The right temperature worldwide

LAUDA

NEW

with LAUDA TD 1 C and MPT C

LAUDA Interfacial instrumentation:

Tensiometer

Company history

The development of LAUDA measuring technology

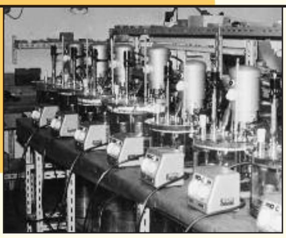
1956

Dr. Rudolf Wobser founds the MESSGERÄTE-WERK LAUDA Dr. R. Wobser KG in the Baden town of Lauda.

1958

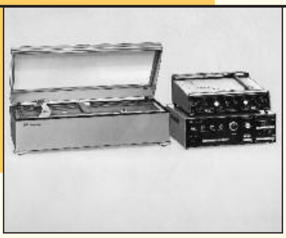
Development of new types of laboratory thermostats in a modular system and development of cooling thermostats with machine cooling.

1959



The first series-production thermostats produce a considerable growth in sales.

1967



Introduction of the first Ring/Plate Tensiometer TE 1 and the Film Balance FW 1 (see picture) – the first representatives of today's product group measuring instrumentation.

1971

Market introduction of the first automatic Capillary Viscosity Measuring System in the world.

1987

Computer controlled Tensiometer with automatic CMC determination (reverse CMC patented by LAUDA).

1989

As a result of the expanding of the range of products, the MESSGERÄTE-WERK LAUDA is renamed as LAUDA DR. R. WOBSER GMBH & CO. KG.

1992

Product introduction of first Drop Volume Tensiometer TVT 1 in the world for measuring dynamic surface and interfacial tension. At the same time, product introduction of the semi-automatic Ring/Plate Tensiometer TD 1 took place. Development of the first Bubble Pressure Tensiometer MPT 1 (see picture) in the world, using to the Fainerman/Miller method.

1994

Modular processor-controlled Viscosity Measuring system PVS with modern Windows software and the automatic Viscosity rinsing system VRM enters the market.

1998

Existing PVS/VRM complemented by fully automatic sampler becomes the VAS 1. The logical step to full automation of viscosity measuring.

Applications of tensiometry

1999

The improved Drop Volume Tensiometer TVT 2, equipped with the latest microprocessor technology and easy to use Windows program, was presented this year.

2000

Introduction of the new generation of Ring/Plate Tensiometer TE 2 at ACHEMA 2000.

2001

The TE 3 with new highly sensitive measurement cell for the highest requirements and new features is developed: e.g. automatic surface cleaning and contact angle determination for fibres.

2003

The new Ring/Plate Tensiometer TD 2 is presented at ACHEMA 2003. The handy equipment offers a comfortable control with large display.

2005

The new instruments MPT C and TD 1 C are examples for the new upcoming tensiometers which are independent from any PC. The easy use via remote control enables mobile, practicable and highly precise working.

A lot has changed since the company was founded in 1956. LAUDA has developed many technical refinements that have now become the standard. Emphasis used to be placed on technical innovation. Today, applications clearly define the focus of attention.

Surface and interfacial measuring technology is used everywhere where surfactants are used, e.g. as wetting and spreading agents, emulsifiers, foam stabilizers, dispersants, lubricants, washing agents and waterproofing agents. Therefore, a tensiometer must be universally applicable.

The LAUDA measuring instrumentation for surfaces and interfaces provide valuable tools in research and development. They are useful in optimizing the wetting properties of coatings, for investigating the adsorption and diffusion of amphiphilic molecules and for the development of cleaners, washing agents and sprays that contain surfactants.

In the analytical laboratory, LAUDA measuring instrumentation is used to characterize emulsifiers and floatation additives, to investigate the dissolving behaviour of powders and tablets, and the adsorption behaviour of proteins and bio-surfactants.

Another application area is quality control. LAUDA measuring instrumentation reliably monitors the surfactant content in aqueous solutions and cleaning agent residues in wastewater.

For physical reasons, tensiometers work optimally only in specific ranges. The area defined by the application is the deciding criteria. LAUDA has provided this brochure to help you to find the best instruments for your requirements. In addition: The informative presentation of the numerous application options and the technical data underline our claim of offering top technical performance at reasonable prices.

Overview

			Measured values	Phases	Methods
Force methods	**Introduction**				
TD 1 C	Economical Ring/Plate Tensiometer with separate remote control and manual adjusting for beginners		Surface tension Interfacial tension Density Weight	Liquid/gaseous Liquid/liquid Liquid	Du Noüy ring Wilhelmy plate Buoyancy method Weighing
TD 2	Cost-effective Ring/Plate Tensiometer with separate remote control and automatic adjustment		Surface tension Interfacial tension Density Weight	Liquid/gaseous Liquid/liquid Liquid	Du Noüy ring Wilhelmy plate Buoyancy method Weighing
TE 3	Fully automatic Ring/Plate Tensiometer with numerous measuring options		Surface tension Interfacial tension Critical micellar concentration Adsorption isotherms Contact angle on interfaces Density	Liquid/gaseous Liquid/liquid Liquid/solid Liquid	Du Noüy ring/ Wilhelmy plate Automatic surfactant feed Automatic dilution ("Reverse" method) Dynamic Wilhelmy method Washburn method Buoyancy method
Dynamic methods	**Introduction**				
TVT 2	Robust Drop Volume Tensiometer for dynamic surface and interfacial tension testing		Dynamic surface tension Dynamic interfacial tension Adsorption processes of emulsifiers	Liquid/gaseous Liquid/liquid	Drop volume method
MPT C	Bubble Pressure Tensiometer for surfactants in millisecond range		Dynamic surface tension Surfactant monitoring Adsorption processes of surfactants	Liquid/gaseous	Bubble pressure method
Recommended Thermostats					
Service					
Glossary					

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Measuring range	Dynamic time range	Temperature range	Application areas (examples)	Control system	Page
					6
< 300 mN/m < 999 mN/m < 2 g/cm^3 < 5000 mg		5… 85 °C	For the testing of physical properties of liquids, solutions, development and testing of surface active substances	Control with handy remote control Command	8
< 300 mN/m < 999 mN/m < 2 g/cm^3 < 5000 mg		5… 85 °C	Determination and testing of physical properties of liquids, solutions, waste water/waters; development and testing of surface active substances (surfactants, emulsifiers); surfactant content determination below CMC	Control with handy remote control Command, RS 232 interface for data transfer to PC	12
2…100 mN/m < 2 g/cm^3	> 1 min	-30…150 °C	Determination and testing of physical properties of liquids, solutions, waste water/waters; development and testing of surface active substances (surfactants, emulsifiers), wetting properties of materials (hydrophobic/hydrophilic), contact angle and surface energies; surfactant content determination below CMC	PC interface and control via Windows software	16
					22
0.1…100 mN/m	1…10 000 s	5…60/90 °C	For the development and selection of emulsifiers and other application optimized surfactants. Pure solvents; surfactant solutions, bio-polymers; quality control (water/ waste water control); Production monitoring in cosmetic industry, brewing, color or paint production, plant protection emulsions; biological liquids (e.g. eye fluids); highly viscous liquids	PC interface and control via Windows software	24
10…100 mN/m	0,001…2 s	5…85 °C	For the development and selection of fast surfactants to optimize of sprays, coating and printing processes, monitoring of surfactant-based aging and contamination; continuous control of surfactant production in reactors; monitoring and to optimize of washing processes; surfactant content determination above CMC	Control with handy remote control Command, RS 232 interface for data transfer to PC	30
			The right LAUDA thermostats available in various different technical configuration levels and with wide temperature ranges optimise the selection of applications.		35
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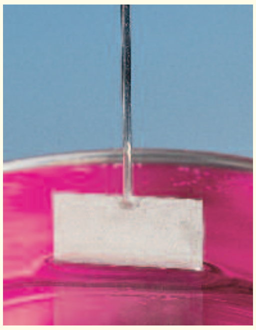
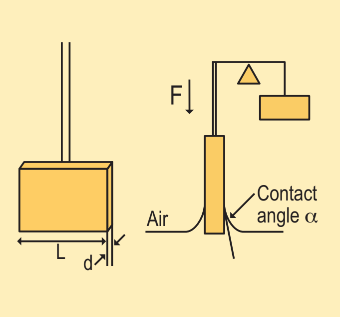
Force methods

Surface and interfacial tensions are called "static" and "quasi-static" when their values, under constant external conditions, do not change, stop changing or change very slowly. They are therefore in or very close to thermodynamic equilibrium. To determine this, a ring (Du Noüy method) or plate (Wilhelmy method) is placed in contact with the surface of the liquid and the resulting force is measured. This force is a measure of the surface/interfacial tension. The geometry of the measuring body is set by standards, e.g. ASTM D971 and DIN 53914.

