CESEP'19 CONFERENCE

8th International Conference on Carbon for Energy Storage and Environment Protection

October 20 - 24th

Alicante (Spain)

ISBN: 978-84-1302-058-7

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Low-cost biochar produced by Hydrothermal Carbonization of compost derived from Municipal Solid Waste

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Introduction

In waste processing facilities equipped with mechanical biological treatment systems, the municipal solid waste (MSW) is separated and the organic fraction is then treated by anaerobic digestion, obtaining compost that can be used as fertilizer. However, the production of compost from MBT is higher than the existing demand. This work proposes the valorization of compost derived from MSW to produced activated carbons by Hydrothermal Carbonization (HTC) [1].

Experimental

HTC was carried out in a Teflon vessel in a stainless-steel body at selected conditions (Time (x_1:1-5 h), compost load (x_2:1-4 g), temperature (x_3:150-230 ºC), 30 mL of water), that were studied through a Doehlert Matrix and Analysis of Variance. Selected responses were total organic carbon (TOC) in the liquid phase and the variation on the carbon content in solid phase.

Results and discussion

Models (Eq. (1-2)) were fitted to the experimental data, with adjusted-$R^2 > 0.94$. Likewise, ANOVA indicated reliable models (*p-values* $< 10^{-5}$ and *lack-of-fit* > 0.3). As expected, the most relevant variable for all responses is x_2. For the liquid fraction (Eq. (2)), the most relevant variable is x_3, whereas, for the carbon content (Eq. (1)), x_1 seems to play a more significant role.

$$\Delta C = C - C_0 = -0.129 - 0.035x_1 - 0.153x_2 + 0.016x_3 + 0.040x_2x_3 - 0.085x_2^2 - 0.016x_3^2 \quad (1)$$

$$TOC = 2033 + 657x_1 + 12219x_2 + 825x_3 + 364x_1x_2 + 401x_1x_3 + 376x_2x_3 - 312x_1^2 + 222x_3^2 \quad (2)$$

The highest possible retention of carbon (≈ 90%) on the solid can be achieved after 1 h of HTC and 1 g of compost at 160 ºC. At a similar condition (x_1: 1 h, x_2: 1 g; x_3: 180 ºC), TOC is predicted to achieve its minimum value (≈ 300 mg·L^{-1}).

Conclusions

Compost from MSW can be valorized through HTC to produce low-cost carbon-based materials, whose properties and quantity produced can be tailored using the developed models.

Acknowledgments

This work was supported by the project "VALORCOMP", with the reference 0119_VALORCOMP_2_P, and project "AIProcMat@N2020", with the reference NORTE-01-0145-FEDER-000006, and the Project Associate Laboratory LSRE-LCM - UID/EQU/50020/2019 - funded by national funds through FCT/MCTES (PIDDAC).

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