The right temperature worldwide

LAUDA

LAUDA Measuring Instruments

Viscometer, Tensiometer

Analysis of oils,
polymers and plastics

LAUDA Measuring Instruments – Overview

Viscothermostats

Proline

Proline thermostats of the PV and PVL series are specially optimized for viscometry. The PV thermostats are particularly suited to high-temperature applications of up to 230 °C. High-quality insulated PVL thermostats can be used in applications as low as -60 °C.

Viscocool and Viscotemp

NEW

Offering a good-value alternative in the temperature range up to 105 °C are the **visco-thermostats**, which come optionally with transparent baths of the ET series or stainless steel baths with insulated glass panes of the Viscotemp series. With the new Viscocool thermostat integrated Peltier elements replace cooling water and additional coolers.

Viscometers

Glass capillary viscometers

NEW

The **glass capillary viscometers** serve to determine the level of kinematic viscosity. They come in versions such as Ubbelohde, Micro-Ubbelohde, Micro-Ostwald, and Cannon-Fenske.

iVisc

The **iVisc** is a fully automatic and compact viscometer with an excellent price-performance ratio for viscosity levels between 0.3 and 30,000 mm²/s.

PVS

The modular setup of the automatic **PVS viscometer** with modern Windows software can be optimally adapted to any application.

VRM

The **VRM cleaning modules** enable the fully automatic cleaning and drying of the glass capillary viscometers.

VAS

The **VAS viscosity auto-samplers** offer the maximum convenience of automation with high sample throughput.

Sample preparation

The sample preparation systems with high-quality balances, dosing systems and magnetic stirrers enable the exact manufacture of polymer solutions via direct PC control.

Tensiometer

TD

The **TD tensiometers** are used to measure the surface and interfacial tensions according to the ring/plate method. The LAUDA TD 1 C is the cost effective starting point to tensiometry. For fully automatic measurement with advanced options, using the LAUDA TD 3 is preferred.

TVT

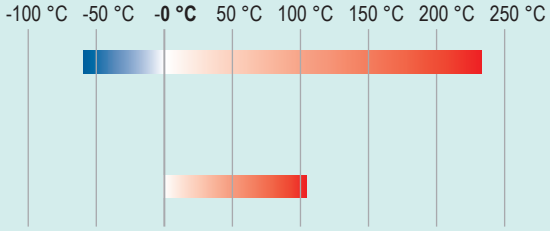
The **TVT 2 tensiometer** broadens usage in tensiometry when it comes to determining the dynamic surface and interfacial tensions according to the drop volume method.

Applications - Polymers

Technical polymers	Viscosity number of polyamides (PA) and polybutylene terephthalates (PBT)
Transparent polymers	Viscosity number and IV value of polyesters (PC, PMMA, PET)
Polyolefins	Molar mass and IV value of polypropylene and polyethylene (UHMWPE)
Polyvinylchloride	Determining K-value according to Fikentscher (PVC)
Medicinal polymers	Molar mass and IV value of hyaluronic acid products and absorbable polymers according to pharmaceutical standards
Cellulose and papers	Degree of polymerization of insulation paper using solution viscosity

Applications - Lubricants, oils and fuels

Lubricants and fuels	Viscosity index and kinematic viscosities of SAE/ISO motor oils at application temperatures
	Low-temperature behavior (paraffin formation) of motor oils, diesel and kerosene
Insulating oils	Kinematic viscosity and interfacial tension of transformer oils
Oil production	Recovery rate in tertiary oil production with surface active substances
Oil transport	Pumpability of crude oils
Waxes, resins, silicone, and polyols	Absolute, kinematic and dynamic viscosities of highly viscous liquids and their temperature dependency



from page 10

ISO 3105, ISO 3104, DIN 51562, DIN 53012, DIN 53014,
ASTM D445, ASTM D446, BS188

from page 20

EN 14210, EN 14370, ASTM D971, ISO 304, ISO 4311,
ASTM D1331, ISO 6295, ISO 1409

ISO 9101, ASTM D2285

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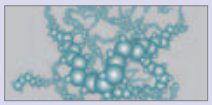
ISO 307, DIN 53727, ASTM D789, ISO 1628-1, ISO 1628-5, DIN 53728-2, ASTM D4603
ISO 1628-1, ISO 1628-4, DIN 7744-2, ISO 1628-6
ISO 1628-1, ISO 1628-3, DIN 53728-3, ASTM D1601
ISO 1628-1, ISO 1628-2, DIN 53726
ISO 1628-1, international pharmacopoeias
DIN 54 270-2, IEC 60450, ASTM D4243



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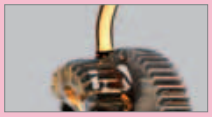
ASTM D2270, ISO 2909, DIN 51 563, ASTM D445

ASTM D1655, ASTM D2532

VDE 0370

ASTM D445, DIN 51562

ASTM D445, DIN 51562



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Advantages

Specialized in plastics and oils

The focus of the measuring instruments business unit is the applications used down the entire value added chain from crude oil to plastics. LAUDA measuring instruments are optimized for determining the viscosity of crude oils, fuels and lubricants as well as for examining rinsing solutions in crude oil production and for quality assurance of fuels and oils.

Everything from a single source

LAUDA provides all of the components needed for viscosity measurement from a single source in accordance with ASTM D 445: Viscothermostats, automatic viscosity measuring systems, glass capillary viscometers, software and sample preparation. The modules can be quickly and easily customized to meet client requirements. High production depth enables the highest degree of flexibility.

Modularity and automation

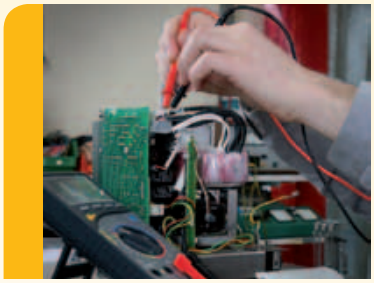
To measure the viscosity values and surface/interfacial tensions of technical plastics, biopolymers as well as of lubricants, oils and fuels, LAUDA measuring instruments are the right solution. Since the components are modular, it is possible to put together a suitable system configuration for research and development, production and quality assurance. The measuring system's degree of automation can be adapted to the tasks and the scope of the sample concentration.

Proverbial quality

For almost 60 years now, LAUDA has been developing, engineering and producing high-class measuring instruments and constant temperature equipment of outstanding quality. From the start, the owners and directors promised to deliver the highest quality standards to their clients, business partners and to the global scientific community. The guarantee of user-friendliness, optimum functionality and high safety standards has always been the full attention and concentration of all LAUDA employees - which, now more than ever, produces what has become the proverbial LAUDA longevity and durability.

First class support – internationally

The LAUDA team at our headquarters and in the international subsidiaries and agencies, the professionally and comprehensively trained sales representatives, and the staff of the specialist laboratory facilities provide friendly, fair and competent advice. Together with our clients, LAUDA helps application experts to configure application-specific systems while taking international standards into account.



Reliable service

LAUDA equipment is known for its robustness and durability. However, should you ever need support - usually after many years of installation - we are there for you: as a LAUDA customer, you have access to comprehensive services, ensuring greater flexibility and profitability. One thing is certain: LAUDA service will not let you down.

Family Company with Tradition

1956 Dr. Rudolf Wobser founds the MESSGERÄTE-WERK LAUDA Dr. R. Wobser KG in Lauda in the region of Baden.

1964 Birth of the heating and cooling systems for industrial thermostating tasks. Three years later: development of the first tensiometers and film balances.

1977 After the death of the father, Dr. Rudolf Wobser, Dr. Gerhard Wobser and his brother Karlheinz Wobser take over the management as partners with unlimited liability.

1982 Launch of the world's first mass-produced thermostats using microprocessor technology. Proportional cooling and external control are further sensational inventions.

1989 As part of the expansion of the range of products, the MESSGERÄTE-WERK LAUDA is renamed LAUDA DR. R. WOBSER GMBH & CO. KG.

1994 The first circulation chillers of the WK class put an economical end to the wasteful use of precious drinking water as a coolant. A new generation of compact thermostats is introduced. The high quality of all LAUDA products is confirmed upon certification according to DIN ISO 9001.

2003 Karlheinz Wobser retires. Dr. Gunther Wobser, part of the company since 1997, is appointed managing partner.

2005 On 1st January, the founding of LAUDA France heralds the start of a new age of internationalisation. This first company outside Germany supports the local agencies with customer advice and care.

2006 On 1st March, LAUDA celebrates the 50th anniversary of the company. Two months later, LAUDA founds subsidiary LAUDA Wostok in Russia – another milestone in the internationalization of the company.

2008 LAUDA consistently continues the global expansion strategy with the founding of subsidiaries LAUDA America Latina C.A., LAUDA China Co., Ltd. and LAUDA-Brinkmann, LP. USA. With the new production hall plus office building and an investment volume of around 3 million Euro, the heating and cooling systems business unit gains space for additional growth.

2009 At ACHEMA, LAUDA presents an equipment showcase. All of the staff from the six foreign LAUDA subsidiaries meet for the first time at the LAUDA World Meeting

2010 In March, after more than 32 years, Dr. Gerhard Wobser retires from his function as Managing Director. His son, Dr. Gunther Wobser, assumes his responsibilities.

2011 With the founding of the Spanish subsidiary LAUDA Ultracool S.L., LAUDA broadens the product range with industrial process circulation chillers from the "Ultracool" brand.

2012 Foundation of subsidiary LAUDA Technology Ltd. in Birmingham, Great Britain

Managing Director
Dr. Gunther Wobser

Company founder
Dr. Rudolf Wobser

Karlheinz Wobser Dr. Gerhard Wobser

With more than 400 employees, more than EUR 60 million in annual turnover and eight foreign subsidiaries, LAUDA is the global leader in the manufacture of innovative thermostatic equipment and systems for science, application technology and production, as well as for high-quality measuring devices. With almost 60 years of experience and a unique product portfolio ranging from compact laboratory thermostats to industrial circulation chillers to customized heating and cooling system projects with more than 400 kilowatts of cooling power, LAUDA is the only company that can guarantee optimized temperature throughout the entire value-added chain for its 10,000 plus customers worldwide.

Quality products from LAUDA keep temperatures constant to an impressive 5 thousandth °C or make targeted changes in an area spanning -150 to 400 °C. Through active cooling or warming, production processes are accelerated or, indeed, made possible in the first place. In such cases, LAUDA, for example, replaces the uneconomical mains-water cooling with environmentally friendly and cost-efficient devices or, alternatively, uses existing forms of primary energy such as thermal discharge. LAUDA measuring instruments determine the surface tension, tension limit and viscosity of liquids precisely.