The Wilhelmy method

Determination of the surface and interfacial tension of liquids





Preferred applications:

- *"Static" surface tension measuring*

Examples of typical samples:

- *Pure liquids, polar and non-polar liquids*
- *Low surfactant concentrations*

Measuring principle:

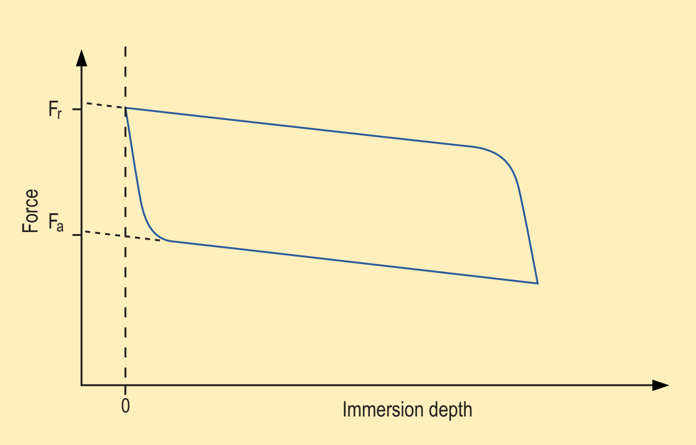
The weight of the plate is tared. If necessary, calibration is performed with a standard weight (100 mg ≙ 24.5 mN/m). The plate is brought into contact with the sample liquid. The meniscus weight is then measured until the measurement values reach stability. The surface tension is calculated from the measured value. Condition: The contact angle $\alpha = 0°$ must be ensured through intensive cleaning, e. g. by thoroughly annealing the measuring body.

$$\sigma = \frac{F}{2\,(L+d)}$$

Equipment suitable for this method:

- *The LAUDA Tensiometer TD 1 C and TD 2 (see p. 8 ff. and p. 12 ff.)*
- *The fully automatic, PC controlled LAUDA Tensiometer TE 3 (see p. 16 ff.)*

Determination of contact angle on solids



Preferred applications:

- *Determination of surface energy of solids*

Examples of typical samples:

- *Foils/films*
- *Painted surfaces*
- *Silicone wafers*
- *Specially treated surfaces*

Measuring principle:

The contact angle and therefore the wettability of a solid can be determined from the known surface tension σ and measured weight of the liquid meniscus. The weight of the solid being measured is tared. The solid is brought into contact with the sample liquid and automatically moved up and down. The recording of force against distance results in a hysteresis force curve (see diagram). The F_r and F_a values determined are used to calculate the advancing angle (α_a) and the receding angle (α_r).

$$\cos\,(\alpha_{r,a}) = \frac{F_{r,a}}{2\,(L+d)\cdot\sigma}$$

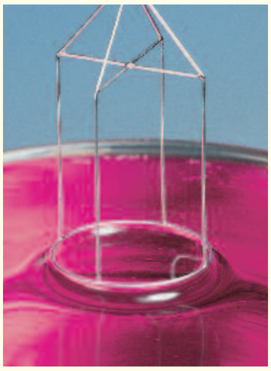
Equipment suitable for this method:

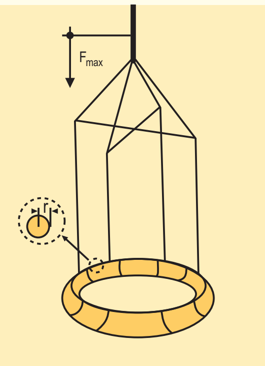
- *The fully automatic, PC controlled LAUDA Tensiometer TE 3 (see p. 16 ff.)*

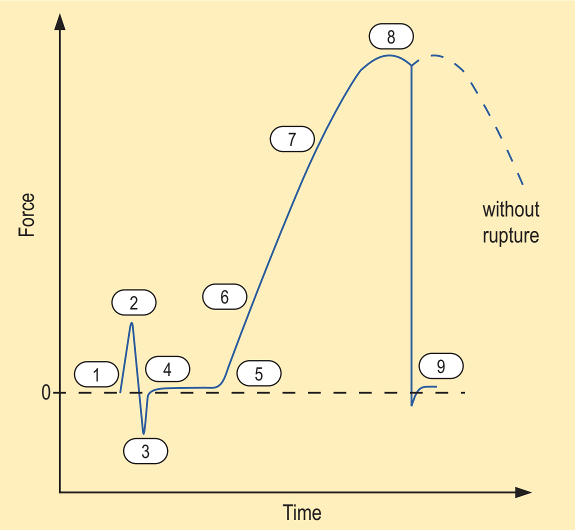
The Du Noüy ring method, rather than the plate method, is preferred despite greater effort (correction of measured value) as it gives triple the resolution. Further reason is simpler cleaning of the robust measuring body. The ring method offers particular advantages in fully automated measurements, e.g. the automatic determination of concentration dependencies (CMC) and in quality control.

The Du Noüy ring method

Determination of the surface and interfacial tension of liquids







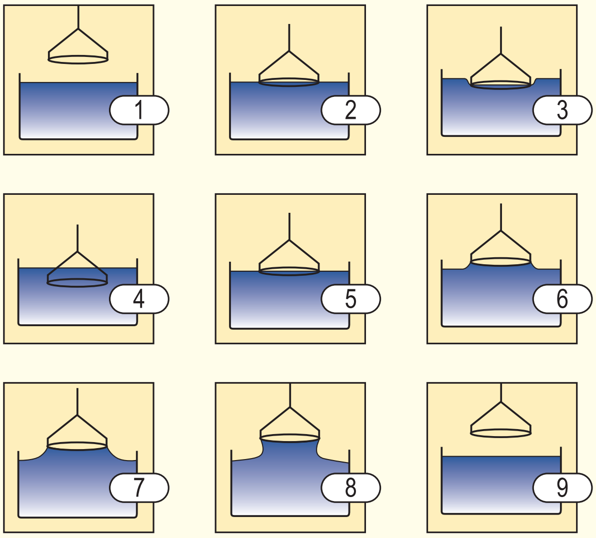
Measuring principle:

The weight of the ring is tared. If necessary, calibration is implemented with a standard weight (500 mg ≙ 40.9 mN/m). The ring is dipped completely into the sample liquid. The ring is then slowly withdrawn from the liquid until maximum force is reached. The surface and interfacial tension are calculated from the maximum force F_{max}.

$$\sigma = \frac{F_{max}}{4\pi R f_{corr}}$$

f_{corr}: *ring correction factor dependent on ring geometry and density* ρ

Ring measuring phases:



Preferred applications:

- *"Static" surface and interfacial tension measurements*
- *Determination of CMC*

Examples of typical samples:

- *Pure liquids, polar and non-polar liquids*
- *All types of surfactants and solutions*
- *Low surfactant concentrations*

Equipment suitable for this method:

- *The LAUDA Tensiometers TD 1 C and TD 2 (see p. 8 ff. and p. 12 ff.)*
- *The fully automatic, PC controlled LAUDA Tensiometer TE 3 (see p. 16 ff.)*

LAUDA Ring/Plate Tensiometer TD 1 C

Economical introduction into the world of tensiometry with the LAUDA Ring/Plate Tensiometer TD 1 C.

The TD 1 C units, whose technology has been completely revised and which bear a new design, offer even easier handling due to the handy remote control Command which has proven itself with LAUDA thermostats and measuring instruments. State-of-the-art processor technology allows extended documentation options. The measuring values are only displayed on the remote control. The evaluation of these values can be printed on an optional protocol printer.

