Prospects for large scale fluidized bed gasification of olive-oil residue: Evaluation of leaching as a pretreatment

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Fluidized bed gasification is considered to be the most advanced method for thermochemical conversion of various biomass fuels, e.g., wood, energy crops, agroresidues, etc., to energy offering economical and environmental benefits.

Ash-related problems including sintering, agglomeration, deposition, erosion and corrosion, due to the low melting point ash of agroresidues consist a main obstacle for economical and viable application of this conversion method for energy exploitation of the specific residues. The effect of leaching (washing) the olive-oil residue in order to improve the thermal behaviour its ash under the gasification conditions was studied on this work. ?1?,?2?,?3?

Gasification tests were performed in a lab scale, fluidised bed gasifier at the temperature level of 850C using silica sand as the bed inert material. A number of olive-oil residues samples, which had been pretreated under a variety of leaching conditions, such as different mass/water ratios and retention times were used in order to investigate the effect of the leaching process on the gasification of the olive-oil residues and to optimize the whole process.

Gasification tests lasting from 3 to 14 hours and with feeding rates from 10 to 15kg/h were performed; the results concerning the ash thermal behavior of the used samples were related to their ash elemental analysis, and to the results from the gasification tests of the untreated olive-oil residues.

The obtained results proved to be very positive with gasification tests that exceeded 14 hours operation and 200 kg of material's feeding without any agglomeration/deposition problem. The gasification process appeared to be improved compared to the case of the non-leached olive residue samples by a factor of four (4) for the leached sample with the minimal treatment.

Agglomeration phenomena were observed only in two cases, where the tests exceeded eight hours of operation and only for the samples that had been marginally treated with the leaching process.

Nevertheless, inspection of the bed material and of the reactor's inner surfaces after the end of these tests revealed that the agglomeration/deposition problems proved to be much lower compared to the case of the untreated olive-oil residue sample.

a) b)

Figure 1. Bed material agglomeration a) Untreated olive residue, b) Leached olive residue

Analysis of the agglomerates using SEM-EDX analysis technique gave valuable information as far as it concerns the mechanisms of the agglomerate formation and of its chemical composition as it is seen in Table 1.

Table 1. Analysis of bed material agglomerates using the SEM-EDX analysis technique

	Untreated olive residue				Leached olive residue	
	White particle		Yellow particle		Yellow particle	
	Initial deposition	Secondary deposition	Initial deposition	Secondary deposition	Initial deposition	Secondary deposition
K_2O	28.07	6.49	45.78	16.14	30.07	6.34
Na_2O	0.14	0.05	0.02	0.00	2.32	0.00
CaO	16.52	69.76	13.12	53.51	8.57	52.16
MgO	0.23	0.34	0.00	0.24	0.80	7.15
SiO_2	52.61	12.05	40.11	23.23	55.23	20.27
Al_2O_3	0.00	0.00	0.00	0.00	0.00	2.28
Fe_2O_3	2.36	9.90	1.05	6.50	2.11	5.05
P_2O_5	0.00	1.27	0.00	0.00	0.91	6.08
SO_3	0.00	0.00	0.00	0.00	0.00	0.43
Cl	0.00	0.11	0.00	0.07	0.00	0.17

Alkali metals and chlorine proved to be sufficiently eliminated from the olive residue body, thus resulting in (a) improved ash thermal behavior during gasification of the specific material, and (b) in a significant change of the mechanism and the rates of fly ash particle deposition in the surface of the silica sand material that initiates the agglomeration/deposition process.

Potassium and secondly calcium appeared to be responsible for the observed agglomeration problems, while the role of chlorine as a facilitator of the reactions among potassium and the other inorganic constituents was clearly identified.

References

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