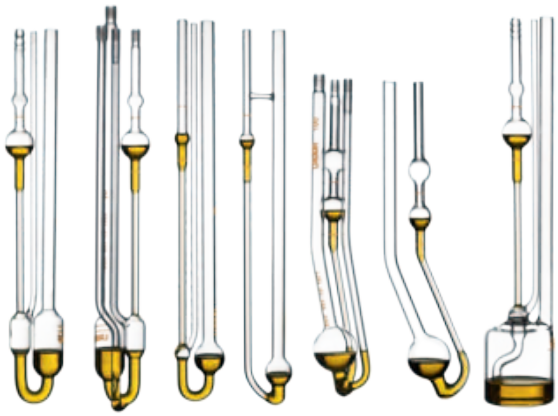
As a highly specialized niche provider, LAUDA ranks either first or second in almost all future-oriented sectors. In the semi-conductor industry, all the renowned manufacturers and suppliers place their trust in LAUDA thermostats and heating and cooling systems. LAUDA quality products also enable both the research and mass production of vital medicines. In the growing medical technology market, circulation chillers made by LAUDA cool patients and guarantee safe open-heart surgery. LAUDA industrial circulation chillers provide reliable and cost effective cooling for printing machines, injection moulding plants and laser processing machines. Further principle applications include material inspection, biotechnology and the cooling of laboratory instruments and machines. LAUDA thermostats are, naturally, also used in the measuring instruments manufactured by us. For example, in order to determine the viscosity of aviation fuel under real conditions at 10,000-meter altitude, the sample is cooled in the laboratory down to -60 °C.

Through numerous innovations and ongoing investment, LAUDA is sustainably improving its excellent market position and is growing both in the main European market as well as overseas.

LAUDA – The right temperature worldwide

News

The greatest precision and longevity: LAUDA glass capillary viscometers



Glass capillaries

Glass capillary viscometers are available in various models which differ in their areas of application, levels of accuracy and operation. Made from borosilicate glass (boro 3.3), these are available now at LAUDA in versions such as Ubbelohde, Cannon-Fenske, Micro-Ostwald, and in special models. Alongside the excellent chemical resistance, the new viscometers distinguish themselves from the rest thanks to a very small heat expansion coefficient, a very high temperature fluctuation resistance, and high mechanical strength. For highly precise, automatic measurements, the Ubbelohde version with suspended ball level is preferred, among other reasons because of its independence of the flow time from the precise sample volume.

To keep measuring times in the optimum range between approx. 60 and 600 seconds, various capillary diameters are offered for different viscosity ranges. The method, particularly with automatic LAUDA measuring technology and precise temperature control using LAUDA viscothermostats, is unrivalled in the precision for measuring liquids with nearly Newtonian (ideal) flow behavior.

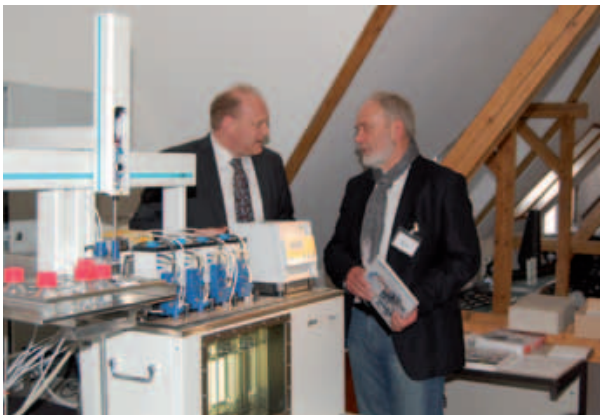
Fully automatic and compact: LAUDA TD 3 tensiometer

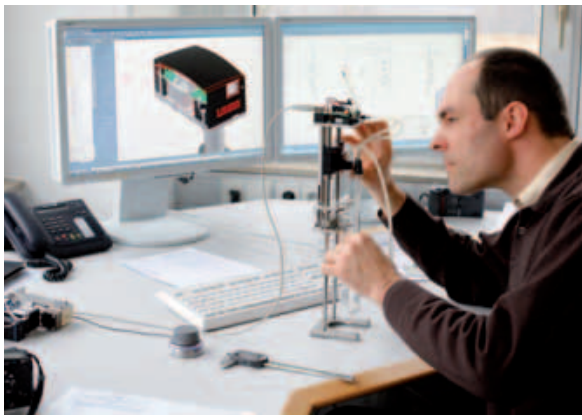
Tensiometer TD 3

The ring/plate method for measuring the surface and interfacial tensions of liquids is an established method with potential: The increasing need for surface active additives and their confirmation in quality checks necessitate fully-automated, user-friendly devices. As a stand-alone device, the compact, fully-automated ring/plate tensiometer TD 3 with LAUDA Command remote control provides everything needed for this, both in lab environments and for on-site application. Surface and interfacial tensions can be easily measured, precisely and repeatably calculated, displayed, printed, saved, and transferred to the computer at the touch of a button.

The LAUDA TD 3 comes in a new design and is equipped with some unique technical features. As such, LAUDA's smallest thermostat, the PTT Peltier thermostating unit, for example, can be easily incorporated into the device. Extremely quick and convenient, the measurement samples can be thermostated from 5 to 80 °C with the minimum of space requirements.

The TD 3 serves to determine the surface/interfacial properties of organic and inorganic liquids, dispersions, and emulsions, among others, for developing surface active substances like surfactants and emulsifiers as well as for confirming the same in waste waters and bodies of water.





Robust and economical: LAUDA viscothermostats

LAUDA is expanding its range of viscothermostats for manual and automatic viscometry. With our latest thermostats, we are closing the gap between the economical ECO ET polycarbonate transparent baths and the powerful Proline PV viscothermostats. The new Viscotemp series supplements the robust, tried-and-tested stainless steel viscothermostats with its excellent price-performance ratio. A first with the Viscocool 6 with low bath volume is the integrated Peltier cooling and lighting in space-saving and compact design.

Viscothermostat Viscocool 6

This way, external cooling is not necessary in order to maintain the often required 20 or 25 °C. The integrated Peltier cooling guarantees an operating temperature range of up to 15 °C below room temperature. Of course, all of LAUDA's viscothermostats meet the high requirements of the international standards of viscosity measurement.

LAUDA – much more than measuring instruments

The right temperature worldwide and the greatest precision – at LAUDA these claims also extended to its high-quality constant temperature equipment and extremely high performance heating and cooling systems.

LAUDA constant temperature equipment

For more than 50 years LAUDA has been designing and manufacturing high-quality constant temperature equipment in an operating temperature range from -90 up to 400 °C. Starting with water baths through to high-performance process thermostats. For routine tasks the economically priced LAUDA Alpha heating and cooling thermostats are the first choice. The product line ECO and Proline thermostats enable professional and, at the same time, economical temperature control. High cooling outputs and fast cooling rates are offered by the Proline Kryomats. The more powerful Integral T and Integral XT process thermostats provide a lightning-fast temperature change with external temperature control. The LAUDA Ultracool industrial circulation chillers with a cooling output of up to 265 kilowatts and a working temperature range from -5 up to 25 °C are used by the manufacturers of, for example, printing machines, injection moulding plants and laser processing machines. LAUDA thermostats are characterized by excellent handling, high ergonomics and intuitive operation.

LAUDA heating and cooling systems

In accordance with the principle of "modular engineering", LAUDA process cooling systems, heat transfer systems and secondary circuit systems are planned and built precisely according to customer's wishes: process-oriented, customized and with precision control, meeting the strictest safety standards. With a temperature range of -150 up to 400 °C, LAUDA systems heat and cool to an accuracy of one tenth of a degree Celsius. As the requirements for temperature regulation systems are constantly increasing, the modern LAUDA heating and cooling modules are flexibly extendable and modifiable. The combination of planning, production, our own test bay and a comprehensive service package makes LAUDA heating and cooling systems a valued partner around the world.

Subsidiaries

LAUDA. The right temperature worldwide.
Our subsidiaries.

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LAUDA cooperates with various representatives around the world. Thoroughly trained and highly qualified employees in sales and service of our representatives give friendly and competent advice to our customers worldwide. Please refer to **www.lauda.de** for detailed contact data of your local LAUDA representative (sector: Company → Worldwide).

LAUDA Viscothermostats

Thermostating in viscometry from -60 to 230 °C

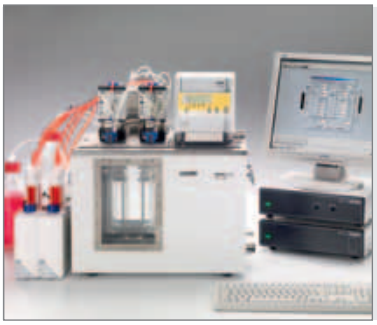
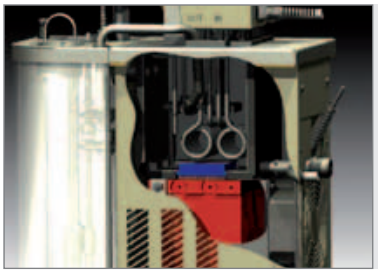
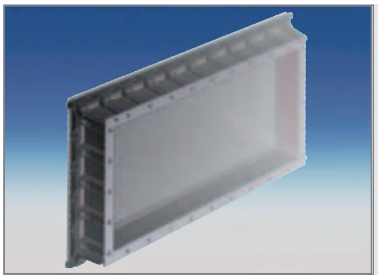
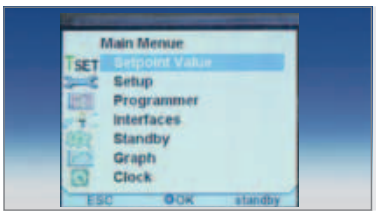
Application examples

- Standard-compliant thermostating of different models of glass capillary viscometers
- Thermostating of automatic viscometers as all-around systems
- Manufacture of dilution series with magnetic stirrers

Precise, economical, flexible

LAUDA viscothermostats are the solution to thermostating all glass capillary viscometers. With their wide temperature range, the control heads of Proline and ECO meet the high requirements of viscosity measurement (ASTM D445, ISO 3105, and DIN 51562). High degree of transparency and homogeneous lighting guarantee good inspection of the measurement processes. Numerous advancement options (e.g. magnetic stirrer, additional cooler, temperature sensors, and software) optimize the range of applications possible. The new Viscocool and Viscotemp viscothermostats are sensible add-ons to the Proline PV and ECO ET. The Viscotemp models supplement the robust stainless steel thermostats with a very good price-performance ratio. The new Viscocool 6 is equipped with integrated Peltier cooling which enables thermostating at up to 15 °C below room temperature in compliance with standards.