Easy determination of surface tension

- *The measuring desk with the sample stage of the easy to handle tensiometer can be manually adjusted.*
- *The sample stage can be moved smoothly by means of ergonomic adjusting screws, like a microscope*
- *Easy measurements with Wilhelmy plate*
- *Simple determination of force maximum during the ring measurement*
- *By means of the high-resolution display of the remote Command control, the increase in wetting force during with drawing of the ring can be followed and the maximum force will be detected automatically and signalised by an acoustic signal without detaching the lamella*
- *The value displayed in the maximum is automatically corrected according to Zuidema and Waters, and thus corresponds to the surface tension of the measured liquid in nN/m*
- *At the touch of a button, the measured value and all parameters can be either saved or directly printed out on an optional protocol printer*

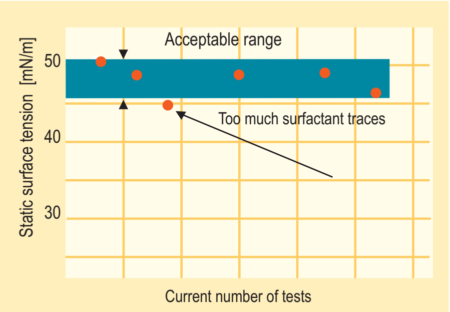
In total the TD 1 C is a very flexible and highly precise measuring instrument.

Example: The perfect instrumentation for professional training

At the university's practical training in physics students must learn to understand the principles in static surface and interfacial tension. This should be done with a simple instrument to learn the basics behind fully automated systems for tensiometry.

Solution:

The robust and intuitive TD 1 C allows students to measure exactly – and without additional corrections – the static surface and interfacial tension of numerous liquids according to the standardized methods of Du Noüy and Wilhelmy. Furthermore, they are able to determine the density of liquid media according to the Archimedes' principle. Now it is possible by a single, well-priced instrument to combine various experiments.



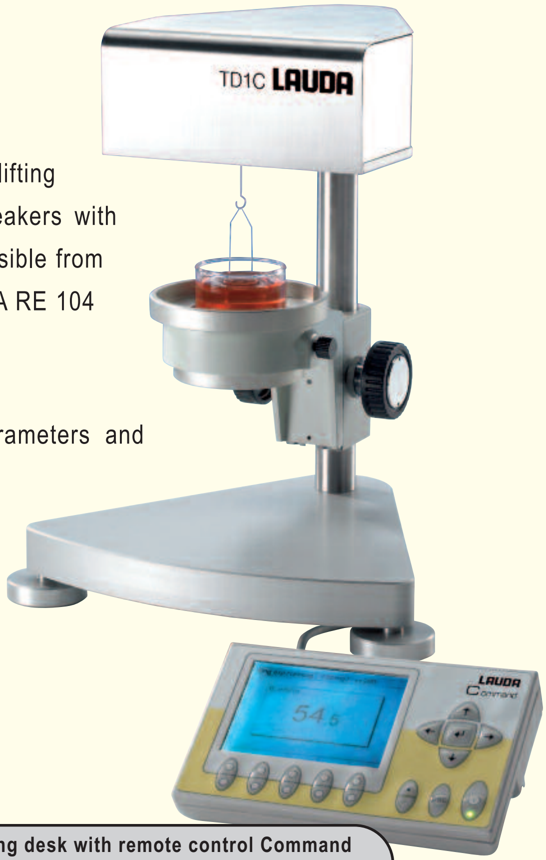
LAUDA Ring/Plate Tensiometer TD 1 C

The TD 1 C model works with Du Noüy ring and Wilhelmy plate according to international standards (DIN 53914, ISO 304, ASTM D971). Furthermore, the density, according to the Archimedes' principle, as well as smaller weights can be measured due to a newly-developed, even more powerful force-measuring cell with a considerably enlarged measuring range.

Easy handling

The measuring desk includes the high-resolution force-measuring cell and the lifting device for the manual positioning of the sample stage. Various standard test beakers with a diameter of up to 8 cm can be inserted into the large sample compartment accessible from all sides. The samples can be brought to the correct temperature by using a LAUDA RE 104 thermostat, for example, connected to a double-walled glass thermostating vessel.

This handy, removable control unit enables the input of the measurement parameters and assumes the evaluation and representation of the measurement results. The large, high-resolution graphic display takes over the menu-driven user guide, and displays single measurements and results. The remote control with its self-explanatory menu-driven operation offers an optimum degree of user-friendliness.



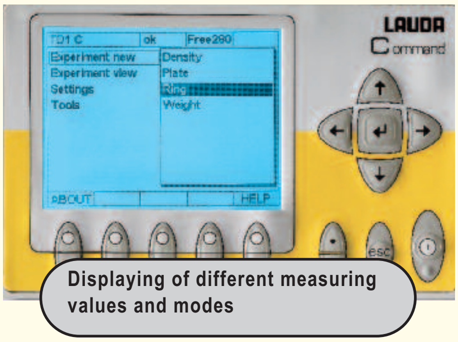
Measuring desk with remote control Command and manual lifting device

The scope of delivery:

- **High resolution (± 0.1 mN/m, ± 1 mg) and enlarged measuring range up to 300 mN/m or 5 g**
- **Automatic maximum detection**
- **Automatic correction of measuring values (according to Zuidema and Waters)**
- **Semi-automatic calibration at three levels of precision with calibration weights**
- **Input of ring/plate dimensions possible**

Other options:

- **Print-out of the measuring values (surface/interfacial tension, density) on an optional printer at the touch of a key**
- **Storage of up to 500 measurements and the accompanying parameters**
- **Numerical sample description determined by the user**



Displaying of different measuring values and modes

Measuring of the surface tension with Wilhelmy plate

Advantages and technical data TD 1 C

The measuring values displayed on the remote control Command, can be printed on an optional protocol printer.

Double walled glass thermostating vessel

Logging of measuring values

Technical data TD 1 C

Measurement type		Surface and interfacial tension; density, weight
Measurements surface and interfacial tension	mN/m	ring < 300; plate < 999
– Resolution	mN/m	0.1
Density measurement	g/l	< 2000
– Resolution	g/l	1
Weight measurement	mg	< 5000
– Resolution	mg	0.1
Calibration		Calibration weight
– Sensitifity		3 levels
Display		320 x 240 Graphic display
Selection of measuring modes		Menu-controlled
Parameter input		Menu-controlled
Sample designation		Numerical (0 - 999)
Data storage	Results	Max. 500, with date, time and measuring parameters
Stage movement (sample)		manual
Maximum recognition		Automatic
Ring correction		Automatic according to Zuidema und Waters
Documentation		Protocol printers
Weight	kg	approx. 5.0
Dimensions (WxDxH)	mm	260 x 230 x 335
Power supply	V; Hz	External power adapter, 100 - 240 V; 50/60 Hz

Standard accessories

- Du Noüy ring
- Calibration weight
- Immersion plunger made from glass for determining density

Further accessories

- Wilhelmy plate
- Double walled glass thermostating vessel
- Protocol printer
- Thermostats (see p. 40)

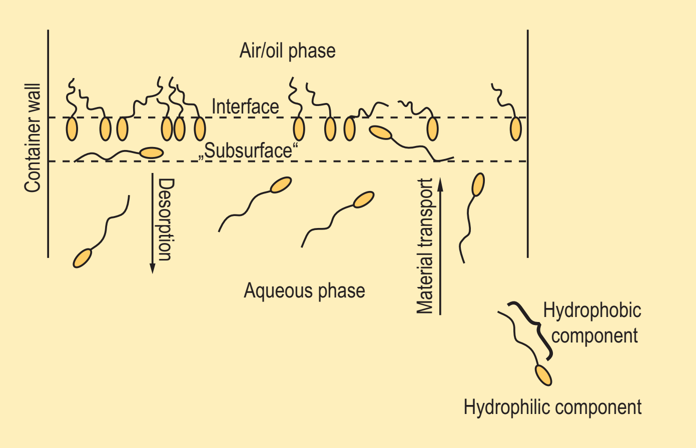
Measuring technology standards

- DIN 53914
- DIN 53993
- ASTM D971
- ISO 304
- ISO 4311

Dynamic methods

Surface and interfacial tensions are called “dynamic” when their values, despite constant external conditions, decrease significantly with increasing age, i.e. when they are not in thermodynamic equilibrium. The most familiar methods for determining these dynamic values are the drop volume and bubble pressure methods. In the drop volume method, the dynamic surface or interfacial tension is determined from the volume of a falling drop.

