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High temperature water vapor sorption of zeolites

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Motivation

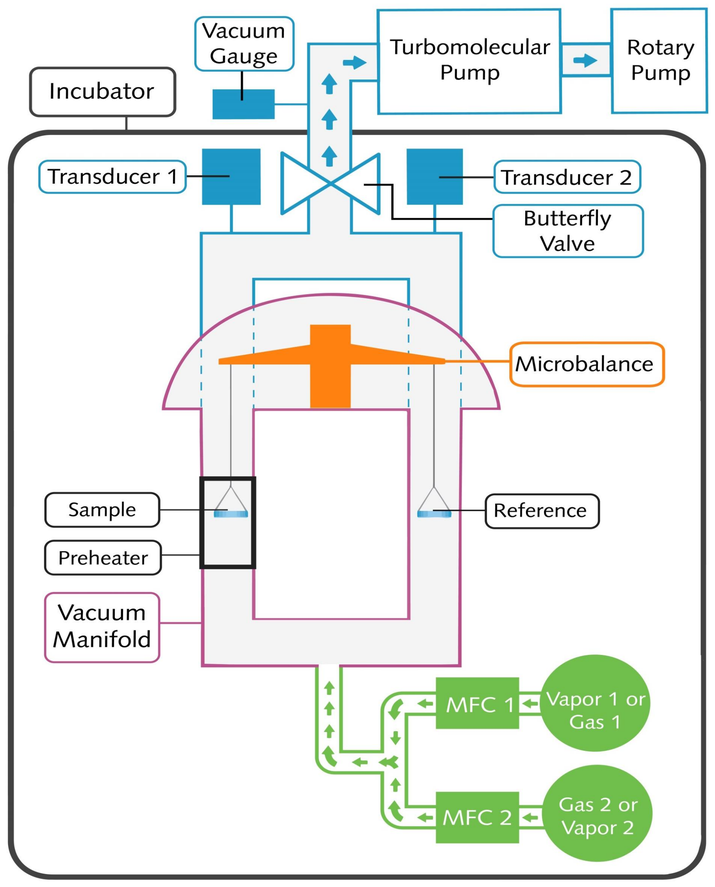
Micro- and meso-porous materials such as zeolites 4A, A10 (Sylosiv) and MCM-41 respectively have gained much of interest nowadays due to their promising applications in novel heating and cooling technologies exploiting thermo-adsorptive effects. Since these materials show exceptionally high uptake in the low partial pressure range in which water can be considered as an adsorbate for cooling applications. As a result, adsorption by these materials in the presence of water vapor is extensively studied in order to provide information on adsorption capacities and energy requirements for regeneration of adsorbents. To gain deeper understanding of their water sorption kinetics and adsorption capacities after several adsorption/desorption cycles, isotherm data for wide range of temperatures that are relevant to industrial processes are required. In addition, the selection of various probe molecules and their mixtures (water- alcohol) give access to physico-chemical parameters that are critical for understanding the material performance in extreme conditions.

The Vacuum Dynamic Vapor Sorption (DVS vacuum) is only gravimetric instrument that can provide real-time sorption data. The instrument is capable of determining both water or/and organic vapour sorption as well as gases or mixture of gas and vapor i.e. competitive sorption isotherm measurements from ambient to high temperatures using both static or dynamic vacuum methods. Moreover, It performs adsorption and desorption isobars measurements.

Principle of Vacuum Dynamic Gravimetric Sorption

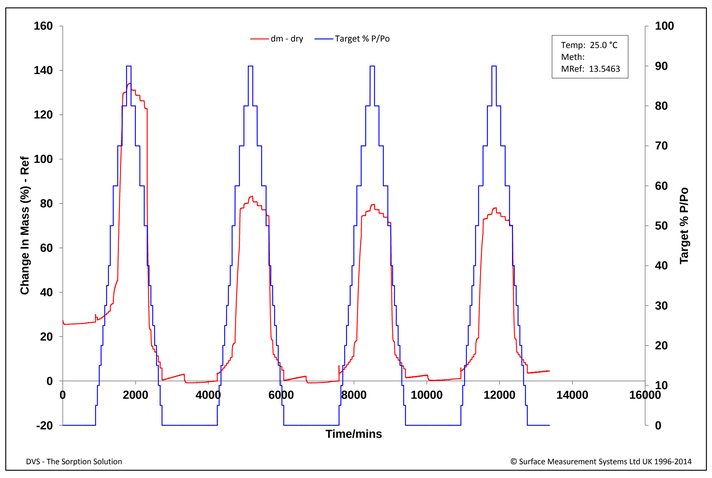
A unique principle of the DVS Vacuum is the ability to control sorbate entry and exit flows simultaneously while recording change in sample mass. The benefits are broad range of sorption experimental partial pressures, real time sorption kinetics (diffusion coefficients), sorbate molecule residence time control and thermal cycling. The DVS Vacuum also covers a wide range of sample and vapor temperatures allowing for sample thermodynamic properties determination. This includes capability of *in-situ* sample pre-treatment at elevated temperatures and vacuum conditions. Wide range of molecules both gas and vapor phase are controlled through sophisticated flow control system. Tailoring the sorbate molecule gives access to many physico-chemical parameters.

