How Adsorbents Work in TSA and CO_2 Absorption

A 3 minute introduction by Julian Barth

At the Carbon Team, adsorbents play a crucial role and are a topic of ongoing research in our partner laboratories. Combined with temperature swing adsorption (TSA), they can separate and capture gasses, in our case CO_2.

Adsorbents are materials designed to attract and hold gases on their surface. Think of adsorbents as special sponges designed to trap CO_2. Just like sponges have pores to hold water, adsorbents have tiny pores that capture CO_2 molecules. But there's a twist: adsobants doesn't just hold the CO_2 forever, they can release it when needed, making them reusable for multiple cycles.

The TSA process can be broken up into two main stages.

1) **The Adsorption Phase**: During this phase, the adsorbent captures CO_2 from a gas stream. The adsorbent material is kept at a room temperature, which makes it easier for CO_2 molecules to stick to its surface.
2) **Desorption Phase**: Once the adsorbent has reached and equilbrium loading of CO_2, the system heats it up. The higher temperature affects this equlibrium, letting go of CO_2 molecules, freeing the adsorbent for reuse. The released CO_2 can then be collected and stored or used for other purposes.

New adsorbants are being disovered and perfected every day to optimize key componenets. This quest is a case of finding a balance between key paramters. The ideal adsorbant should of course have a great adsoption capacity and high selectivity (targenting only CO_2 molecules). However, its thermal stability, moisture tolerance and cost of regeneration are just as important factors.

Three adsorbants have already made their proofs:

- **Zeolites** are crystalline, porous materials with precise pore sizes that selectively trap CO_2 molecules, making them ideal for high-concentration CO_2 capture in industrial settings.
- **Metal-Organic Frameworks (MOFs)** are highly tunable materials with massive internal surface areas, offering exceptional CO_2 capture capacity and selectivity, especially in advanced technologies.

- **Activated Carbon** is a versatile, porous material derived from organic sources, known for its high surface area and ability to work effectively in humid and diverse temperature conditions.

Adsorbents are our vital tools at the carbon team for tackling climate change. By selectively capturing CO_2 through adsorption and using thermal energy to release it, these systems offer a smart and sustainable way to manage carbon emissions.

Don’t hesitate to reach out to us for more information !