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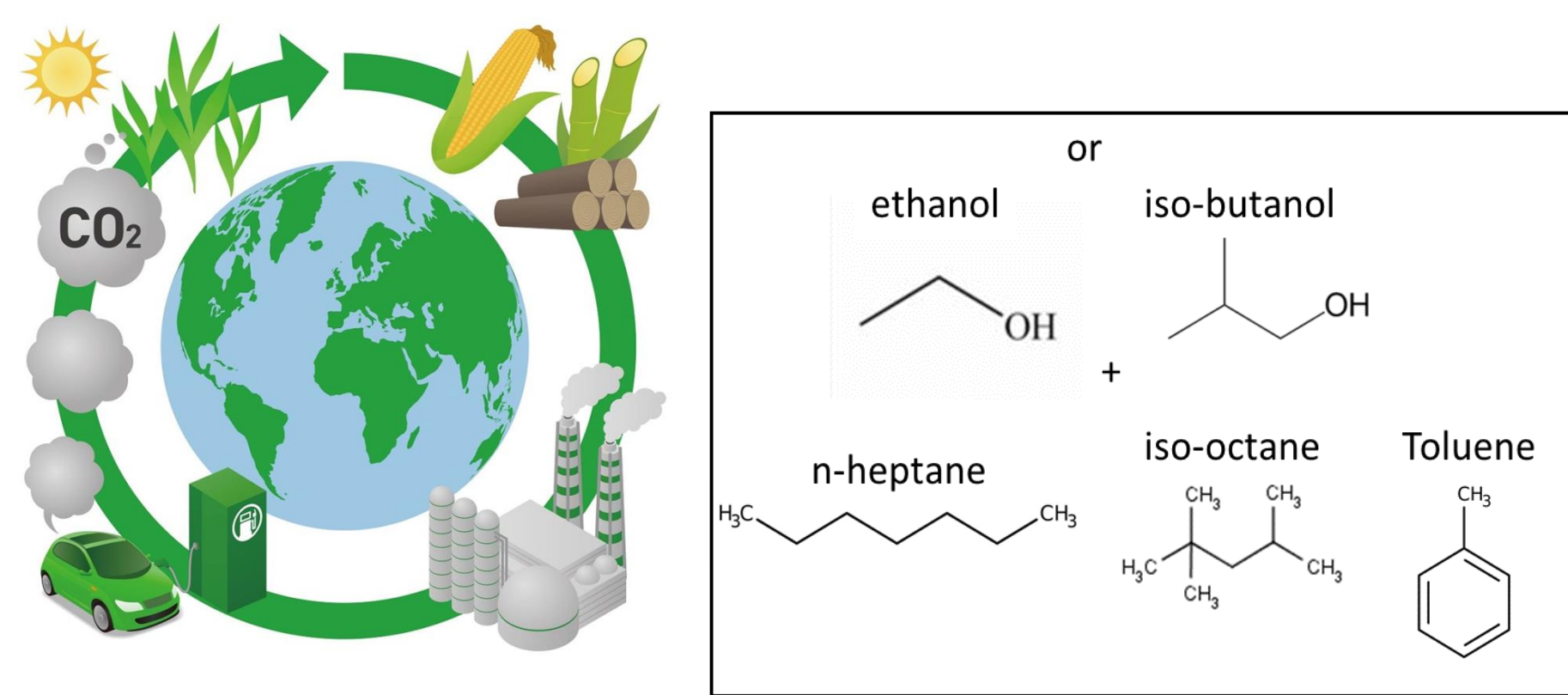
Experimental Study of the Impact of Oxygenated Fuels on Pollutant Emissions on Flame Conditions

