LAUDA Drop Volume Tensiometer TVT 2

Drop by drop, the LAUDA TVT 2 can measure very small dynamic interfacial tensions as precisely as the surface tensions for highly viscous samples.

The LAUDA Drop Volume Tensiometer TVT 2 is used to measure the surface and interfacial tension of liquids. Its strengths lie in the high-precision determination of dynamic interfacial tension. The TVT 2 uses the characteristic that the volume of a drop released from a needle in air is dependent on its surface tension or on its interfacial tension between the two phases if released into a second, immiscible phase (oil). This measuring principle has been realised in a measuring device that is easy to use thanks to precision engineering and modern electronics.

The TVT 2 is a suitable device for many applications that cannot, or only partially, be evaluated by other devices.

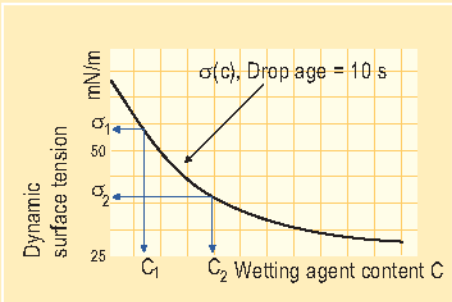
– *Characterization of the dynamic behaviour of surfactant molecules at the surface and interface within seconds – or hours*
– *High-precision measuring of interfacial tensions in a very wide range down to very small values (0.1 mN/m)*
– *Measurements on highly volatile and/or toxic substances through gas-tight system sealing*
– *No wetting problems as occurs, for example, with ring, plate and frame methods*
– *Low sample requirements (0.25 ml to 5 ml)*
– *Simple thermostating options over a wide temperature range (5...90 °C)*
– *Measurements of rising and falling drops*
– *Syringes and needles for various applications*
– *Highly viscous and skin-forming liquids are easily and rapidly measured*

Example: Wetting agent concentration in galvanic baths

Wetting agent concentrations in galvanic baths must be evaluated as rapidly and simply as possible. Ring/plate tensiometers cannot record any concentration differences for evaluation.

Solution:

The dynamic surface tension of baths containing surfactants shows a significant dependency, even at concentrations that are greater than the critical micellar concentration. Reproducible drops with defined lifetime can be generated with the TVT 2. The surface tension/concentration dependence can be represented as a reference curve and this can then be used to determine the wetting agent content of other samples.

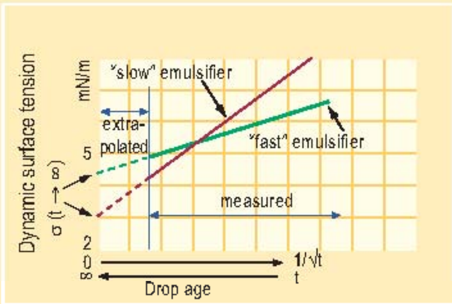


Example: Screening tests of emulsifiers

To facilitate pre-selection of suitable emulsifiers for stabilizing emulsions, the interfacial activity and adsorption behaviour must be determined as rapidly and simply as possible. Normal ring/plate tensiometers are suitable for this only to a certain extent.

Solution:

