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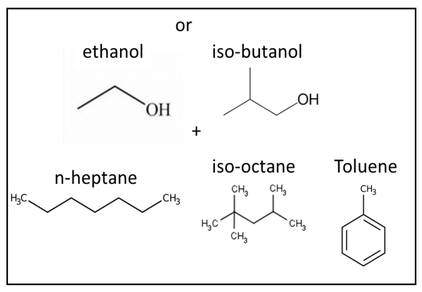
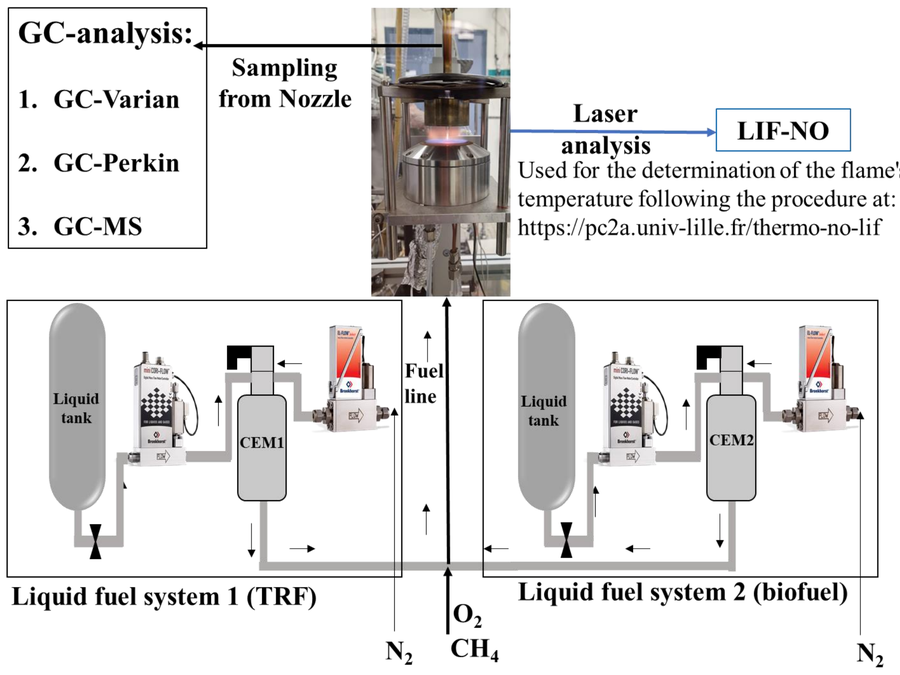
Context

Bio-fuels (alcohols for example): a promising lever to reduce the fossil fuel dependency and the net CO_2 emissions.

Ref: https://edgy.app/consumers-pay-extra-biofuels



Experimental Method



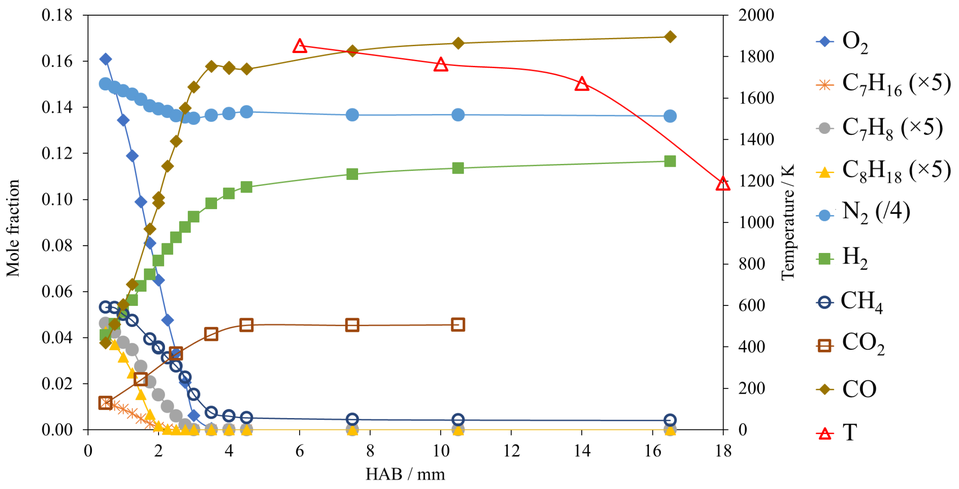
Flame conditions. TRF: ternary toluene reference fuel. TRF-E: TRF with ethanol. TRF-B: TRF with iso-butanol:

Name	Flow rate (Ln/min)						Φ
	O_2	N_2	CH_4	TRF	Biofuel	Total	
TRF	2.313	6.6	0.678	0.264	0.000	9.9	1.82
TRF-E	2.243	6.6	0.728	0.227	0.057	9.9	1.82
TRF-B	2.269	6.6	0.710	0.218	0.058	9.9	1.82

- 10% in volume of ethanol and iso-butanol is added to TRF flame
- The estimated uncertainties of the GC experiment are <15% for main species, <25% for abundant intermediates. All flames were measured in the same campaign. Therefore, a relative comparison of trends between the flames can be performed with significantly higher precision.
- The estimated error for temperature measurements: ~5%

Results

TRF flame structure: mole fraction profiles of reactants (n-heptane C_7H_{16}, toluene C_7H_8, iso-octane C_8H_{18}, CH_4, O_2), diluent (N_2), major products (H_2, CO, CO_2), and temperature points in the burned gas zone.

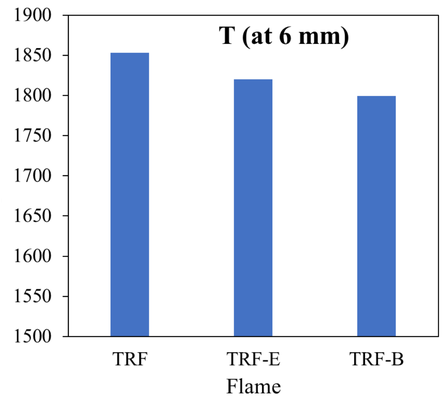


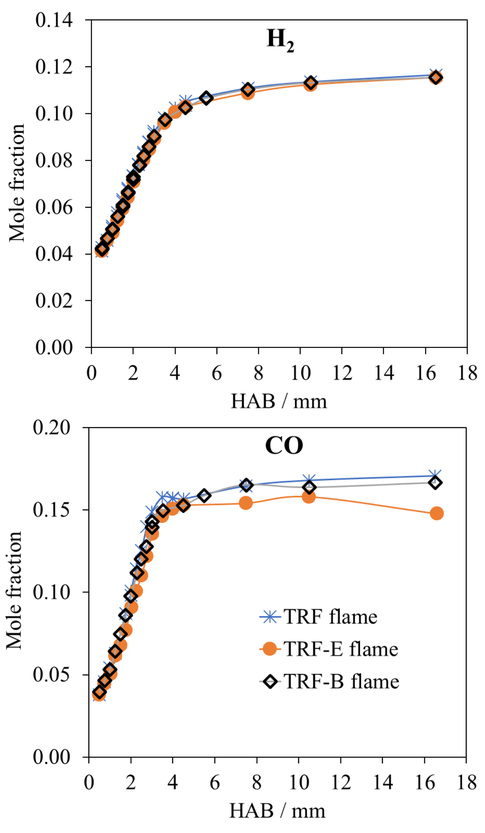
HAB: Height Above the Burner

Summary of the detected species

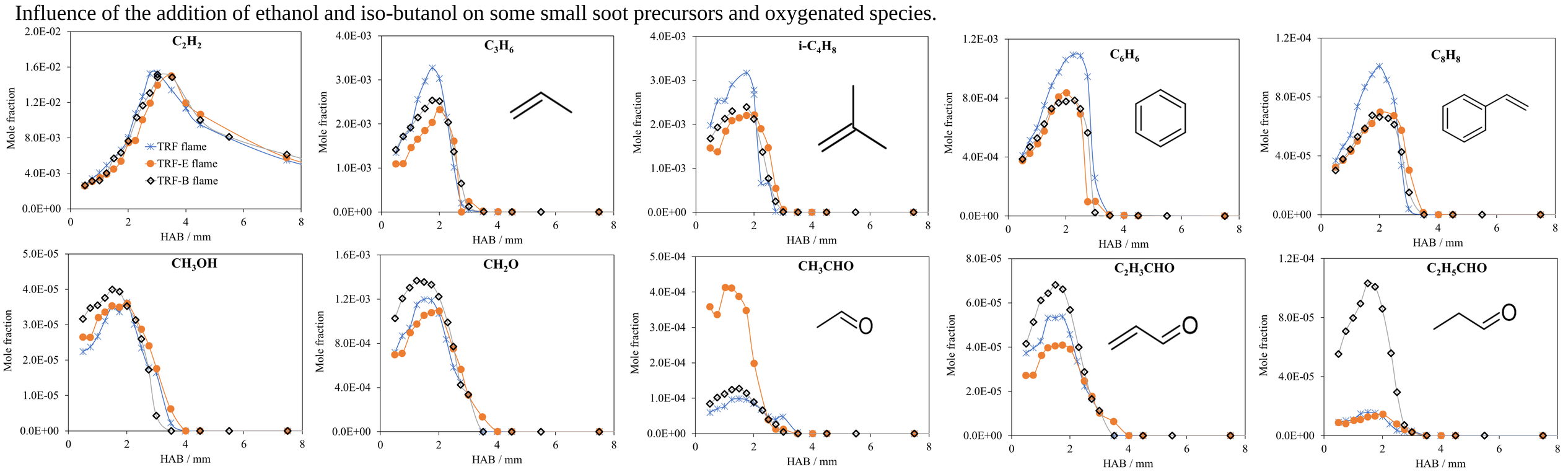
C_0 species	O_2, H_2, N_2
C_1 species	CO, CO_2, CH_4
C_2 species	C_2H_6 (Ethane), C_2H_4 (Ethylene), C_2H_2 (Acetylene)
C_3 species	C_3H_8 (Propane), C_3H_6 (Propene), aC_3H_4 (Allene), pC_3H_4 (Propyne)
C_4 species	iC_4H_8 (iso-Butene), $1C_4H_8$ (1-Butene), $1,3C_4H_6$ (1,3-Butadiene), BC_4H_6 (1-Butyne), i-C_4H_{10} (iso-Butane), C_4H_4 (Vinylacetylene)