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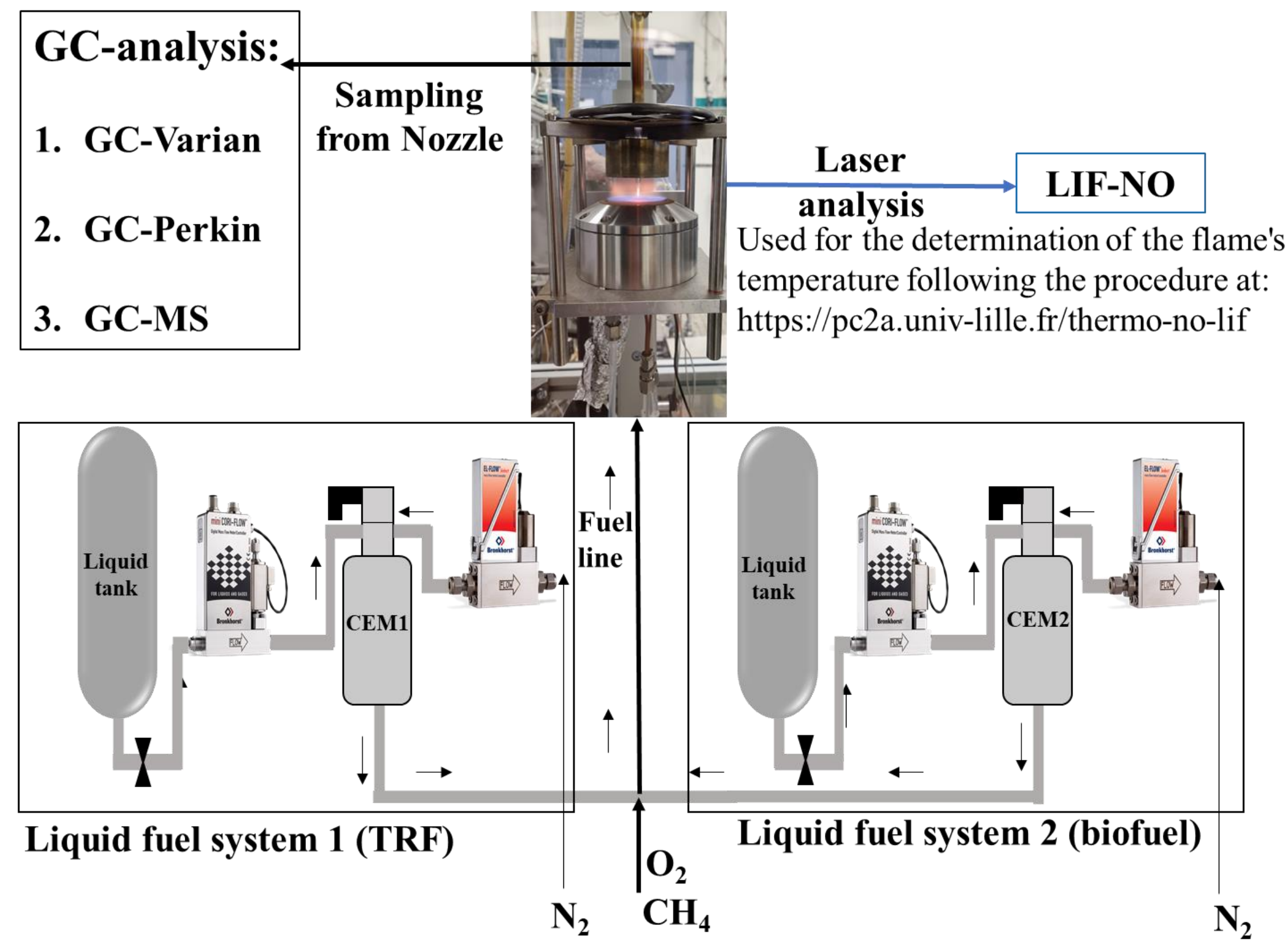
Context

Bio-fuels (alcohols for example): a promising lever to reduce the fossil fuel dependency and the net CO₂ emissions.



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

Experimental Method



Flame conditions. TRF: ternary toluene reference fuel.