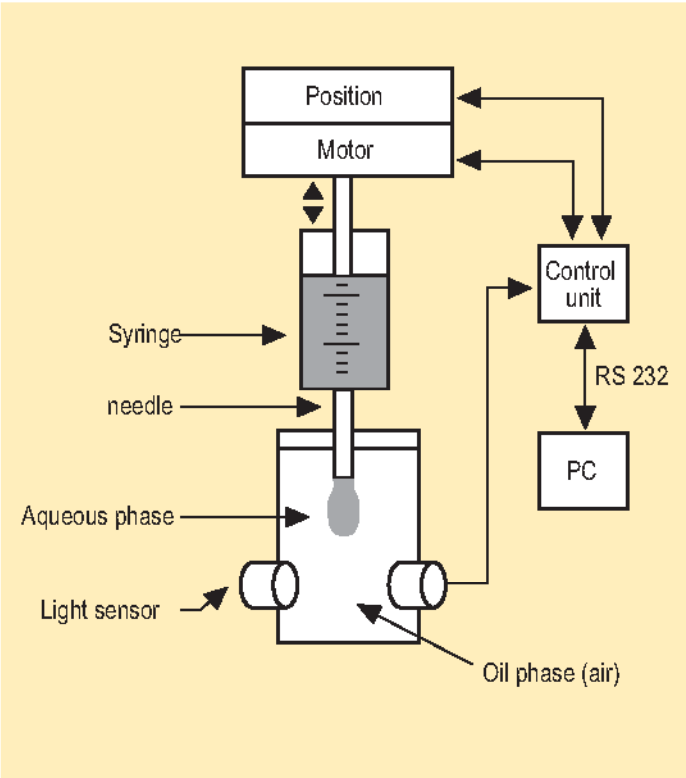
The dynamic interfacial tension at the interface between the two phases shows, in addition to the interfacial activity, how fast emulsifiers reach the interfaces. Reproducible aqueous drops with variable lifetimes in the oil phase can be generated with the TVT 2. This can be used to determine the interfacial tension dependent on the interface age. The extrapolation to "infinity" provides the thermodynamic equilibrium value.



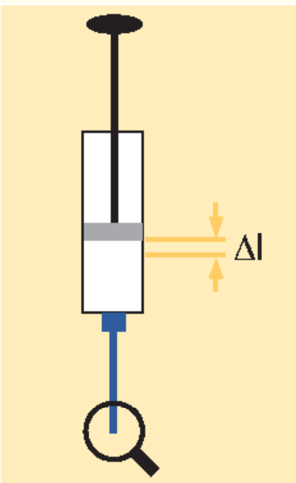
LAUDA Drop Volume Tensiometer TVT 2

The LAUDA Drop Volume Tensiometer increases the options for measuring dynamic surface and interfacial tensions. With the TVT 2, time-critical functions, such as drop monitoring and speed control, have been moved from the PC to a powerful microprocessor. This means that the instrument can be controlled under Windows with minimum loading of the computer, even when multi-tasking. New functions, such as e.g. individual drop measuring of up to 100 drops, are now possible. The LAUDA Tensiometer TVT 2 consists of a measurement desk and a control unit. The core of the electronic component is a microprocessor that controls the

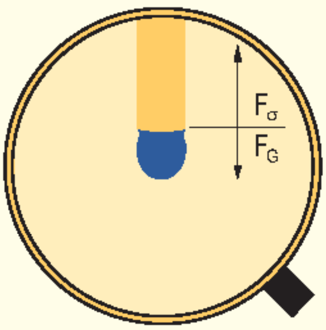
Simple function principle for highly precise results



Sample drops are produced by the plunger being pushed into a needle with a known diameter. The syringe plunger path Δl is measured to the micrometer with a high-resolution distance encoder and the speed is precisely adjusted and controlled by the PLL control system. At a certain size, determined by the holding force (see "Dynamic methods"), the drop breaks away and falls into a collection tube. As it does so, it is recorded by the light sensor, which transfers the data to the microprocessor. This then measures the distance of the syringe plunger and determines the time from the precursor drop. This data is transferred from the control unit via the RS 232 to the PC. There the drop volume V is calculated from the distance Δl and the cross-section area A of the syringe and this is used to determine the surface/interfacial tension taking into account density difference.

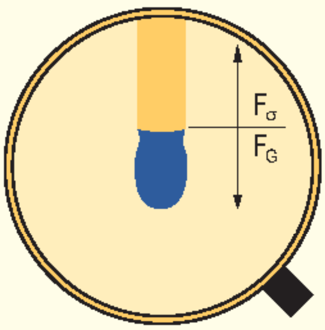


By multiplying the distance Δl of the syringe plunger with the known cross-section area A of the syringe, one obtains the volume V of the falling drop and therefore the surface/interfacial tension (see "Dynamic methods").



