Zeolite design for selective adsorption and separation processes

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Gas separation processes need of complex infrastructures and are highly demanding of energy [1]. This is the case of two particular gas separation processes. i) Natural gas upgrading in which CO2 must be removed prior to be transported, either as liquid or through pipelines [2] and ii) olefin recovery from C2 and C3 raffinate streams coming from the steam cracker [3].
These two separations are highly challenging and of huge economic impact since the first could be of interest for small natural gas resources, while the second could avoid of the cryogenic distillation units used in current refineries.
The particular necessities of these two separations are nice examples for showing how properties of zeolites (or any adsorbent) can be tailored for maximizing the production of the separation units at the lowest energy demand.

First, the influence of pore aperture and channel dimensionality and chemical composition in the adsorption capacity and gas selectivity for upgrading of Natural Gas was studied. It has been found that zeolites of relatively low micropore volume to surface area ratio give a better performance for CO_2/CH_4 separation. Also, the chemical composition of the zeolite influences the polarity of the adsorbent, being of paramount importance for effective CO_2/CH_4 separation [4]. Additionally, cation gating effect occurs and relocation of compensating cations reduces the effective window opening for gas diffusion [5,6].

Secondly, we show the applicability of pure silica zeolites for olefin separations, since the lack of any acid site avoid the pore blocking due to olefin oligomerization inside the void volumes of zeolites. The rational selection of the adequate zeolite structure maximizes the adsorption capacity of the desired olefin [7-9]. Finally, it will be show how very tiny modification in the pore opening could have a dramatic influence into the selectivity during competitive adsorption processes [10,11].

These results exemplify which are some of the parameters governing adsorption processes and the strategies taken for improving productivity and selectivity during gas separation processes.

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