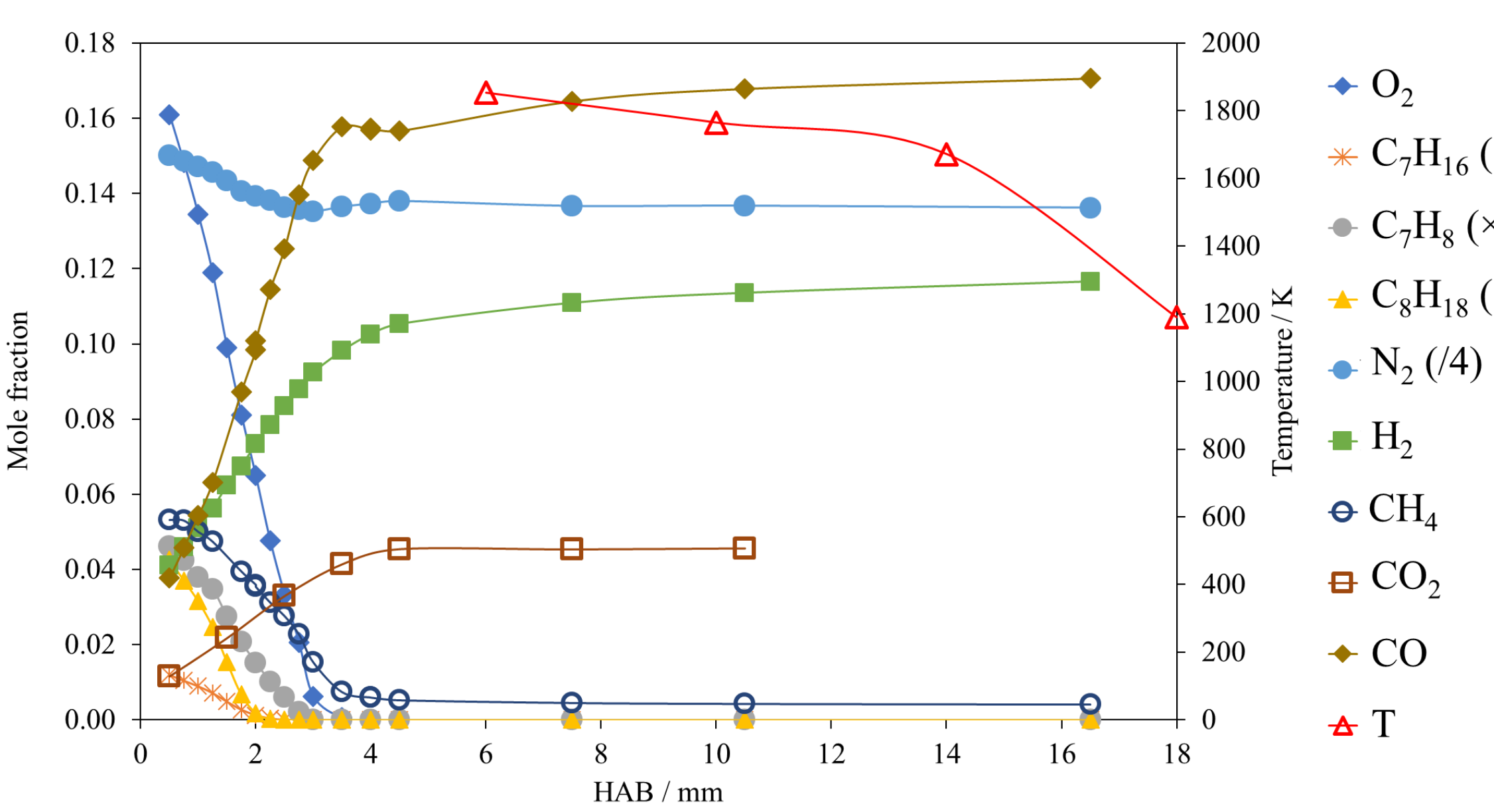
TRF-E: TRF with ethanol. TRF-B: TRF with iso-butanol:

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 C₇H₁₆, toluene C₇H₈, iso-octane C₈H₁₈, CH₄, O₂), diluent (N₂), major products (H₂, CO, CO₂), and temperature points in the burned gas zone.

