PhD Open Days

Radiative transfer from turbulent flames of hydrogen and hydrogen blended with other fuels

PhD programme in Mechanical Engineering
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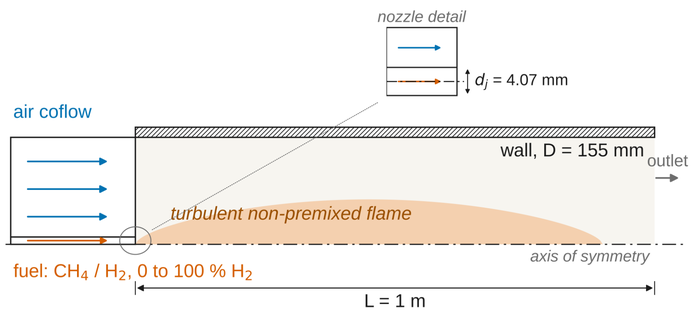
Research question: can a ceramic or glass kiln keep the same radiative heat load on the product when natural gas is replaced by hydrogen?

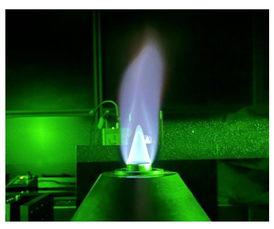
−11 %
net radiative loss, methane to hydrogen, same power

÷ 2
emitting volume of the flame: a size effect, not CO_2

40 to 54 %
of the radiative loss comes from turbulence (TRI)

