XXV ENCONTRO

GALEGO
PORTUGUÉS
DE QUÍMICA

XXV ENCONTRO GALEGO-PORTUGUÉS DE QUÍMICA

20 al 22 de noviembre de 2019

Edificio Cinc. Ciudad de la Cultura

Santiago de Compostela-Galicia (España)

Colegio Oficial de Químicos de Galicia

Sociedade Portuguesa de Química

Asociación de Químicos de Galicia

XXV ENCONTRO GALEGO-PORTUGUÉS DE QUÍMICA.
Noviembre 2019

Coordinador Editorial
Cristina Díaz Barral
Manuel Rodríguez Ménez

Edita
Colegio Oficial de Químicos de Galicia
Rúa Lisboa, nº 10, Local 31E – Edificio Área Central Fontiñas.
15707 Santiago de Compostela (A Coruña)
www.colquiga.org

Tirada
50 Ejemplares y 250 en formato digital

Imprime
OCERO
Sada (A Coruña)

Depósito Legal
VG699-2017

ISBN
978-84-09-16320-5

Este libro de comunicaciones y conferencias, presentadas en el XXV Encontro Galego-Portugués de Química, Colegio Oficial de Químicos de Galicia

Catalogación recomendada Libro de resúmenes del XXV Encontro Galego-Portugués de Química. Edificio Cinc. Ciudade da Cultura. Santiago de Compostela (España) 2019

Kinetic modelling of the hydrothermal carbonization of compost derived from Municipal Solid Waste

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Nowadays, municipal solid waste (MSW) management commonly includes a mechanical and biological treatment process (MBT). The solid stream from the anaerobic digestion of the organic fraction can be processed to obtain a compost, which can be used as fertilizer. However, compost production is higher than the existing demand, and the expected developments on up-coming directives ruling "End-of-waste" criteria are leading to barriers on the use of MSW-derived fertilizers [1]. Thus, the development of new alternatives for the treatment of organic wastes and compost valorization are necessary. This work deals with the valorization of compost from MBT, through the production of catalysts by Hydrothermal Carbonization (HTC) [2]. HTC of the compost was carried out in a Teflon vessel inserted in a stainless-steel body at different operating conditions (150-230 ºC,1-5 h, 1-4 g of compost, 30 mL). A Doehlert Matrix was considered to plan the experiments. The carbon balance and the kinetic equations were evaluated from experimental data reporting the carbon content in the liquid (estimated by TOC analysis) and solid phases (estimated by elemental analysis). A lumped kinetic model based on the elemental carbon content is proposed (Fig. 1), anticipating that the compost (C) undergoes reactions that originate liquid intermediates (L), reaction 1, and sequentially results in hydrochar (HC) and gases (G), reactions 2 and 3, respectively. In addition, it was assumed that HC and G were also produced from the compost directly, reactions 4 and 5, respectively. The highest kinetic constant at 190 ºC ($8.3 \cdot 10^{-4}$ min^{-1}) was found for the formation of the liquid soluble intermediates from compost (reaction 1), whereas the production of hydrochar from the liquid intermediates (reaction 2) shows the lowest kinetic constant ($3.1 \cdot 10^{-4}$ min^{-1}). The lowest activation energy was estimated for reaction 1 (23 $kJ \cdot mol^{-1}$), while reactions 2 and 4, related to the formation of hydrochar, resulted in the highest values (85 and 195 $kJ \cdot mol^{-1}$, respectively), meaning that the production of hydrochar strongly depends on the temperature.

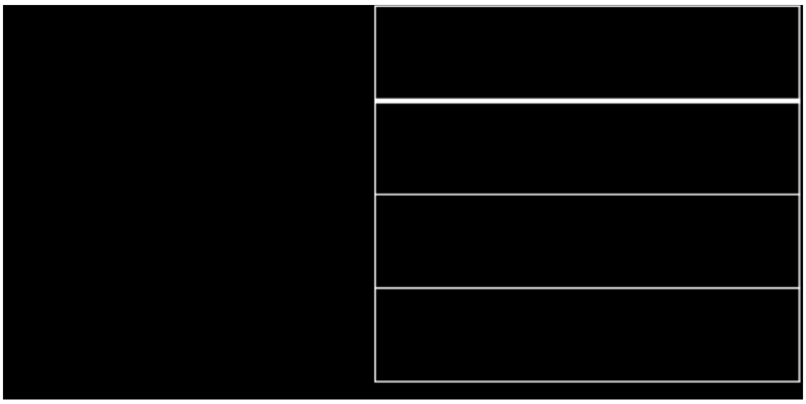

Fig.1. Proposed mechanism for the thermochemical conversion of compost to hydrochar.

Acknowledgements
This work was financially supported by project "VALORCOMP - Valorización de compost y otros desechos procedentes de la fracción orgánica de los residuos municipales", 0119_VALORCOMP_2_P, and project "AIProcMat@N2020 - Advanced Industrial Processes and Materials for a Sustainable Northern Region of Portugal 2020", reference NORTE-01-0145-FEDER-000006, supported by NORTE 2020, under the Portugal 2020 Partnership Agreement, through FEDER; the Associate Laboratory LSRE-LCM - UID/EQU/50020/2019 - funded by national funds through FCT/MCTES (PIDDAC); and CIMO (UID/AGR/00690/2019) through FEDER under Program PT2020.

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