Water Vapor Sorption of Product Packages

proUmid GmbH & Co. KG

Application Note 15-01

Introduction

Dynamic Water Vapor Sorption is the method of choice to determine water uptake and to record sorption isotherms of materials like powders, granules, flakes, tablets or candies. Sorption testers are often used to perform stability testing of new products. These long-term tests may run over several weeks or even months giving valuable results with respect to the influence of temperature and relative humidity on the shelf-life of a product.

Further on, the analysis of how much water vapor permeates through the packaging at particular climatic conditions is of high importance. Sorption of water migrated into the package from the outside atmosphere has a major impact on the shelf-life of a packaged product.

Sample Tray for Large Objects

The SPS and Vsorp sorption testers with their high balance sensitivity along with their large dynamic load range of up to 220 g enable the analysis of fine powder samples with a minimum sample amount as well as large objects with high resolution and accuracy.

The Large Objects Tray for large samples (see Fig. 1) that is available for the SPS as well as the Vsorp series is designed to hold product packages of dimensions up to 88 mm length, 68 mm width and 28 mm in height.

Food Application – Candy Packages

Water uptake of three candy packages using the LO sample tray with a SPSx-1µ High Load sorption tester was measured. Fig. 1 shows the three packages placed on the sample tray. The samples on positions 1 and 3 were without an additional film packaging whereas sample 2 was enveloped with a transparent plastic film. The test was done at constant temperature of 25°C. The packages were first dried at 0 % RH, then the humidity was increased rapidly up to 90% RH. Weighing was done every 10 minutes.

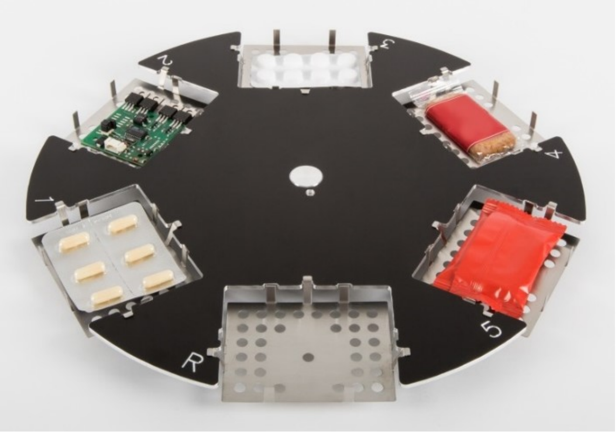

Fig. 1: SPS with Large Object tray with 5 sample positions and one reference pan for moisture sorption analysis of product packages.

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Discussion

The sorption curves in Fig. 2 show that the water uptake behavior of the two types of packaging was significantly different. In case of the samples without film packaging, the increase of the RH from 0 % to 90 % first caused a rapid uptake of water. In the further course of the test, water vapor, which migrated through gaps into the inside of the packaging, was adsorbed by the candy at a constant rate, resulting in a nearly linear increase of the sample weight.

In the sample with film packaging, water vapor sorption occurred at a much lower rate. The results showed that the plastic film around the packaging provides a better diffusion barrier than the packaging itself. This slows down the rate at which water molecules are adsorbed by the candy inside the packaging. Nevertheless, it was still possible to clearly determine the sorption rate.

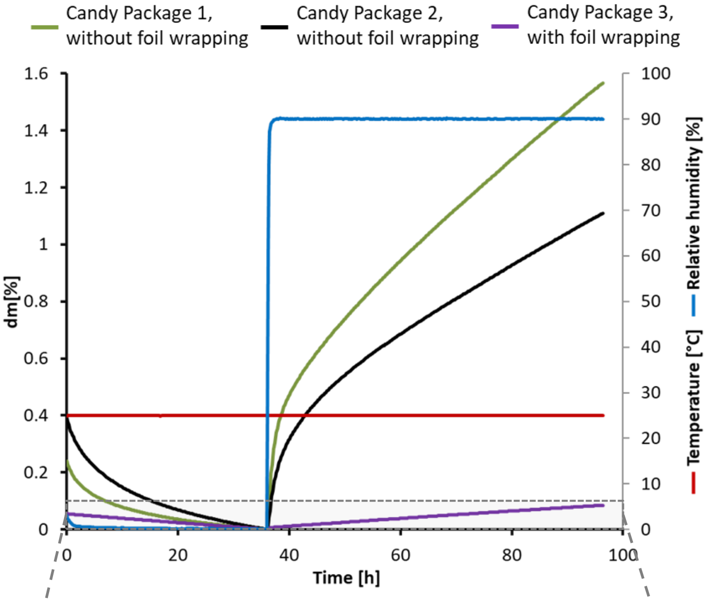

Fig. 2: Sorption kinetics of different types of candy packages when increasing the relative humidity from 0 % to 90 % at a constant temperature of 25°C.

