Surface Measurement Systems
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DVS Application Note 15

Faster Sorption Isotherms using Helium Carrier Gas

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This application note demonstrates the use of helium carrier gas to reduce the measurement time required for such materials and thus further increase productivity.

Introduction

Dynamic Vapour Sorption is widely used in many R&D labs throughout the world to measure moisture sorption and desorption isotherms, providing researchers with a 10-100 fold increase in faster measurement time over traditional static methods. Although typical measurement time for one complete cycle of moisture sorption/desorption using nitrogen carrier gas is approximately 24 hours, very hygroscopic materials (i.e. cellulose), or microporous materials (i.e. activated carbons) often take 2 days or more if good establishment of equilibrium is required.

Method

To demonstrate the effect of using helium carrier gas on the moisture sorption kinetics, sorption/desorption isotherms on activated carbon were measured using both nitrogen and helium carrier gases. A sample size of approximately 10 mg was used for both experiments, and a humidity profile of 0% RH, 20% RH, 40% RH, 60% RH, 80% RH, 95% RH was chosen for the sorption and desorption isotherms. A dm/dt value of 0.005% min^{-1} was chosen for the establishment of equilibrium.

Results

The moisture sorption and desorption kinetics for the activated carbon are shown in Figure 1. The data is expressed as the percentage change in mass referenced to the sample mass after the drying stage. The data clearly demonstrates the increase in speed gained by using helium carrier gas over nitrogen. In this case the total sorption/desorption measurement time was reduced by approximately 1/3, with the most striking gain in speed occurring during the 60% RH sorption and the 40% RH desorption steps. These two humidity steps correspond to the steepest parts of the isotherm, where the sorption kinetics are limited by the diffusion of water molecules into the microporous structure.

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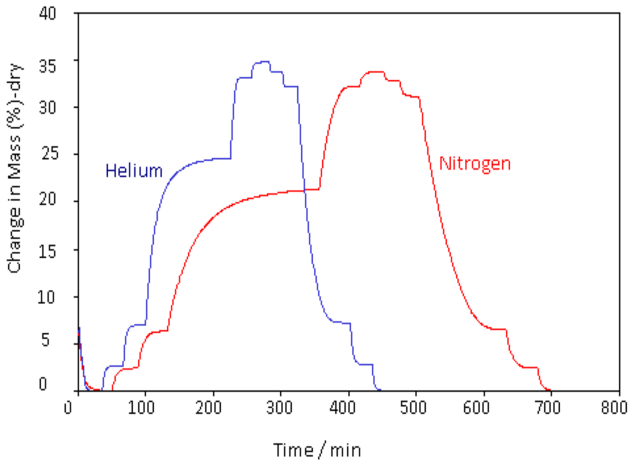

Figure 1. Kinetics of moisture sorption/desorption for activated carbon.

The data does however show some subtle differences between equilibrium moisture contents for the two carrier gases. It is believed that this may be due to small calibration errors in the mass flow controllers, which need to calibrated for use with helium rather than nitrogen to achieve optimum results.

Conclusion

The use of helium to speed up the kinetics of sorption and desorption by DVS has been demonstrated on activated carbon, where a 1/3 increase in speed is observed. A similar increase in speed has also been observed for other materials within our laboratory such as microcrystalline cellulose, and demonstrates the significant scope for productivity gains using a combination of DVS and helium carrier gas.

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