

Efficient simultaneous removal of petroleum hydrocarbon pollutants using a silica aerogel-like material

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Aromatic compounds in the petroleum comprises the polycyclic aromatic hydrocarbons (PAHs) (e.g., benzo(a)pyrene) and the monoaromatic hydrocarbons (MAHs) (e.g. benzene, toluene, and xylene isomers (BTXs)) [1]. The biodegradation of PAHs and BTXs compounds is slow and is associated with mutagenic, teratogenic and carcinogenic effects in humans [2].

Aerogels are nanoporous materials made by a sol-gel process followed by drying at supercritical conditions. The combination of the techniques used for the synthesis of these materials impart into them unique properties such as large surface areas ($\sim 10^6$ m²/kg) and high porosity (>90%), they are easily recovered and they exhibit capacities which enormously exceed that of usually used adsorbents [3-5].

In this work, using methyltrimethoxysilane (MTMS) as the precursor and according to the preparation procedure of Xero-a samples described earlier, a material was obtained with a non-wetting behavior and without significant shrinkage when dried under ambient pressure [6]. The interaction between the aerogel-like material prepared with MTMS and mix solutions containing BTXs and PAHs (pyrene, benzo(b)fluoranthene and benzo(a)pyrene) has been evaluated through sorption isotherms and kinetics.

For the simultaneous quantification of 6 different analytes, we used a HPLC-DAD method, previously optimized. We found that the sorption kinetics follows a pseudo-second order equation and the isotherms can be modelled by using the BET equation. These findings show that a concomitant chemi- and physisorption can happen during the sorption process. Furthermore, we have also observed that the removal efficiency is similar for all adsorbates and are equal to 16-18%, which leads to a total removal efficiency of around 100%. Desorption experiments show desorption rate of ca. 100% for PAHs; however, BTX shows higher interaction with the aerogel and lower desorption rates (below 50%). The silica aerogel-like adsorbent was characterized, before and after equilibrium with BTXs and PAHs solutions, by thermogravimetry (TG), Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM). Finally, the capacity of this aerogel for removing all these pollutants from a real gasoline sample is discussed.

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