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Liquid fuel system 1 (TRF)









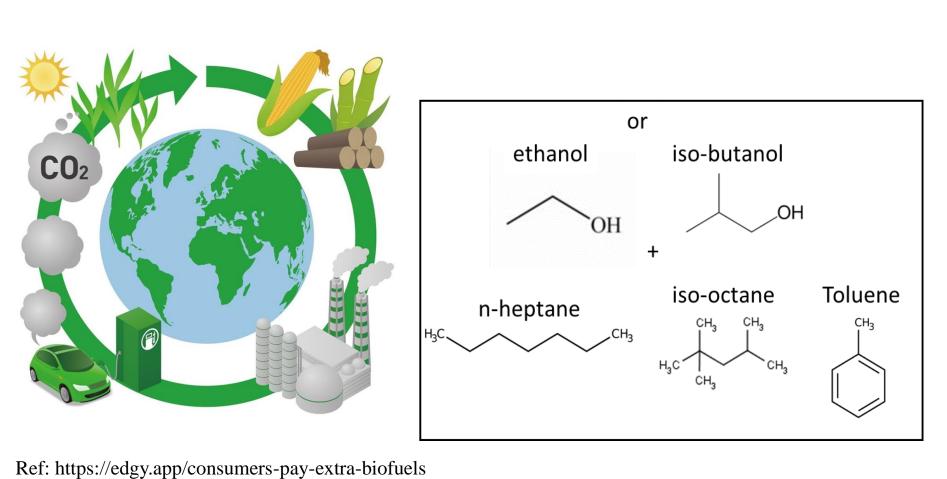
# **Experimental Study of the Impact of Oxygenated Fuels on Pollutant Emissions on Flame Conditions**

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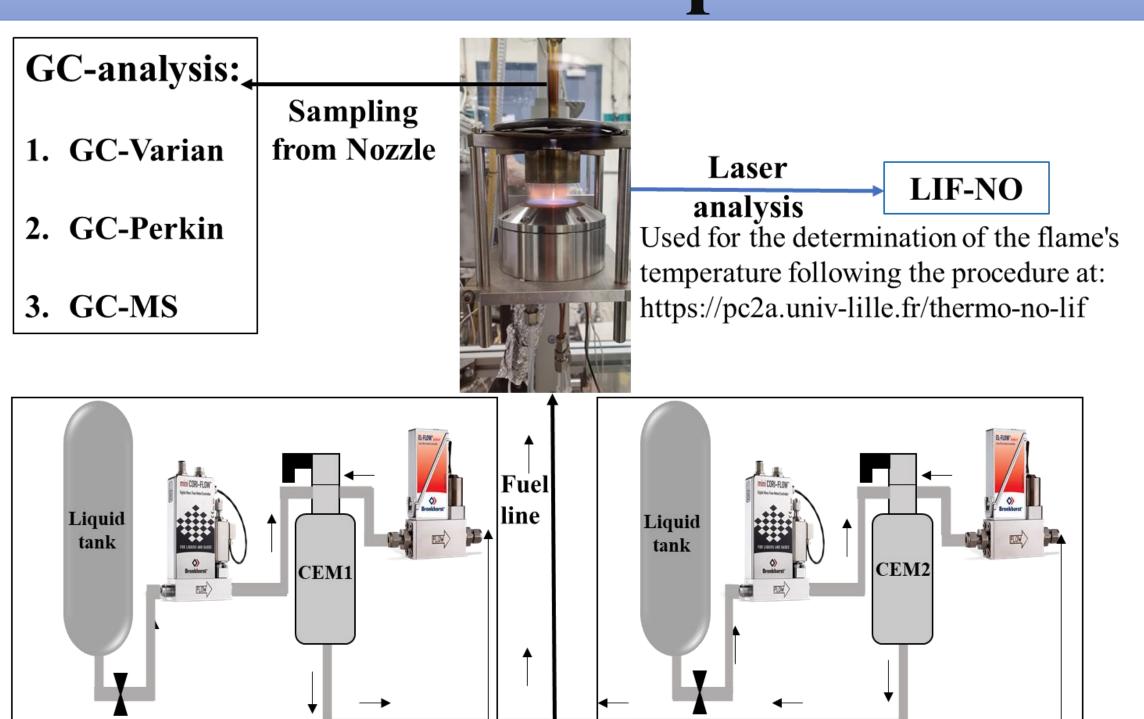
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## Context

Bio-fuels (alcohols for example): a promising lever to reduce the fossil fuel dependency and the net CO<sub>2</sub> emissions.



