Analysis and extraction of bio-oil by biomass pyrolysis: an alternative fuel source for jet engines and gas turbines

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1. Introduction – Most of the processes to convert biomass into liquid fuels consist of a pyrolysis process followed by a catalytic cracking to enhance the resulting liquid bio-oils [1].
Although both kinetic and degradation mechanisms for the pyrolysis process have been widely reported in the scientific literature, only a few works have focused on the use of bio-oils obtained from pyrolysis as alternative fuels, which would yield lower emission rates than other energy sources. Thermochemical conversion of biomass (pyrolysis, gasification, combustion) is therefore regarded as a promising non-nuclear technology in the middle term [2].
The present work is part of a PhD Project aimed at analysing the feasibility of using bio-oil as an alternative fuel source for jet engines, gas turbines and heating burners. A self-designed laboratory-scale jet engine will be operated with the obtained bio-fuel, and its performance will be further compared with that of the engine as operated with the standard JP-8 kerosene used to run this type of pure jet engines.
The project also involves an exhaustive analysis to optimise an efficient method for the extraction of the useful fraction of bio-oil from the total liquid volume obtained from the pyrolysis process. Furthermore, an innovative method using supercritical CO_2 to achieve the highest possible output of useful bio-oil from the total pyrolysed mass is currently being developed.

2. Experimental – The so obtained bio-fuel (kerosene plus bio-oil) will be tested in a self-designed laboratory-scale jet engine, so that specific parameters regarding exhaust gas temperature (EGT), thrust, life span and efficiency.
Two extraction methods will be attempted to obtain the useful fraction of bio-oil from the total volume of condensed liquid: an organic-solvent process and a novel and clean method based on supercritical CO_2.

3. Results and Discussion – The pyrolytic process was observed to yield a return of 0.389 kg liquid product (oil and aqueous phase) per kg biomass (Table I). Oil phases obtained after extraction with organic solvents were quantified as 34.72%. Physicochemical characterisation of all phases will be carried out by chromatographic techniques.
The so obtained oil will be subjected to catalytic cracking for hydrocarbon chains between C_{12} and C_{15}, thus ensuring bio-fuel samples to carry on the study.
This resulting bio-oil will be mixed up with kerosene in increasing fractions up to 20%. Several tests will then be performed to analyse emissions, EGT, specific fuel consumption, thrust and engine life span.

Table I. Fractions after the pyrolysis process.

BIOMASS \ FRACTIÓN	Solid (carbon)	Liquid	Gas
Thistle	28.94%	38.91%	32.15%
Olive seed	23.50%	36.71%	39.79%

4. Conclusions – The method herein presented might offer an efficient alternative process for bio-fuel extraction from biomass wastes, which would definitely improve CO_2 footprint reduction in commercial air transport activities, co-generation plants, heating burners or any other kerosene-fuelled facility.

5. References

[1] Demirbas A.J. Anal. *Appl. Pyrolysis* 2004, **72**, 243-248.
[2] Putun E. *Energy Sources* 2002, **24**(3), 275-285.