Water vapor sorption of plaster

– Application Note 20-07

Introduction

Dynamic vapor sorption measurements are an important instrument in the development and evaluation of building materials like plaster, cement, mortar and similar.

Due to the wide range of uses and tasks for such materials, a variety of products are available to meet the requirements of the respective application.

An important criterion here is the water absorption capacity of the material. For example, plasters developed for use in bathrooms should have a higher water absorption capacity than plasters used in living spaces or as exterior and thermal insulation plasters.

Plasters for interior applications are commonly hygroscopic and therefore suitable to passively regulate the climate in terms of room humidity. By absorbing moisture at high relative ambient humidity and a subsequent desorption at low room humidity, a pleasant room climate can be maintained [1].

For outdoor use, the durability and weather resistance of building materials is an important criterion. Both strongly depend on the interaction of the material with moisture. Since water is involved in most physico-chemical processes, the property profile of the material should meet the requirements of the specific site of use [2].

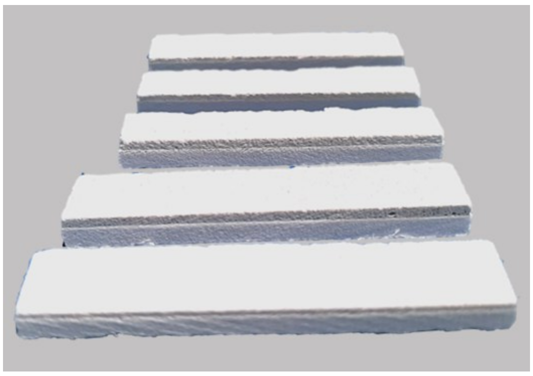

Fig. 1. Plaster samples for DVS measurements

Fig. 2. Vsorp for moisture sorption analysis

Dynamic water vapor sorption measurements can be used to specifically adapt new formulations, structures and processes to specific requirements. The behavior of the material under the influence of changing relative humidities as well as temperature effects can be analyzed. Furthermore, DVS measurements can be used to simulate and accelerate ageing processes induced by climatic effects. Thus, statements on the durability of materials can be made more quickly.

The devices of the SPS and Vsorp series allow both a sensitive and time-saving measurement of the water vapor sorption behavior due to the multi-sample option. In addition, large sample dishes with a diameter of 86 mm (available for Vsorp basic and Vsop plus) and the optional accessory “Large Object Kit” with a dimension of 68 x 88 x 28 mm (width x length x height) enable the measurement of large samples, which is particularly interesting for building materials to obtain representative results.

DVS analysis

The water vapor sorption and desorption of plasters was analyzed with a Vsorp Basic. The measurement was performed at a temperature of 25 °C. The plaster samples were preconditioned at a relative humidity of 50 %. Afterwards the RH was increased to 90 %. After reaching equilibrium, the relative humidity was lowered to 50 % to measure the desorption behavior of the samples.

Results

The measurement protocol aims to simulate the behavior of the plaster samples when exposed to changing climatic conditions, e.g. temporary increase of air humidity with subsequent room ventilation.

Results show that equilibrium conditions during the sorption step are reached after ~ 18 h for samples 1-4. Fastest humidity equilibration, was observed for sample 5 which was in equilibrium with the ambient RH after
~ 7 h. Desorption behavior of the samples follows the same trend. However, with ~ 7 h for samples 1–4 and 2 h for sample 5, desorption equilibrium is reached 2.5 to 3.5 times faster.

The test samples were prepared by applying the plaster on a supporting, concealed layer. Fig. 3 shows the results of the water absorption, standardized to the surface area of the test specimen.

To eliminate the influence of different layer thicknesses, results are illustrated standardized to the thickness of the sample in Fig. 4.

Based on these results, clear differences in water absorption capacity can be seen, ranging from 33 g/m^2 to 107 g/m^2 when the samples are exposed to an ambient relative humidity of 90 %.

Furthermore, the comparison of samples 2 and 3 as illustrated in Figs. 3 and 4 shows that although the plaster layer height of sample 2 is only half that of sample 3, the moisture absorption capacity of sample 2 is higher (Fig.4).

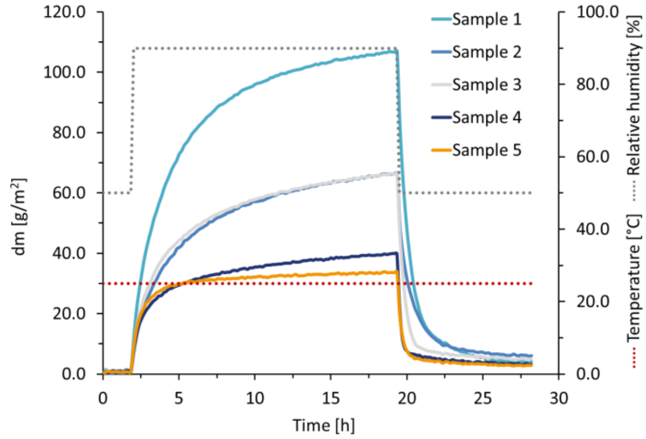

Fig. 3: Sorption and desorption behavior referred to the surface of the test specimen.

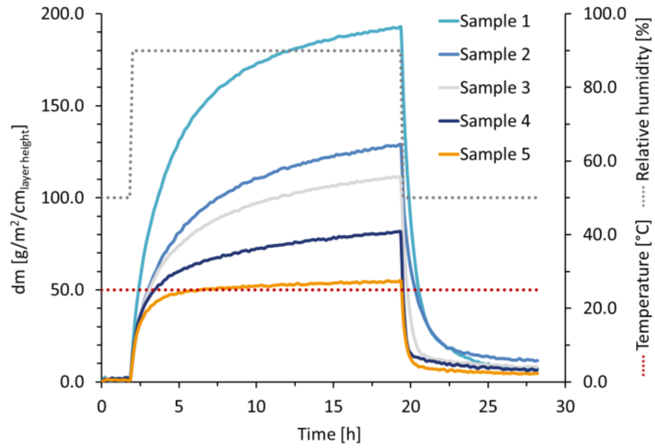

Fig. 4: Sorption and desorption behavior of plaster samples referred to sample surface and thickness.

This can be explained by the fact that the water is not only adsorbed on the surface but also absorbed inside the sample. Results give an indication of the influence of the inner structure on the water sorption of the material.

In addition, sorption data of the materials show a certain hysteresis, resulting in residual water contents between 2.8 g/m^2 (sample 5) and 6.1 g/m^2 (sample 2).

Conclusion

Results show that proUmid's Vsorp device enables a clear distinction between different plaster materials. Thus, regarding moisture absorption, the material properties can be characterized sensitively.

Analysis of the water vapor sorption behavior of building materials is an effective tool for developing new formulations, testing of new applications and in the field of quality assurance.

References

[1] D. Maskell, A. Thomson, P. Waler, M. Lemke, Direct measurement of effective moisture buffering penetration depths in clay plasters, in: 7th Int. Conf. Build. with Earth (LEHM 2016), 2016.

[2] M. Saeidpour, L. Wadsö, Moisture equilibrium of cement-based materials containing slag or silica fume and exposed to repeated sorption cycles, Cem. Concr. Res. (2015). doi:10.1016/j.cemconres.2014.12.005.