## Experimental Method



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

	Flow rate (Ln/min)						
Name	$O_2$	$N_2$	$CH_4$	TRF	Biofuel	Total	Φ
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%

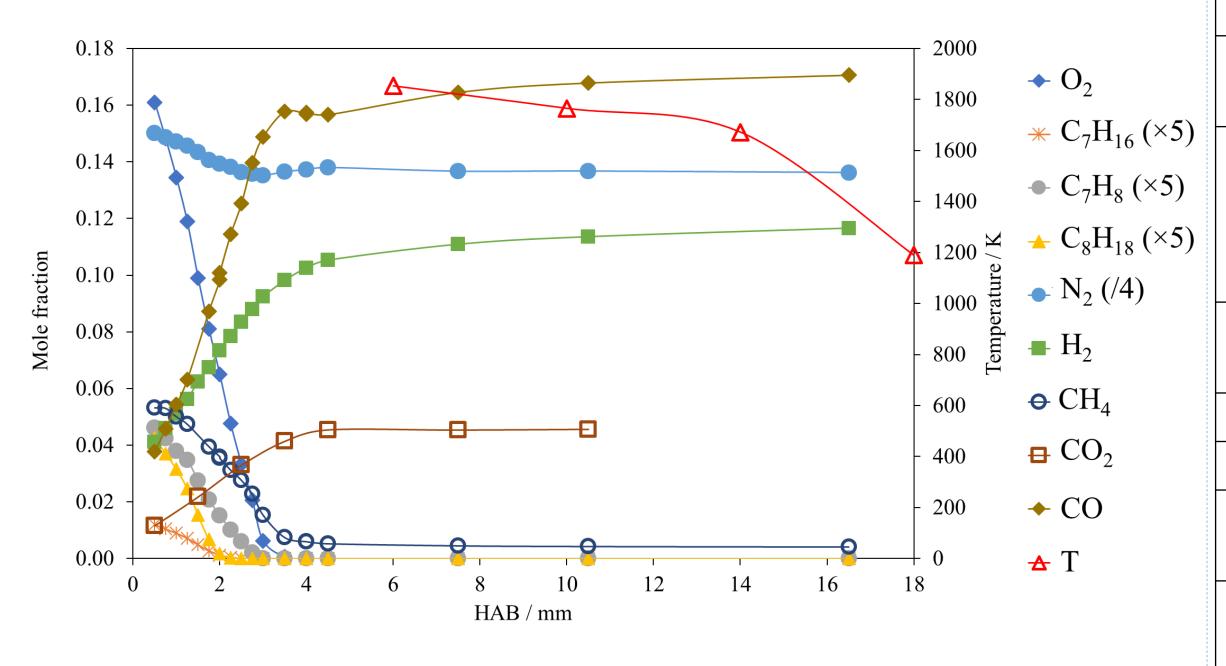
## Results

 $CH_4$ 

 $N_2$ 

Liquid fuel system 2 (biofuel)

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

 $C_0$  species  $C_2$ ,  $C_2$ ,  $C_3$   $C_4$   $C_2$  species  $C_2$   $C_3$   $C_4$   $C_2$   $C_4$   $C_5$   $C_6$   $C_6$   $C_6$   $C_7$   $C_8$   $C_9$   $C_9$ 

