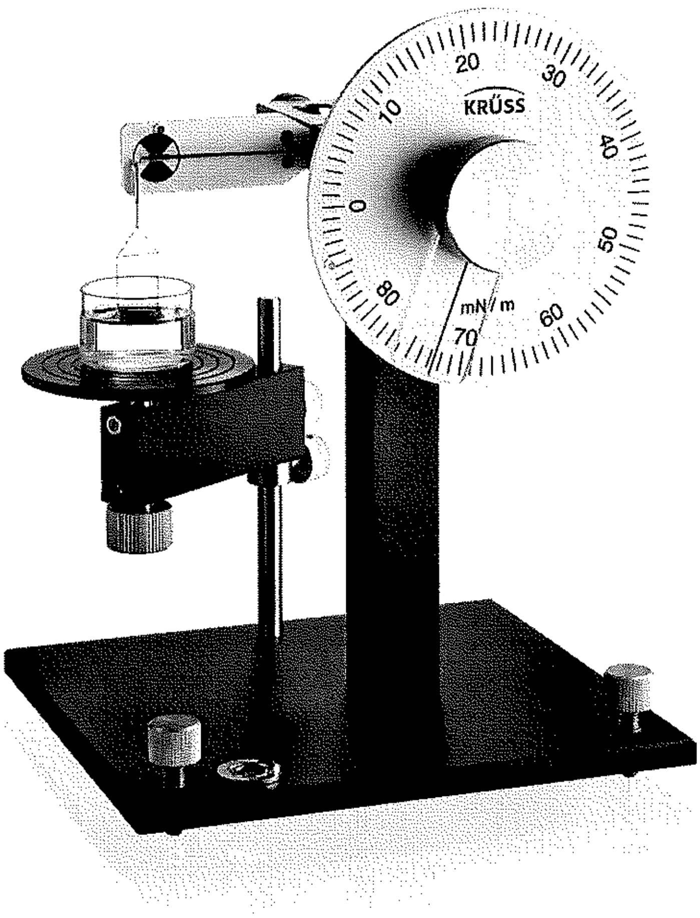
Force Tensiometer – K6



User manual

V3-02

Contents

1 The K6 Tensiometer

1.1 Design of the apparatus

A torsion wire is tensioned between the two clamping chucks (→ pages 10 and 11). Using the two handwheels (No. 2 on page 11) a torsion may then be imposed on the wire. The tensiometer is adjusted with the handwheel at the back end of the wire. The handwheel in the front part of the wire is firmly connected to a pointer. The pointer glides over a scale on which the value of the interfacial tension is indicated in mN/m. The balance beam (9) is clamped onto the torsion wire in an angle of 90°. The measuring device is suspended at the end of the balance beam.

The measuring device must be absolutely level so that all parts of it are subjected to the same forces at the same time when passing through the surface. When turning the torsion wire the balance beam leaves the zero-position: the ring is lifted or lowered. This vertical movement is registered by projecting the balance beam on mark (7). The measuring platform (6) used to support the glass vessel, filled with the liquid to be analyzed, can be raised and lowered. The precise adjustment has to be performed with handwheel (5).

1.2 Basic rules for surface tension measurements

Similar to other analyzing methods the measurement of interfacial tension is subject to a number of effects leading - unless they are correctly observed - to incorrect or even misleading results.

All parts of the apparatus coming into contact with the liquid to be measured have to be kept meticulously clean, since the interfacial tension reacts in a very sensitive way to all kinds of contamination.

The enrichment of molecules active in the surface or the interface generally takes place very slowly, that is to say, the parameters age and temperature influence the measurement significantly. During any measuring series it is therefore essential to maintain constant test conditions. Temperature stability of the liquid can be obtained with the thermostat vessel K 801 (5).

1.3 Thermostat vessel K 801

If measurements have to be performed at a constant temperature, the flat table, delivered with the standard equipment has to be replaced by the thermostat vessel K 801 that is connected to a thermostat.

For a further test of the proper shape of the ring, hold it by the shaft and rotate it by turning the shaft between your thumb and forefinger. The ring should rotate without any recognizable variation in height and without side-to-side movement. The light reflexes from the surfaces can help you in your assessment.