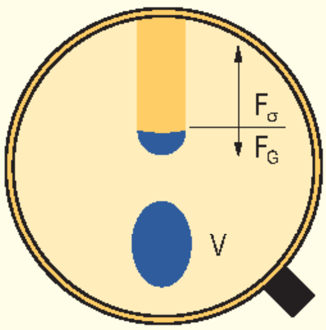
The drop grows: The weight of the drop increases, but is still smaller than the holding force.

$F_G < F_\sigma$



The drop grows to a maximum, where the weight of the drop just compensates for the holding force.

$F_G = F_\sigma$



The drop then falls and is detected. The growth of the next drop begins.

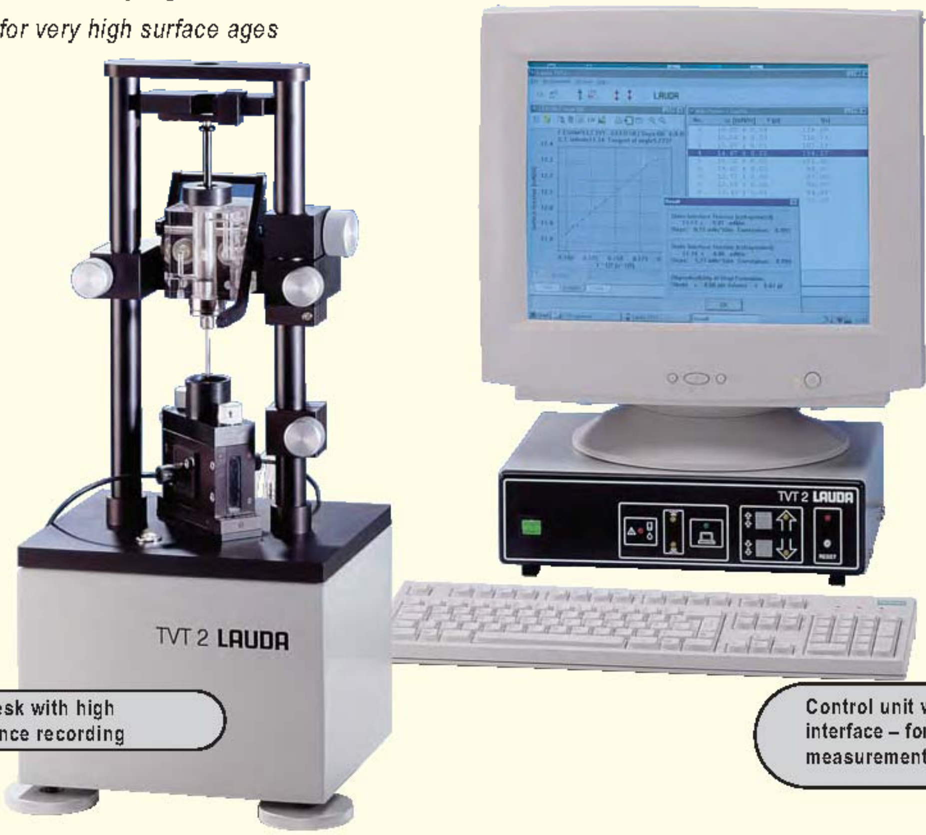
$F_G \ll F_\sigma$

discharge speed, counting the encoder pulses and provides communication. LED's and pictograms indicate the current status of equipment. Keys are provided for positioning the syringe plunger also in offline operation. Communication with the operating PC during online mode is enabled via an RS 232 interface. The measurement desk contains the easily replaceable and thermostable syringe, the light barrier, a high-resolution distance encoder and the precision mechanics for drop generation.