Surfactants at interfaces



Origin of the “dynamics”

Surface-active substances, because of their structure, prefer to migrate to surface or interfacial regions. The migration characteristics of these molecules mean that, over time, they enrich the surface/interfacial regions. This constantly decreases the surface/interfacial tension. At the same time, a few molecules manage to leave the surface/interfacial regions. If the number of molecules arriving equals those leaving, then a stable surface/interfacial tension value is reached. These dynamic effects are based on previously poorly understood surfactant properties. In many analysis cases using so-called general tensiometers (ring/plate), this effect can lead to serious measuring errors. The analysis of these effects is particularly important in time-controlled surfactant actions, such as, e.g. rapid coating processes, droplet formation in sprays and liquid jets, wetting processes or emulsion stability. The drop volume and bubble pressure methods are particularly suitable for recording these dynamic changes.

The drop volume method

Determination of the dynamic surface tension and the interfacial tension between immiscible liquids

Surface tension:

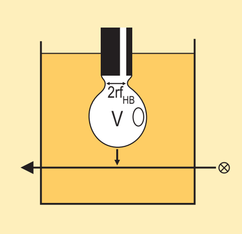
Drops are generated using a suitable device. These drops grow as long as their weight is less than their holding force on the capillary. As soon as this weight has reached the same level as the holding force, the drop falls and the volume of the falling drop is measured. The surface tension is then calculated from this volume.

$$\sigma = \frac{g\rho V}{2\pi r f_{HB}}$$

Interfacial tension:

Drops of a liquid with a high density, e.g. water, are generated in a liquid with low density, e.g. oil. Both fluids are immiscible (water/oil). As soon as the weight, minus buoyancy, reaches the same level as the holding force, the drop will fall. The volume of the falling drop is measured and the interfacial tension calculated.

$$\sigma = \frac{g(\rho_1-\rho_2)V}{2\pi r f_{HB}}$$



Preferred applications:

- *For surface and interfacial tension*
- *Particularly suitable for dynamic interfacial tensions*

Examples of typical samples:

- *For solutions, oils and viscous systems that contain surfactants*
- *Particularly suitable for emulsifiers, “average-speed” surfactants and average surfactant concentrations*

Equipment suitable for this method:

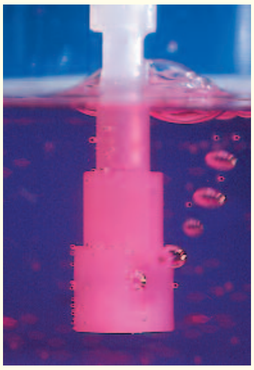
- *The LAUDA Tensiometer TVT 2 – easy to use, robust and PC controlled (see p. 24 ff.)*

ρ: sample density · g: acceleration due to gravity · f_{HB}: correction factor · ρ_1: density of specific heavier sample · ρ_2: density of specific lighter sample · σ: surface and interfacial tension

In the bubble pressure method, the pressure in a small gas bubble is used to determine the dynamic surface tension. The age of the drop/bubble can be varied in both the drop volume and bubble pressure methods. This enables specific dynamic effects to be investigated. The LAUDA Tensiometers TVT 2 and MPT C work with very wide time ranges that overlap. The Drop Volume Tensiometer TVT 2 enables measuring of interfacial tension with surface aging up to several hours.

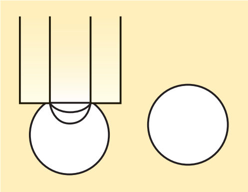
Maximum bubble pressure method

Determination of the surface tension of liquids



Measuring principle:

Air is blown through a capillary into the liquid being measured. The pressure in the gas bubble formed on the end of the capillary rises. Maximum pressure is reached when the bubble reaches the hemispherical shape. At this point in time, the radius of the hemispherical bubble corresponds to the radius of the capillary. Once the hemispherical shape is exceeded, the pressure only serves to expand the bubble until it detaches itself. The surface tension can be calculated with the Laplace equation from the maximum bubble pressure and the bubble radius. The time from the start of bubble formation to the hemispherical shape (maximum pressure) is the surface age corresponding to the surface tension. The time from the hemispherical shape until the bubble detaches is the dead time. It is not relevant for the measurements.



$$\sigma = \frac{r_{cap} \cdot (P_{max} - P_h)}{2} \quad ; \quad P_h = \rho \cdot g \cdot h$$

h: immersion depth · ρ: sample density · g: acceleration due to gravity · σ: surface tension · r_{cap}: capillary, internal radius · P_{max}: maximum pressure · P_h: hydrostatic pressure

Preferred applications:

- *Dynamic surface tension*
- *For systems containing surfactants*

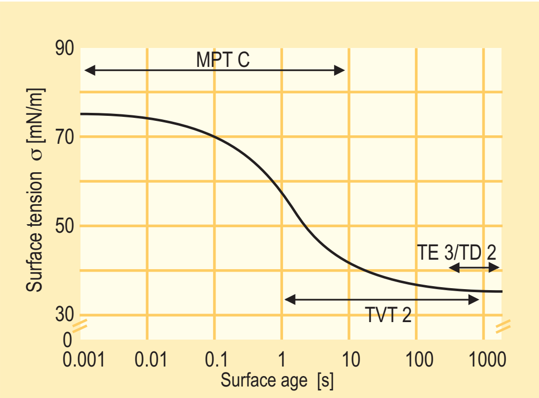
Examples of typical samples:

- *Very "rapid" surfactants and/or high surfactant concentrations*

Equipment suitable for this method:

The MPT C: it enables precise determination of dynamic surface tension with surface ages measured from fractions of milliseconds up to 2 s (MPT C) (see p. 30 ff).

LAUDA Tensiometers supplement each other



If depicted in a logarithmic way the surface tension/surface age is an S-shaped curve which is characteristic for each surfactant and its concentration. Each of the LAUDA Tensiometers covers a certain range of the surface age for physical-technical reasons. The range defined by the application is therefore the deciding criteria in selecting the equipment. Using the combination of different LAUDA Tensiometers provides nearly complete coverage of the time range.

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.

Applications TVT 2

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.

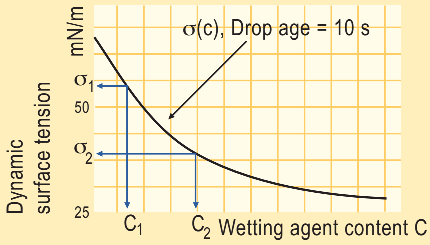
- *Characterization of the dynamic behaviour of surfactant molecules at the surface and interface within seconds – or hours*
- *High-precision measuring of interfacial tensions in a very wide range down to very small values (0.1 mN/m)*
- *Measurements on highly volatile and/or toxic substances through 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.

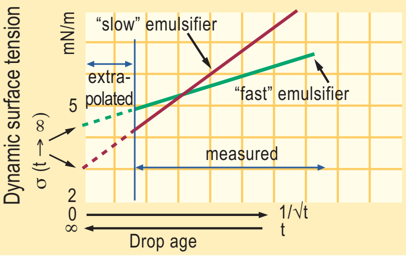


Example: Screening tests of emulsifiers

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:

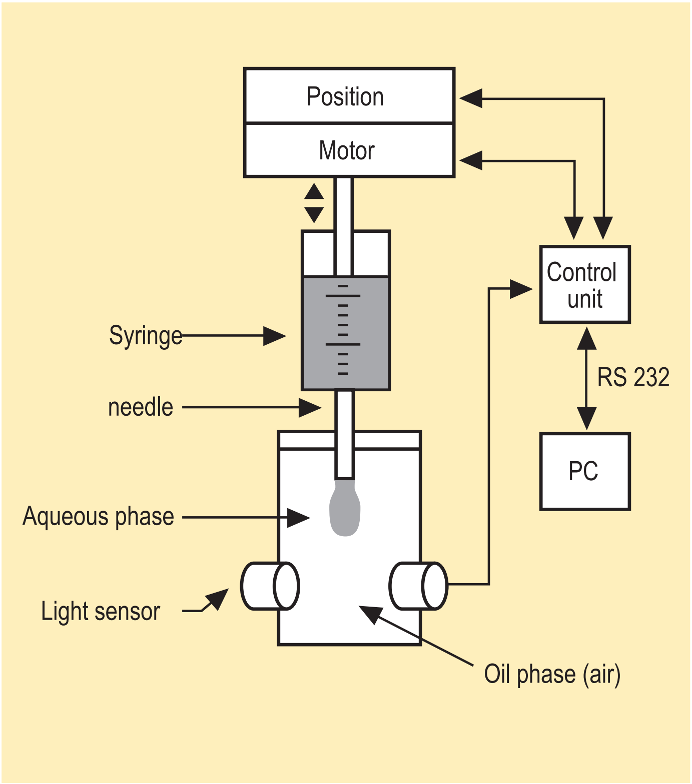
The dynamic interfacial tension at the interface between the two phases shows, in addition to the interfacial activity, how fast emulsifiers reach the interfaces. Reproducible aqueous drops with variable lifetimes in the oil phase can be generated with the TVT 2. This can be used to determine the interfacial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