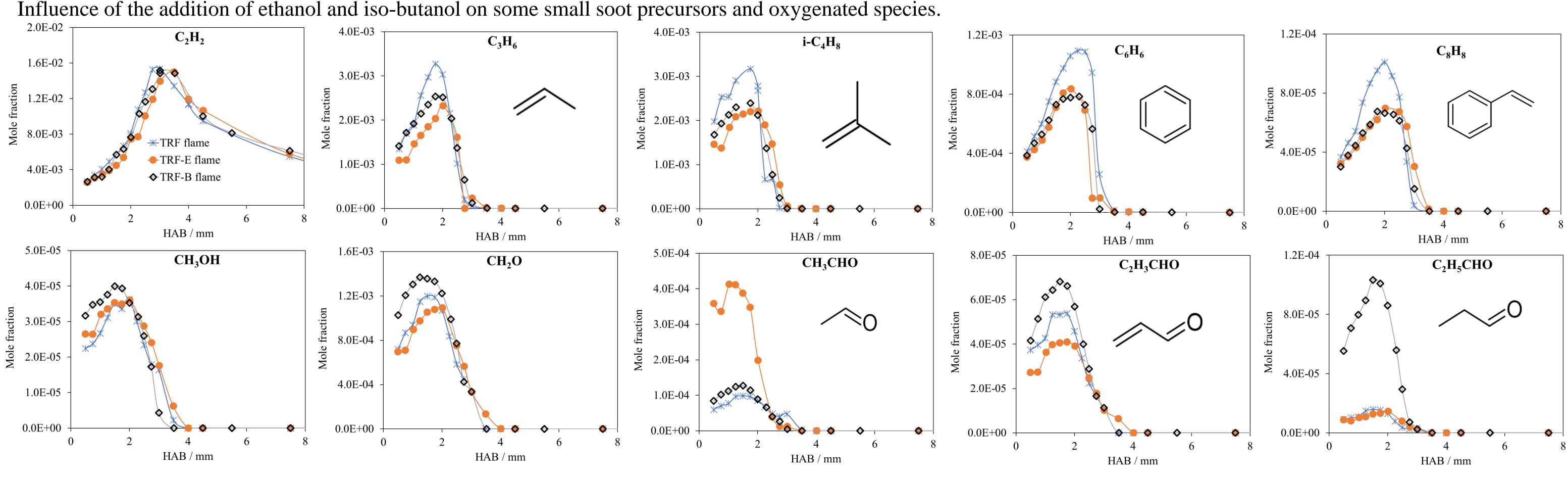
Summary of the detected species

C<sub>2</sub>H<sub>6</sub> (Ethane), C<sub>2</sub>H<sub>4</sub> (Ethylene), C<sub>2</sub>H<sub>2</sub> (Acetylene) C<sub>3</sub>H<sub>8</sub> (Propane), C<sub>3</sub>H<sub>6</sub> (Propene), aC<sub>3</sub>H<sub>4</sub> C<sub>3</sub> species (Allene), pC<sub>3</sub>H<sub>4</sub> (Propyne) iC<sub>4</sub>H<sub>8</sub> (iso-Butene), 1C<sub>4</sub>H<sub>8</sub> (1-Butene),  $1.3C_4H_6$  (1.3-Butadiene),  $BC_4H_6$  (1-C<sub>4</sub> species Butyne),  $i-C_4H_{10}$  (iso-Butane),  $C_4H_4$ (Vinylacetylene)  $n-C_5H_{12}$  (n-Pentane),  $C_5H_{10}$  (1-Pentene, C<sub>5</sub> species cis, trans-2-Pentene), ... C<sub>6</sub> species  $C_6H_6$  (Benzene), ... C<sub>7</sub>H<sub>8</sub> (Toluene), C<sub>7</sub>H<sub>16</sub> (n-Heptane) C<sub>7</sub> species  $C_8H_{18}$  (iso-Octane),  $C_8H_8$  (Styrene),  $C_8H_{10}$ C<sub>8</sub> species (Ethylbenzene), ... (Ethanol),  $C_4H_9OH$  $C_2H_5OH$ butanol), CH<sub>2</sub>O (Formaldehyde), CH<sub>3</sub>OH Oxygenated (Methanol), CH<sub>3</sub>CHO (Acetaldehyde), species  $C_2H_3CHO$ (Acrolein),  $C_2H_5CHO$ (Propanal), CH<sub>3</sub>COCH<sub>3</sub> (Acetone), ...

Influence of the addition of 0.14  $H_2$ ethanol and iso-butanol on final 0.12 products (CO and  $H_2$ ) and 0.10 flame temperature: fraction 80.0 0.02 T (at 6 mm) 1850 8 10 12 HAB / mm 1750 CO 1700 0.15 1650 fraction 0.10 1600 1550 \*TRF flame Mol ◆TRF-E flame TRF TRF-E TRF-B 0.05 ◆TRF-B flame Flame

0.00

HAB / mm



# Conclusion and Perspectives

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

- $\triangleright$  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
- $\triangleright$  Ethanol limits the production of CH<sub>2</sub>O and C<sub>2</sub>H<sub>3</sub>CHO, but considerably increases the amount of CH<sub>3</sub>CHO
- $\triangleright$  Iso-butanol promotes the formation of all oxygenated species and especially C<sub>2</sub>H<sub>5</sub>CHO
- 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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