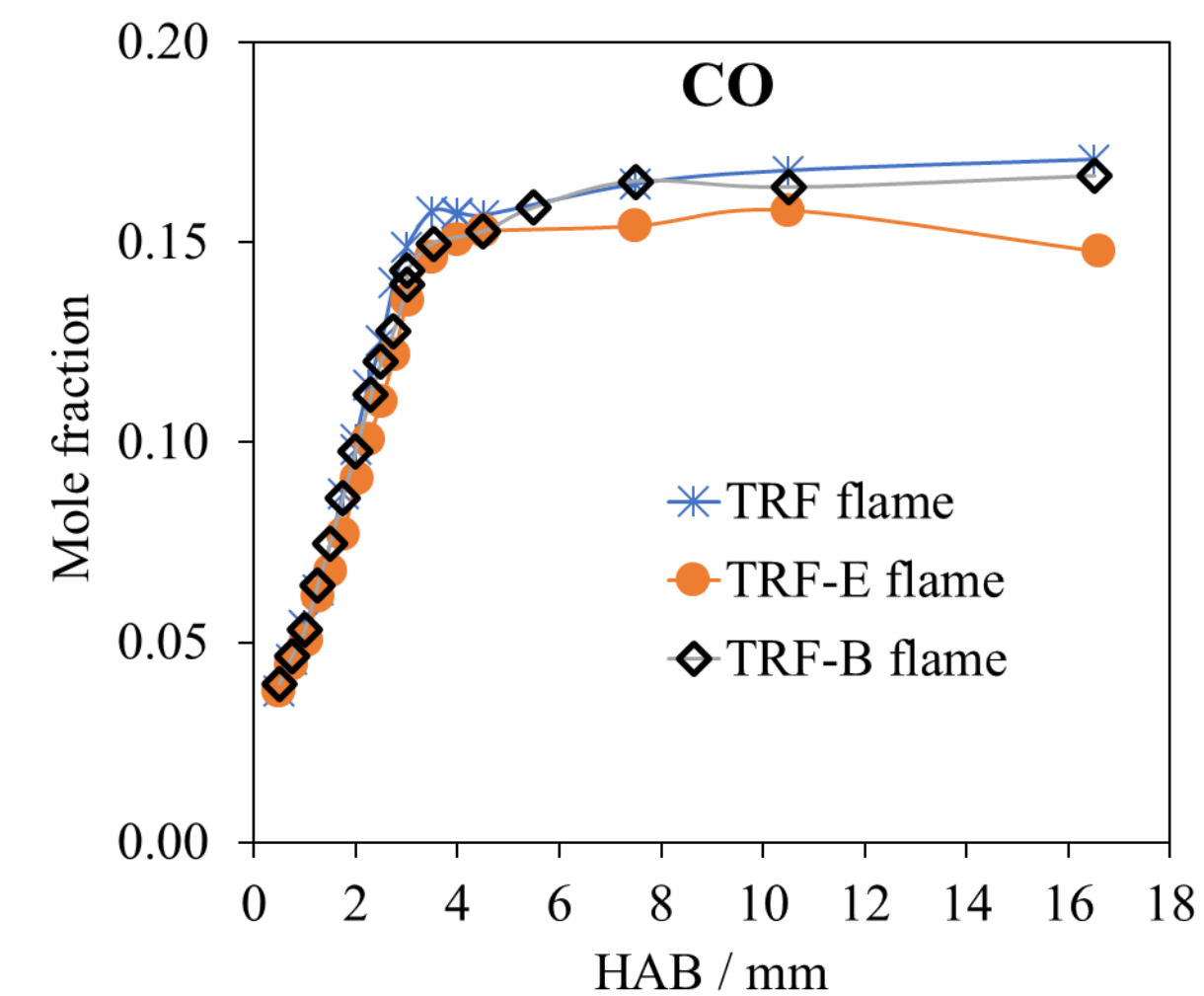