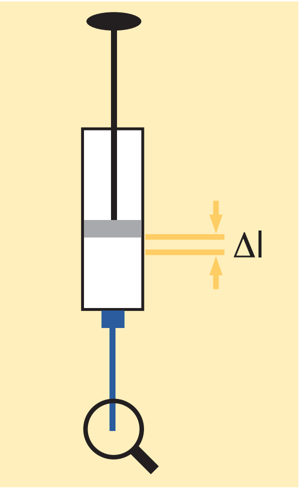
LAUDA Drop Volume Tensiometer TVT 2

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

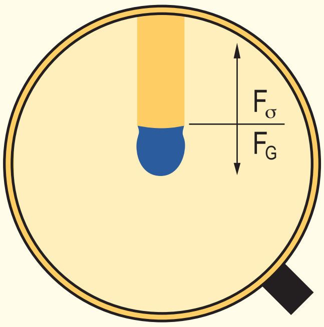
Simple function principle for highly precise results



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.

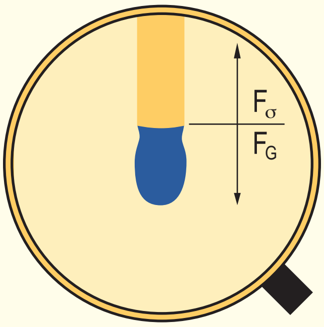


By multiplying the distance Δl of the syringe plunger with the known cross-section area A of the syringe, one obtains the volume V of the falling drop and therefore the surface/interfacial tension (see "Dynamic methods").



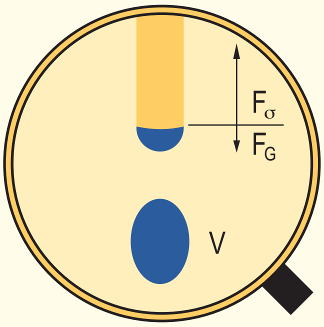
The drop grows: The weight of the drop increases, but is still smaller than the holding force.

$F_G < F_\sigma$



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.

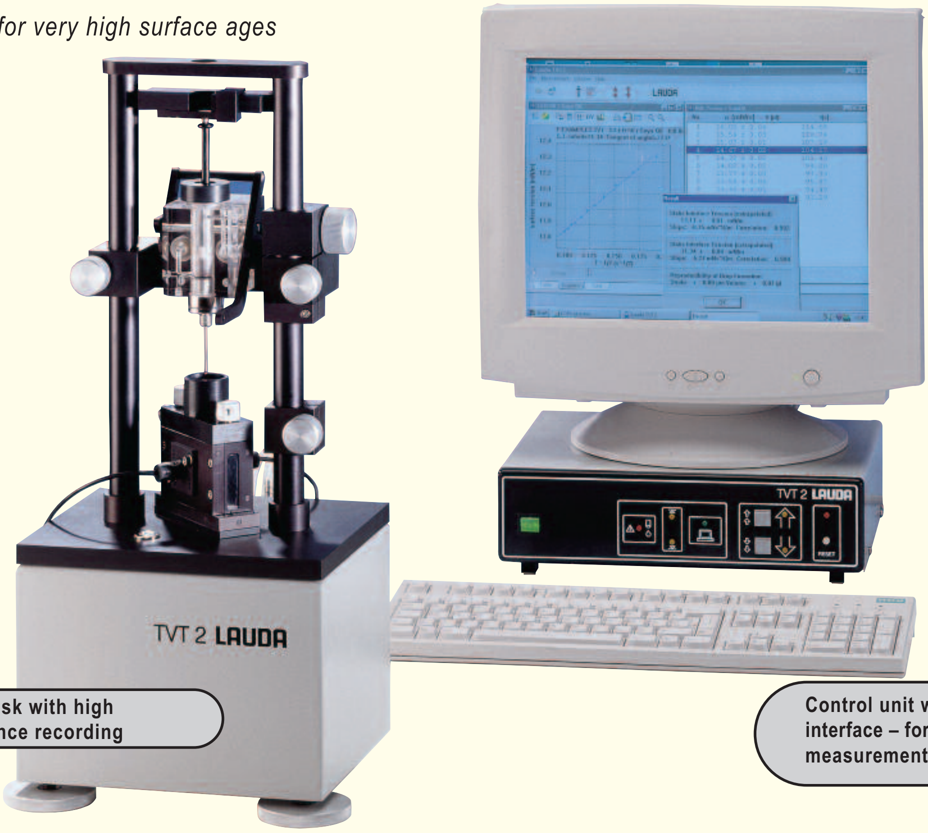
$F_G \ll F_\sigma$

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

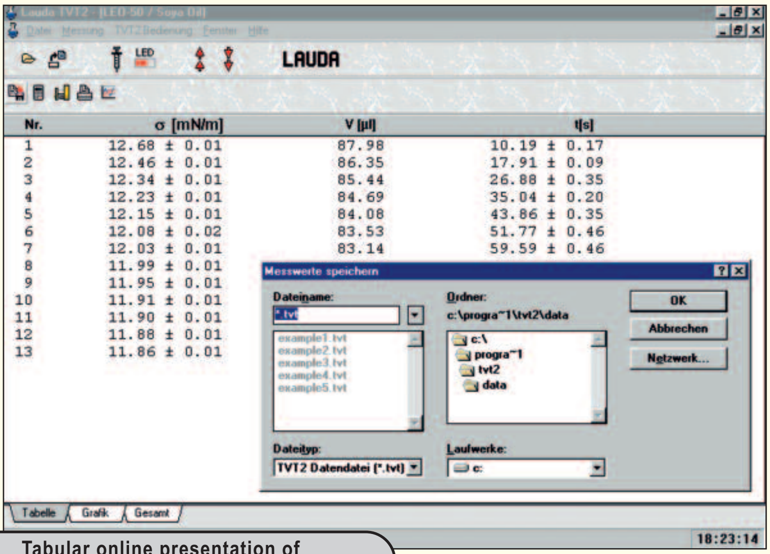
- *Ground, precisely measured spindles*
- *Consists of a discharge device, driven by PLL-controlled, low-vibration DC motor*
- *High-resolution, micrometer-precise distance encoder for volume determination*
- *High-quality gas-tight syringes with constant internal diameter*
- *Drop formation needles 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*

LAUDA Drop Volume Tensiometer TVT 2

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



Nr.	σ [mN/m]	V [µl]	t[s]
1	12.68 ± 0.01	87.98	10.19 ± 0.17
2	12.46 ± 0.01	86.35	17.91 ± 0.09
3	12.34 ± 0.01	85.44	26.88 ± 0.35
4	12.23 ± 0.01	84.69	35.04 ± 0.20
5	12.15 ± 0.01	84.08	43.86 ± 0.35
6	12.08 ± 0.02	83.53	51.77 ± 0.46
7	12.03 ± 0.01	83.14	59.59 ± 0.46
8	11.99 ± 0.01		
9	11.95 ± 0.01		
10	11.91 ± 0.01		
11	11.90 ± 0.01		
12	11.88 ± 0.01		
13	11.86 ± 0.01		

Messwerte speichern

Dateiname: *.tvt

example1.tvt
example2.tvt
example3.tvt
example4.tvt
example5.tvt

Ordner: c:\progra~1\tvt2\data

c:\
progra~1
tvt2
data

Dateityp: TVT2 Datendatei (*.tvt)

