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EFFECT OF OXYGEN CONCENTRATION ON THERMAL DECOMPOSITION OF TWO-PHASE OLIVE MILL SOLID

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Spain is the world's leading olive oil producer and exporter, with around the 33% of the total production. However, during production of olive oil, several wastes are generated, which represent an important environmental problem. Main byproducts are the olive stone and the two-phase olive mill solid (TPOMS) waste, being the second one more problematic due to its high moisture content. In the last years, different approaches have been development in order to valorize this waste. One interesting approach is the recovery of energy value present in the solid, obtaining from this waste a bioenergy source.

MATERIAL AND METHODS

- TPOMS waste (Figure 1) was provided by the "Cooperativa Nuestra Señora del Castillo" extraction plant located in Vilches, in the province of Jaen (Spain). This semi-solid waste contains around 55–60% moisture, has a dark color, and forms a sludge-like mass. It was collected in sterile plastic containers, dried overnight at 60 ºC and milled with an analytical mill (IKA MF-10). This waste is a mixture of pulp and olive stones from the crushing of olives, which yield the oil in a two-phase decanter system.



Figure 1

- The thermal degradation process of the TPOMS in two oxygen-containing atmospheres (10 % O_2 and 20 % O_2) was analyzed by thermogravimetric methods. Dynamic experiments were performed in a Perkin Elmer thermobalance model STA 6000 (Figure 2) at three different heating rates (5, 10 and 20 ºC/min), from 30 ºC (303 K) up to 800 ºC (1073 K), including in this way the entire range of decomposition. The flow rate of the carrier gas (N_2; purity ≥ 99.5 %) was 20 mL/min and the sample had a weight of approximately 40 mg.

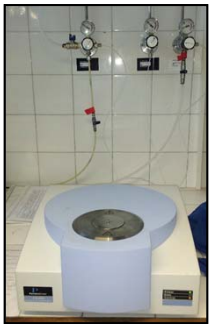


Figure 2

RESULTS AND DISCUSSION

TG curves

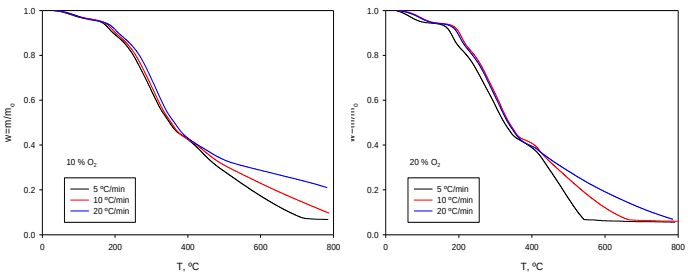


Figure 3

DTG curves

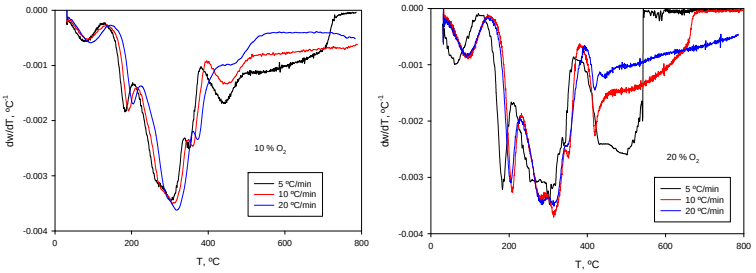


Figure 4

The influence of the oxygen concentration on the solid degradation has been analyzed. The results are shown in Figures 3 and 4 and Table 1 where w represents the mass fraction. Five general steps of decomposition can be distinguished on curves. In general, for three heating rates, an increase in the oxygen concentration produced an increase in the solid conversion of TPOMS during its thermal decomposition. Concretely, the oxygen in the atmosphere influenced the position and amplitude of the DTG curve (Figure 4). Results showed relatively little effect of oxygen concentration at low temperatures, however, the influence of oxygen concentration is particularly important for higher temperatures values (at higher temperatures a significant solid weight loss was obtained, mainly corresponding to the char oxidation). The increase in the temperature accelerates the char oxidation rate, which would lead to a further increase in the sample temperature and a lower yield to char. Also, a superior influence of heating rate is presented in atmospheres with higher oxygen, for example, a greater char combustion was observed at a heating rate of 5 ºC/min comparing to 20 ºC/min.

Table 1

Atmosphere	Steps	Temperature range (ºC)	T_{DTG}, (ºC)		
			5 ºC/min	10 ºC/min	20 ºC/min
10 % O_2	Moisture loss and elimination of volatile compounds dragged by water vapor	50-175	78	84	93
	Descomposition of hemicellulose	175-300	185	191	201
	Descomposition of cellulose	300-370	305 350	305 356	315 365
	Descomposition of lignin	175-800	--	--	--
	Char Oxidation	400-480	450	439	430
20 % O_2	Moisture loss and elimination of volatile compounds dragged by water vapor	50-175	62	82	85
	Descomposition of hemicellulose	175-205	181	206	204
	Descomposition of cellulose	240-370	303 341	306 352	314 352
	Descomposition of lignin	175-800	--	--	--
	Char Oxidation	370-540	501	420	420