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Co-combustion of Lignite and Solid Wastes from Olive Oil Industry

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Municipal, industrial and agricultural solid wastes continuously increase along with the human development. The management of such wastes is of major importance since it is associated with severe environmental impact. Until recently, in Greece the main solid waste management-treatment is landfill. Other waste management approaches include composting and recycling of wastes in the concept of circular economy, that are still in early stages in Greece.

The participation of municipal solid waste (MSW) in the energy production under the so-called "waste-to-energy" scheme is gaining ground globally. The thermal processing technologies commonly used worldwide are incineration (combustion), pyrolysis and gasification. The benefit of the thermal treatment of wastes is triple: decreasing the waste volume, turning them into harmless material and producing energy. In Greece, the energy recovery from wastes by combustion has been recently regarded as a potential solution for the proper management of municipal solid wastes, due to its low cost and simple procedure (Athanasiou et al., 2015; Vamvuka et al., 2016).

Olive oil industry solid waste is a recalcitrant waste and poorly biodegradable due to its relative high lignin content. Thus, common biological treatment is not sufficient for the management of olive oil waste. Olive oil waste have been utilized for bio-compounds recovery (Nunes et al., 2019) as well as alternative fuel (Morvová, 2017) and biogas production (Afif et al., 2019). The biogas production and product valorization are in general expensive and rather sophisticated processes. On the other hand, thermal processes are simple and have relatively low cost.

The objective of this study is the investigation of the co-combustion of lignite with olive oil solid waste at different proportions as a potential alternative fuel with higher Gross Calorific Value (GCV).

Two olive oil waste samples: a) extracted olive pomace (EOP) and b) olive stone (OLS) were collected from an olive mill in Katerini, Greece. Lignite (LIG) sample was collected from the mines of the Western Macedonia area, Greece. All samples were firstly air-dried for two weeks. Then, the samples were ground to size less than one millimeter (<1 mm). Eventually, they were dried in an oven at 80 ^{o}C for 24 hours. Raw EOP and OLS, and raw lignite as well as 3 different blends at proportions (waste-lignite) 30-70, 50-50 and 70-30 were prepared by mixing. Gross Calorific Values were determined in a Leco AC-500 isoperibol bomb calorimeter according to ASTM D 5865-13 standard (ASTM D 5865-13, 2013). Proximate analysis (moisture, ash, volatile matter and fixed carbon) of the samples was performed in a Leco TGA 701 device according to the ASTM D 7582 (ASTM D 7582-15, 2015).

In Figure 1 the results of proximate analysis are presented. It is obvious that OLS and EOP samples exhibit much higher volatile content and much less ash percentage compared to lignite sample. High volatile matter is translated to higher heating capacity. This becomes apparent from the Gross Calorific values that are presented in Table 1. EOP has a GCV much higher than lignite and OLS exhibits almost double GCV compared to the respective value of lignite.

Thus, it can be concluded that blends of lignite with solid waste from olive oil industry appears to be very attractive as alternative fuel. However, further studying is required in order to estimate and compare emission and pollutant capacity issues of such wastes.

Table 1. Gross Calorific Values (GCV) of all samples (EOP: extracted olive pomace, OLS: olive stone, LIGA: lignite)

Sample ID	GCV (MJ/Kg)
EOP	19.63
EOP70 LIG30	17.02
EOP50 LIG50	15.78
EOP30 LIG70	14.28
OLS	22.30
OLS70 LIG30	18.96
OLS50 LIG50	18.58
OLS30 LIG70	13.54
LIGA	12.68

