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Application Report

Wettability of powder

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Author: HL
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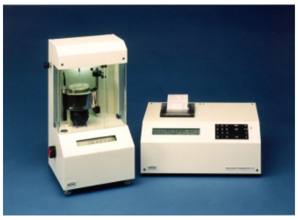


Force Tensiometer – K12

Method:

Keywords: Washburn method, powder wetting, pepper oil, starch, salt, contact angle, powder carrier system

Contact Angle Measurement of Spice Oil on Powder Carrier Systems

Introduction

Wettability of powders is in many industrial processes an important parameter for successful production.

In food industry it is necessary to cover a porous carrier system with flavor oil to get a spice powder. The oil is sprayed on the powder or the powder pigments are dispersed in the oil by a mixer. By these ways a flavor oil (mostly high concentrated) is transisted in a spice powder which is easier to dose and to use in practice.

By means of contact angle measurement a pre-selection of carrier systems for specific flavor oil is possible. Carrier systems with small contact angles show a better wetting behavior as those with big one. For development of new products it can be very useful to find carrier systems which are wetted well by the liquid.

There are two different main approaches to get contact angles of liquids on powder. The first is an optical one by means of a goniometer using the sessile drop technique, the second one uses a processor tensiometer to run sorption experiments and calculate contact angles by a Washburn calculation model [1][2]. The drawback of the sessile drop technique is that the powder has to be compressed to a block and when the drop is adjusted on the surface it may be absorbed too fast for optical contact angle measurement. A compressed powder also shows mostly a different wetting behavior as the powder used in practice. The sessile drop technique is a perfect method for non-porous systems, but for contact angle measurements of liquids (with angles smaller than 90° on the solid) on porous systems like powders the second mentioned method leads to better results.

Experimental

In this note the wetting behavior of high concentrated pepper oil on salt (NaCl) and potato starch (cellulose) as typical carrier systems in food industry is reported using a KRÜSS Processor-Tensiometer K12 with software package K121. The powder is loosely packed into sample holder FL12 with a wire net (width 70μm) at the bottom of the cell. Following parameters for n-hexane and pepper oil were used to calculate material constant and in a second step contact angle: surface tension, viscosity and density.

	surface mN/m]	viscosity [mPa s]	density [g/cm³]
n-hexane	18.4	0.33	0.660
pepper oil	33.5	64.47	0.921

Results

For material constant calculation salt and starch both were measured five times with n-hexane and the results of the Washburn calculation (unit of material constant c is 10^{-2} cm^5) assuming total wetting for each curve are:

Salt	0.0112321	0.0096104	0.0099283	0.0111162	0.0094981
Starch	0.0218155	0.0211591	0.0217282	0.0226395	0.0220080

In cases like here (variation of single measurement is high) it is of advantage that the software package K121 can create an average curve and calculates a material constant from this average curve. This increases the validity of material constant determination. The material constants for the average curves are:

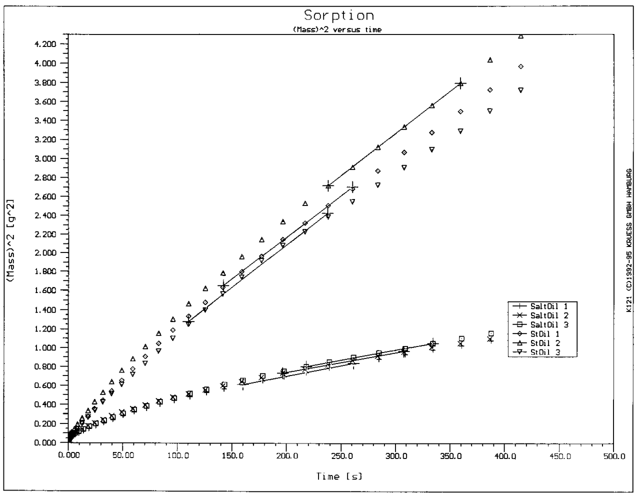
$$c_{salt} = 0.0105505\ [10^{-2}\ cm^5]$$

$$c_{starch} = 0.0220523\ [10^{-2}\ cm^5]$$

Using these values for material constants sorption measurements of pepper oil in salt and starch delivers following results (each experiment was run three times) for contact angle:

Salt	61.0 ° (0.9997)	63.3 ° (0.9996)	62.2 ° (0.9998)
Starch	23.3 ° (0.9998)	24.1 ° (1.0000)	21.2 ° (0.9947)

The following diagram shows the above mentioned six sorption measurements of pepper oil:



Conclusion

The results of contact angle determination shows smaller contact angles for potato starch as for salt. Assuming same particle sizes, same particle porosity and sample preparation, pepper oil wets potato starch better than salt. In this case starch is the more efficient carrier system for pepper oil.

Literature

[1] E.W. Washburn, Phys.Rev. 17, 374, (1921)

[2] K. Grundke, M. Boerner, H-J. Jakobasch, Colloids and Surfaces, 58 (1991) p. 47-59

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