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Application Note 3

Determining the Surface Tension between Coloured Printing Ink and Fountain Water

An Application Oriented Example for the Pendant Drop Method with the DataPhysics OCA 20

The Problem

The surfaces of printing plates can be sub-divided into 2 different areas. One is made up of the hydrophobic surface, which transfers the ink and the other of hydrophilic areas (spheres) which are networked by fountain water. In order that the limits between printing ink and fountain water don't mix (so-called tinting), it is necessary to establish the surface tension limits between printing ink and fountain water. Conventional methods for determining the surface tension between phases liquid/liquid, for example, using the ring tensiometer are relatively imprecise and experimentally expensive and because of the small density difference, for the most part no defined phase limit is shown. With the OCA 20 and the software modules SCA 20 and 22 the accurate determination of the interfacial tension according to the pendant drop method is easily possible.

Diagram 1 Image of a paint drop in Perfluorhexane

Method

Likewise, because of the small density difference, the tension limit cannot be determined with the pendant drop method. If the surface tension as well as the polar and dispersed parts of the two separate liquids is known, the surface tension limits can be calculated easily.

The polar and dispersed parts of the different liquids can be measured using the pendant drop method, so that in one measurement the entire surface tension is determined and in a further measurement the dispersed parts are determined by measuring the surface tension limits against an non polar liquid.

First of all the surface tension of the coloured printing ink and the fountain water were measured using the pendant drop method. In order to establish the dispersed and polar parts of the different components, the surface tension limits of the fountain water were established in comparison to dodekan. The ink analysed in this instance is soluble in alkaline, therefore it isn't possible to establish the surface tension limit. In perfluorhexan, a completely inert, unpolar solvent, the ink is insoluble. Establishing the surface tension limit is therefore simple. It is worth noting that perfluorhexane has a higher density than printing ink and an expanding drop was measured on the end of a specially bent needle. A representation of the drop is shown in diagram 1.

For an exactly description of the analysis to this measurement see also DPI application note “The Pendant Drop Method With the DataPhysics OCA 20”.

Results

One colored printing ink and three different types of fountain water were measured. In table 1 the surface tension measurements as well as their dispersed and polar parts are given.

Table 1 Surface Tensions σ, together with dispersed σ^d and polar σ^p parts of printing ink.

	σ [mN/m]	σ^d [mN/m]	σ^p [mN/m]
Printing ink	31.02	27.72	3.30
Fountain Water 1	52.07	26.92	25.15
Fountain Water 2	46.28	27.19	19.09
Fountain Water 3	39.10	18.68	20.42

As expected, the results for the printing ink surface tension was around 30 mN/m with a smaller polar part of some 10%. The three different fountain waters showed a large variation of the two different parts. It was shown that the dispersed part was sometimes less than, sometimes greater than the value of pure water (σ_{Wasser}^d = 21.8 mN/m), the polar part is however always less than that of water (σ_{Wasser}^p = 51.0 mN/m).

The calculation for surface tension $\sigma_{1/2}$ between fountain water and printing ink can be made using the Owen Wendt formula:

$$\sigma_{1/2} = \sigma_1 + \sigma_2 - 2\left(\sqrt{\sigma_1^d \cdot \sigma_2^d} + \sqrt{\sigma_1^p \cdot \sigma_2^p}\right) \quad (1)$$

In this σ_1 is the surface tension of the printing ink, σ_1^d it’s dispersed part and σ_1^p its polar part. Index two details the different fountain waters used.

By using the values from table 1 in formula 1, the following results were obtained. The mistake shown resulted from calculation made according to the standard deviation law corresponding to the standard deviation of rows to every 10 measuring points.

Table 2 Surface tension between printing ink and fountain water

	σ [mN/m]	Δσ [mN/m]
Fountain Water 1	10.23	1.20
Fountain Water 2	6.51	1.18
Fountain Water 3	8.19	1.18

Using the values in table 2 it is clear that the surface tension between printing ink and fountain water only partly correlates with the overall surface tension of the fountain water. Although fountain water 3 shows the smallest surface tension, it has a higher surface tension limit than fountain water 2.

Conclusion

A method has been presented that simply and precisely establishes the surface tension between printing ink and fountain water. With the examples of coloured inks and fountain water, which are currently under further development in industry, it has been shown that an exact assessment of the surface tension limits between printing inks and fountain water is only possible if one establishes the exact surface tension. The overall surface tension alone is not enough to predict the relationship of liquids to each other.