Your advantages at a glance

	The viscothermostats advantages	Your benefits
	• Numerous add-on options	• Automatic dilution series with automatic dispensers • Stirrer integration for the “in-situ“ dissolving of polymer samples • Temperature monitoring and Wintherm software • Solid basis for VAS viscosity auto-sampler systems
	• Integrated Peltier cooling with Viscocool 6	• Up to 15 °C below room temperature, no additional cooler necessary • Saving space in the lab • Good price-performance ratio
	• Viscotemp 18 made from solid, break-proof glass • Round and extremely compact • Excellent circulation	• Absolute resistance to chemicals • Thermostating up to 105 °C • Fully transparent • Up to five manual measuring stations • Compatible with iVisc and PVS systems • Temperature stability and homogeneity
	• Optimized insulation at high temperature • Heatable five-fold glazing in the Proline PVL versions	• Very wide temperature range from -60 (PVL) to 230 °C (PV) • Minimal heat loss • No fogging up of the glass panes at low temperatures
	• Menu navigation via monochrome LCD (ECO Silver) or color TFT display (ECO Gold) in plain text • Programmer of both versions integrated	• Simple and clear use • Clear visibility of the parameters • Automation of temperature progression and test series

Proline Viscothermostats

LAUDA viscothermostats are optimized for directly observing inserted objects. The temporal and spatial temperature stability required for precisely determining the viscosity is guaranteed for the full temperature range. As such, they are ideal for use with the fully automated LAUDA PVS or iVisc viscometers. Thanks to the double-chamber principle, a constant liquid level in the measuring room is guaranteed regardless of the rate and temperature. The PVL models are equipped with five layers of insulating glass and by connecting a DLK 45 through-flow cooler or Proline RP 890 cooling thermostat are suited to low-temperature measurements down to -40 or -60 °C.

Viscothermostat PV 24 C

Special features

- Corrosion-resistant stainless steel bath with 15, 24 or 36 liter bath volumes
- Double-chamber system for constant liquid level in the measuring chamber of bath
- Cover plates for up to six automatic or nine stop watch (manual) measuring stations
- Multi-glazing with optional heating avoids fogged up glass panes
- Integrated heat exchanger for counter-cooling
- Can be combined with LAUDA flow coolers
- High control precision thanks to adaptive PID regulation
- Optional external sensor controls the temperature at the measuring location
- Integration of magnetic stirrers and combination with VAS systems possible

Temperature range

-60**…230 °C

Included accessories

2 hose nipples and 4 plugs for pump connection · 2 hose nipples for cooling coil

Additional accessories

Heatable window frame – only for PVL 15 C, PVL 24 C · solenoid valve for cooling water · additional cooler · remote control Command

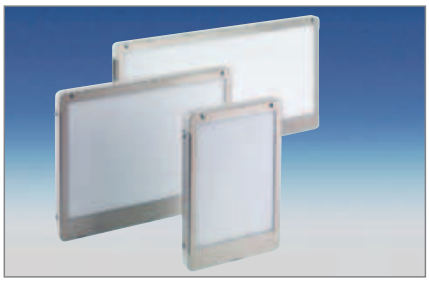
Technical features		PV 15/PV 15 C	PV 24/PV 24 C	PV 36/PV 36 C	PVL 15/PVL 15 C	PVL 24/PVL 24 C
Temperature range	°C	0*...230	0*...230	0*...230	-60**...100	-60**...100
Temperature stability	±K	0.01	0.01	0.01	0.01	0.01
Heater power 230 V (115 V/208-220 V)	kW	3.5 (1.8/-)	3.5 (-/3.5)	3.5 (-/3.5)	3.5 (1.8/-)	3.5 (1.8/-)
Pump pressure max.	bar	0.8	0.8	0.8	0.8	0.8
Pump suction max.	bar	–	–	–	–	–
Pump flow pressure max.	L/min	25	25	25	25	25
Pump flow suction max.	L/min	–	–	–	–	–
Bath volume	L	11…15	19…24	28…36	11…15	19…24
Bath opening/depth	mm	230x135/320	405x135/320	585x135/320	230x135/320	405x135/320
Glass pane size	mm	149x230	326x230	506x230	149x230	326x230
Dimensions	mm	506x282x590	740x282x590	1040x282x590	506x282x590	740x282x590
Cat. No. Master 230 V; 50/60 Hz		LCD 0276	LCD 0278	LCD 0280	LCD 0282	LCD 0284
Cat. No. Master 115 V; 60 Hz/208-220 V; 60 Hz		LCD 4276/-	LSO 4312/LCD 8778	-/LCD 8280	LCD 4282/-	LCD 4284/-
Cat. No. Command 230 V; 50/60 Hz		LCD 0277	LCD 0279	LCD 0281	LCD 0283	LCD 0285
Cat. No. Command 115 V; 60 Hz/208-220 V; 60 Hz		LCD 4277/-	-/LCD 8779	-/LCD 8281	LCD 4283/-	LCD 4285/-

* Possible with LAUDA additional cooler ** Possible with LAUDA Proline RP 890

Proline accessories

NEW Background lighting

Cat. No.	Description	Suitable for
LCZ 9738	BL 15	PV 15, PVL 15
LCZ 9739	BL 24	PV 24, PVL 24
LCZ 9740	BL 36	PV 36
EKS 097	Cable BL PVS	PV15, PVL 15, PV 24, PVL 24

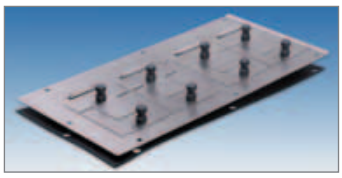


LCZ 9738, LCZ 9739, LCZ 9740

Cover plates

Cat. No.	Description
LTZ 045	Cover plate PV 15 V (for 2 measuring stands)
LTZ 048	Cover plate PV 15 VK (for 1 measuring stand/2 thermostating positions)
LTZ 017	Cover plate PV 15 K (for 3 manual measuring stations)
LTZ 046	Cover plate PV 24 V (for 4 measuring stands)
LTZ 049	Cover plate PV 24 VK (for 3 measuring stands/3 thermostating positions)
LTZ 019	Cover plate PV 24 K (for 5 manual measuring stations)
LTZ 023	Cover plate PV 24 7K (for 7 manual measuring stations)
LTZ 047	Cover plate PV 36 V (for 6 measuring stands)
LTZ 021	Cover plate PV 36 K (for 9 manual measuring stations)
LTZ 052	Insert for manual measurements

LTZ 045



LTZ 046

Magnetic stirrer sets

Only factory mounted

Cat. No.	Description
LMVZ 967	2 stirring positions
LMVZ 968	4 stirring positions

LMVZ 967

Through-flow cooler

Cat. No.	Description
LFD 111	DLK 45 LiBus, 230 V; 50 Hz
LFD 811	DLK 45 LiBus, 208-220 V; 60 Hz

LFD 111

Additional cooler

Cat. No.	Description
LCK 1897	Proline RP 890 (down to -60 °C), 230 V; 50 Hz
LCK 8897	Proline RP 890 (down to -60 °C), 208-220 V; 60 Hz

LCK 1897

Further through-flow cooler and other accessories, see page 17

LAUDA Viscocool and Viscotemp

Viscocool and Viscotemp Viscothermostats with transparent bath and control head Silver and Gold

The tried-and-tested ET 15 baths made from polycarbonate provide space for immersion of a maximum of three glass capillary viscometers for manual measurement using the stop watch or for up to two automatic measuring stations for iVisc or S 5 (PVS). If required, when using dilution viscometers for example, up to two magnetic stirrers can be added to the thermostat.

Specifically for applications near room temperature (15 to 30 °C), the ET range was expanded upon with the inclusion of the extremely compact, electronic Viscocool 6 version which is cooled using Peltier technology. It can provide cooling without a cooling water connection or any additional devices. The similarly new round solid glass bath Viscotemp 18 is used particularly for temperatures around 100 °C for operation with silicone oils and with aggressive samples. Outstanding insights in the smallest space can be achieved thanks to up to five stop watch measuring stands. Alternatively, it can be equipped with an iVisc or PVS measuring stand and thermostating position.

Viscothermostat Viscocool 6

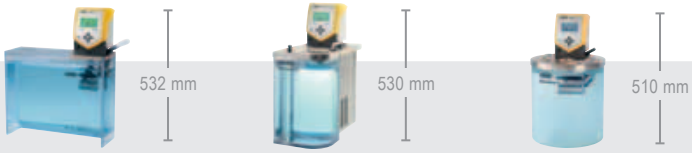
Special features

- Baths made from polycarbonate or glass with 6 to 18 liters bath volume
- Ideal for operation between 20 and 40 °C
- For up to two automatic or five stop watch measuring stations
- Optionally with the control head ECO Silver or ECO Gold (except for Viscocool 6)
- Simple design makes quick cleaning possible
- Variopump with six pumping levels and pump flow distribution for perfect homogeneity
- Display with standards-compliant resolution of 0.01 K
- Can be combined with LAUDA through-flow coolers
- Intuitive operation via cursor and softkeys
- Polycarbonate bath Viscocool 6 with integrated Peltier cooling and double chamber system

Temperature range
15...105 °C

Included accessories
Pump connection set with 13 mm plastic nipples (ET 15 S, Viscotemp 18 S) or M16 x 1 thread (ET 15 G, Viscotemp 18 G) · plugs

Additional accessories
Cooling coil · tubing · cover plates · Pt100/LiBus module · remote control Command

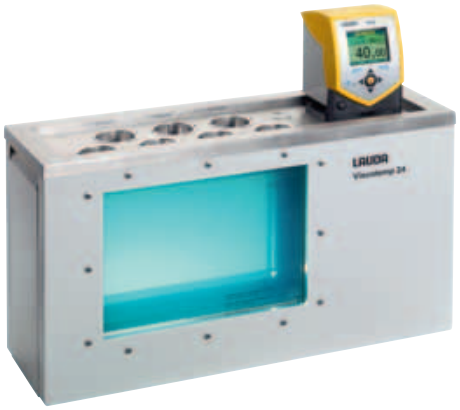


Technical features		ET 15 S/G	Viscocool 6	Viscotemp 18 S/G
Working temperature range	°C	20*...100	15...90	0*...105
Temperature stability	±K	0.01	0.01	0.01
Heater power 230 V (115 V)	kW	1.3/2.6 (1.3/1.3)	1.3 (1.3)	1.3/2.6 (1.3/1.3)
Pump pressure max.	bar	0.55	0.55	0.55
Pump flow max.	L/min	22	22	22
Bath volume	L	15	6.5	18.5
Bath opening/depth	mm	275x130/310	188x128/330	ø290/320
Dimensions	mm	428x130x532	206x415x530	ø310x510
Cat. No. Silver 230 V; 50/60 Hz		LCD 0288	LCD 0292	LCD 0294
Cat. No. Silver 115 V; 60 Hz		LCD 4288	LCD 4292	LCD 4294
Cat. No. Gold 230 V; 50/60 Hz		LCD 0289	–	LCD 0295
Cat. No. Gold 115 V; 60 Hz		LCD 4289	–	LCD 4295

* Possible with external cooling

Viscotemp
Viscothermostats with stainless steel bath and control head Silver and Gold

The new Viscotemp 15, 24, and 40 viscothermostats with high-quality stainless steel baths and glass windows can be used in the most common temperature range from 0 up to 105 °C. The clearly designed single-chamber systems with optional background lighting provide a glass-clear view and can be easily cleaned. They are ideal for determining, for example, the viscosity index of motor oils or the solution viscosity of plastics. The Viscotemp 15 type offers space for up to four manual maesuring stations or two automatic measuring stands, iVisc or S 5 (PVS). Viscotemp 24 has space for seven viscometers or up to four automatic measuring stands. Both versions can be fitted with cleaning modules. Viscotemp 40 was designed exclusively for manual measurements with twelve measuring stations. With the Therm 180 heat transfer liquid, the thermostats can be operated as a corrosion-resistant thermostating bath for aggressive samples, e.g. for polyamides dissolved in sulfuric acid.



