Adsorption of Volatile Organic Compounds by means Hybrid Material

L. Rivera-Montenegro [(1)], M. Gutiérrez-Arzaluz [(2)], V. Mugica-Álvarez [(2)], S. Alfaro-Hernández [(3)], M. Torres-Rodríguez [(2)]

[(1)] Posgrado en Ciencias e Ingeniería, Universidad Autónoma Metropolitana-Azcapotzalco, Mexico, (phone: (+52)55 66675569; e-mail: lau.riveram17@gmail.com).
[(2)] Departamento de Ciencias Básicas, Universidad Autónoma Metropolitana. Mexico.
[(3)] ESIQUIE, Instituto Politécnico Nacional, Mexico

1. Introduction – VOC's (Volatile Organic Compounds) are an important group of organic compound widely studied due to their relationship with of tropospheric ozone formation and the negative effects generated by them on human health and the environment. Some VOCs are checked or cataloged as CMR (carcinogenic, mutagenic and/or toxic of reproduction) (Gallego et al., 2013). Currently, multiple technologies have been developed for the control of VOC's, among which the adsorption in different materials, such as MOFs, that are considered excellent adsorbents (Llewellyn et al., 2014). However, when the MOF is used to capture gases and vapors, an adequate pore size is not enough (Barea et al., 2014), since more specific interactions must also be considered to control the interaction between the adsorbate and the adsorbent, in the case of hybrid materials based on MOF, these interactions can improve the adsorption, selectivity and/or efficiency of adsorption of MOF towards certain compounds and their thermal stability.

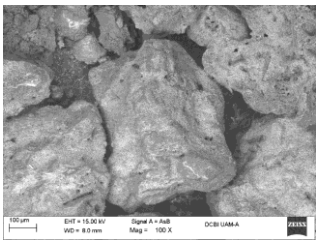

Image 1. SEM Hybrid Material

The purpose of this work is to adsorb: Toluene, Xylene, Formaldehyde and a mixture of the three compounds respectively, into a hybrid material formed by MOF76-Ce supported on Mexican natural zeolite, type clinoptilolite, very abundant in Mexican soil, which is a microporous material with a large specific surface and high thermal stability.

2. Experimental – The synthesis of MOF76-Ce was performed by the solvothermal method reported by Ethiraj et al. (2016). The hybrid adsorbent was prepared, by means of ultrasound dispersion, 0.15g of MOF76-Ce in 3g of Mexican zeolite type clinoptilolite, previously washed, dried and sieved (#mesh: 0.841). The adsorption tests of Xylene, Toluene, Formaldehyde and a mixture of the three gases before mentioned were carried out at room temperature in both: the precursor materials and the hybrid material, which were previously pre-treated. Afterwards the gas was desorbed from the sample to temperature programmed in a TPD analyzer. All materials, before and after the adsorption process, were characterized by SEM/EDS, FTIR, XRD and TGA.

3. Results and Discussion – Prior to adsorption stage all the samples were characterized, the results confirm the obtained of MOF76-Ce and its incorporation in the natural zeolite, being successful the obtainment of the hybrid material proposed: Image 1. About the adsorption tests carried out for the VOC's: Formaldehyde, Toluene, Xylene and the gas mixture, the hybrid material turned out to be a good adsorbent for the pollutants, according to the results thrown by the TPD, having the best adsorption towards Xylene, with 2.2 mmol of Xylene/g of adsorbent, in a range of desorption temperatures, between 120 and 380°C for all tests, therefore, it is considered that the adsorption forces are medium strength. The results of FTIR and SEM/EDS of the hybrid material, after the adsorption study, show that the material retains the same structure, morphology and elemental composition, unlike the MOF, whose characteristic bands are diminished in the FTIR.

4. Conclusions – The hybrid material studied in this work turned out to be a good adsorbent for all the pollutants studied: Formaldehyde, Toluene and Xylene (VOC's) both individually as mixture at room temperature. The MOF being supported on the natural zeolite formed a more thermally stable hybrid material, preventing the deterioration of its structure, and with the possibility of regenerate it or mainly used it as a catalyst for the complete elimination of VOC's through catalytic oxidation.

5. References

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