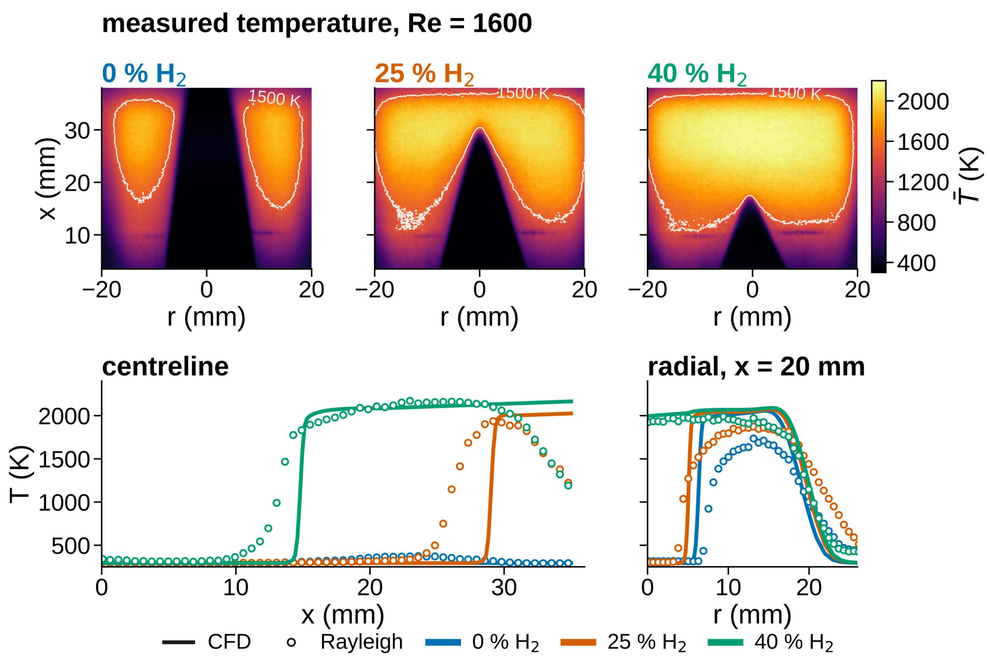
1 APPROACH





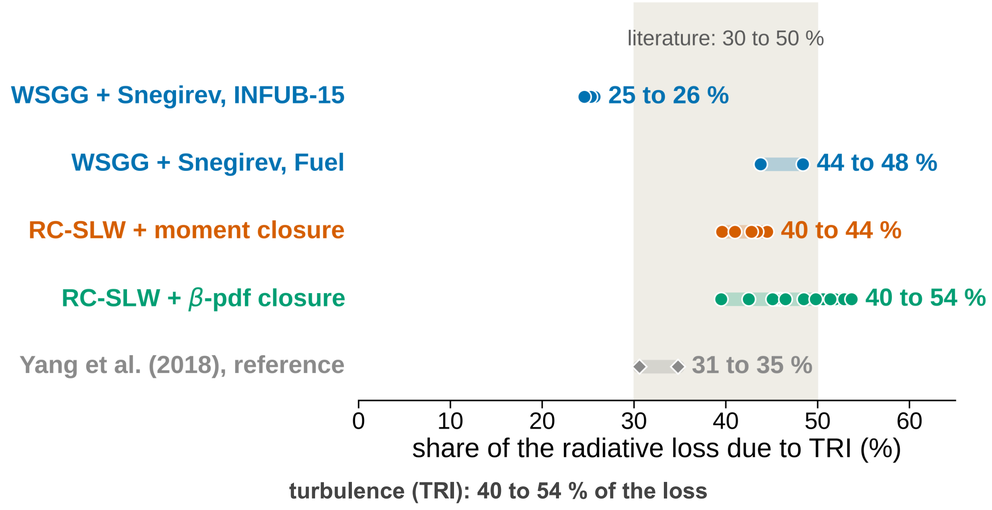
- RANS + flamelet + DOM; WSGG, RC-SLW; TRI closure; Fluent UDFs; checked vs Yang et al. and Rayleigh

2 EXPERIMENT VS CFD



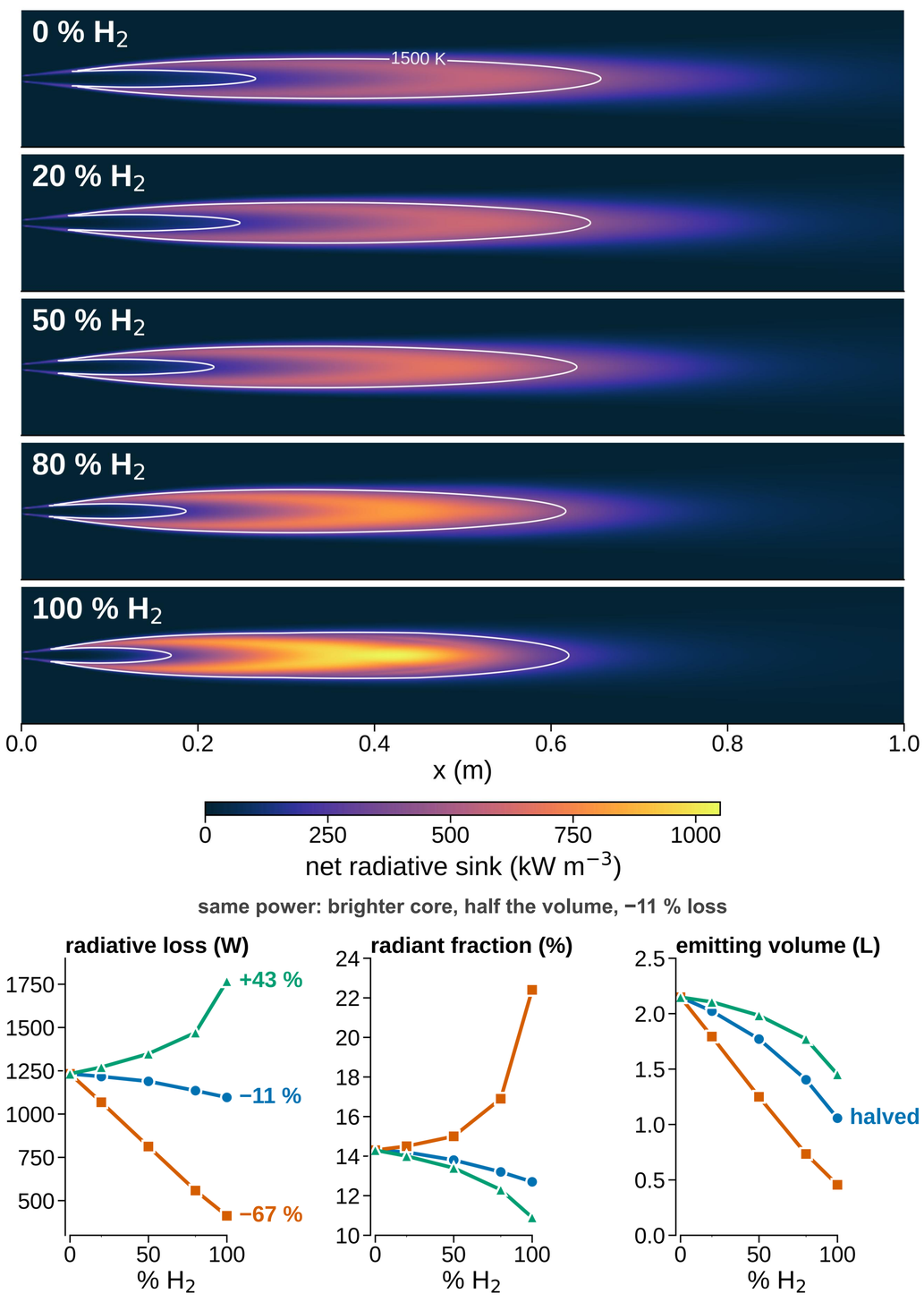
Rayleigh vs CFD: peak temperature within 4 %; the flame flickers, so the measured front is smoother