Viscothermostat Viscotemp 24 G with cover plate 24 K
– Cover plates not included in delivery –

Special features

- Corrosion-resistant stainless steel bath with 19 to 44 liter bath volumes
- For up to four automatic or 12 stop watch (manual) measuring stations
- Optionally with control head ECO Silver or ECO Gold
- Clear design makes quick cleaning possible
- Variopump with six pumping levels and pump flow distribution for perfect homogeneity
- Display with standards-compliant resolution of 0.01 K
- Can be combined with LAUDA through-flow coolers
- Intuitive operation via cursor and softkeys

Temperature range
0...105 °C

Included accessories
Pump connection set with 13 mm plastic nipples (Silver) or M16 x 1 thread (Gold) · plugs

Additional accessories
Cooling coil · tubing · cover plates · Pt100/LiBus module · remote control Command

Technical features		Viscotemp 15 S/G	Viscotemp 24 S/G	Viscotemp 40 S/G
Working temperature range	°C	0*...105	0*...105	0*...105
Temperature stability	±K	0.01	0.01	0.01
Heater power 230 V (115 V)	kW	1.3 /2.6 (1.3/1.3)	1.3 /2.6 (1.3/1.3)	1.3 /2.6 (1.3/1.3)
Pump pressure max.	bar	0.55	0.55	0.55
Pump flow max.	L/min	22	22	22
Bath volume	L	19	27	44
Bath opening/depth	mm	430x145x320	607x145x320	607x250x320
Glass pane size	mm	152x233	329x233	329x233
Dimensions	mm	532x233x552	708x233x552	708x328x552
Cat. No. Silver 230 V; 50/60 Hz		LCD 0296	LCD 0298	LCD 0300
Cat. No. Silver 115 V; 60 Hz		LCD 4296	LCD 4298	LCD 4300
Cat. No. Gold 230 V; 50/60 Hz		LCD 0297	LCD 0299	LCD 0301
Cat. No. Gold 115 V; 60 Hz		LCD 4297	LCD 4299	LCD 4301

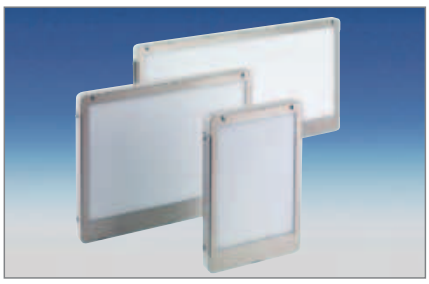
* Possible with external cooling

The cover plates/bath bridge necessary for operation need to be ordered separately, see page 16

Viscotemp accessories

NEW Background lighting

Cat. No.	Description	Suitable for
LCZ 9738	BL 15	Viscotemp 15
LCZ 9739	BL 24	Viscotemp 24, Viscotemp 40



LCZ 9738, LCZ 9739

Cooling coil set

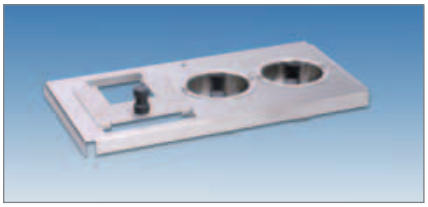
For connecting cooling water or external cooling devices with a circulation pump

Cat. No.	Description
LCZ 0719	Cooling coil set ET 15, connections at the right

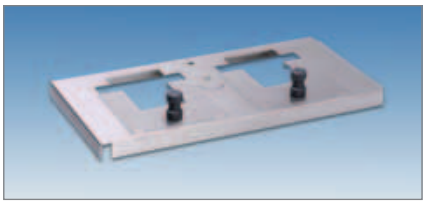
LCZ 0719

NEW Cover plates

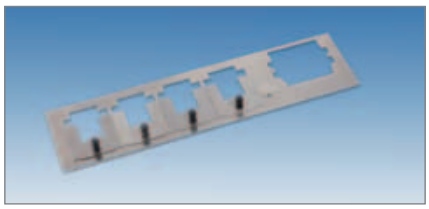
Cat. No.	Description	Suitable for
LCZ 041	Cover plate E 15 V (for 2 measuring stands)	ET 15
LCZ 040	Cover plate E 15 VK (for 1 measuring stand/2 thermostating positions)	ET 15
LCZ 0685	Cover plate E 15 K (for 3 manual measuring stations)	ET 15
LCZ 0737	Cover plate Viscotemp 18 1V1K (for 1 measuring stand/1 thermo-stating position)	Viscotemp 18
LCZ 0736	Cover plate Viscotemp 18 5K (for 5 manual measuring stations)	Viscotemp 18
LCZ 0730	Cover plate Viscotemp 15 2V (for 2 measuring stands)	Viscotemp 15
LCZ 0731	Cover plate Viscotemp 15 1V2K (for 1 measuring stand/2 thermo-stating positions)	Viscotemp 15
LCZ 0729	Cover plate Viscotemp 15 4K (for 4 manual measuring stations)	Viscotemp 15
LCZ 0733	Cover plate Viscotemp 24 4V (for 4 measuring stands)	Viscotemp 24
LCZ 0734	Cover plate Viscotemp 24 2V4K (for 2 measuring stands/4 thermo-stating positions)	Viscotemp 24
LCZ 0732	Cover plate Viscotemp 24 7K (for 7 manual measuring stations)	Viscotemp 24
LCZ 0735	Cover plate Viscotemp 40 12K (for 12 manual measuring stations)	Viscotemp 40
LTZ 052	Insert for manual measurements	
HPB 139	Bath bridge	Viscotemp 15, Viscotemp 24



LCZ 040



LCZ 041



LCZ 0733

LCZ 0736 LCZ 0737

Magnetic stirrer set

Cat. No.	Description
LMZ 841	One-place magnetic stirrer set for ET 15 S/G

Additional Viscocool, Viscotemp and Proline accessories

Tubing

To connect thermostat and DLK

Cat. No.	Description
LZS 001	Silicone tubing, 8 mm I.D. (9 mm insulated)
LZS 007	Silicone tubing, 11 mm I.D. (9 mm insulated)
LZS 018	Viton tubing, 11 mm I.D. (9 mm insulated), when using silicone oils (Therm 180, 200, 240, Kryo 20)
EZS 012	Tubing clamps

LZS 018

Temperature probes

For external temperature regulation

Cat. No.	Description
ETP 059	Pt100-94 Temperature probe for external control
LRZ 918	Pt100/LiBus module

ETP 059

Through-flow cooler

Cat. No.	Description
LFD 010	DLK 10, 230 V; 50 Hz
LFD 710	DLK 10, 100 V; 50 Hz/115 V; 60 Hz
LFD 108	DLK 25, 230 V; 50 Hz
LFD 708	DLK 25, 100 V; 50 Hz/115 V; 60 Hz
UK 263	Control cable for Proline and ECO

LFD 010

Interfaces

For temperature controlling via PC (TEMP-DLL)

Cat. No.	Description
LRZ 913	RS-232-/-485 Interface
EKS 089	USB 2.0 cable: Mini USB

LRZ 913

Heat transfer liquids

For operation between 25 and 100 °C

Cat. No.	Description
LZB 114	Therm 180, 5-L canister
LZB 214	Therm 180, 10-L canister
LZB 314	Therm 180, 20-L canister

Water stabilizer

Cat. No.	Description
LZB 929	AquaStab, algicide for viscothermostats, 100 ml

LAUDA Glass capillary viscometers

Viscosity measuring with Ubbelohde, Cannon-Fenske and Micro-Ostwald capillary viscometers

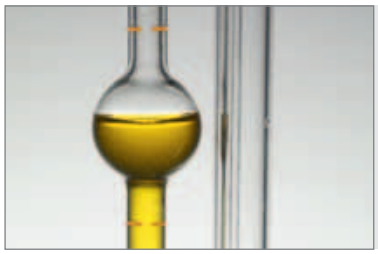
Application examples

- Determining the viscosity number, intrinsic viscosity (mean molar mass) and other parameters of technical polymers such as PA, PET, PBT, PE, PP and PVC in accordance with EN-ISO 1628, ISO 307 for the quality control of plastics
- Measuring absolute viscosities of engine oils and other lubricants in accordance with ASTM D445, viscosity index in accordance with ISO 2909 at 40 and 100 °C

Accurate and standard-compliant

Glass capillary viscometers are available in various designs, which differ with respect to application area, accuracy and operation. As of now, they can be supplied by LAUDA in the Ubbelohde, Cannon-Fenske, Micro-Ostwald and special designs. For high-precision, automatic measuring, the Ubbelohde version with the suspended level is preferred, among other reasons because the flow time is independent of the precise sample volume. To keep the measuring times within the optimum range between approx. 60 and 600 s, different capillary diameters are supplied to cover the complete viscosity range. The procedure, particularly with automatic LAUDA measuring technology and precise temperature control using LAUDA clear-view thermostats, is unrivaled in terms of accuracy for measuring liquids with nearly Newtonian (ideal) flow properties.

Your advantages at a glance

	The glass capillary viscometer advantages	Your benefits
	• Ring marks with no detection disturbances	• Precise, positioned, NIR permeable ring marks with exactly 40 mm clearance. The capillary constant is valid for stopwatch and automatic measuring systems.
	• Corrosion resistant labelling	• There is no risk of abrasion or etching off of the labeling even with the use of strong acids and aggressive solvents used as samples or cleaning agents.
	• Ubbelohde for dilution series with calibration certificate and filter frit	• Absolute measuring now also possible with calibrated dilution viscometers. The integrated frit ensures filtration when the sample dissolves in the viscometer.
	• Complete application from one supplier	• LAUDA supplies all components for the viscosity application – clear-view thermostats, automatic viscosity measuring systems and glass capillary viscometers.
	• Customer-specific variants available on request	• Special variants as desired by the customer, specifically for adaptation to automatic measuring systems.

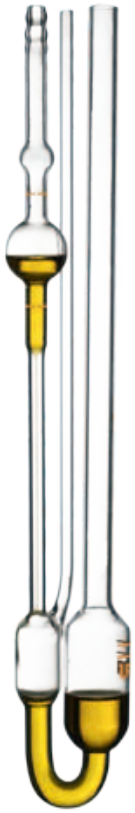
LAUDA Glass capillary viscometers

Ubbelohde Viscometers

For automatic and stopwatch measurement. Standard design with no thread for easy removal prior to external cleaning.