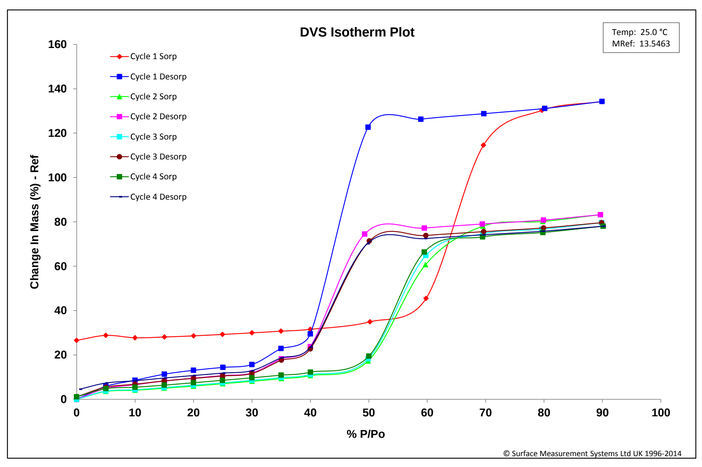
Schematic drawing of DVS vacuum



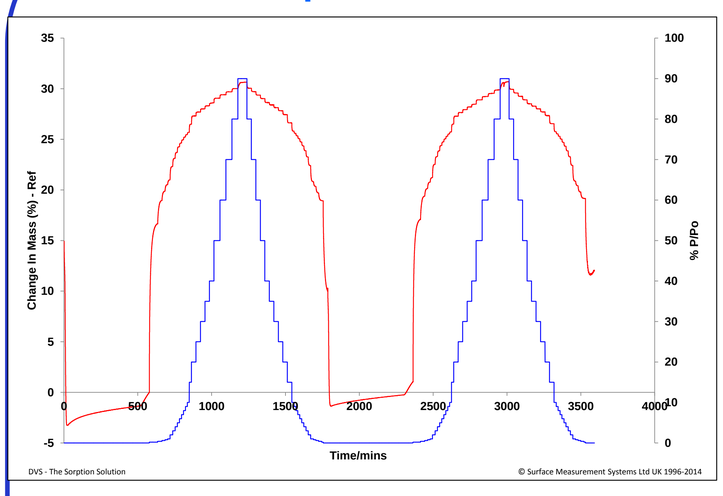
Experimental results

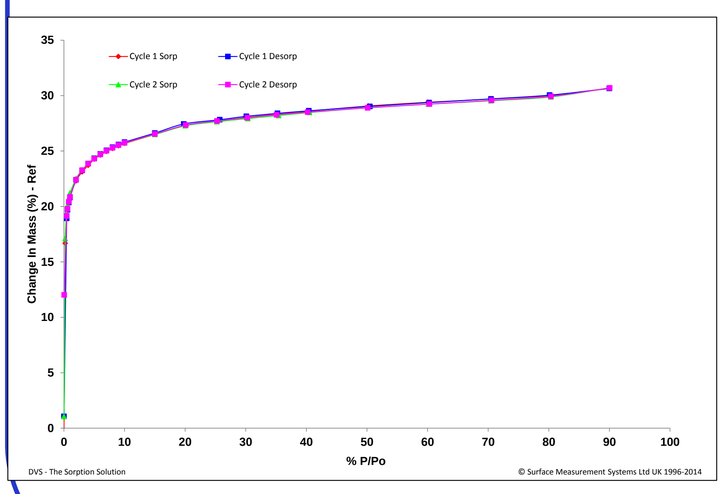
MCM-41 water sorption at 25°C



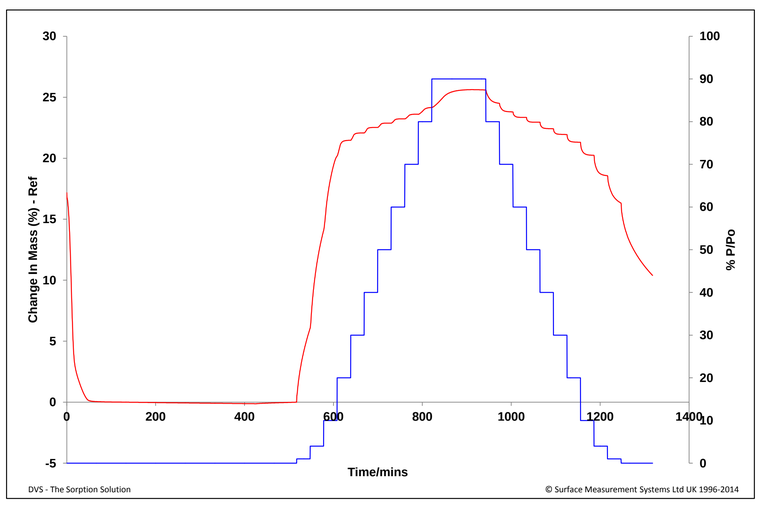


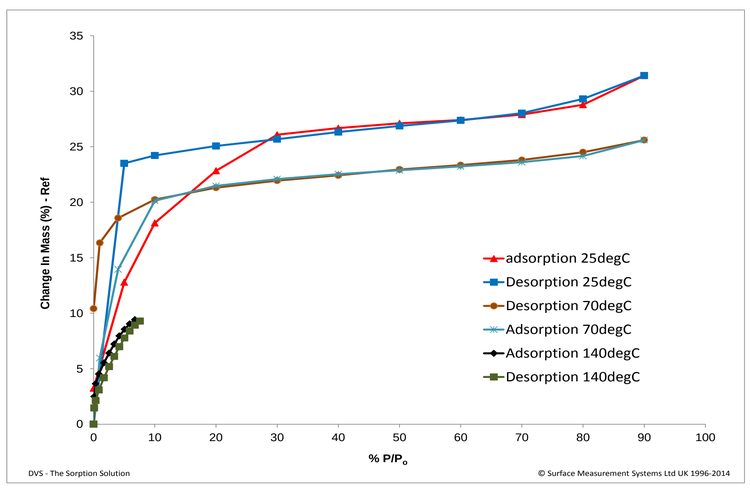
A10 water sorption at 40°C



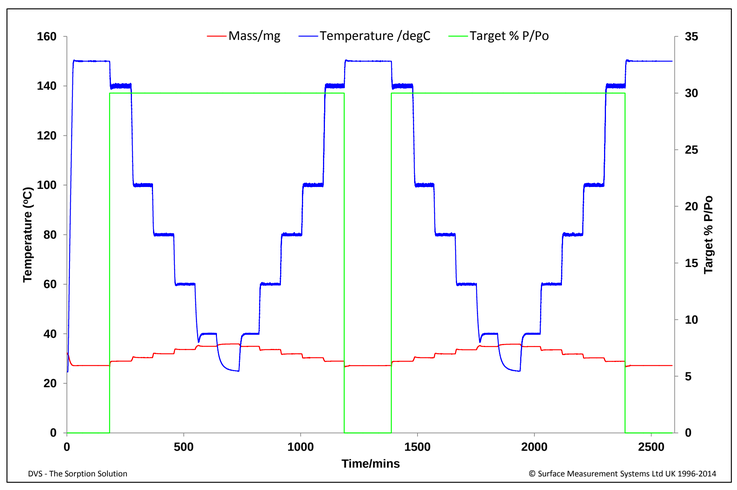


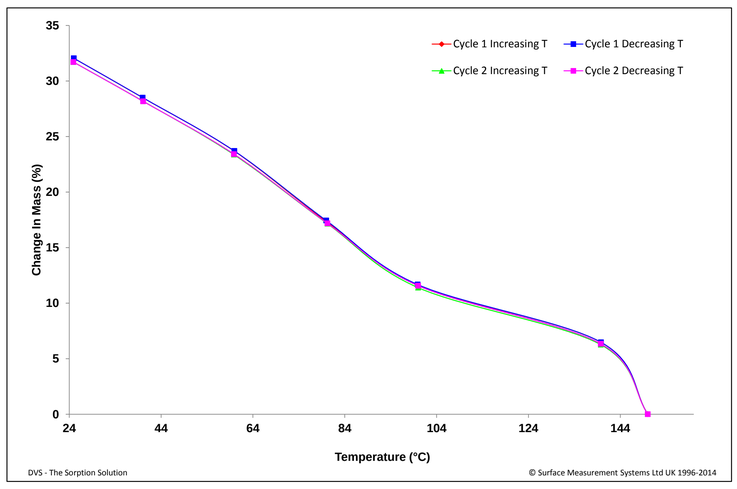
4A water sorption at 25, 70 and 140°C





A10 water sorption isobar at 0.95 kPa





Conclusion

Sorption data obtained using condensable vapors shows that DVS vacuum provides the unique approach to obtain adsorption and desorption isobars plus dynamic physisorption isotherms at different temperatures.

References: Li, X Microporous and Mesoporous Materials, 2014. **201**(0): p. 151-159; Garcia-Heller, V Renewable and Sustainable Energy Reviews, 2014. **34**(0): p. 8-19