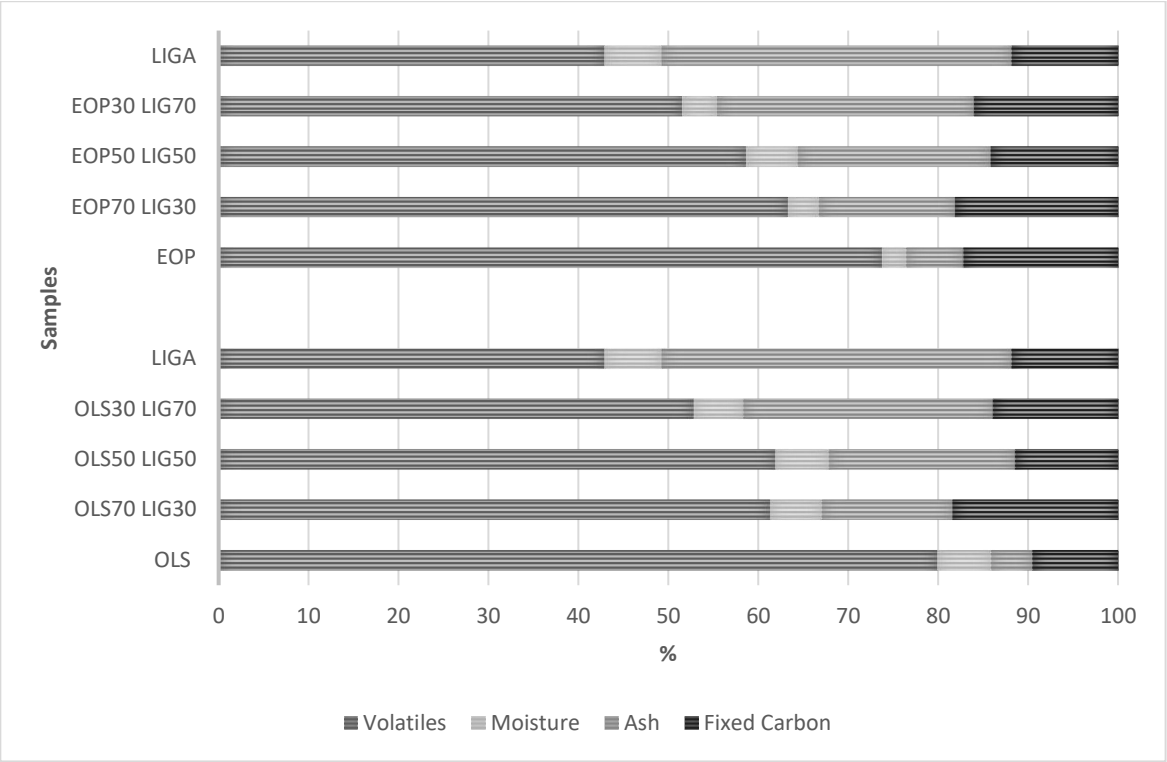

Figure 1. Proximate Analysis of the raw pre-dried samples and their blends (EOP: extracted olive pomace, OLS: olive stone, LIGA: lignite)

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References

ASTM D 7582-15, 2015. Standard Test Methods for Proximate Analysis of Coal and Coke by Macro Thermogravimetric Analysis. ASTM International, West Conshohocken, PA.

ASTM D 5865-13, 2013. Standard Test Method for Gross Calorific Value of Coal and Coke. ASTM International, West Conshohocken, PA.

Afif, R. A., Linke, B., 2019. Biogas production from three-phase olive mill solid waste in lab-scale continuously stirred tank reactor. Energy 171, 1046-1052.

Athanasiou, C., Tsalkidis, D., Kalogirou, E., Voudrias, E, 2015. Feasibility analysis of municipal solid waste mass burning in the Region of East Macedonia – Thrace in Greece. Waste Management & Research 33(6), 561–569.

Morvová, M., Onderka, M., Morvová, M. Jr., Morva, I., Chudoba, V., 2019. Pyrolysis of Olive Mill Waste with On-line and Ex-post Analysis. Waste and Biomass Valorization 10, 511-520.

Nunes, M.A., Pawlowski, S., Costa, A.S.G., Alves R. C., Oliveira, M.B.P.P., Velizarov, S., 2019. Valorization of olive pomace by a green integrated approach applying sustainable extraction and membrane-assisted concentration. Science of The Total Environment 652, 40-47.

Vamvuka, D., Tsamourgeli, V, Zaharaki D. Komnitsas, K., 2016. Potential of poor lignite and Biomass blends in energy production. Energy Sources, Part A: Recovery, Utilization, And Environmental Effects 38, 2079-2085.