

## **Isotherms of Water Adsorption/Desorption on Porous Solids at Temperatures between 105 and 250 °C**

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Quantitative prediction of the amounts of vapor adsorbed in porous solids is difficult despite a significant body of existing experimental results and extensive modeling efforts. Variations in pore sizes and shapes (even in manufactured materials with a high degree of uniformity), adsorption mechanisms, and adsorbate-adsorbent interactions lead to poor predictions of adsorption, particularly for different adsorbates over ranges in temperature. Most existing adsorption data were obtained using nitrogen near its normal boiling point as the adsorbate, or for a few other liquids near room temperature.

Measurements of adsorption of water on solids have been made between 105 and 250 °C using the ORNL isopiestic apparatus. This apparatus is unique in its capability for precise weighing of samples at elevated temperature and at pressure between vacuum and 40 bars. The gravimetric method, in contrast to the more common volumetric method, allows for continuous monitoring of the changes of the adsorbent itself such as degassing, oxidation, or decomposition.

Isotherms of water adsorption and desorption obtained at 105, 150, 200, and 250 °C are reported for four groups of samples: natural rocks from geothermal reservoirs, zeolites, activated carbon fibers, and porous silica glasses. These materials include both hydrophilic and hydrophobic surfaces which exhibit a wide variety of adsorption behavior, from purely physical adsorption with only high-pressure hysteresis loops due to the capillary condensation mechanism, to extensive low-pressure hysteresis due to more specific interactions between the adsorbent and water, and a complete lack of hysteresis in purely microporous solids. From a modeling point of view, the main benefit of measuring adsorption in a wide range of temperatures is to differentiate between the temperature-sensitive process of capillary condensation, and other mechanisms, which do not depend on temperature. The clear effect of temperature on the size of the hysteresis loop is contrasted with very weak temperature dependence at low pressures. In terms of the classical theory of capillarity based on the Kelvin equation, the collapse of the hysteresis loop at high temperature is due to the decreasing surface tension of water.