch, A. Liñán, Effects of heat release on triple flames, *Phys. Fluids* 7 (1995) 1447–1454.