Technical note

# Delta-8 multichannel microtensiometer: plate-to-plate / day-to-day reproducibility

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## Overview

This study was initiated to gain hands-on experience on the daily operation and reproducibility of the Delta-8 platform during a two week period. Eighty (80) individual isotherms of sodium dodecyl sulfate were recorded to assess the day-to-day and plate-to-plate reproducibility.

## Experimental

Surface tension measurements were carried out on a Delta-8 multichannel microtensiometer in standard configuration. The instrument utilizes eight parallel microbalances fixed to meet the positions of the wells in a 96 format. The resolution of the balances is 0.05 mN/m. The surface tension measurement is based on the Du Nouy method, i.e the maximum force exerted by the surface tension is recorded as the probes are withdrawn from the solutions. The probes have a diameter of 0.5 mm and the measurement solution is completely wetting their surface. The instrument features automatic cleaning of the probes by heating prior to the measurement of the 96-well plate. The measurement loop, i.e. the cleaning of the probes and the measurement of the 96-well plate, takes less than 2 minutes.

In this study data were collected during a two week period, *i.e.* ten days. On each day eight parallel serial dilutions of aqueous sodium dodecyl sulfate (SDS) were prepared, such that the concentrations were $25 \times 0.625^{(n-1)}$ mM were $n$ ranges from 1 to 11. SDS was obtained from SERVA and was used as received without further purification. MQ-water (Millipore) was used throughout. All liquid handling was conducted by manual pipetting (Biohit Proline) into disposable 96-well plates. The same Delta-8 instrument and probes were used throughout the experiment. The isotherms were analyzed with the Gibbs adsorption model embedded in the Delta-8 Manager software. The instrument was calibrated daily before the measurements by adjusting the measurement scale so that the surface tension of water corresponded to 72.8 mN/m (standard calibration routine).

## Results and discussion

The surface tension of all 80 isotherms are plotted versus the SDS concentration in Figure 1. The standard deviations of the surface pressures at each concentration are listed in Table 1. The standard deviation of individual channels for ten separate runs were between 0.2 and 1.1 mN/m, while the standard deviation of all channels, i.e. 80 surface pressure readings at each concentration, varied between 0.6 and 1.1 mN/m. Thus, high consistency and reproducibility between both inter and intra channel recordings was obtained.

Table 2 summarizes the statistics of the air/water partitioning coefficient, molar cross-sectional area, critical micelle concentration, and maximum surface pressure. The free energies related to the air/water partitioning and the micelle formations are also shown in this table. The values obtained here are in good agreement with those obtained earlier for

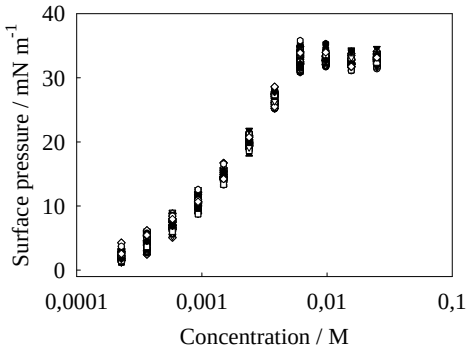


Figure 1: Comparison of 80 isotherms for SDS in aqueous solution.

SDS [1, 2].

The preparation of the dilution series is of key importance for this type of experiments, where data are collected from several dilution series. Additionally, liquid handling routines must be adapted for handling surface active compounds. This involves cautious emptying of the pipette tips while avoiding the formation of foam. We have found that automated liquid handling systems are, in the case of surfactant solutions, preferable in comparison to manual pipettes, yielding high reproducibility once optimum parameter settings have been established. In this study, the dilution series were prepared manually, and accordingly, the standard deviations found reflect the reproducibility of the preparation procedure of the dilution series rather than the accuracy and precision limits of the instrument. It is, however, stressed that the variation of the characteristic parameters of the adsorption isotherms collected in Table 2 are small despite variations due to the manual preparation procedure.

## Concluding remarks

The above results demonstrate high precision and reproducibility of the Delta-8 platform. Furthermore, the small variations in the isotherms, partly due to manual liquid handling, was shown not to be detrimental for obtaining repeatable data on molar cross-sectional area, critical micelle concentration, maximum surface pressure, and air-water partitioning coefficient.

## References

[1] P. Suomalainen and C. Johans. Technical note: Delta-8 multichannel microtensiometer: intra- and inter-assay precision, www.kibron.com. 2003.

[2] C. Johans and P. Suomalainen. Technical note: Delta-8 multichannel microtensiometer: day-to-day operation, www.kibron.com. 2003.

Table 1: Standard deviations (mN/m) for the surface pressures recorded with parallel channels (A-H).

| $c$ /mM | ch A | ch B | ch C | ch D | ch E | ch F | ch G | ch H | All chs. |
|---|---|---|---|---|---|---|---|---|---|
| 0.23 | 0.4 | 0.4 | 0.4 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 |
| 0.36 | 0.5 | 0.5 | 0.6 | 0.4 | 0.8 | 0.6 | 0.6 | 0.4 | 1.0 |
| 0.58 | 0.7 | 0.6 | 0.4 | 0.6 | 0.8 | 0.6 | 0.8 | 0.5 | 0.9 |
| 0.93 | 0.7 | 0.6 | 0.6 | 0.7 | 0.6 | 0.7 | 0.6 | 0.8 | 0.8 |
| 1.49 | 0.7 | 0.7 | 0.8 | 0.7 | 0.6 | 0.6 | 0.4 | 0.8 | 0.7 |
| 2.38 | 0.8 | 0.8 | 0.8 | 0.7 | 0.6 | 0.5 | 0.5 | 0.7 | 0.7 |
| 3.81 | 0.8 | 0.6 | 0.5 | 0.6 | 0.9 | 0.8 | 0.9 | 0.8 | 0.8 |
| 6.10 | 1.1 | 1.0 | 0.9 | 1.0 | 1.0 | 0.9 | 0.8 | 0.8 | 1.1 |
| 9.77 | 0.6 | 0.3 | 0.5 | 0.5 | 0.4 | 0.5 | 1.0 | 0.5 | 0.6 |
| 15.63 | 0.4 | 0.5 | 0.7 | 0.7 | 0.5 | 0.8 | 0.5 | 0.6 | 0.6 |
| 25.00 | 0.4 | 0.3 | 0.8 | 0.7 | 0.5 | 0.9 | 0.4 | 0.4 | 0.6 |

Table 2: Mean values and standard deviations for the characteristic parameters and free energies of the CMC and $K_{\mathrm{aw}}$ for 80 SDS isotherms.

| | $K_{\mathrm{aw}}$/mol$^{-1}$ | $RT \ln K_{\mathrm{aw}}^{-1}$/ kJ mol$^{-1}$ | $A_{\mathrm{s}}$/Å$^2$ | CMC/mM | $RT$ lnCMC/ kJ mol$^{-1}$ | $\Delta\pi$ (mN/m) |
|---|---|---|---|---|---|---|
| Mean | 1980 | -18.7 | 34.2 | 6.3 | -12.5 | 32.7 |
| SD | 207 | 0.2 | 1.46 | 0.37 | 0.14 | 0.4 |
| CV% | 10.4 | 1.3 | 4.4 | 6.3 | 1.1 | 1.2 |