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# Improved Model for the Isosteric Heat of Adsorption and Impacts on the Performance of Heat Pump Cycles

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## Abstract

The isosteric heat of adsorption strongly associates with the energetics of the adsorption processes. Being a direct function of the uptake amount, accurate modelling of the isosteric heat of adsorption is crucial in the design and development of adsorption systems. The isosteric heat of adsorption is often calculated using the Clausius-Clayperon equation with the perfect gas assumption and negligible adsorbed phase volume. We present a thermodynamic model of the isosteric heat of adsorption that addresses the non-ideal behaviour and the variation in the adsorbed phase density. The model is first validated using experimental data in comparison with the models that invoke the ideal gas assumption with negligible adsorbed phase volume which are available in the literature. Using these models, the isosteric heat for adsorption processes is examined from partial vacuum to high pressure as well as adsorption temperatures above the critical point. The impact of the prediction by each model on the system performance is then assessed in terms of the theoretical *COP*. For the realistic evaluation of system *COP*, an improved equilibrium cycle model is developed and the system performance is investigated using various models for the isosteric heat of adsorption. For adsorption at partial vacuum conditions, the *COP* values by the ideal model are up to 1.8% higher when compared to the calculations using the present model. For high-pressure adsorption below the critical temperature, for example; Maxsorb III + R134a pair, the present model predicts 13% lower *COP* than the models available in the literature. The variation in the adsorbed phase density addressed in the present model leads to a higher value of isosteric heat (3.8% to 8.6%) for adsorption above the critical temperature.

Keywords: Adsorption; Isosteric heat; Adsorbed phase volume; Non ideal correction

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