This makes the TVT 2 unique

The excellent precision and reproducibility of the measuring values provided by the TVT 2 are due to, amongst other factors, the following technical equipment:

- *Individual drop volume determination*
- *Positioning accuracy in micrometer range*
- *Variation of advance speed by a factor of 300 through the PLL speed control*
- *Automatic adjustment of advance speed to actual volume status of drop*
- *Automatic adjustment of light sensor intensity to suit the liquid used*
- *Simple application of various syringe/needle combinations and sizes*
- *Quasi-static mode for very high surface ages*



Measurement desk with high resolution distance recording

Control unit with keys and RS 232 interface – for communication between measurement desk and PC

The underlying precision technology

- *Ground, precisely measured spindles*
- *Consists of a discharge device, driven by PLL-controlled, low-vibration DC motor*
- *High-resolution, micrometer-precise distance encoder for volume determination*
- *High-quality gas-tight syringes with constant internal diameter*
- *Drop formation needles made from steel or glass, for rising and falling drops*
- *Optical, electronically controlled drop sensor*
- *Hermetically sealed collection tube*
- *Sturdy construction, no problems with corrosive or toxic samples*
- *Syringe and cell can be thermostated to 60 °C, or optionally 90 °C, with LAUDA thermostats*

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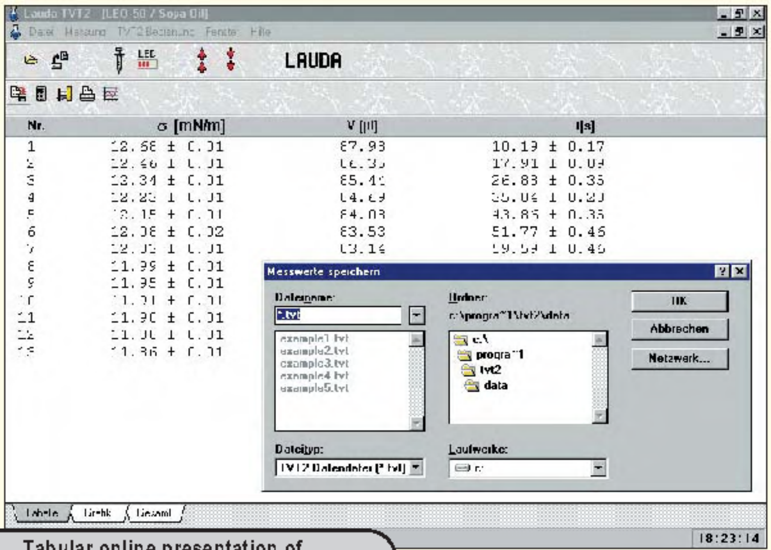
The dialogue-based, self-explanatory user guidance on the PC with MS-Windows (from Version 95) and the sturdy, easy to operate mechanics means that it can be used even by untrained personnel. The software provides test guidance, optimized for the applications, and many options for graphic and tabular representation and output of measuring data.

The scope of delivery:

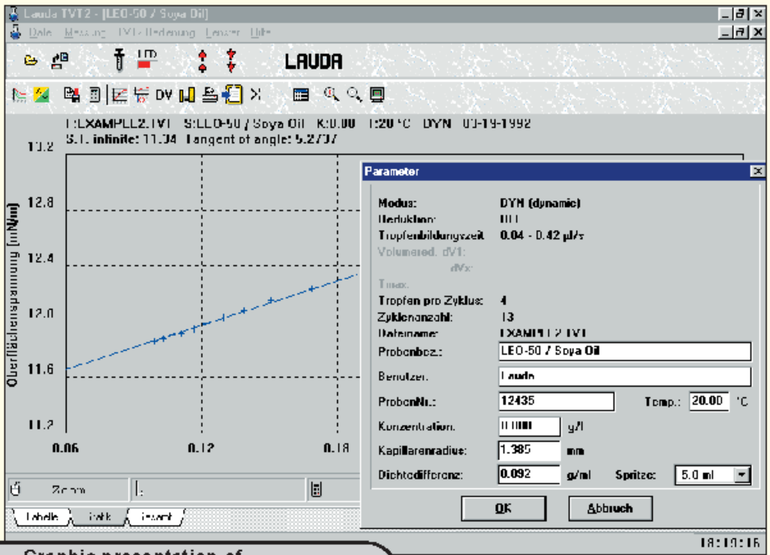
- Simple software installation
- Self-explanatory Windows user guidance
- Output of recorded measuring data in graphic or tabular form to standard printers
- Data back-up of measuring data on various media or further processing with standard programs



