WCCE11 - 11th WORLD CONGRESS OF CHEMICAL ENGINEERING
IACCHE - XXX INTERAMERICAN CONGRESS OF CHEMICAL ENGINEERING
CAIQ2023 - XI ARGENTINIAN CONGRESS OF CHEMICAL ENGINEERING
CIBIQ2023 - II IBEROAMERICAN CONGRESS OF CHEMICAL ENGINEERING
Buenos Aires - Argentina - June 4-8, 2023
BUENOS AIRES 2023
JUNE 4 - 8
"The global chemical engineering working for a better future world"

Multifunctional eco-friendly adsorbent cryogels based on xylan derived from coffee residues

Quintero, L.V. [1]; Osma, J.F. [2]; Salokhe, S. [3]; Azimov, U. [3]; Nabarlatz, D.A. [1]

[1] INTERFASE, Chemical Engineering department, Universidad Industrial de Santander, Cl. 9 No. 27, Bucaramanga, Santander, Colombia. Email dnabarla@uis.edu.co
[2] Innovation and Technology INC, Carrera 19A # 88-14, Bogota, Colombia. Email faccelo@yahoo.com
[3] Faculty of Engineering and Environment, Northumbria University, Newcastle upon Tyne, NE1 8ST, UK. Email ulugbek.azimov@northumbria.ac.uk

Agriculture and animal farming are a significant source of NH_3, CH_4, CO_2 or NO_x emissions. According to FAO 2020 greenhouse gas emissions account for 17% of total emissions. Besides this, agriculture and animal farming are also responsible for a range of local environmental issues such as health concerns, water, and air pollution and phosphorous and nitrogen failed manage. For this reason, there is a growing need to capture these pollutants leading to the development of new strategies and approaches. One of them is the use of solid adsorbents and/or absorbents, were most of the materials used for their development are usually toxic (such as amines) or having a poor biodegradability, becoming another environmental problem. In Colombia, agriculture represents the 7,4 % of participation of its national GDP [1], and, as a member of Paris Agreement on climate change, needs to comply with current trends on greenhouse gas reduction and minimize the impact of such practices to the environment, people, and animals. The aim of this study was to develop responsive eco-friendly cryogels with high surface area and large pore volumes, which would be used for the adsorption of air pollutants, having a positive environmental impact since it represents a sustainable technology in agricultural and fertilizer industry [2]. Cryogels were developed using natural polymers, mainly xylan (XYL) extracted from coffee parchment (an agricultural residue) from 1-10% w/v, and polyvinyl alcohol (PVA) [10 %p/v], which is biodegradable, non-toxic and has good chemical and thermal stability. Also, a lower amount of sodium alginate (SA) [2 %w/v] and bentonite (BEN) [0.5 % w/v] were added to achieve a low oxygen permeability and higher porosity. On the other hand, crosslinking was accomplished by the physical method called “freeze-thawing” and subsequent freeze-drying. Cryogels were characterized using scanning electron microscopy to study their morphology and semi-quantitative composition, also measuring porosity and density by liquid saturation method. Analysis showed most of the porosities in the cryogels remained around 50-60%, showing a maximum of 63%, where the addition of BEN increased the porosity of cryogels by 50%, and decreased cryogel density from 0.38 g/cm^3 to 0.167 g/cm^3 creating more airy and lighter structures. Besides this, porosity was affected when the amount of xylan was increased, having a slight increase on their density showing that xylan tends to form denser structures. These effects were compatible with those obtained in SEM analysis, where irregular open and interconnected porous structures appeared in most cases, the increase in the amount of xylan added created more closed and less aligned structures. For all the cases, pore diameter varied from 9.23-20.13 [µm]. Overall, addition of BEN resulted in improving mechanical properties and creating adsorption sites in structures that will favor the gas diffusion through the pores. These cryogels represent a great environmental alternative as solid adsorbents since they are totally biodegradable and largely composed of agro-industrial material waste.

[1] Departamento Administrativo Nacional de Estadística - DANE. (2021). PIB Medición con enfoque territorial - *Cuentas Nacionales Colombia* DANE 2021. Available on: https://www.dane.gov.co/index.php/estadisticas-por-tema/cuentas-nacionales/cuentas-nacionalesdepartamentales#:~:text=Informaci%C3%B3n%202021%20preliminar&text=Para%202021pr%2C%20Bogot%C3%A1%20D.%20C.,67%25%20del%20PIB%20de%20Colombia.

[2] Song, J., Liu, J., Zhao, W., Chen, Y., Xiao, H., Shi, X., Liu, Y., & Chen, X. (2018). Quaternized Chitosan/PVA Aerogels for Reversible CO2 Capture from Ambient Air. *Industrial and Engineering Chemistry Research*, 57(14), 4941–4948.