IMPACT OF HYDROGENATION ON MISCIBILITY OF FAST PYROLYSIS BIO-OIL WITH REFINERY FRACTIONS TOWARDS BIO-OIL REFINERY INTEGRATION

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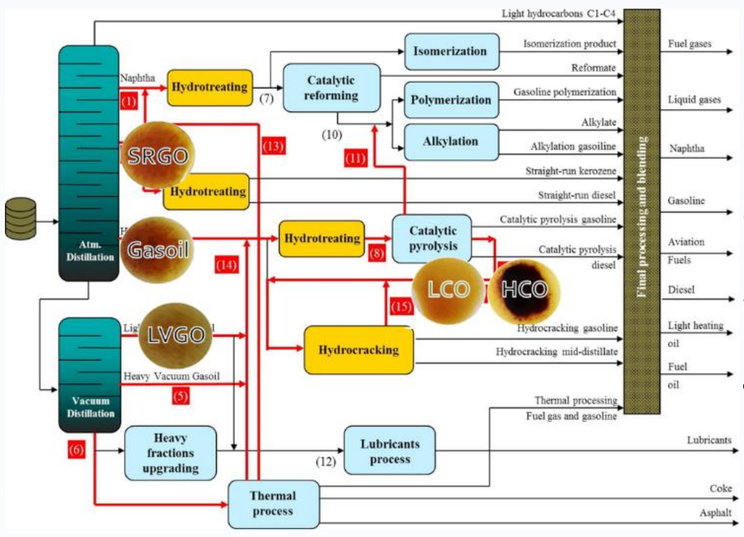
Objectives

- Investigation of compatibility of raw and hydrotreated pyrolysis oil with potential refinery entry points in terms of miscibility.

Methodology

Raw Pyrolysis oil and BIOMATES were mixed to ~30vol.% with petroleum refinery intermediates:



1) Properties

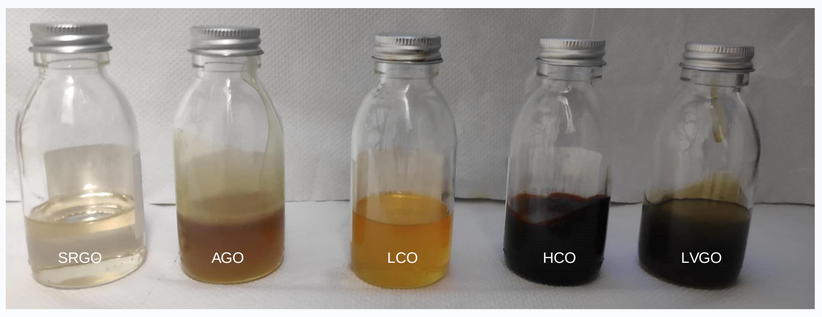
2) Microscopic observation

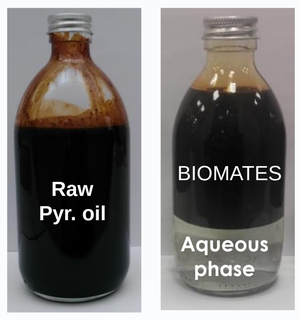
3) Dynamic interfacial tension

4) Oxidation stability

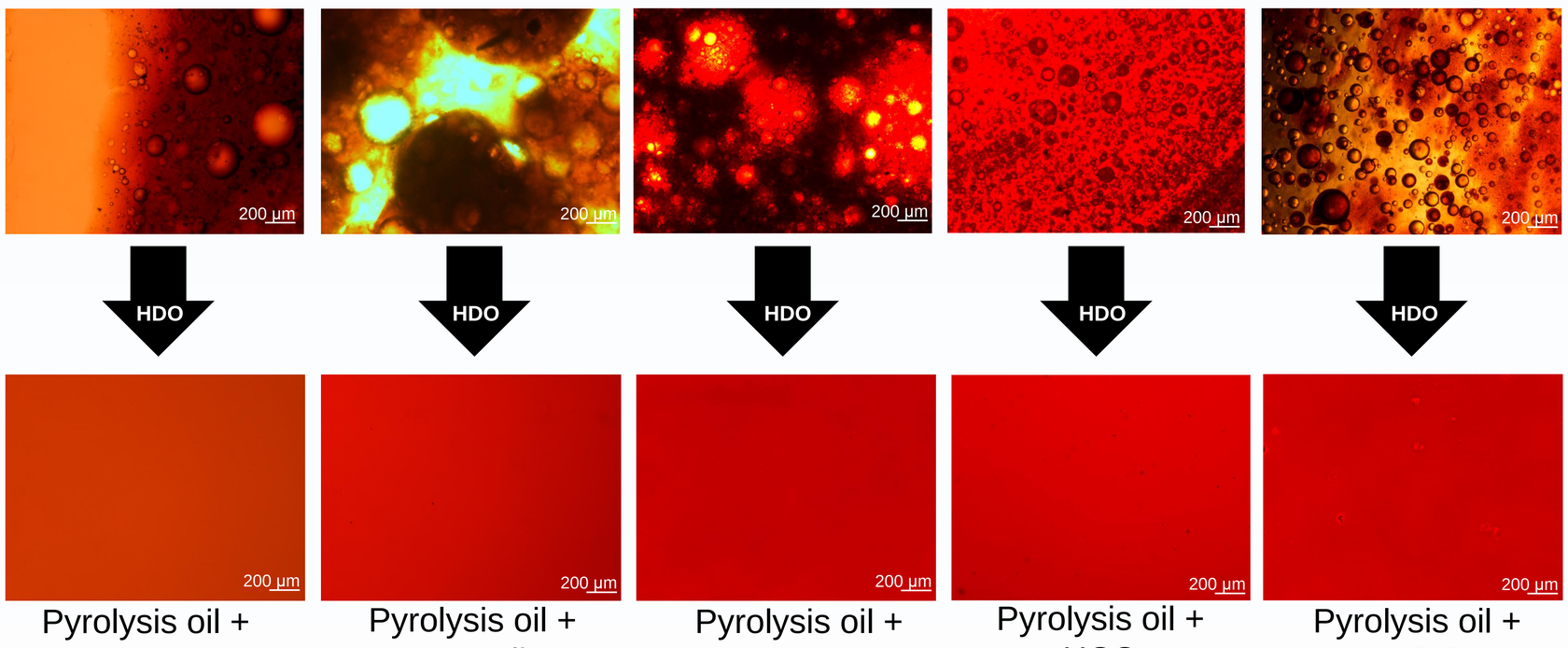
Feedstock Properties

	Units	Pyr. oil	BIOMATES	SRGO	GO	LCO	HCO	LVGO
Density (288K)	g/cm^3	1.138	0.918	0.846	0.867	0.943	1.081	0.896
Viscosity (313K)	mm^2/s	106.1	7.54	3.157	16.09	2.193	239.4	17.49
Surface Tension	mN/m	36.4	32.1	27.6	29.4	30.9	34.2	30.7
C	wt%	57.73	85.85	85.53	85.87	88.95	89.43	85.91
H	wt%	8.23	11.84	13.98	13.5	9.82	8.17	12.99
N	wt%	0.74	0.87	0.19	0.25	0.11	0.24	0.20
S	wt%	0.047	0.039	0.18	0.35	0.9	1.87	0.46
O	wt%	33.25	1.40	0.12	0.03	0.22	0.29	0.44
Water	mg/kg	400,000	480	50	55	105	75	45
Refractive index	-	1.5304	1.5000	1.4697	1.4940	1.5460	1.5720	1.4962
Oxidation stability	min	16.1	35.3	1039.8	1011.2	239.0	169.5	1028.2





Results & Discussion



Raw Pyrolysis oil → not miscible with fractions

Presence of distinct phases due to high water content (high polarity).

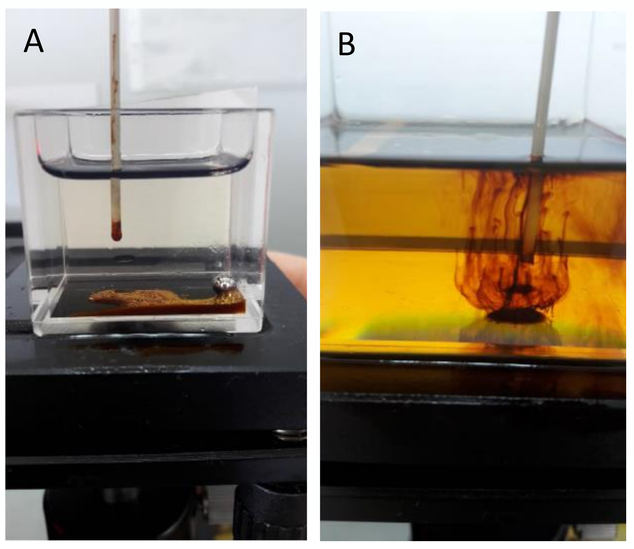
Different shape and size in each blend based on petroleum fractions organic compounds.

BIOMATES → miscible with all fractions

Perspicuous blends with no distinction between phases in mixtures with all petroleum fractions.

Similar results in all blends with petroleum fractions.

BIOMATES 30vol.% +	Units	SRGO	GO	LCO	HCO	LVGO
Density (288K)	g/cm^3	0.861	0.896	0.935	1.012	0.903
Viscosity (313K)	mm^2/s	3.168	12.020	2.954	25.85	12.94
Surface Tension	mN/m	28.2	29.4	30.6	33.1	30.9
C	wt%	85.71	85.91	88.22	88.54	86.03
H	wt%	13.22	12.93	10.28	9.18	12.71
N	wt%	0.41	0.45	0.35	0.42	0.42
S	wt%	0.14	0.26	0.66	1.39	0.33
O	wt%	0.52	0.52	0.49	0.47	0.51
Water	mg/kg	180	185	220	200	175
Refractive index	-	1.475	1.494	1.532	1.573	1.496
Oxidation stability	min	263.4	232.2	109.8	83.8	247.6



A: Raw Pyrolysis oil is **not miscible** with petroleum fractions due to zero mass transfer, absence of cloudy effect and change of color in sample.

B: BIOMATES is **miscible** with petroleum fractions due to one phase liquid after some minutes and due to zero interfacial tension between upgraded bio-oil and petroleum samples.

- Blends with 30vol.% BIOMATES **favor flow properties** of some fractions (GO, HCO, LVGO).
- Heavy fractions (LCO, HCO) tend to **reduce density** when BIOMATES is added.
- Elemental composition is not altered significantly with the addition of BIOMATES (**low oxygen, high carbon and hydrogen content**).

Conclusions

- Addition of BIOMATES in petroleum fractions leads to miscible mixtures expanding possible candidates for co-processing.
- A hydrotreatment step is essential for stabilizing raw Pyrolysis oil and make it more compatible with petroleum intermediate streams.

Acknowledgements

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A. Dimitriadis, D. Liakos, U. Pfisterer, M. Moustaka-Gouni et al. (2021), "Impact of hydrogenation on miscibility of fast pyrolysis bio-oil with refinery fractions towards bio-oil refinery integration", Biomass & Bioenergy (Accepted for publication)