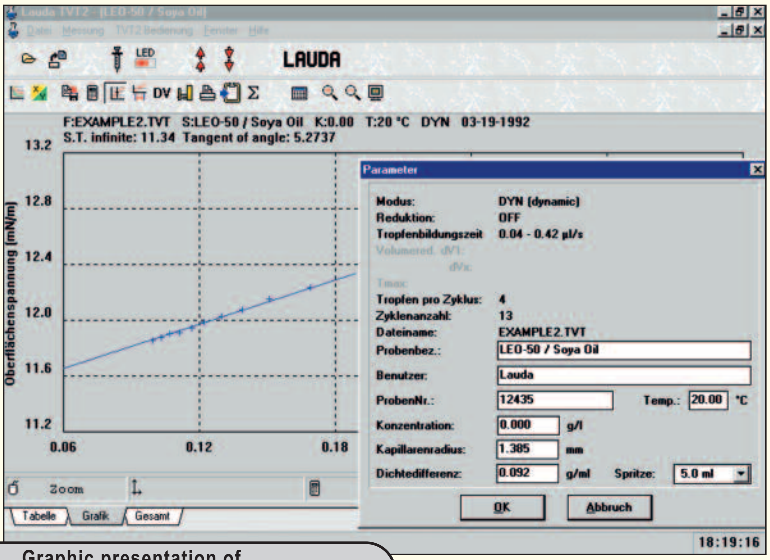
Laufwerke: c:

OK
Abbrechen
Netzwerk...

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)



F:EXAMPLE2.TVT S:LEO-50 / Soya Oil K:0.00 T:20 °C DYN 03-19-1992
S.T. infinite: 11.34 Tangent of angle: 5.2737

Parameter

Modus: DYN (dynamic)
Reduktion: OFF
Tropfenbildungszeit 0.04 - 0.42 µl/s
Volumered. dV1:
dVx:
Tmax:
Tropfen pro Zyklus: 4
Zyklenanzahl: 13
Dateiname: EXAMPLE2.TVT
Probenbez.: LEO-50 / Soya Oil
Benutzer: Lauda
ProbenNr.: 12435
Temp.: 20.00 °C
Konzentration: 0.000 g/l
Kapillarenradius: 1.385 mm
Dichtedifferenz: 0.092 g/ml
Spritze: 5.0 ml

OK
Abbruch

Graphic presentation of
a dynamic measurement

Technical data TVT 2

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

Measuring technology standards

- ISO 9101
- ASTM D2285

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

LAUDA Bubble Pressure Tensiometer MPT C

The handy LAUDA Bubble Pressure Tensiometer MPT C also records fast surfactants in millisecond range.

The bubble pressure tensiometer MPT C has been added to the family of LAUDA tensiometers. As opposed to scientific research tensiometers as the MPT C – the final step has been taken for the full automation of dynamic surface tension measuring. Ultimate user-friendliness is achieved without having to take a detour via the PC. The extremely compact stand-alone device offers all the necessary features for the simple measurement of dynamic surface tensions in the laboratory or as a mobile device.

Exact measurements of the dynamic surface tension independent of a PC

The measurements are precise and reproducible, yet time-consuming settings can be presented, stored and transferred to a PC at the touch of a button. The measuring method according to Fainerman also guarantees exact surface tensions at even extremely small surface ages and the accompanying "real" bubble age.

The program offers two measuring procedures. In the first mode, the bubble frequency is reduced in stages, whereby a specified flow range is gradually passed through in order to clearly determine and represent the dependency of the dynamic surface tension from the surface age. The flow is re-adjusted at every single measuring point and is identified as measured value. The evaluation of the measurements and the necessary correction, such as for calculating the dead time, is carried out on a scientifically-founded base.

In the "constant flow" mode, the bubble frequency and, thus, the surface age, is kept constant in order to document any changes in the surfactant concentration, e.g. in the course of reactions.

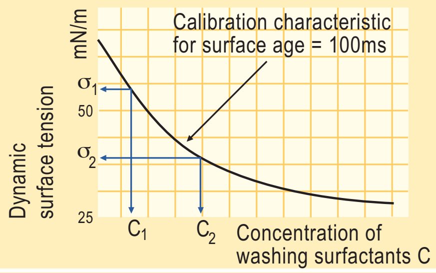
Various areas of application

Thanks to the self-explanatory user guidance, the simple cleaning of the capillaries as well as the compact structure of the unit, the unit is especially suitable for the quality control of dynamically-critical surfactant solutions or for the fast determination of a surfactant at concentrations above the critical micelle concentration. The MPT C is robust, user-friendly and highly precise. Measurements are carried out completely independently by the user and documented along with the necessary settings. Thus complying with the strict specifications of the GLP guidelines.

Example: optimisation of the surfactant dosage

It is only by measuring the surface tension of extremely short-lived surfaces of washing-up liquids that the surfactant content can also be determined above the critical micelle concentration and be optimised directly in the process or a dosage formula be developed from it.

Solution:
The MPT C allows fast and easy measurements of surface tension even at high concentrations of surfactants. Precise determination of concentration is possible due to an extremely large dynamic range from 1 millisecond up to several seconds.

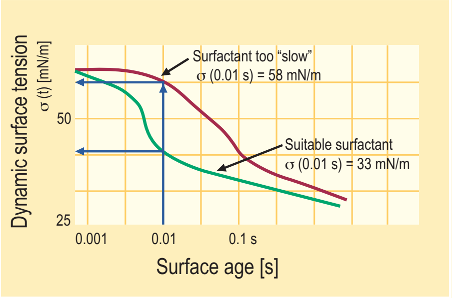


Example: Optimization of drop size

The drop size in sprays, e.g. for agrochemicals, cosmetics or inkjet printers, is dependent on the surface tension immediately after leaving the nozzle. The surfactants that produce the right drop size must “rapidly” reduce surface tension. Normal tensiometers are too slow to measure these rapid changes.

Solution:

The dynamic surface tension is measured by the MPT C on surfaces that are only a few hundredths of a second old. This corresponds to the age of the droplet immediately after leaving the nozzle. This allows suitable surfactants to be selected and their concentration is optimized.

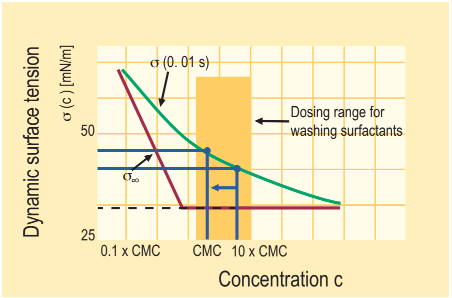


Example: Determination of surfactant consumption

The surfactants consumed during the washing processes are measured online via the changes in surface tension. Normal tensiometers were found to be unsuitable for this process as the surfactant concentration always lies significantly above the critical micellar concentration (CMC).

Solution:

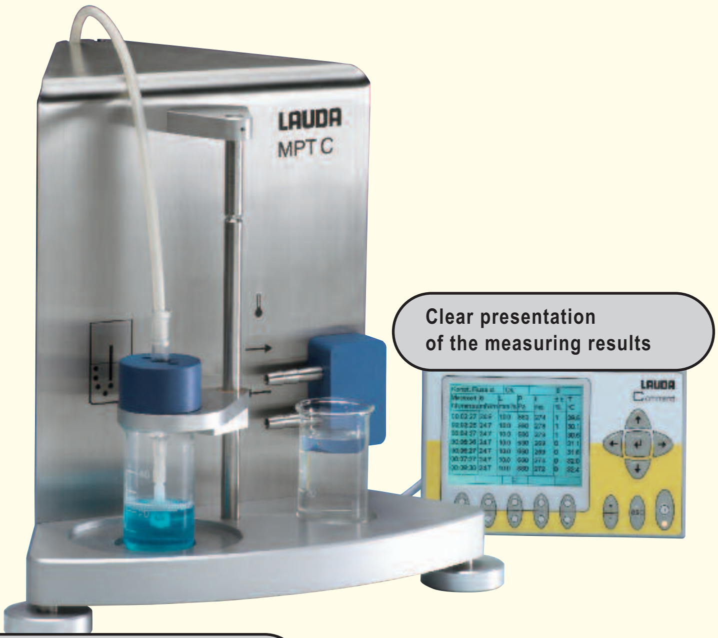
The dynamic surface tension shows a clear dependency on concentration at surface ages of 0.01 s, even above the CMC. This means that the MPT C can determine the effective surfactant concentration and hence surfactant consumption.