- ISO 3105, DIN 51562, BS 188, NFT 60-100
- Filling volume: 15...20 ml
- Total length: approx. 290 mm
- Measurement accuracy: ±0.2 %

Also available in ASTM version



Type	Cap. const. mm²/s²	DIN/ASTM mm²/s	PVS or iVisc mm²/s	Ø i mm	Cat. No. calibrated	Cat. No. uncalibrated
0c	0.003	0.7...3	0.3…2	0.47	EGV 700	EGV 709
0a	0.005	1…5	0.5…3	0.53	EGV 701	EGV 710
I	0.01	2…10	0.7...7	0.63	EGV 702	EGV 711
Ic	0.03	6…30	2…20	0.84	EGV 703	EGV 712
II	0.1	20…100	6…60	1.13	EGV 704	EGV 713
IIc	0.3	60…300	20…200	1.50	EGV 705	EGV 714
III	1	200…1,000	60…600	2.01	EGV 706	EGV 715
IIIc	3	600…3,000	200…2,000	2.65	EGV 707	EGV 716
IV	10	2,000…10,000	600…6,000	3.60	EGV 708	EGV 717
IVc	30	6,000…30,000	2,000…20,000	4.70	EGV 699	EGV 697

Ubbelohde Viscometers for automatic cleaning

For automatic and stopwatch measurement. With screw connections and aspirating tube for permanent installation. Recommended for automatic cleaning with LAUDA VRM modules.

- ISO 3105, DIN 51562, BS 188, NFT 60-100
- Filling volume: 18...22 ml
- Total length: approx. 290 mm
- Measurement accuracy: ±0.2 %

Also available in ASTM version

Type	Cap. const. mm²/s²	DIN/ASTM mm²/s	PVS or iVisc mm²/s	Ø i mm ±0,01	Cat. No. calibrated	Cat. No. uncalibrated
0c	0.003	0.7...3	0.3…2	0.47	EGV 930	EGV 940
0a	0.005	1…5	0.5…3	0.53	EGV 931	EGV 941
I	0.01	2…10	0.7…7	0.63	EGV 932	EGV 942
Ic	0.03	6…30	2…20	0.84	EGV 933	EGV 943
II	0.1	20…100	6…60	1.13	EGV 934	EGV 944
IIc	0.3	60…300	20…200	1.50	EGV 935	EGV 945
III	1	200…1,000	60…600	2.01	EGV 936	EGV 946
IIIc	3	600…3,000	200…2,000	2.65	EGV 937	EGV 947
IV	10	2,000…10,000	600…6,000	3.60	EGV 938	EGV 948

Micro-Ubbelohde Viscometers

For small sample quantities and/or short measurement times. Designed with no thread for easy removal prior to external cleaning. Compatible with LAUDA VRM modules.

- DIN 51562/2
- Filling volume: 3...4 ml
- Total length: approx. 290 mm
- Measurement accuracy: ±0.5 %

Type	Cap. const. mm²/s²	DIN/ASTM mm²/s	PVS or iVisc mm²/s	Ø i mm	Cat. No. calibrated	Cat. No. uncalibrated
I	0.01	1…6	0.30…6	0.40	EGV 718	EGV 723
Ic	0.03	3…18	0.8…18	0.53	EGV 719	EGV 724
II	0.1	10…60	3…60	0.70	EGV 720	EGV 725
IIc	0.3	30…180	8…180	0.95	EGV 721	EGV 726
III	1	100…800	30…800	1.26	EGV 722	EGV 727

Micro-Ostwald Viscometers

For small sample quantities and/or very short measurement times. Designed with no thread for easy removal prior to external cleaning. Compatible with LAUDA VRM modules. Precise volume input required. Especially recommended for heavy-foaming samples.

- Filling volume: 2 ml
- Total length: approx. 290 mm
- Measurement accuracy: ±0.5 %

Type	Cap. const. mm²/s²	DIN/ASTM mm²/s	PVS or iVisc mm²/s	Ø i mm	Cat. No. calibrated	Cat. No. uncalibrated
I	0.01	1…6	0.30…6	0.43	EGV 820	EGV 825
Ic	0.03	3…18	0.8…18	0.60	EGV 821	EGV 826
II	0.1	10…60	3…60	0.77	EGV 822	EGV 827
IIc	0.3	30…180	8…180	1.00	EGV 823	EGV 828
III	1	100…800	30…800	1.36	EGV 824	EGV 829

LAUDA Glass capillary viscometers

Cannon-Fenske Routine Viscometers for automatic cleaning

Viscometers for automatic and stopwatch measurement. With screw connections and aspirating tube for permanent installation. Recommended for automatic cleaning with LAUDA VRM modules. Precise volume input required.

- ISO 3105, ASTM D 2515, BS 188
- With filling and cleaning tube
- Filling volume: approx. 5...10 ml
- Total length: approx. 245 mm
- Measurement accuracy: ±0.3 %

Type	Cap. const. mm²/s²	DIN/ASTM mm²/s	PVS or iVisc mm²/s	Ø i mm	Cat. No. calibrated	Cat. No. uncalibrated
50	0.004	0.8...4	0.4...3	0.44	EGV 951	EGV 986
75	0.008	1.6...8	0.8...6	0.54	EGV 952	EGV 987
100	0.015	3...15	2...10	0.63	EGV 953	EGV 988
150	0.035	7...35	4...25	0.78	EGV 954	EGV 989
200	0.1	20...100	8...60	1.01	EGV 955	EGV 990
300	0.25	50...250	20...100	1.27	EGV 956	EGV 991
350	0.5	100...500	40...200	1.52	EGV 957	EGV 992
400	1.2	240...1,200	100...500	1.92	EGV 958	EGV 993
450	2.5	500...2,500	200...1,000	2.35	EGV 959	EGV 994
500	8	1,600...8,000	700...3,500	3.20	EGV 960	EGV 995
600	20	4,000...20,000	1,500...7,500	4.20	EGV 961	EGV 996

Cannon-Fenske Routine Viscometers

For automatic and stopwatch measurement. Standard design with no thread for easy removal prior to external cleaning. Precise volume input required.

- ISO 3105, ASTM D 2515, BS 188
- Filling volume: approx. 5...10 ml
- Total length: approx. 245 mm
- Measurement accuracy: ±0.3 %

Type	Cap. const. mm²/s²	DIN/ASTM mm²/s	PVS or iVisc mm²/s	Ø i mm	Cat. No. calibrated	Cat. No. uncalibrated
50	0.004	0.8...4	0.4...3	0.44	EGV 861	EGV 873
75	0.008	1.6...8	0.8...6	0.54	EGV 862	EGV 874
100	0.015	3...15	2...10	0.63	EGV 863	EGV 875
150	0.035	7...35	4...25	0.78	EGV 864	EGV 876
200	0.1	20...100	8...60	1.01	EGV 865	EGV 877
300	0.25	50...250	20...100	1.27	EGV 866	EGV 878
350	0.5	100...500	40...200	1.52	EGV 867	EGV 879
400	1.2	240...1,200	100...500	1.92	EGV 868	EGV 880
450	2.5	500...2,500	200...1,000	2.35	EGV 869	EGV 881
500	8	1,600...8,000	700...3,500	3.20	EGV 870	EGV 882
600	20	4,000...20,000	1,500...7,500	4.20	EGV 871	EGV 883

Ubbelohde Dilution Viscometers

For convenient implementation of dilution series and determining concentration dependencies, e.g. IV value measuring of polymers. Standard design with no thread for easy removal prior to external cleaning. Can be connected with LAUDA VRM modules and dosing units. Recommended for automatic measuring with LAUDA viscosity measuring systems.

- Fill volume: 15...75 ml
- Total length: approx. 290 mm
- Measurement accuracy: ±0.2 %

Type	Cap. const. mm^2/s^2	PVS or iVisc mm^2/s	Ø i mm	Cat. No. calibrated	Cat. No. uncalibrated
0c	0.003	0.3…2	0.47	EGV 912	EGV 921
0a	0.005	0.5…3	0.53	EGV 913	EGV 922
0a	0.005	0.5…3	0.53	EGV 913-1*	EGV 922-1*
I	0.01	0.7...7	0.63	EGV 914	EGV 923
I	0.01	0.7...7	0.63	EGV 914-1*	EGV 923-1*
Ic	0.03	2…20	0.84	EGV 915	EGV 924
II	0.1	6…60	1.13	EGV 916	EGV 925

*With integrated filter: porosity G 2

Accessories

Cat. No.	Description
UG 003	Viscometer frame for Ubbelohde and Micro-Ubbelohde
UG 094	Viscometer frame for Micro-Ostwald
EZ 054	Cannon-Fenske viscometer holder for 2-legged capillaries (only for manual measuring)
EAO 156	Digital hand stop watch
EZ 287	Suction ball, 60 ml, opening 6.3 mm Ø
LZB 011	Labosol S for cleaning the glass capillary viscometer, 1 L
HKB 532	Adapter for Micro-Ubbelohde (for installation into automatic systems)

UG 003

Application table

LAUDA supplies glass capillary viscometers in various designs. Use the following table to see which capillary is best suited for your application.

	Ubbelohde	Micro-Ubbelohde	Micro-Ostwald	Cannon-Fenske Routine
Manual measurement	++	++	+	+
Automatic measurement	++	++	+	+
Frothing liquids	○	○	+	+
Volatile samples	○	○	+	+
Small samples/detergent quantities	-	++	+	-
High/low temperature	+	+	○	○
Black and used oils	○	-	-	○

++ use by preference + well suited ○ less suited - unsuitable

LAUDA iVisc

Capillary viscometer for fully automatic viscosity measurement and evaluation

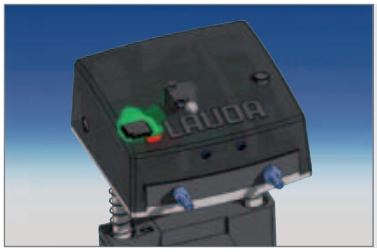
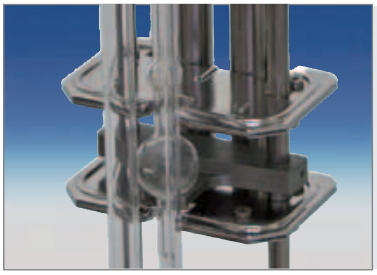
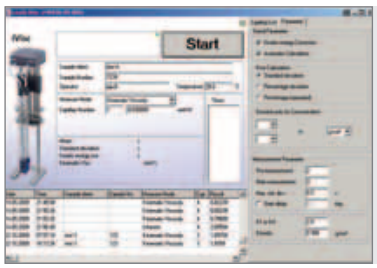
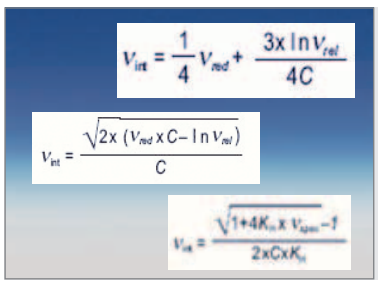
Application examples

- Determining viscosity numbers for quality assurance in the plastics industry
- Absolute viscosities in the petroleum industry for motor oil, lubricant, fuel, kerosene, additives, etc.
- Determining chain length of pharmaceutical and biological macro-molecules

Compact and easy to operate

The fully automatic, space-saving **iVisc** is easy to operate and suitable for getting started in professional viscometry. Simply insert the USB cable into the PC or netbook, start the software and the capillary viscometer is ready to go. The state-of-the-art measuring instrument offers a Windows user interface which could not have a more intuitive or easy design. As such, the system condition, the ongoing measuring or pause times as well as the measuring data in table form can be seen at a glance. The capillary data can be transferred into the measuring window via drag & drop. Using “pull down“ menus, important application-specific evaluations and all common approximation formulas for intrinsic viscosities (IV values) can be specified as a measure for polymer chain lengths. By taking the necessary corrections into account, the absolute kinematic viscosities and, if the density is known, the dynamic viscosities can be evaluated from the precisely measured processing times.