C_5 species	n-C_5H_{12} (n-Pentane), C_5H_{10} (1-Pentene, cis, trans-2-Pentene), …
C_6 species	C_6H_6 (Benzene), …
C_7 species	C_7H_8 (Toluene), C_7H_{16} (n-Heptane)
C_8 species	C_8H_{18} (iso-Octane), C_8H_8 (Styrene), C_8H_{10} (Ethylbenzene), …
Oxygenated species	C_2H_5OH (Ethanol), C_4H_9OH (Iso-butanol), CH_2O (Formaldehyde), CH_3OH (Methanol), CH_3CHO (Acetaldehyde), C_2H_3CHO (Acrolein), C_2H_5CHO (Propanal), CH_3COCH_3 (Acetone), …

Influence of the addition of ethanol and iso-butanol on final products (CO and H_2) and flame temperature:





Influence of the addition of ethanol and iso-butanol on some small soot precursors and oxygenated species.



Conclusion and Perspectives

The addition of biofuels leads to significant changes in TRF flame structure:

- Ethanol and iso-butanol decrease the mole fractions of C_3H_6, i-C_4H_8, C_6H_6, and C_8H_8, but do not affect C_2H_2
- The two alcohols do not have the same effect on oxygenated intermediate species
- Ethanol limits the production of CH_2O and C_2H_3CHO, but considerably increases the amount of CH_3CHO
- Iso-butanol promotes the formation of all oxygenated species and especially C_2H_5CHO
- Flames temperatures are not significantly affected by the addition of biofuels

❑ Further investigation is needed to explore the influence of biofuel addition on heavier species such as PAHs and soot.

Acknowledgments

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