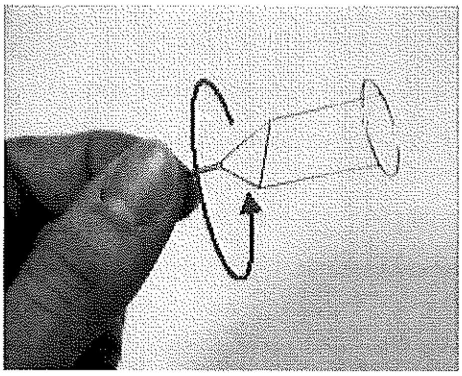


Fig. 1: Checking the shape of the ring

In case of a ring deformation it is possible to re-establish the proper shape by yourself. The necessary ring adjustment tool TO01 can be ordered at KRÜSS.

2.4 Safekeeping after use

Before putting the ring back into the box it must be cleaned as described in section 2.2 .

Hold the open box in one hand and the shaft of the ring in the other hand. Lead the shaft into the box as far as possible, than let the ring glide into its position..

4 Measurement

See pages 10 and 11:

4.1 Measuring interfacial tension at the phase border liquid/gas

The carrier of table (6) is carefully raised until the ring submerges centrally into the liquid for some 5 mm and is then adjusted with screws (10) and (12). In order to obtain a plain surface the liquid should calm down for a while. By turning screw (5) to the left the measuring table is lowered until the lever arm (9) moves downwards, out of the white field of mark (7), that is to say, the ring is held fast by the surface-film of the liquid. Actual measurement begins at this point.

By turning handwheel (2) clockwise the torsion of the ribbon is increased and thus a pull is applied to the ring. This leads to an upward displacement of the lever arm (9) out of the white field of mark (7). The lever arm (9) is now brought back to zero-position by lowering the measuring-vessel (turn screw (5) to the left)). This alternating of careful increase of the pull and subsequent lowering of the measuring-vessel has to be repeated until the film "breaks", that means, until the upward pull acting on the ring has completely overcome the interfacial tension forces and breaks out of the surface in an upward direction.

4.2 Measurement of interfacial tension at the phase border liquid/liquid

When measuring interfacial tension between two immiscible liquids (e.g. oil and water), the ring is first submerged into the lower specific heavier phase (in this case water). The specific lighter phase (in this case oil) is then pipetted above carefully.

Measurement is performed analogue to 4.1. The interfacial tension value has been reached when the lever arm (9) can no longer be brought into zero-position by slowly lowering the measuring-table (over-elongation of the film). After each measurement the adjustment of the circuit division of the instrument has to be brought back into its zero-position.

4.3 Calibration

The interfacial tensiometer is calibrated by KRÜSS with double distilled water (interfacial tension at 20°C = 72.8 mN/m). If another value should be obtained in the course of time, in particular when using a new ring, it is best to operate with a correction factor. If the value obtained for water at 20°C is not 72.8 mN/m but 73.2 mN/m, the correction factor will be equal to the quotient of the theoretical and indicated value:

$$\frac{72.8}{73.2} = 0.995$$

The indicated values must then be multiplied by this correction factor.

