

Using the HPVA to Analyze High-Pressure Carbon Dioxide Capture on Porous Carbons

The Particulate Systems HPVA (High Pressure Volumetric Analyzer) can evaluate the adsorption and desorption isotherms of carbons, metal organic frameworks (MOFs), and other materials at pressures up to 200 bar using a variety of gases. One application of the HPVA that is of particular interest in today's push for greener manufacturing and industrial processes is measuring carbon dioxide capture on carbons. Carbons can be used in stack scrubbers to capture the carbon dioxide produced by fossil fuel burning power plants and chemical refineries. The high-pressure system of the HPVA can also simulate conditions similar to the conditions underground where carbon dioxide can be stored using sequestration.

The HPVA was used to evaluate the amount of carbon dioxide that can adsorb onto two porous carbons – Carbosieve S-III and Ultra Microporous Carbon (UMC) at pressures up to 40 bars. The carbon sample was placed in a sample tube and installed on the degas port of the HPVA, where it was evacuated under vacuum and heated to 350 °C. To ensure the removal of all water vapor and adsorbed gases, the sample

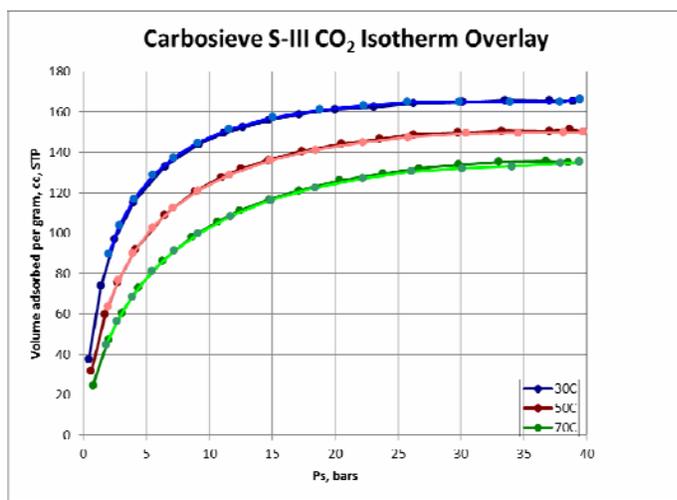


Figure 1: The carbon dioxide excess adsorption/desorption isotherms of carbon S-III. For differentiation purposes, the desorption curve is a lighter shade than the adsorption curve.

was kept at 350 °C for a period of 20 hours. After 20 hours the sample was brought back to room temperature and moved to the analysis port of the HPVA. An isolation valve on the sample stem prevents any atmospheric gases and water vapor from contaminating the sample after degassing. Once on the sample port, the carbons were analyzed at three temperatures: 30 °C, 50 °C, and 70 °C. The analysis temperature was held constant by means of a re-circulating temperature control bath. The analysis temperature was held to ± 0.1 °C throughout each analysis, with the exact sample temperature measured by an RTD integrated into the HPVA system. Each isotherm experiment took approximately 24 hours to complete. The isotherms are shown in Figures 1 and 2.

Due to the non-ideal nature of carbon dioxide at elevated pressures, the volumetric calculations are corrected using the compressibility factor (z) of carbon dioxide as a function of temperature and pressure. The compressibility factor at each temperature and pressure is determined using the National Institute of Standards and Technology (NIST) Reference Fluid Thermodynamic and Transport Properties Database (REFPROP), Version 8.0, 2007.

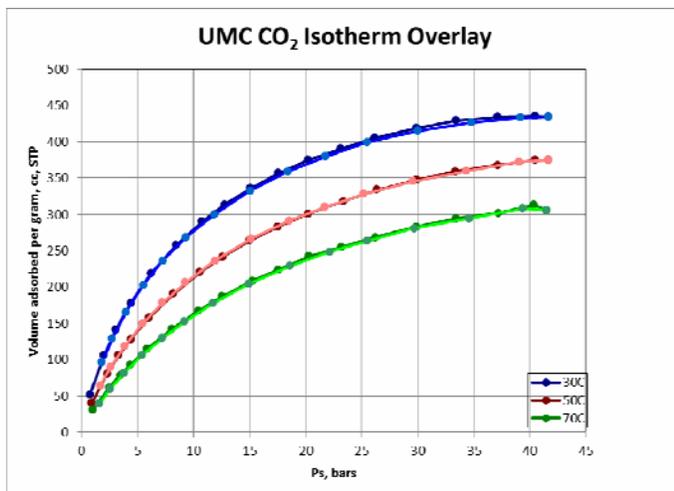


Figure 2: The carbon dioxide excess adsorption/desorption isotherms of carbon DW509. For differentiation purposes, the desorption curve is a lighter shade than the adsorption curve.