Tabular online presentation of a dynamic measurement

Other options:

- Online calculation of the determined surface/interfacial tensions
- Standard mode for determination of surface/interfacial tension in rapidly adsorbing and surfactant-free systems
- Two measuring methods for characterizing the adsorption behaviour of surfactants
  - A) by varying the drop formation time
  - B) by determining the drop separation time at a given drop volume
- Representation of recorded measuring data in tabular or graphic form on-screen (up to 5 test series in one graphic)
- Extrapolation to static values (equilibrium) even with very slow surfactant adsorption through fitting of theoretical curves
- Automatic measurement of the temperature dependency (only in conjunction with LAUDA thermostats from the E3xx range – see p. 40)



Graphic presentation of a dynamic measurement

To precisely record the drop sizes that can vary widely during interfacial tension measurements and provide sufficient drops for series measurements, syringes with 0.25 ml – 5 ml volumes and needles with various diameters and materials can be used. Rising drops can also be measured with the Reverse measuring set. Moreover, the use of disposable needles/cannulae makes cleaning superfluous, which significantly simplifies and speeds up routine measurements.

Simple to change: syringes of various volumes and needles for falling and rising drops

Technical data TVT 2		
Measuring range	mN/m	0.1...100
Resolution		
– Stroke	µm	0.1
– Volume	µl	0.01
– Surface/interfacial tension	mN/m	0.01
– Drop formation time	s	0.1
Reproducibility of individual drops for pure liquids (mechanical tolerances):		
– Stroke	µm	< 2.5
– Volume (with reference to syringe volume)	‰ µl	0.07
– Surface tension	mN/m	0.08 x Syringe volume [ml] [1]
– Interfacial tension	The above value must be multiplied with $\Delta\rho$ (density difference)	
– Drop formation time for t < 100 s [2]	s	0.1 ... 0.5
Reproducibility of mean value over 5 drops		
– Surface tension (depending on syringe and needle type)	mN/m	0.01 ... 0.05
Absolute accuracy	approx. 0.5 % of end value of surface tension	
Drop times	s/µl	0.04 (at 5 ml) 170 (at up to 0.25 ml)
Speed control	< 1 %	
Temperature range	°C	5...60, 5...90 (with special thermostating block)
Interfaces		RS 232
Dimensions of TVT 2 measurement desk (WxDxH)	mm	220 x 240 x 555
Dimensions of TVT 2 control unit (WxDxH)	mm	340 x 270 x 105
Weight of TVT 2 measurement desk	kg	8.0
Weight of TVT 2 control unit	kg	4.2
Power consumption	W	0.1
Power supply	V; Hz	80 - 230; 50/60

Standard accessories

- Software
- RS 232 cable
- Mains cable
- Connecting cable measurement desk/control unit
- Light barrier cable (transmitter and receiver)
- Syringe 2.5 ml
- Standard needle SK1
- Cell
- Thermostating block (60 °C or 90 °C model)
- Allen key
- Cell handling tool

Recommended accessories

- Syringe with various volumes
- Thermostating block (max. 60 °C or alternatively 90 °C)
- Spare screw cap for needles
- Temperature probe
- Cell handling tool
- Adapter
- RS 232 cable
- Steel needle
- Reverse needle
- Glass needle
- Cell (heat-proof glass)
- Reverse measuring set
- Thermostats (see p. 40)
- Disposable syringes and cannula

[1] this means, for instance:

Syringe volume [ml]	0.25	0.5	1	2.5	5
$\Delta\sigma$ [mN/m]	± 0.02	± 0.04	± 0.08	± 0.16	± 0.32

[2] depending on drop size and discharge speed

Measuring technology standards

- ISO 9101
- ASTM D2285