5 Changing the balance system

⇨ See pages 10 and 11

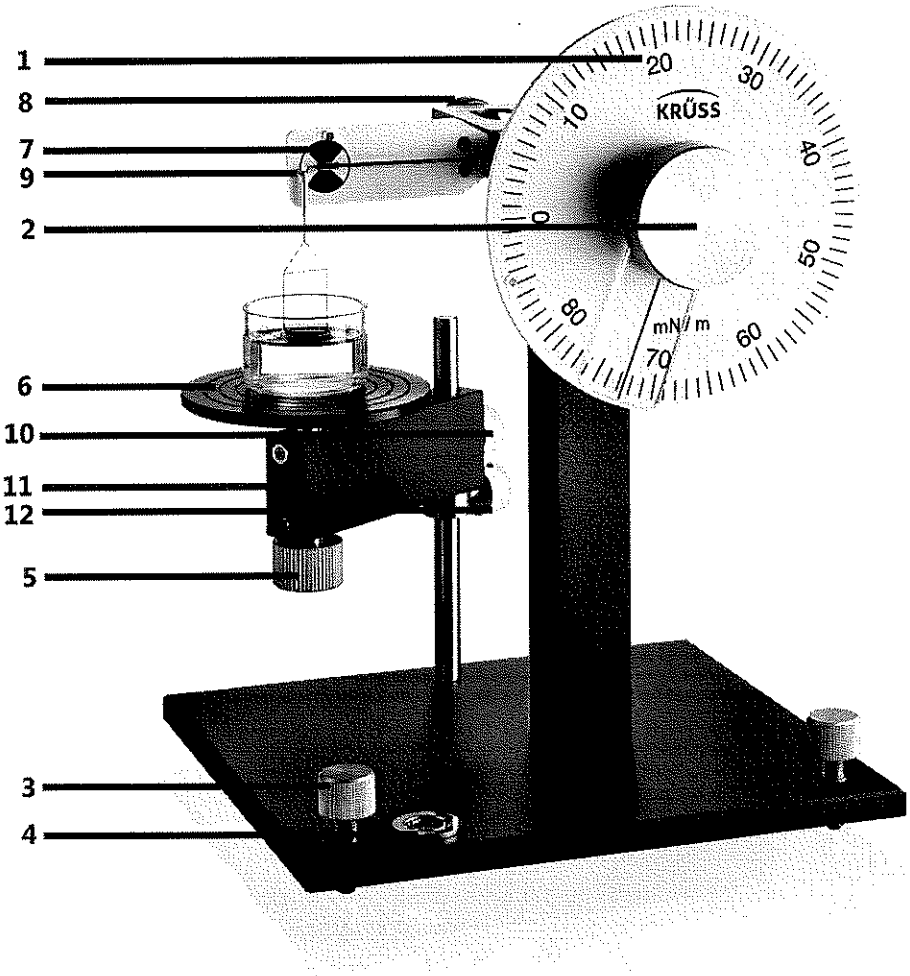
5.1 Dismounting

1. Turn clamping device (1) with handwheel (1a) in horizontal position.
2. Turn clamping device (2) with knurled screw (2a) in horizontal position.
3. Push knob (3) and dismount the balance beam and the torsion wire.

5.2 Installation

1. Carefully insert the balance system SP0110 (the balance beam in upright position). Put the wire holder (4) into the clamping device (1).
2. Press knob (3) and put the wire holder (4a) into the clamping device (2). It is recommended to use a pair of tweezers for this procedure.
3. Carefully center the wire holders (4 and 4a) so that the torsion wire is exactly in the middle of the clamping devices.
4. Position the balance beam underneath pin (5).
5. Suspend the platinum ring. Set the graduated circle to zero (1a). Turn the knurled screw (2a) until the balance arm stays exactly in the middle of the white mark below pin (5).
6. The instrument is ready for measurements.

Construction of the K6



(1) Scale in mN/m; (2) handwheel with pointer; (3) screws for level regulation; (4) bubble level; (5) micrometer screw; (6) sample table; (7) mark; (8) handwheel for zero adjustment; (9) balance beam; (10) and (12) handwheels for fixing the crossbar; (11) sample table carrier

6.2 Measurement value correction

When the ring is lifted, not only the force resulting from surface tension but also the gravitational force of the lifted liquid volume V_h is measured and thus falsifies the measurement.

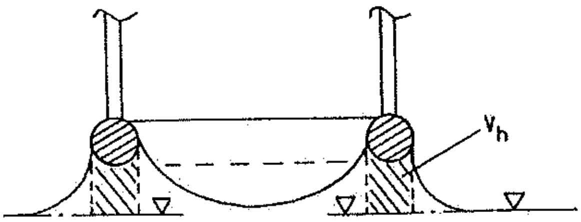


Fig. 4: Ring with lamella

For this reason, a correction factor with which the measured value must be multiplied is necessary.

Correction according to Harkins & Jordan

The correction values for a range of density differences between the phases were obtained experimentally and published in a tablework by HARKINS and JORDAN. Instructions and a table for the correction with K6 are given on p. 14.

Correction according to Zuidema & Waters

For measurement values <25 mN/m and density differences > 1g/cm^3 the equation by ZUIDEMA and WATERS should be applied (see p. 16).

Density difference	0.65	0.8	1.0	1.2	1.4
50	1.004	0.988	0.972	0.957	0.945
48	1.001	0.985	0.967	0.954	0.943
46	0.998	0.980	0.964	0.951	0.941
44	0.994	0.978	0.960	0.948	0.938
42	0.990	0.975	0.957	0.944	0.935
40	0.987	0.972	0.954	0.941	0.931
38	0.981	0.968	0.951	0.938	0.929
36	0.979	0.963	0.946	0.935	0.923
34	0.975	0.958	0.942	0.931	0.919
32	0.970	0.954	0.940	0.926	0.915
30	0.964	0.950	0.935	0.921	0.911
28	0.959	0.944	0.930	0.916	0.906
26	0.954	0.940	0.924	0.911	0.904
24	0.949	0.935	-	-	-
22	0.942	0.929	-	-	-
20	0.937	0.921	-	-	-
19	0.933	0.918	-	-	-
18	0.930	0.914	-	-	-
17	0.924	0.911	-	-	-
16	0.920	0.906	-	-	-
15	0.915	0.902	-	-	-