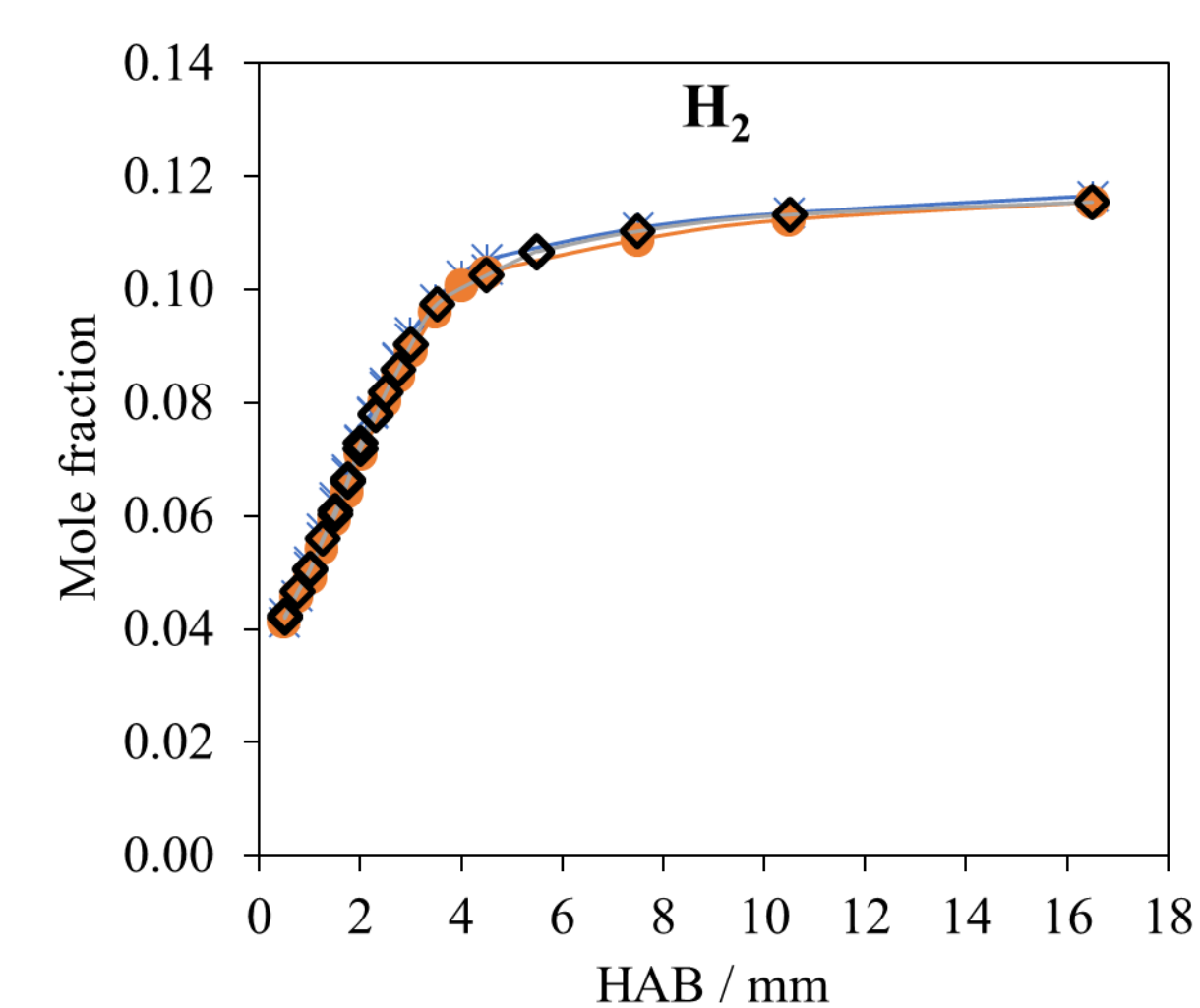
