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Application Note 2

Absorption Measurements with the DataPhysics OCA 20 / OCAH 200

Quantitative determination of the absorption behavior of filter membranes

The Problem

In order to characterize the properties of porous absorbent materials; physical measuring methods are used in addition to chemical ones in industry and in research. This often involves measuring the static absorption capacity in such a way that the maximum absorption of a particular liquid is determined. With further development and optimization of such materials the absorption rate is however of great interest from a time perspective as it often shows the characteristic pore size in certain application fields. The absorption kinetics are determined not only by the upper surface and the volume porousness but also by the direction dependency of the speed of the spread. When using more than one liquid the differing viscosity of the absorbent liquid must also be taken into consideration. Using the example of filter membranes as they are used for example in beer production, we will show how with the help of the contact angle measuring system OCA 20 / OCAH 200, an exact quantitative prediction of absorption kinetics with the absorption of water can be made.

Method

In the analyzed case it was the absorption behavior of water that was of most interest.

Of course the suggested method is not limited to water as an absorbent liquid. In order to place the drop onto the membrane a defined liquid volume was dropped from a cannula and syringe.

As the volume taken in this way is dependent on the upper surface tension of the water and the diameter of the cannula, drops of only about the same volume can be placed on the equipment. The dropping of the drop has the advantage over depositing it that even at the beginning of the absorption, the shape of the drop is not influenced by the cannula. Immediately after the impact of the drop on the base, the drop flattens out however after some 40 ms the networking reaction reaches its equilibrium.

In order to enable the recording of the interesting data like e.g. the volume, the networking surfaces or the contact angle with sufficient accuracy, it is necessary to firstly record the absorption process in the form of a picture sequence using a rate of 50 pictures per second (with the OCA 20). As an alternative the recording of data during the absorption process can be considered (automatic measurement). Compared to recording a picture sequence this does have a disadvantage: due to the absorbed liquid, the base frequently wells up and therefore the base line at the boundary between drop and base needs to be automatically recognized. Given that the recording of a picture sequence takes less time to measure each value, a faster speed can be achieved than with the automatic measurement. With recording a picture sequence there is the possibility to control the analysis of the individual pictures and to make corrections if necessary and therefore avoid wrong measurements. The prerequisite for this method is that the recording takes place with a high enough picture rate according to the speed of absorption. By using the specially developed high speed measuring system OCAH 200 a measurement can be obtained every 2.8 ms.

Results

In picture 1 the absorption of a hydrophilic filter membrane is represented by a picture sequence of 6 pictures, between each frame is given. The whole series consists of 109 pictures. From the description it is clear that the volume of the drop as well as the contact angle continuously decreases.

In order to more precisely analyze the rate of absorption; the measured drop volumes are applied

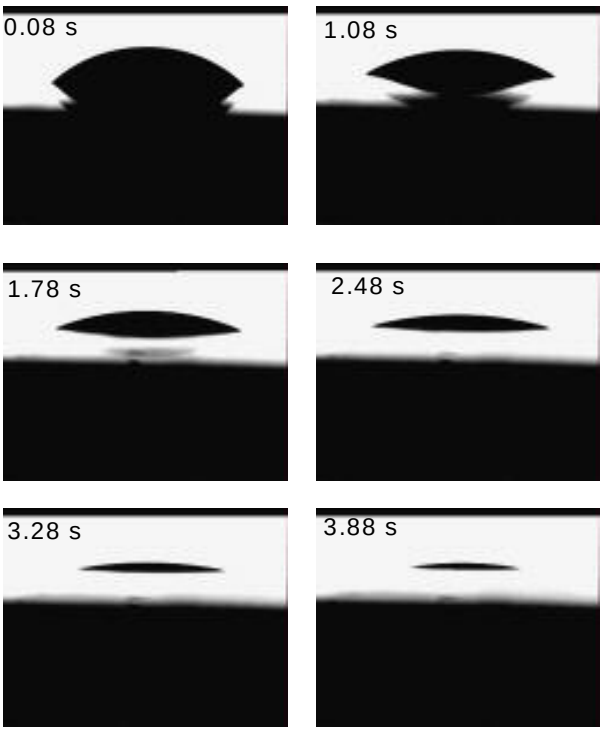

Figure 1 Picture sequence of the absorption of a water drop on a filter membrane.

as a function of time for 3 membranes. The different absorption speeds for the different pre-treated membranes are clearly recognizable.

A faster decrease (steeper curve) of the contact angle is seen for the untreated and hydrophobic membrane within the first few seconds than is the case later on.

This faster absorption vertical is for the absorption vertical to the membrane level than at membrane level. This effect had already been theoretically predicted and concerns the inefficient creation of new surfaces between water and air as the water spreads out within the membrane. As this surface is considerably influenced by the upper surface porousness of the upper and lower sides of the

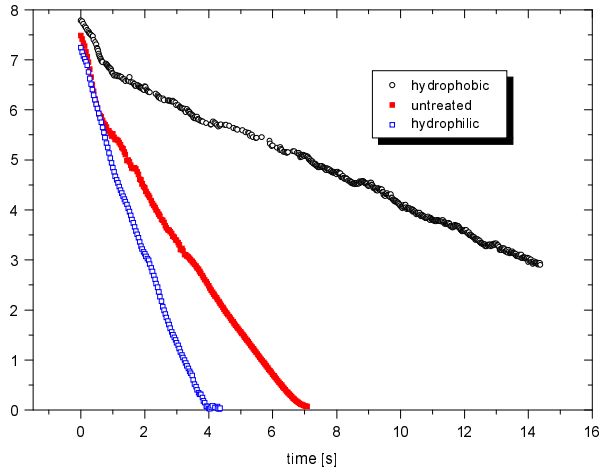

Figure 2. Volumes as a function of time on different pretreated filter membranes.

membrane, possible conclusions can be drawn from the difference of the gradients about the properties of the upper surface. At each measurement, a whole range of further measurements are recorded in addition to the drop volume e.g. contact angle and networking surface which are then available for analysis at any time.

Conclusion

Using different filter membranes it was shown that with the OCA 20, using modern speed optimum video measuring technology, it is possible to directly and simply analyze the faster absorption processes. Only through the timely and exact determination for example, of the volume of a liquid drop on absorbent membranes, can the details of the absorption process be deduced and thereby the desired material properties optimized.