Your advantages at a glance

	The iVisc advantages	Your benefits
	• Full control of the measuring process • Pumps, valves and light sensors integrated into the iVisc	• Time-saving thanks to automation • Minimum space requirement • No external devices necessary
	• Intelligent and self-adaptive NIR meniscus scanning	• Exact time measurement even with colored and dark liquids
	• Intuitive software: 1. Identification of the capillary type 2. Selection of desired measurements 3. “START“	• Simple measurement progression • Virtually impossible to make operating errors • Tabular view of the measurement results • Results protocol via standard printer
	• Comprehensive calculation algorithms already integrated	• Determining kinematic, dynamic, relative, inherent, and reduced viscosity • Intrinsic viscosity according to Billmeyer, Huggins, Maron, Martin, Schulz-Blaschke, and Solomon-Ciuta
	• One cable for power supply and data transmission • Parallel operation of two iVisc units possible with one PC or netbook	• The fastest device installation using plug & play technology • No power adapter necessary • Energy-saving • Double sample throughput

LAUDA iVisc

iVisc
Capillary viscometer

The compact, intelligent viscosity measuring stand is designed for a large spectrum of standard glass capillary viscometers (e.g. Ubbelohde, Cannon-Fenske, and Micro-Ostwald). In a suitable LAUDA thermostat (e.g. LAUDA ET 15 S, Viscocool 6 or Viscotemp) and the corresponding glass capillary viscometer, the kinematic viscosities in the range from 0.3 to 30,000 mm²/s can be determined. A wide range of applications can be accommodated as a result.

Capillary viscometer iVisc

Special features:

- "Plug & play" device installation
- Connection of up to two iVisc units per computer
- Intuitive operation using software start/stop button on the device
- Exact and "intelligent" optical meniscus sensing for problematic liquids
- Control and power supply via computer with USB possible (PC, netbook, etc.)
- Operating status display via LEDs
- Just one cable (USB) for control and power supply
- Just 1 watt of power consumption
- Measurement temperature from -20 to 150 °C

Additional accessories (see also page 35):
Viscometer frames · adapter for Micro-Ubbelohde · utilizable glass capillary viscometer: Ubbelohde, Cannon-Fenske, Micro-Ubbelohde, Micro-Ostwald

Computer on request

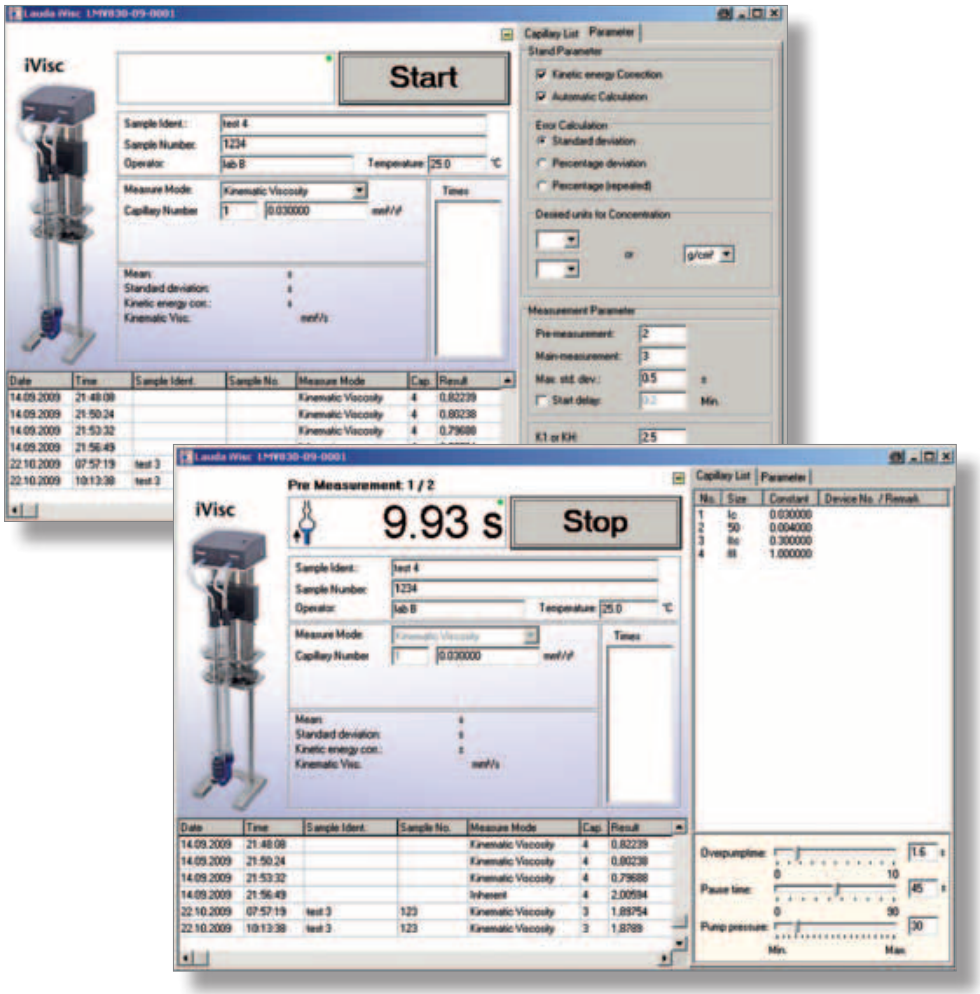
Technical features		iVisc
Sample temperature range	°C	-20...150
Ambient temperature	°C	10...45
Measurement range Time	s	0...9,999.99
Recommended measurement range for flow timing	s	30…1,000
Viscosity range	mm²/s	0.3...30,000
Resolution of time measurement	s	0.01
Error in time measurement	ppm	1
Meniscus detection		Optical (near infrared)
Total power consumption	W	1
Dimensions (WxDxH)	mm	95x96x425
Power supply		USB
Weight, net	kg	1.4
Cat. No.		LMV 830

We had the user in mind ...

The full control of the measuring process including the pumps and pressure compensation valves, the highly flexible meniscus sensing using NIR light sensor, and the precise measurement of the flow time of the sample using the measuring capillary are all done in the head of the measuring stand. Standard-compliant measurements of the K-value, intrinsic, reduced, and inherent viscosity are made possible “out-of-the-box“. Complex measuring applications can also be easily established and configured.

The most common formulas and calculations are included in the software. The clear software interface considerably simplifies measuring praxis. After the simple insertion of a filled glass capillary, a software program coordinates all of the steps necessary to perform the measurement and it then executes the evaluation. Here, the precise measuring of the flow time is based on intelligent, self-adaptive NIR meniscus sensing.

- Integrated glass viscometer database
- Display of the current measuring and pause times
- Software clearly designed for a single display window
- Easy data transfer possible (e.g. Excel)



Step 1:
Identification of the capillary type

Step 2:
Selection of desired measurements

Step 3:
“Start“

Step 4:
Issue of the measurement protocol

LAUDA PVS

Modular processor viscosity measuring system for efficient system solutions

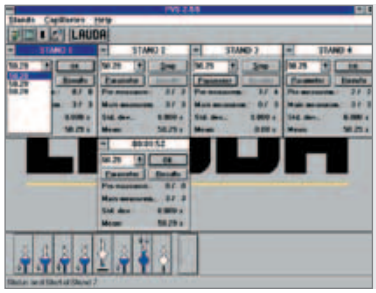
Application examples

- Production-accompanying specification of viscosity numbers for technical plastics
- Measurement of the viscosity index for classification of motor oils
- Determining absolute viscosities of fuels at application temperatures
- Determining chain lengths of hyaluronic acid products and resorbable polymers

Modular and flexible

The modular structure of the LAUDA **PVS** system permits efficient system solutions which are perfectly adapted to the needs of users. This way, you can design the configurations very flexibly for a higher number of samples and new tasks by integrating special components and software modules. The extensive automation; for example, with the cleaning of the glass capillary viscometers, the sample preparation and sample loading, maximizes efficiency while keeping manual efforts to a minimum. The associated reduction in use and contact with chemicals makes a telling contribution to occupational safety and environmental protection. LAUDA PVS is made up of stand-alone, independent functional units. Measuring stands, cleaning modules, automatic samplers and dosing systems are controlled centrally from an easy to operate Windows measuring program.

Your advantages at a glance

	The PVS advantages	Your benefits
	• Modular principle • Easy to upgrade • Flexible combinations possible • Replaceable	• Good value, application-specific system designs • Higher sample throughput • Adaptable to new applications • High redundancy and system stability • Fast error-correction
	• Central control unit • Slot system • RS 232 interface • Universal power adapter	• Time-saving thanks to “multi-tasking“ of intelligent micro-processor controlled components • Connection of up to eight measuring stations and other components • Secure communication via PC • Power supply globally compatible
	• PC measuring program fully compatible with all standard Windows versions • Parallel view of all measuring processes • Application-specific software modules • GLP compatibility with password-protection	• Every PC compatible with COM interface • Measuring results and system condition at a glance • No individual evaluations or calculations necessary • Program interventions and measurement data are always traceable
	• Compact • Clear design • Pneumatic components right beside the measurement location	• Powerful despite small footprint • Fully automatic machines fit into laboratory fume hoods • Measurement processes can be easily followed • Dead volumes are avoided • Solvent savings and quick system response
	• Software modules and components for the preparation of polymer solutions	• Everything from a single source • Saving of labor even as early as specification • High precision with the least effort

PVS
Viscometer basic modules

The measuring stand S 5

The S 5 is the actual measuring station of the PVS system. The head of the stand-alone measuring stand S 5 is comprised of the opto-electronic meniscus detectors as well as the entire micro-processor control of the measuring process including miniature pump and valves in the head of the unit. The measuring time of the sample is determined to the millisecond using a processor-controlled infrared light sensor. The robust micro-pump for pushing the sample up into the measuring ball as well as the chemical-resistant valves in the head of the stand make reliable continuous operation possible.