3 TURBULENCE MATTERS

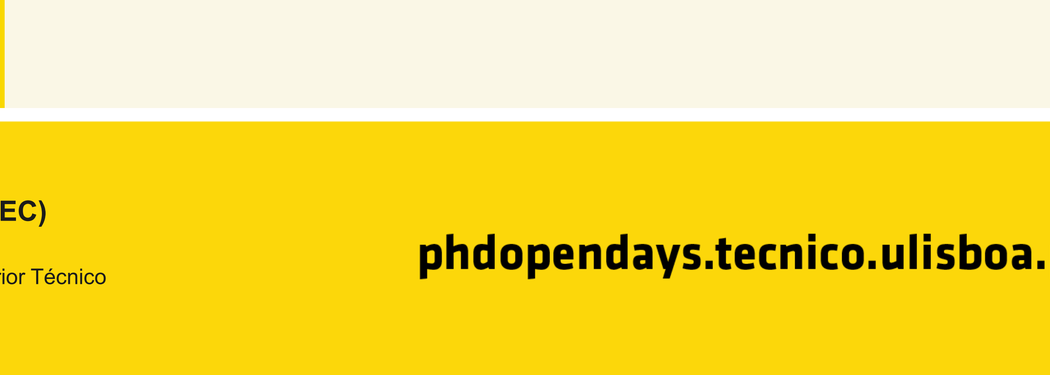


turbulence (TRI): 40 to 54 % of the loss

4 HYDROGEN AND THE RADIATING FLAME



same power: brighter core, half the volume, −11 % loss



three constraints: −11 %, −67 % or +43 %

CONCLUSIONS

- Hotter and brighter flame, yet less radiation: flame size sets the heat load
- Same power: −11 %; same fuel flow: −67 %; same Reynolds: +43 %
- Turbulence (TRI) is 40 to 54 % of the loss: it must be in the model

FOR A HYDROGEN RETROFIT

- keep the flame volume; excess air and firing rate set radiant vs convective
- simulate non-grey, with TRI

Publications INFUB-15 2026; IHTC-18 2026 (with A. Gamboa); ICH_2 2026; Fuel, submitted 2026. **References** Yang et al., IJHE 43 (2018) 15537; Brookes and Moss, CNF 116 (1999) 49; Solovjov et al., JQSRT 197 (2017) 26; Bordbar et al., CNF 161 (2014) 2435; Coelho, PECS 33 (2007) 311. **Acknowledgements** Grant from EcoCerâmica e Cristal de Portugal (ECP), project ECP-00076-IST, financed by the PRR and managed by IAPMEI; FCT support via LAETA (UID/50022/2025). And the FCT funding to IN+, LA/P/0083/2020.

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