The ergonomic measurement desk contains the sensitive pressure sensors and the holder for the capillaries included as standard accessories, humidifier and sample beakers. A temperature probe, combined with a LAUDA thermostat guarantees the stability of the temperature. The measuring capillary can be inserted directly into the reaction vessel via a hose connection up to one metre in length or via a flow cell (bypass) for the "online" monitoring of the surfactant reactions.

Simplest handling via external remote control

The external, handy remote control Command with a graphic display can be intuitively used without the need for any special know-how. The integrated microcontroller offers a series of useful testing methods with which, for example, it can automatically carry out a scan of the dynamic surface tensions over a range of 1 to 2000 milliseconds, thus recording the adsorption kinetics of even very fast surfactants in a complete, comprehensive manner.



Clear presentation of the measuring results

High-resolution pressure sensors guarantee the precise pressure logging

Measuring with double-walled thermostating vessel

The scope of delivery:

- Extremely large dynamic range from 1 ms up to several seconds
- Automatic recognition of the transition point bubble/jet range
- Tabular representation of the dynamic surface tensions, number of measured points, real bubble age
- Graphic representation of the dependency of the dynamic surface tensions on the bubble age, linearly or logarithmically
- User-defined measuring point distance and duration of the measurement
- Storage of up to 50 measure results including the accompanying parameters

Other options:

- Numerical description of samples determined by the user
- Output of the measured values on an optional printer or PC via RS 232-interface
- Plug-in boards with relay output in order to control the processes via the surface tension

Advantages and technical data MPT C

Output of the measured values is optional via a printer or a data transmission software on the PC via the RS 232-interface. The measurement and the documentation of the temperature in the sample can also be carried out by means of an optional digital temperature probe.

Steel and glass capillaries for various samples

Complementary accessories simplify work

Technical data MPT C

Measured value		Dynamic surface tension
Measuring methods		Constant flow, automatically changed volume flow, constant surface age
– Resolution	mN/m	0.1
Measuring range of surface tension	mN/m	10 to 100
Dynamic range	s	0,001 - 2
Monitoring mode “constant flow“	min.	1 to 60 and more
Temperature range (sample)	°C	5 - 85
Temperature measurement		Digital (optional)
– Resolution	°C	0.1
– Precision	°C	0.5
Display	mm	320 x 240 graphic display, 11 x 40 characters
Display modes		Tabular, graphic: surface tension as a function of the surface age (t, Lg t)
Selection of measuring mode		Menu-controlled
Parameter input		Menu-controlled
Sample description		Numerical
Measuring point distance mode “constant flow“	min.	Selectable
Data storage		Max. 50 results with date and time
Duration of experiment	min.	3 to 20 (depending on the measuring point density)
Interfaces		RS 232
Documentation		Protocol printer, PC (optional)
Data transmission software		For PC running WINDOWS 98 and higher (optional)
Weight	kg	Approx. 6.5
Dimensions (WxDxH)	mm	280 x 300 x 300
Power supply	V	External power adapter, 100 - 240 V; 50/60 Hz

Standard accessories

- Two glass capillaries
- Set of beakers to take samples

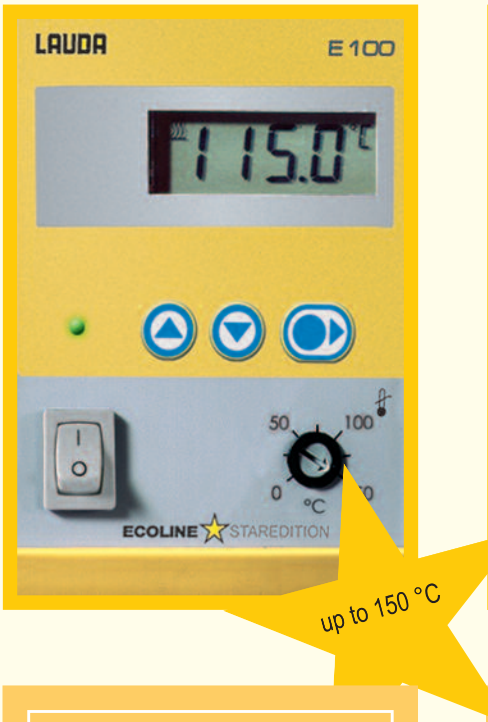
Further accessories

- Digital temperature probe for measuring in the sample
- Data transmission software for PC under WINDOWS (optional)
- Double-walled thermostating vessel
- Diverse types of capillary
- Protocol printer
- Membrane pump for capillary rinsing
- Online flow cell
- Rinsing set

Measuring standards

- ASTM D 3825

Recommended LAUDA thermostats for tensiometers



E 100

- LCD display, resolution of indication 0.1 °C
- Symbols to show operating status
- Simple 3-key operation
- User-friendly menu guidance
- Display of actual or set temperature
- Overtemperature protection
- Low-level protection
- Vario pump technology
- Audible alarm
- Fault report with automatic self-tests
- Facility for calibration
- Enlarged temperature range up to 150 °C

E 200 (as E 100, but additionally)

- 2-line LCD display, resolution of indication 0.05 °C
- Parallel display actual/set temperature
- Setting resolution selectable °C or 0.01 °C
- Messages of operating states in clear text
- Remote fault indication through floating contact
- RS 232 and RS 485 interfaces
- 2-point factory calibration as standard
- Basic-Programmer for 20 temperature/ time segments, with loop, alteration and pause function

E 300 (as E 100/E 200, but additionally)

- Back-lit 2-line LCD display, resolution of indication 0.05/0.01 °C
- External control
- Screw-on nipples with M 16x1 thread
- Mains voltage outputs for solenoid valve for controlled cooling with mains water or to operate through-flow cooler
- Analogue inputs and outputs 0...10 V or 0/4...20 mA with standard signals e.g. for peripheral equipment
- Remote control as accessory
- Programmer for max. 150 temperature/time segments, devided into 5 pro-grams with loop, alteration and pause function
- LAUDA Wintherm Plus PC software controlled with any PC by interfaces

The right thermostat	E 103	E 203	E 306	RE 104	RE 204	RE 306
Ring/plate tensiometer TD 1 C	●	●	–	–	–	–
Ring/plate tensiometer TD 2	●	●	–	●	●	–
Ring/plate tensiometer TE 3	–	–	●	–	–	●
Drop volume tensiometer TVT 2	–	–	●	–	–	●
Bubble pressure tensiometer MPT C	●	●	–	–	–	–
Bubble pressure tensiometer MPT 2	–	–	●	–	–	●

● = recommended thermostat

Thermostats

LAUDA Ecoline Staredition cooling baths of various sizes made of high-quality stainless steel are made to measure for all of your wishes and provide optimum cooling and heating curves thanks to their insulation. All of the Ecoline Staredition cooling thermostats are equipped with power-saving automatic cooling control. All the units have carrying handles and a drain tap. The panel with the ventilation slots at the front can easily be removed for cleaning.

LAUDA Ecoline Staredition thermostats offer you the top digital technology that is indispensable in the laboratory of today. In order to get only as much technology as you actually require, we have provided the Ecoline Staredition with three different control heads with different performance packages. You only pay for what you actually need.

Cooling thermostat RE 306

Heating thermostats

Technical features		E 103	E 203	E 306
Working temperature range	°C	20...150	20...150	20...200
Temperature stability	± °C	0.02	0.01	0.01
Heating power	kW	1.5	2.25	2.25
Discharge pressure max.	bar	0.4	0.4	0.4
Pump flow max.	L/min	17	17	17
Bath volume	L	2.5...3.5	2.5...3.5	3.5...5.5
Bath opening*/depth	mm	135x105/150	135x105/150	150x130/160
Cat. No.	230 V; 50/60 Hz	**LCB 0691**	**LCB 0692**	**LCB 0699**

Cooling thermostats

Technical features		RE 104	RE 204	RE 306
Working temperature range**	°C	-10...150	-10...200	-20...200
Temperature stability	± °C	0.02	0.01	0.01
Heating power	kW	1.5	2.25	2.25
Cooling output at 20 °C	kW	0.18	0.18	0.20
Discharge pressure max.	bar	0.4	0.4	0.4
Pump flow max.	L/min	17	17	17
Bath volume	L	3...4.5	3...4.5	4...6
Bath opening/depth	mm	130x105/160	130x105/160	150x130/160
Cat. No.	230 V; 50/60 Hz	**LCK 0861**	**LCK 0862**	**LCK 0866**

* Dimensions of bath opening are overall dimensions of the bath which are slightly reduced downwards.
** Working temperature range is equal to ACC-range.

