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MixSorb L[®]: Determination and evaluation of single- and multi-component sorption isotherms with breakthrough curves

Introduction

Climeworks is a Swiss company specializing in the removal of carbon dioxide through direct air capture (DAC). Climeworks' ultimate goal is the reversal of climate change. As carbon dioxide is one of the main drivers of climate change, they focus their efforts on its removal. They achieve this removal through an adsorption-desorption process that is the core of their DAC plants.

As the location of the plants has an effect on temperatures and relative humidity in the air, the respective impact of these parameters on the performance of the sorbent materials within Climeworks' portfolio is important when considering the sorbent selection.



Fig. 1: Climeworks' CO₂ collector

Procedure

The goals of this project were achieved by first conducting a series of breakthrough experiments performed on the MixSorb L sorption analyser by 3P instruments. The measurements were carried out at different temperatures ranging from 5°C to 35°C, at different levels of relative humidity ranging from 0% to 90% and varying levels of CO₂ concentrations ranging from 60ppm to 600ppm in order to assess the adsorption capacities within these ranges. This data was then analysed and integrated in the MixSorb Manager Software to calculate adsorption isotherms.

The isotherm data of all viable runs was then used to determine and fit a representative adsorption isotherm model that was used to discuss the adsorbent material properties

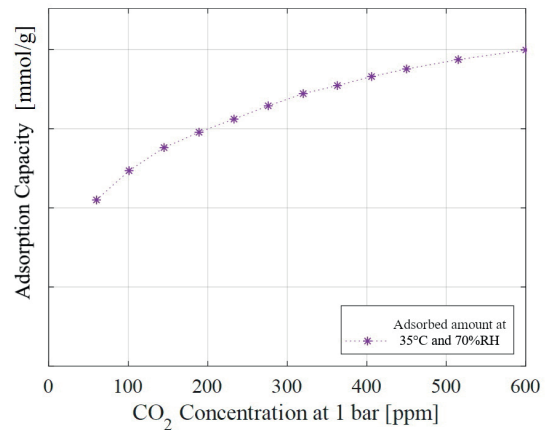


Fig. 2: Isotherm curve: CO₂ Adsorption capacity as a function of CO₂ inlet concentration. Resulting values are not shown due to confidentiality

Results

A realistic interactive Langmuir-BET adsorption model was developed and proved to be a suitable fit. The model matched the measurements with a mean relative absolute error of under 10%. The used cases of this project revealed some limitations of the MixSorb L, the CO₂ adsorption properties have been successfully investigated within the temperature, humidity, and CO₂ concentration ranges defined.

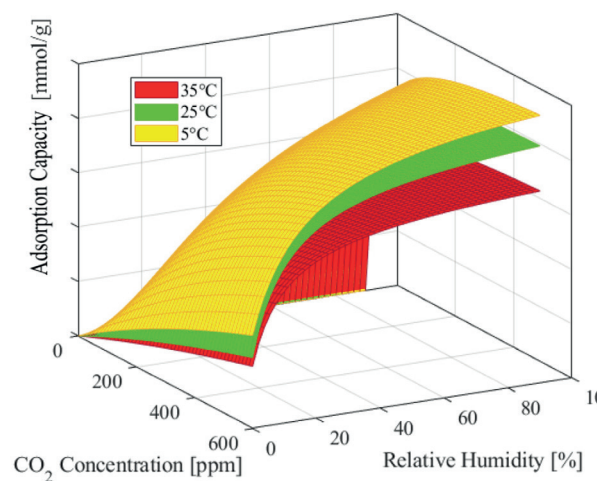


Fig. 3: Modelled results. CO₂ Adsorption capacities are not shown due to confidentiality