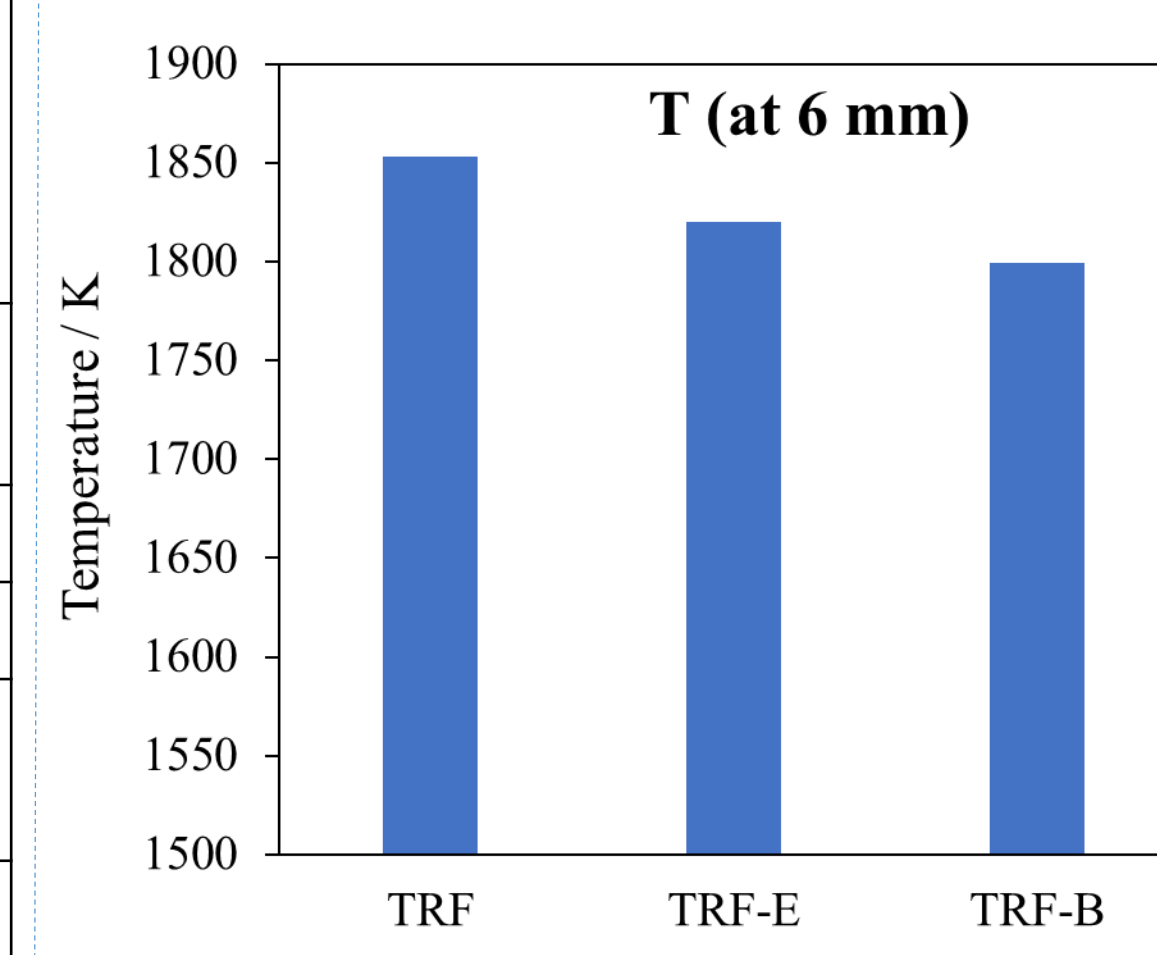