The enlarged scale in Fig. 3 enables a closer look on the sorption behavior of the sample with an additional film packaging. The abrupt jump in sample weight immediately after the increase of the relative humidity to 90 % indicates the adsorption of water molecules on the surface of the film. After covering the surface, the water molecules diffuse through the film at a constant rate and are adsorbed both by the candy inside the packaging and by the packaging itself.

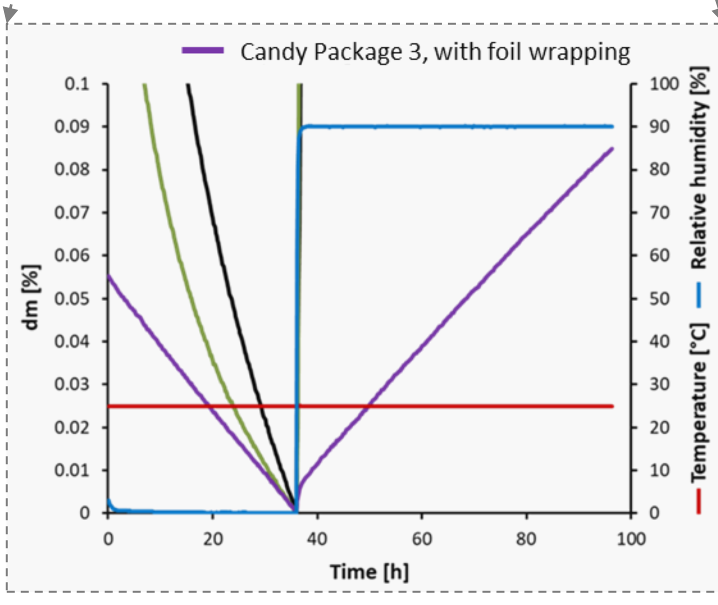

Fig. 3 : Sorption kinetics of a candy package enveloped with plastic film when increasing RH from 0% to 90%.

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Permeability rate

The permeability rate was determined from the slope of the linear part of the sorption curve (Fig. 4).

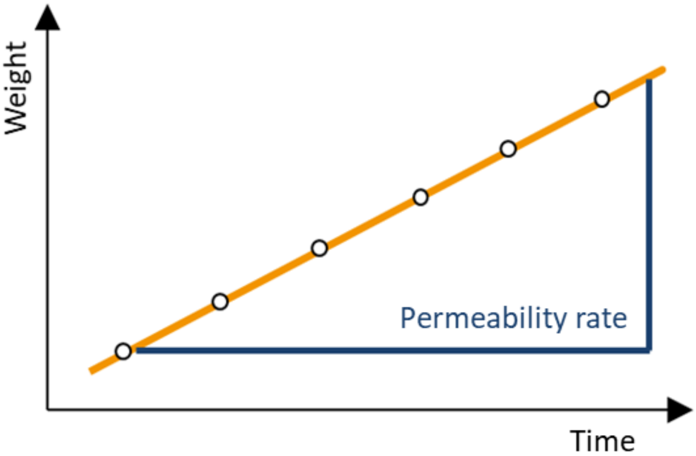

Fig. 4: Exemplary curve of a water vapor permeability measurement.

With unknown surface area of the packaging, the unit is [g/day]. If the surface area of a film packaging is known, the standard unit [g/day*m²] for permeability tests according the EN ISO 7783-1 is used.

Permeability rate of candy packages:

Package 1 (—):	0.056 g/day
Package 2 (—):	0.042 g/day
Package 3 (—):	0.006 g/day

Conclusion

- The SPS and Vsorp sorption systems are well suited to analyze water vapor sorption of large samples such as product packages.
- Determination of the water vapor permeability rate (g/day) of product packages is feasible even on sealed packages.
- The sample tray for large objects adds another dimension to the analytical capabilities of the SPS and Vsorp multi-sample sorption testers and allows the analysis of the sample material itself as well as the final product in its packaging.
- The applicability of the sorption tester is thereby extended from research and product development to the process of package design, increasing the instrument value to the end-user.