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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 CO_2 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

- \geq 10% in volume of ethanol and iso-butanol is added to TRF flame
- \succ 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.

 \succ The estimated error for temperature measurements: ~5%

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

iso-butanol

(n-	Summar	y of the detected species	Influence of the addition of ethanol and iso-butanol on final products (CO and H_2) and flame temperature:			
ent	C ₀ species	O_2, H_2, N_2				
111	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)				
, TT (7)	C ₃ species	C ₃ H ₈ (Propane), C ₃ H ₆ (Propene), aC_3H_4 (Allene), pC_3H_4 (Propyne)				
$H_{16} (\times 5)$ $H_8 (\times 5)$ $H_{18} (\times 5)$ (/4)	C ₄ species	i C_4H_8 (iso-Butene), $1C_4H_8$ (1-Butene), 1,3 C_4H_6 (1,3-Butadiene), BC_4H_6 (1- Butyne), i- C_4H_{10} (iso-Butane), C_4H_4 (Vinylacetylene)	1900 1850 - T (at 6 mm) 1800 - I 1800 - I I I I I I I I I I			
	C_5 species	n-C ₅ H ₁₂ (n-Pentane), C ₅ H ₁₀ (1-Pentene, cis, trans-2-Pentene),	1750 - 17500 - 17500 - 1750 - 1750 - 1750 - 1750 - 1750 - 1750 - 1750 -			
I ₄	C ₆ species	C_6H_6 (Benzene),	ad 1650 -			
2	C ₇ species	C_7H_8 (Toluene), C_7H_{16} (n-Heptane)	i i 600 −			
	C_8 species	C_8H_{18} (iso-Octane), C_8H_8 (Styrene), C_8H_{10}	1550 -			

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

HAB / mm HAB / mm HAB / mm HAB / mm HAB / mm

Conclusion and Perspectives

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

- \succ Ethanol and iso-butanol decrease the mole fractions of C₃H₆, i-C₄H₈, C₆H₆, and C₈H₈, but do not affect C₂H₂
- \succ The two alcohols do not have the same effect on oxygenated intermediate species
- \succ Ethanol limits the production of CH₂O and C₂H₃CHO, but considerably increases the amount of CH₃CHO
- \succ 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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