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PII: S2213-3437(17)30095-7
DOI: http://dx.doi.org/doi:10.1016/j.jece.2017.03.003
Reference: JECE 1509

To appear in:

Received date: 2-2-2017
Revised date: 1-3-2017
Accepted date: 3-3-2017

Please cite this article as: Meriem Moussa, Najoua Bader, Nausika Querejeta, Inés Durán, Covadonga Pevida, Abdelmottaleb Ouederni, Toward sustainable hydrogen storage and carbon dioxide capture in post-combustion conditions, Journal of Environmental Chemical Engineering http://dx.doi.org/10.1016/j.jece.2017.03.003

Toward sustainable hydrogen storage and carbon dioxide capture in post-combustion conditions

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Abstract

This work addresses two environmental issues of major concern: hydrogen storage for hydrogen economy implementation and CO_2 capture to reduce greenhouse gas emissions. For these purposes, two granular activated carbons were synthesized through chemical activation of olive stones by means of potassium salts (KOH and K_2CO_3). The porosity characterizations reveal typical ultramicroporous carbons with average pore sizes of about 0.53 and 0.69 nm for K_2CO_3 and KOH-activated carbons, respectively. The volumetric measurements of cryogenic hydrogen adsorption show monolayer process. At sub-atmospheric pressures the narrower micropores show stronger binding energy to hydrogen molecules. However, at higher pressures this porosity range saturates and KOH-activated carbon exhibits a H_2 storage capacity of 3wt%, 70% of which is achievable at only 1 bar. CO_2 shows a similar behavior than H_2 when it was adsorbed purely at 0°C, and AC_KOH retains its excellence with a capacity of 5.6 mmol g^{-1}at 1 bar. Finally, the two carbons were tested as CO_2 adsorbents in conditions representative of post combustion capture applications (10% CO_2 at atmospheric pressure and at 50°C). Both carbons show fast adsorption-desorption kinetics,