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Application Note 20

Validation of the Spinning Drop Tensiometer SVT20N with optical standards (DCS-SVT reference plastics rods, item No. 2000833)

Preparation

The DCS-SVT plastics reference rods provide an artificial interfacial tension standard due to the Vonnegut approximation for cylindrically extended droplets in a spinning drop tensio-meter. This is an easy and reliable approach avoiding chemical contamination problems with real fluid pairs and their temperature and time dependant interfacial tension.

Image 1: DCS-SVT rods with four different diameters

Two items are necessary for a successful validation process. First: one of the plastics rods of the set inserted into a water filled capillary and second: the opened MS Excel sheet for the interfacial tension calculation (SVT_Validation_Vonnegut.xls).
The reference diameter of the selected plastics rod should be taken from the label on the tube (see Image 1) or should be measured with a micrometer screw. The rods are made of polypropylene with a lower density (ρ= 0.9177 g/cm³) than water (ρ(20 °C)= 0.9982 g/cm³). In case that other liquids than water are used (e.g. solutions or special solvents), please make sure that these liquids do not attack the polypropylene rods by dissolution. Furthermore, the embedding liquid used should possess a higher density than the rod.
Close the capillary now and insert it into the SVT. Please set the rods to the center area of the capillary and run the SVT at an intermediate rotational speed of about 5000 rpm.

Measurement

Please set the refractive index inside the parameter box of the SVTS software to a value of 1.333 for water and press the <Apply>-Button.

Keep the suspended plastics rod rotating stable in the capillary and make a reference run. The densities inside the parameter input window can be chosen to 1.00 for the phase 1 and 0.70 for phase 2. Any value for the densities can used because the plastics rod will not change the diameter at higher rotational speeds as this is usually the case for a liquid/liquid interface.
Keep the rod contour as a full cylinder extending from the left to the right hand side of the image and completely inside the chosen range of interest. Select a cylinder measurement. Make a complete interfacial tension measurement and compare the measurement value with the theoretical value given in the MS Excel sheet. Repeat the measurement with several other rotational speeds and density differences.

Using the table

The MS Excel sheet provides a calculation result for the theoretical interfacial tension in relation to the measured interfacial tension (see Fig. 1). Please type in the actual diameter of the rod in meter (mm/1000) into the second cell. Set the rotation speed to e.g. 5000 rpm (U/min) and the density difference as suggested before to 0.3 g/cm³ which is equivalent to 300 kg/m³. The interfacial tension will be calculated auto-matically in the next cell (SFT/ IFT measure-ment). Finally, type in the measured interfacial tension (IFT) value to the next cell and get the difference between the two values in per cent.
For a successful validation the relative difference between the theoretical and the experimental interfacial tension should be smaller than 3%.

The reason of this smaller relative deviation is usually associated with the rod shape. Very small mechanical tolerances of the rod and it's surface quality yield tiny contour deviations about one or two image pixels inside the measurement frame. By increasing the optical magnification on the SVT optics and using the same rod, the difference between the theoretical and the experiment value - and therefore the error bound - can be reduced. Compare all your results with different speeds and density differences. If the the tolerances fall within 3 % deviation the instrument can be considered as validated.

Trouble shooting

Sometimes it happens that the differences are higher than 3%. The most common reason is that the rod diameter is in error or that the used reference rod was not rotating stable enough during the validation measurement. Please repeat the measurement and redo your calculation.
After the calibration of the magnification it is also possible to use another rod with a different diameter in the capillary. The validation can be extended by using different rod diameters but otherwise identical settings for the density difference, rotational speed etc.

Calculation Vonnegut
σ = Interfacial tension
Δς = Density difference
ω = Rotation Speed
D = Drop diameter
$\sigma = \frac{\Delta\varsigma * \omega^2 * D^3}{32}$

Measurements SVT

01.01.2009
Software B.35
Sample PP

Sample	Drop or Stick diameter [m]	Rotation speed [U/min]	Density difference [kg/m^3]	Interfacial tension calculated [mN/m]	SVT IFT measurement	Difference in %
1	0,000822	5000	300	1,4275258	1,45	1,57

Remarks
Set the density difference in the soft ware to 1 (outer phase) and 0.7 (inner phase) to get a difference of 0.3
The magnification value has no influence to the validation

Fig. 1: Excel-sheet