The control unit PVS 1

The PVS 1 control unit is the core of the system as well as the switching station between the PC and individual components. It can be equipped with up to four inserts depending on the configuration.

Measuring stand S 5

Control unit PVS 1

Special features S 5/PVS:

- Completely micro-processor controlled
- Highly precise time measurement
- Intelligent infrared (NIR) detection
- Short tubing to the viscometer
- Electrical connections only
- For Ubbelohde, Micro-Ubbelohde, Cannon-Fenske-Routine, Micro-Ostwald
- Interface to the PC via RS 232 control unit can be easily extended with insert cards for:
  - Up to eight S 5 stands
  - Up to four VRM modules
  - Up to four MT dosing systems
  - Four motor locks on the VAS auto-sampler systems

Included accessories:
Software PVS on CD-ROM · RS 232 cable · connection caps for glass viscometer · connection cable

Additional accessories:
Adapter for Micro-Ubbelohde · suitable viscothermostats · cleaning modules VRM · dosing systems · software modules

Technical features		Measuring stand S 5
Meniscus detection		Optical (infrared)
Light sensor control		Digital (µP)
Sample temperature range	°C	-65...160*
Measurement range Time	s	0…9,999.99
Recommended measurement range	s	30...1,000
Viscosity range	mm^2/s	0.3...50,000
Resolution of time measurement	s	0.01
Error in time measurement	ppm	1
Dimensions (WxDxH)	mm	90x90x500
Weight, net	kg	4.5
Cat. No.		**LMVZ 948**

Technical features		PVS 1/2	PVS 1/4	PVS 1/6	PVS 1/8
Measuring stations		2	4	6	8
Interface		RS 232 C	RS 232 C	RS 232 C	RS 232 C
Dimensions (WxDxH)	mm	340x270x105	340x270x105	340x270x105	340x270x105
Weight, net	kg	4,6	4,6	4,6	4,6
Ambient temperature	°C	10…45	10…45	10…45	10…45
Total power consumption	kW	0,1	0,1	0,1	0,1
Cat. No. 90-240 V; 50/60 Hz		**LMV 812**	**LMV 813**	**LMV 814**	**LMV 815**

* Higher temperatures on request

VRM
Cleaning modules

The cleaning modules enable the fully automatic cleaning and drying of the viscometers. Depending on the fittings, one or two viscometers can be connected and two different cleaning liquids can be selected separately. Even very hot samples of up to 160 °C or highly viscous samples with 1,000 mm²/s can be pumped out into waste bottles with pre-dilution. The glass viscometers can then be cleaned using cleaning solvents and dried with a volatile solvent and ambient air. High-quality materials guarantee resistance to many common solvents. With the VRM 4 S, even concentrated sulfuric acid can be used for cleaning.

Cleaning module VRM 4

Special features:

- Automatic (online) rinsing of the viscometer
- Inert and corrosion-free for all standard solvents
- Individual specification of cleaning procedures using PC software
- Automatical filling and draining
- Two different rinsing agents (the first for cleaning, the second for drying)
- VRM 4 (except for sulfuric acid)
- VRM 4 S (for sulfuric acid)
- VRM 4 HT (for high temperatures and high viscosity), external pump necessary
- No external connections necessary

Included accessories:
Connection cable to PVS · 2 connection stoppers for GL 45 vessels · tubing set for filling bottles and waste bottles

Necessary accessories:
Connection sets with sample locks suitable for capillary viscometers · suction pump (for VRM 4 HT) · mounting sets for viscothermostats

Additional accessories:
Filling level safety set

Technical features		VRM 4	VRM 4 S	VRM 4 HT ①
Temperature range	°C	20....100	20....100	20....160
Viscosity range samples	mm*/s	0,3....100②	10....50	0,3....1000
Max. cleaning agents		2	2	2
Solvent resistance		++③	+④	++③
Acid resistance		+⑤	++⑥	+⑤
Dimensions (WxDxH)	mm	130x160x130	130x160x130	130x160x130
Weight, net	kg	4,8	4,8	4,6
Cat. No.		**LMR 911**	**LMR 912**	**LMR 913**

① Only operable with external suction pump or vacuum connection ② Expandable using special cleaning routines ③ Resistant to all solvents common to the plastics and mineral oil industry
④ Except for ketones (e.g. acetone) ⑤ Except for sulfuric acid ⑥ Resistant to all acids common to solution viscosity

VAS
Fully automatic sampler

The sampler based on the Combi-PAL sampler of CTC offers the convenience of full automation at the highest sample throughput rate as an add-on to the two-station (VAS 1/2) or four-station (VAS 1/4) measuring systems. Depending on the size of the sample bottles, up to 63 samples can be processed in one session. Heated sample racks with similarly thermostated syringes guarantee trouble-free measurement of hot polymer solutions or oils without the samples cooling down over the course of the process. The system is controlled using a special PVS program which permits the safe application-specific allocation of the measurement samples to the matching glass viscometers, e.g. through direct "drag & drop" from the task list which was generated during sample preparation. The measurement of the samples is done in the S 5 measuring stand, while the cleaning of the glass capillary viscometers and dosing syringes is done via suitable VRM modules.

Special features:

- Retrofittable two-station measuring system VAS 1/2
- Four-station measuring system VAS 1/4 for the highest sample throughput
- Heatable sample rack and syringe for highly-viscous samples or temperature-critical samples
- Easy to program sample processing
- Fast sample switching possible
- Assignment of processing priorities
- Sample-specific applications can be defined (e.g. kinematic and relative viscosity, IV and K-values)
- Direct injection into viscometers without contamination at the tubing
- Optional rinsing with two solvents or with next sample
- Automatic program-controlled sample locks

Included accessories:
2 (VAS 1/2) or 4 (VAS 1/4) measuring stands S 5 · pre-configured control panel PVS 1 · mounting plate for clear-view viscothermostats PV 24 · software VAS on CD-ROM

Necessary accessories:
Control unit for CombiPAL · connection sets with motor locks (suitable for glass capillary viscometers) · various sample racks · syringe rinsing station · cleaning modules · viscothermostat PV 24

Additional accessories:
Insert filter · syringe heating · sample bottles 30/50 ml

Technical features		VAS 1/2	VAS 1/4
Temperature range	°C	20....135	20....135
Viscosity range samples	mm²/s	0.3....100①	0.3....100①
Syringe volumes	ml	5	5
Measuring stands S 5		2	4
Control panel PVS		PVS1/4	PVS1/6
Interfaces		2 x RS 232	2 x RS 232
Applications (sample types)		1②	2②
Sample counts 50 ml		35/24①	35/24①
Sample counts 30 ml		63/43	63/43
Dimensions (WxDxH)	mm	1200x600x1200	1200x600x1200
Weight, net	kg	56	68
Cat. No.		**LMV 818**	**LMV 819**

① Expandable using special cleaning routines ② Samples with incompatible solvents or cleaning agents

Automatic sample preparation for polymer solutions

These stations are based on the dosing units of Mettler-Toledo and are operated for PC-controlled solvent loading, e.g. in order to determine the limiting viscosity number (intrinsic viscosity and molecular mass) with programmable concentration levels. In this regard, special dilution viscometers are used in viscothermostats equipped with magnetic stirrers (see from page 10).

In connection with Mettler-Toledo XP-type laboratory balances and an additional software module, the preparation of well-defined polymer-solutions can be carried out quickly and safely via PC in a stand-alone dissolving station with just a few manual operations and without the common and laborious weighing process. The proper, standards-compliant solution concentration is always automatically produced according to standards while taking the filler content into account.

Special features:

- Automatic dilution series can be executed on up to four measuring stations simultaneously
- Specially developed RS 232 interface box
- Multiple dosing systems can be controlled via PC or plug-in board for PVS
- Can also be combined with VRM
- Can also be used in connection with integrated magnetic stirrers for “in-situ“ sample preparation
- High-quality XP balance and special software module for gravimetric or volumetric dosing
- No influence on the solvent temperature and pre-thermostating not necessary
- Direct transfer of concentration and initial weight to the PVS software
- User navigation via high-resolution display on the balance
- Input of sample data via PC or barcode reader
- Multiple solvents – can be added for different sample types

Included accessories:
Dosing units MT · replaceable burets 20 ml · RS 232 interface boxes with power adapter · weighing balance XP 204 with dosing attachment and software module

Necessary accessories:
Hose sets and adapters for viscometer and weighing balance

Additional accessories:
Centrifuge · barcode reader · crushing pliers · magnetic stirrer (heatable) · funnel for granules

Technical features		Set 1	Set 2
Total dosing systems[1]		1	2
Viscosity range	mm²/s	0.5...20	0.5...20
Dosing volumes	ml	10…100 ml	10…100 ml
Grain size ^{d}max.	mm	3	3
Interface		RS 232 C	RS 232 C
Balance[1]		XP-204	XP-204
Cat. No.		**LMVZ 977**	**LMVZ 978**

[1] Technical data, see Mettler-Toledo documentation

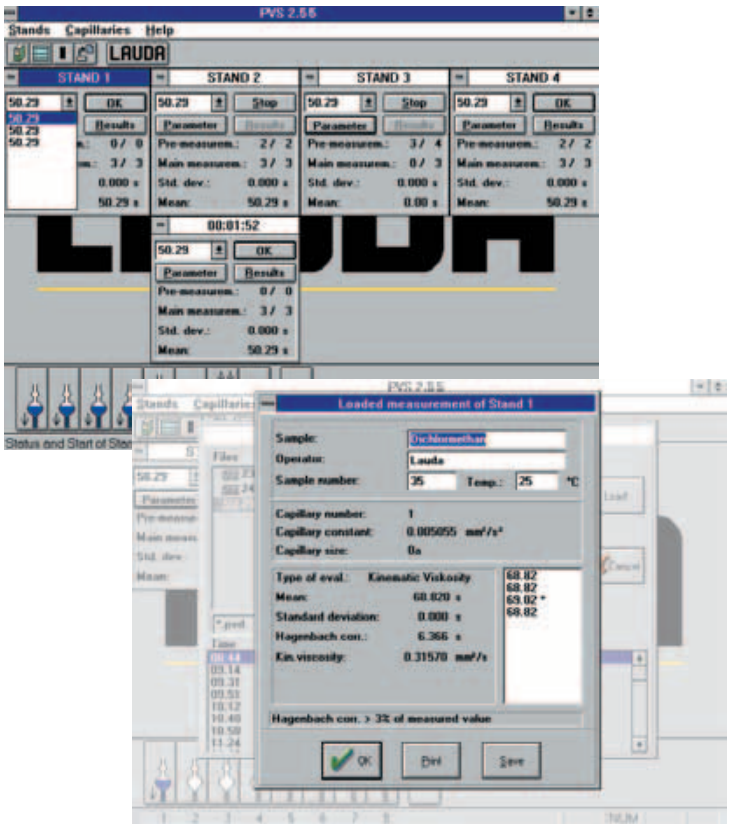
LAUDA PVS

Software based on Windows

All PVS system configurations are controlled by a standard PC through an interface. In addition, the high-performance and user-friendly standard version of the PC program calculates the kinematic, dynamic, relative, reduced and inherent viscosity and the K-value from the measured running times. Further key material figures can be determined using additional software modules.

