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Reference Isotherms for Water Vapor Sorption on Nanoporous Carbon: Results of an Interlaboratory Study

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The ubiquitous nature of water makes understanding its effects on the chemical structure and properties of materials important to the development, processing, and applications of materials associated with food production, pharmaceuticals, construction, separation processes, sorbent-based industries, and emerging water sorption applications such as water harvesting and thermal energy storage.

A water vapor sorption isotherm is a measure of water content as a function of relative pressure (P/P_0) for pure water measurements or relative humidity (RH), when water is entrained in another gas. With the large number of isotherms generated by automated instrumentation, there is an increasing need for standardized measurement protocols, reference materials, and reference data. The National Institute of Standards and Technology (NIST) initiated a program to develop reference materials, reference data, and measurement protocols to improve adsorption metrology. The NIST Facility for Adsorbent Characterization and Testing (FACT Lab) recently led an interlaboratory study (ILS) to develop reference water vapor isotherms.

This ILS, sponsored by the Versailles Project on Advanced Materials and Standards (VAMAS), investigated water vapor sorption on a pelletized nanoporous carbon at 25 °C as a function of relative pressure (P/P_0) for pure water measurements and relative humidity, when a carrier gas is used. The sorbent used in this study is a certified reference material (CRM) with a high BET specific surface area produced by the German Federal Institute for Materials Research and Testing (Bundesanstalt für Materialforschung und prüfung or BAM) and is known as BAM-P109. This study examines both static and dynamic measurements at sub-atmospheric and atmospheric pressures, because the saturation pressure of water at 25 °C is only 3.17 kPa. This study is the first ILS to report reference data for a vapor sorption isotherm using a CRM. Thirteen laboratories participated in the study and contributed nine pure water vapor isotherms and four relative humidity isotherms, using nitrogen as the carrier gas. From these data, were reference isotherms, along with the 95% uncertainty interval ($U_k=2$), were determined and are reported.

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