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Hydrogen storage via physisorption: the combined role of adsorption enthalpy and entropy

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Abstract: Materials capable of cost-effective on-board hydrogen storage and delivery are currently being sought worldwide as a means to facilitate a hydrogen-based energy transition in the transportation sector. Among the solutions proposed, hydrogen storage by physisorption on porous solids constitutes a main avenue of research, and for intelligent design of such materials a detailed knowledge of gas adsorption thermodynamics is of the utmost importance. Analysis of the available data for hydrogen adsorption on alkali and alkaline-earth cation exchanged zeolites clearly shows that standard adsorption enthalpy (ΔH^0) and entropy (ΔS^0) are correlated, in the sense that larger ΔS^0 values correspond to larger ΔH^0 values. It was also shown that, referring to absolute values, the relative rate at which adsorption entropy changes decreases gradually as adsorption enthalpy increases thus resulting in a non-linear correlation between ΔH^0 and ΔS^0. These results are discussed and corresponding implications for hydrogen storage via physisorption are highlighted.

Key Words: Adsorption thermodynamics; enthalpy-entropy correlation; hydrogen physisorption; hydrogen storage.

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