HAB: Height Above the Burner

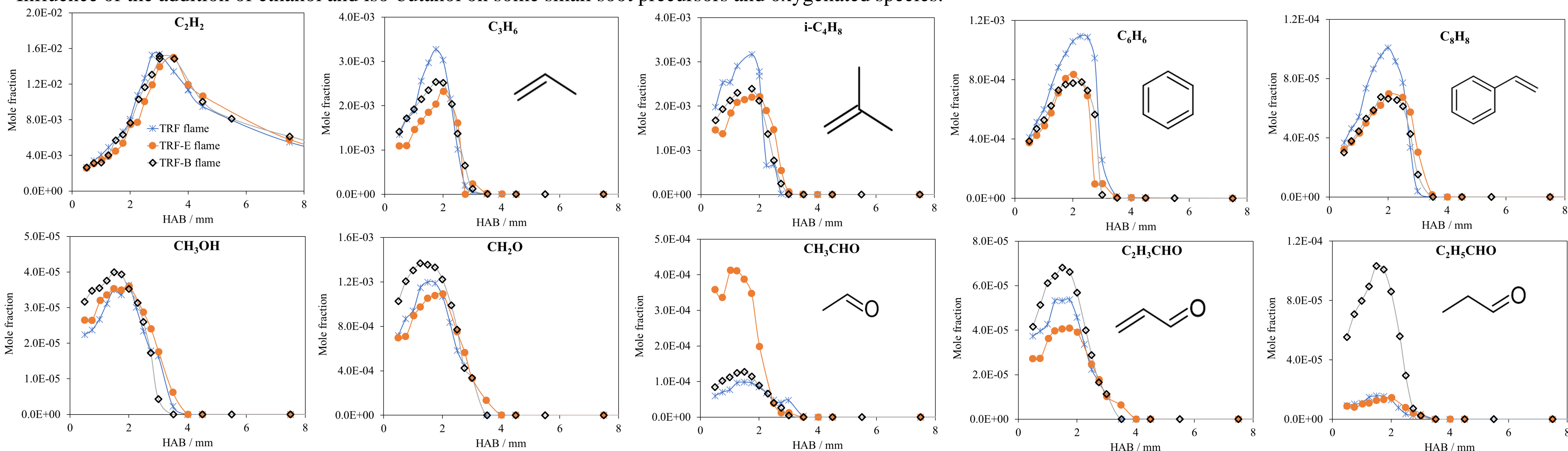
Summary of the detected species

C ₀ species	O ₂ , H ₂ , N ₂
C ₁ species	CO, CO ₂ , CH ₄
C ₂ species	C ₂ H ₆ (Ethane), C ₂ H ₄ (Ethylene), C ₂ H ₂ (Acetylene)
C ₃ species	C ₃ H ₈ (Propane), C ₃ H ₆ (Propene), aC ₃ H ₄ (Allene), pC ₃ H ₄ (Propyne)
C ₄ species	iC ₄ H ₈ (iso-Butene), 1C ₄ H ₈ (1-Butene), 1,3C ₄ H ₆ (1,3-Butadiene), BC ₄ H ₆ (1-Butyne), i-C ₄ H ₁₀ (iso-Butane), C ₄ H ₄ (Vinylacetylene)
C ₅ species	n-C ₅ H ₁₂ (n-Pentane), C ₅ H ₁₀ (1-Pentene, cis, trans-2-Pentene), ...
C ₆ species	C ₆ H ₆ (Benzene), ...
C ₇ species	C ₇ H ₈ (Toluene), C ₇ H ₁₆ (n-Heptane)
C ₈ species	C ₈ H ₁₈ (iso-Octane), C ₈ H ₈ (Styrene), C ₈ H ₁₀ (Ethylbenzene), ...
Oxygenated species	C ₂ H ₅ OH (Ethanol), C ₄ H ₉ OH (Iso-butanol), CH ₂ O (Formaldehyde), CH ₃ OH (Methanol), CH ₃ CHO (Acetaldehyde), C ₂ H ₃ CHO (Acrolein), C ₂ H ₅ CHO (Propanal), CH ₃ COCH ₃ (Acetone), ...

Influence of the addition of ethanol and iso-butanol on final products (CO and H₂) 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 C₃H₆, i-C₄H₈, C₆H₆, and C₈H₈, but do not affect C₂H₂
- The two alcohols do not have the same effect on oxygenated intermediate species
- Ethanol limits the production of CH₂O and C₂H₃CHO, but considerably increases the amount of CH₃CHO
- Iso-butanol promotes the formation of all oxygenated species and especially C₂H₅CHO
- 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.

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