Unusually Low heat of Adsorption of CO_2 on AlPO and SAPO Molecular Sieves

Nuria González-Camuñas[1], Eduardo Pérez-Botella[1], Raquel Martínez-Franco[2], Ángel Cantín[1], Miguel Palomino[1], Manuel Moliner[1], Susana Valencia[1] and Fernando Rey [1]
[1] Instituto de Tecnología Química, Universitat Politècnica de València-Consejo Superior de Investigaciones Científicas, Valencia, Spain, [2] Institut Français du Pétrole (IFP) Energies Nouvelles, Lyon, France.
nugonca@upvnet.upv.es

Adsorbents combining molecular sieving properties and low heats of adsorption of CO_2 are of clear interest in CO_2 separation processes as they will provide high selectivities and regenerabilities. Materials that have been studied as adsorbents for CO_2 include carbonaceous materials, metal organic frameworks (MOFs), covalent organic frameworks (COFs), supported amines, zeolites, AlPOs and SAPOs [1]. Selectivity, working capacity and easiness of regeneration are the three parameters to be maximized in the selection of an adsorbent. Out of the mentioned materials, supported amines and some MOFs and low silica zeolites interact chemically with CO_2. The CO_2/CH_4 and CO_2/N_2 selectivities on these materials is usually very high, due to the specific interaction between the CO_2 and the adsorbent. However, this strong interaction also leads to large amounts of energy required for regeneration. Adsorption of CO_2 on high and pure silica zeolites, together with carbonaceous materials, many MOFs and AlPOs and SAPOs takes place via a physisoprtion mechanism, which means that the interaction between sorbent and sorbate is weaker, thus meaning regeneration will be less energy intensive. Nevertheless, this does not mean that CO_2/CH_4 and/or CO_2/N_2 selectivities have to be low [2]. In this work, we have studied the adsorption of CO_2 on AlPOs and SAPOs with LTA, CHA and AFI structure and compared the calculated isosteric heats of adsorption with those of analogous zeolites previously reported. The surprisingly low isosteric heats of adsorption (13-25 KJ/mol) found in these materials suggest that AlPOs and SAPOs can present major advantages in the field of CO_2 separation and adsorption in comparison to zeolites, if materials with structures that maximize selectivities of CO_2 over methane or nitrogen are found. This could mean a great improvement in the regeneration process compared to the most frequently used zeolitic adsorbents for this application while maintaining most of their adsorption capacity and selectivity [3].

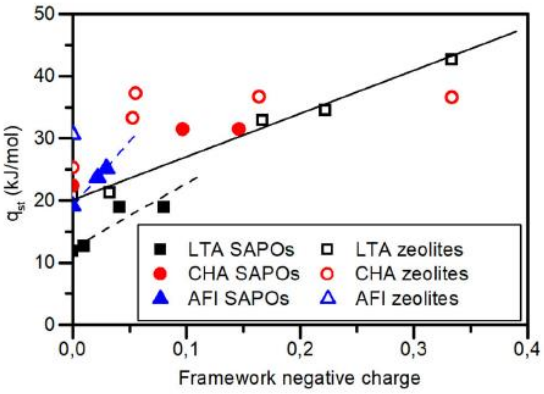

Figure 1: Isosteric heats of adsorption of CO_2 at low loading on zeolites (open symbols), AlPOs and SAPOs (filled symbols)

REFERENCES

[1] Lee, S. Y., and Park, S. J., J. Ind. Eng. Chem,23, 1–11 (2015).
[2] García, E. J., Pérez-Pellitero, J., Pirngruber, G. D., Jallut, C., Palomino, M., Rey, F., et al., Ind. Eng. Chem. Res. 53, 9860–9874 (2014).
[3] Pérez-Botella E, Martínez-Franco R, González-Camuñas N, Cantín Á, Palomino M, Moliner M, Valencia S and Rey, Front. Chem., 8:588712 (2020).