We have been in the business of thermostating and measuring technology for more than 50 years. The precision equipment from LAUDA is highly esteemed worldwide in all branches of research and industry. Thanks to our worldwide sales service network, we have a presence in over 70 countries around the world. Our key capability, in addition to thermostating liquids, is the precise static and dynamic measuring of surface and interfacial tensions, together with the viscosity of liquids and polymer solutions.

We set the standards – around the world

- *LAUDA is a pioneer in the development of automatic interfacial measuring systems. We have produced, e.g.:*
  - *The first automatic film balance*
  - *The first fully automated tensiometer*
  - *The first computer-controlled film balances and tensiometers*
- *More than 30 years experience in implementation of scientific measuring methods guarantees user-friendly series instruments.*
- *The automated process introduced by LAUDA for the determination of the critical micellar concentration is a global standard. Special variants, such as, e.g. "Reverse" CMC are patent protected.*
- *The sturdiness of our devices speaks for itself: Most LAUDA instruments are still in operation today.*
- *The high LAUDA quality standard has been certified by DIN EN ISO 9001:2000 and is to be renewed every 3 years. LAUDA devices comply with international standards EN 61010-1 and EN 61010-2-010, the EMC and low voltage directives.They are particularly well known for their safety in long-term operation.*

Our competence carries you further

- *Your individual requirements are met by experienced and specialist engineers and designers in the fields of measuring instruments, microprocessor electronics, firmware and hardware, together with software specialists.*
- *We provide you with solid and professional support in the area of surface/interfacial measuring instruments with globally recognized experts who have long-term national and international experience.*
- *The LAUDA Service Center and specially trained service technicians at the LAUDA representational centres help you rapidly and unbureaucratically.*
- *We can also help you with questions that go beyond the area of interfacial technology, e.g. regarding viscosity or thermostating technology, and we can provide you with competent contacts.*

Specially for you

- *We not only support you in the maintenance and calibration of your equipment, but also in the installation, adaptation to your requirements and interpretation of the results obtained. On request, our experts can advise you on-site.*
- *We offer a sample service before purchase to ensure that your samples can be measured.*
- *We take time for our customers: We offer you individual solutions and personal consultation by telephone or E-mail.*
- *Our sales network guarantees you qualified service practically around the entire world.*
- *Regular seminar with globally recognized experts in theory and practice of interfacial technology and important applications provide you with further training and exchange of experiences in neighbouring fields.*

Our strength is our service

- *The continual updating of products and software broadens the range of possible applications.*
- *Special update contracts serve as prevention and guarantee unbureaucratic help in the case of technical problems.*
- *Our manuals support you in the optimal use of our hardware and software. They include the theoretical background of methods and equations, together with help for evaluation and interpretation, and a comprehensive bibliography.*
- *The proven LAUDA Thermostats provide all measuring instruments with optimal thermostating technology from our own company.*
- *We guarantee long-term supply of spare parts and a wide range of accessories. Rapid delivery times ensure that you are always on time.*

Glossary

Important terms in tensiometry

Adsorption
is the accumulation of (amphiphilic) molecules at the surfaces and interfaces of liquids and solids. This leads, amongst other things, to a reduction in surface/interfacial tension.

Bubble Pressure Tensiometer
is used to determine the surface tension of liquids from the pressure in gas or air bubbles that are generated in the measuring liquid with a capillary of known dimensions. This method is not suitable for determining interfacial tensions between liquid phases.

CMC measuring
is the determination of the surfactant concentration at which the surfactant molecules begin aggregating into micelles (CMC concentration). This can be determined from the dependency between the concentration of the surfactant in the solution and the surface tension.

Contact angle/contact angle measuring
characterizes the wetting properties of liquids on solid bodies. The contact angle can be determined by measuring individual drops on a solid or from the forces required to move a solid in contact with a liquid lamella. The contact angle is used to calculate surface energy.

Correction as per Harking and Jordan
Harkin and Jordan produced tables for correcting surface and interfacial tensions measured with a ring. These values are standardized.

Correction as per Zuidema and Waters
Zuidema and Waters developed a polynomial for correcting surface and interfacial tensions measured with a ring.

Critical micellar concentration (CMC)
At this concentration, surfactant solutions suddenly change their physical properties. The reason for this is the formation of organized aggregates (micelles) of the surfactant molecules when the critical micellar concentration is exceeded. The structure of the micelles is dependent on the character of the solvent and the structure of the surfactant molecules.

Diffusion coefficient
characterizes the thermal migration movements of molecules in the material examined. In tensiometry, the diffusion coefficient refers to the migration of molecules in the liquid measured.

Drop Volume Tensiometers
determine the surface/interface tension of liquids at the moment of drop separation, from the volume of the drop that is formed in air or in an immiscible second liquid. The densities of the phases concerned must be known in order to calculate the surface/interface tension from the measured drop volume.

Du Noüy ring
is a measuring body made of a platinum-iridium alloy to determine surface/interfacial tension from the tensile force of a lamella produced by this body using a Ring/Plate Tensiometer.

Du Noüy ring method
is used to measure the surface/interface tension using a standardized ring with a ring/plate tensiometer. The ring is immersed in the liquid and then drawn out. This forms a liquid lamella that is stretched to its maximum. The surface/interface tension is calculated from the resulting force. The calculated value must be corrected.

Dynamic interface or surface tension
is the measurable reduction in interfacial/surface tension with time due to adsorption of surface active substances.

Dynamic measuring process (tensiometry)
is used to calculate the surface/interfacial tension dependent on surface age.

Emulsion
is a disperse system consisting of two immiscibel liquids, such as water or an aqueous solution and an organic. The dispersed or inner phase is present in form of small droplets, surrounded by the dontinuous or matrix phase.

Interfacial energy
is the sum of free energy of all the molecules present in the interface between different materials. The interface between a liquid and a gas is designated as the surface and the corresponding energy from this region is the surface energy.

Interfacial tension
is the work that must be applied to increase the interface of the liquid by one surface area unit. This is equivalent to the specific interfacial energy.

Lenard frame
simple test wire. Is used as an alternative to the Du Noüy ring.

Reverse CMC
Reverse CMC is the determination of CMC by automatically reducing surfactant concentration. This measuring method is based on a LAUDA patent. It is faster and offers significant advantages in handling compared to other methods.

Ring/Plate Tensiometers
measure the force with which a lamella attacts a Du Noüy ring or Wilhelmy plate. This is used to calculate the surface/ interfacial tension between liquid phases. Ring/Plate Tensiometers are also used for dynamic contact angle measuring and CMC measuring with software controlled burettes.

Surface age
is the age of a surface since its creation. In bubble pressure tensiometry, this is the period from the beginning of bubble formation to the hemispherical shape of the bubble. In drop volume tensiometry, this is the period between the creation and separation of a drop.

Surface tension
is the interfacial tension between a liquid and any gas.

Surfactant
is a interfacially active substance. The reason for this activity is an asymmetric structure of the surfactant molecule, consisting of a hydrophobic (water-repelling) part and a hydrophilic (water-soluble) part. The interfacial tension is reduced by the adsorption of these molecules at the interface.

Suspension
is a disperse system, i.e. a fine, but not molecular distribution of a solid body in a liquid.

Washburn method
The contact angle is calculated from the weight increase over time of powders in contact with liquids.

Wilhelmy plate
is a standardized plate, usually made of a platinum alloy. It is used to measure surface tension with a Ring/Plate Tensiometer. The material of the plate is selected so that its contact angle to the test liquid is equal to zero. Optimal cleaning, e.g. by in a Bunsen flame, is essential.

Wilhelmy plate method
is used to measure the surface tension using a standardized plate with a Ring/Plate Tensiometer. The plate is moved towards the surface until the meniscus connects with it. The surface tension is calculated from the resulting force. Due to uncertain wetting behaviour, the plate can only be used for interfaces under certain limitations.

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