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Competitive siloxane adsorption in multicomponent gas streams for biogas upgrading

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Abstract

Biogas, produced in anaerobic digesters, is used as a renewable fuel after undergoing several upgrading processes. Adsorption onto activated carbon is the most widely used technology to remove harmful volatile compounds, such as siloxanes. However, the competition for the adsorptive sites with other biogas impurities reduces the performance of the adsorbents increasing the operative costs.

This work studies the competitive adsorption of volatile organic compounds and siloxanes into activated carbons of different sources and activation processes. Ten selected materials were exhaustively characterized in terms of textural and chemical properties. Dynamic competitive adsorption tests displayed different equilibrium uptakes for each target compound depending on the properties of each carbon type. Chemically activated carbons demonstrated a higher adsorption capacity and higher selectivity for bulky siloxanes, being the most suitable adsorbents for biogas upgrading. The performance of the adsorbents was also investigated in the presence of moisture, which enable siloxane hydrolysis reactions in the carbon surface, leading to the formation of α-ω-silanediols, especially on phosphoric acid-activated carbons.

The technical implications of this work are discussed in terms of biogas volume treated per volume of adsorbent at the first siloxane breakthrough. Phosphoric acid activated carbons are capable of treating higher number of bed volumes, reducing the costs associated to the adsorbent replacement.