The user is given comprehensive support by the program. All parameters are entered on the PC via mouse-click and keyboard and transferred via the interface to the PVS system.

The measuring results and evaluations can be printed out in the form of a log and saved in a file in ASCII format. The measurements report logs all measuring data on a day in chronological order and saves them in a file marked with the day's date. This data can be viewed at all times which means that consistent documentation is guaranteed. Further processing in other programs, like MS Excel for example, and in other networks can be accomplished without any problems.



Software basis:

- Windows software, runs on all conventional PCs and operating systems
- Parallel operation of up to eight measuring stations
- Calculation and display of:
  - Processing times and their mean values
  - Standard deviation
  - Kinetic energy correction (e.g. according to Hagenbach or ISO 1628/6)
  - Absolute kinematic viscosity
  - Absolute dynamic viscosity
  - Relative viscosity
  - Reduced viscosity (viscosity number)
  - Inherent viscosity (logarithmic viscosity number)
  - K-value according to Fikentscher
- Communication with preparation software and LIMS

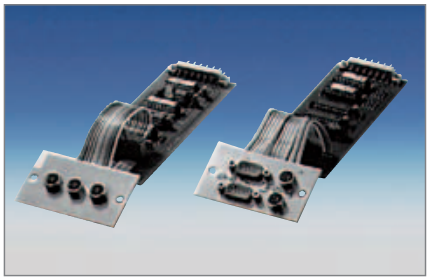
Additional software modules:

- INV-DLL: Intrinsic viscosity of polymers (mean molar mass)
- VID-DLL: Viscosity index of oils
- ENZ-DLL: Reaction activities of specific enzymes (time dependence of the viscosity)
- TEMP-DLL: Setting and control of the thermostat temperature (temperature-dependence of the viscosity)
- Special version for VAS 1 sampler systems

PVS and iVisc accessories

Plug-in boards and software

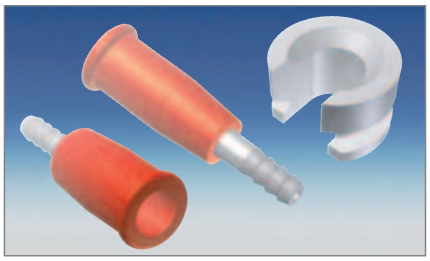
Cat. No.	Description
LMVZ 930	2-stands measuring plug-in ME 2
LMVZ 932	Control plug-in for dilution series
LDVM 2015	Software module INV DLL (intrinsic viscosity)
LDVM 2016	Software module VID DLL (viscosity index according to ISO 2909)
LDVM 2017	Software module ENZ DLL (enzyme activity)
LDVM 2023	Software module TEMP DLL (temperature display and control)
EKS 037	RS 232 connection cable, 1.5 m
UK 230	Connection cable S 5, VRM, PVS



LMVZ 930 LMVZ 932

Additional accessories

Cat. No.	Description
HKA 001	Small connection cap, silicone
HKA 002	Large connection cap, silicone
HKB 532	Adapter MUO (for Micro-Ubbelohde and Micro-Ostwald)
RKJ 014	Silicone tubing, 3x1.5 mm (unstable for H_2SO_4, silicone oil)
RKJ 020	Viton tubing, 3x1.5 mm (unstable for acetone)
LZB 011	Labosol S for viscometer cleaning, 1 liter
LMC 001	Windows PC (type on request)
LMC 003	Printer (type on request)
EBK 008	Barcode reader



HKA 002 HKA 001 HKB 532

LZB 011 EBK 008

Accessories for sample preparation

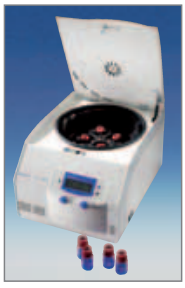
Dosing, dilution and initial weighing

Cat. No.	Description
EBK 016	Dosing unit MT
EBK 017-1	Replacement buret MT, 20 ml
LMVZ 876	Control box MT
UD 652	Valve unit for connecting up 2 dosing units
UK 233	Connection cable for UD 652
HKA 118	Large connection cap, Viton, for connecting to dosing unit
EBK 006	Analytical balance Mettler XP 204
LMVZ 976	Attachment for gravimetric dosing on XP 204

EBK 016, EBK 017-1 EBK 006

Dissolving and filtering

Cat. No.	Description
EBK 010	Magnetic stirrer RT35, 35 positions
EBK 013	Magnetic stirrer block MRH15, heated, 15 positions
EBK 014	Centrifuge for separating filler materials
EG 062	Sample bottles GL 32, 50 ml
EZV 100	Connection screw cap with hole, GL 32
EZ 195	PTFE stirrer, small



EBK 014

EBK 013

VRM accessories

Connection sets and software

For connecting a viscometer to a VRM module. One connection set is required for each viscometer.

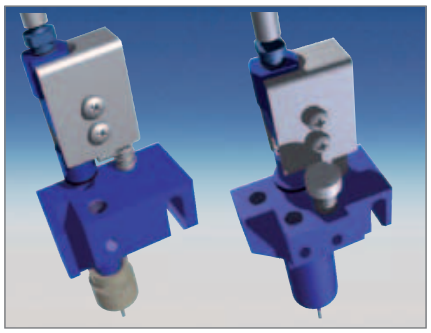
Cat. No.	Description
LMRZ 909	Connection set 1 (only for viscometers with aspirating tube and screw connection)
LMRZ 910	Connection set 2 (only for viscometers without aspirating tube)
LMRZ 920	Connection set 6 (only for viscometers without aspirating tube and dilution viscometers)
LMRZ 923	Connection set 9 (only for viscometers with aspirating tube and screw connection and at viscosities >100 mm²/s)

Mounting sets for thermostats

Cat. No.	Description
LMRZ 904	For PV 15/PVL 15 (for 1 VRM)
LMRZ 905	For PV 24/PVL 24 (for up to 2 VRM)
LMRZ 906	For PV 36 (for up to 3 VRM)
LMRZ 908	For ET 15 S/G (for 1 VRM)
LMRZ 916	For ET 15 S/G (for up to 2 VRM)
LMRZ 927	For Viscotemp 15/Viscotemp 24 (a fastening set is required for each VRM)

Additional accessories

Cat. No.	Description
EGP 012	Single-use syringe, 20 ml, 100 units
EGZ 015	Steel needles for EGP 012, 100 units
LMVZ 959	Filling tips PVDF, 100 units
EG 060	Glass funnel for liquid samples
HX 615	Funnel for granules
UD 410	Filter insert for funnel EG 060
UD 404	Filter for cleaning agent
EG 058	Glass bottle GL 45, 1 liter
EG 059	Glass bottle GL 45, 2 liter
EG 064	Glass bottle GL 45, 5 liter
LMRZ 907	Stopper for glass bottles
EBK 019	Fill level monitoring set
EBK 018	5-channel signal box
EYS 014	Pane sensors, separate
EKN 020	Extension cable, 3 m
EKN 021	Extension cable, 5 m
LMRZ 809	Suction pump VRP, for connecting to VRM modules



LMRZ 909 LMRZ 910

LMRZ 904 LMRZ 927

EGP 012 + EGZ 015

EG 058 EG 060

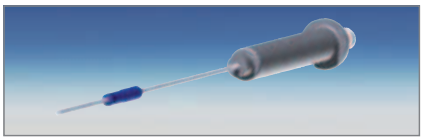
EBK 019

Sampler accessories

Dosing syringes

Cat. No.	Description
LMVZ 970	Syringe rinsing station
LMVZ 972	Syringe rinsing station (temperature-adjustable)
UD 442	Dosing syringe for VAS 1
UD 556	Dosing syringe for cartridge filter LMVZ 958
UD 442-1	Dosing syringe for dichloroacetic acid, Titan, 5 ml
EZ 261-1	Syringe protecting tube for dichloroacetic acid, Titan

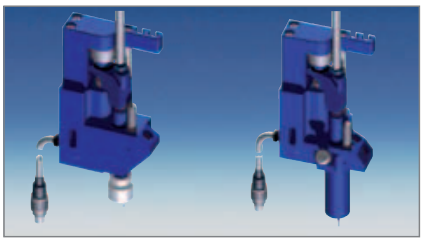
LMVZ 970



UD 556

Connection sets for cleaning modules

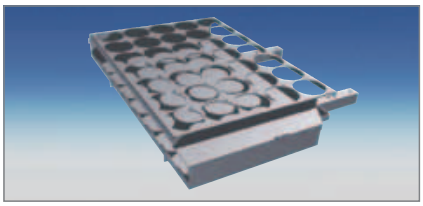
Cat. No.	Description
LMRZ 924	Connection set 3 (for viscometers with aspirating tube and screw connection)
LMRZ 925	Connection set 5 (for viscometers without aspirating tube)
UD 701-B	Automatic sample locks 1 (included in LMRZ 924)
UD 703-B	Automatic sample locks 2 (included in LMRZ 925)
LMRZ 902	Tubing set 1 (included in LMRZ 924)
LMRZ 912	Tubing set 3 (included in LMRZ 925)



UD 701-B UD 703-B

Sample racks and accessories for 50 ml bottles

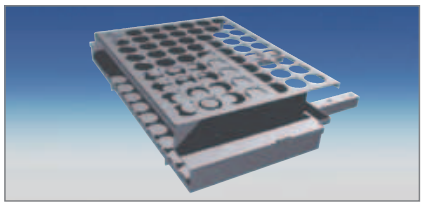
Cat. No.	Description
LMVZ 939	Sample rack PG 50, 35 positions
LMVZ 946	Sample rack PGH 50, 24 positions max. 160 °C
LMVZ 969	Sample rack PGH 50 MR, 15 positions max. 200 °C, with magnetic stirrer block EBK 013
EG 062	Sample bottles with thread GL 32 for PG 50, 50 ml
EZV 100	Connection screw cap with hole, 1 for each EG 062
EDF 122	Sealing rings for EZV 100, 50 units
EDF 093	Small aluminum plates for EG 062, 1,000 units each



LMVZ 939

Sample frames and accessories for 30 ml bottles

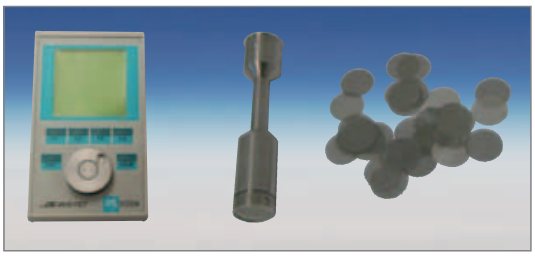
Cat. No.	Description
LMVZ 947	Sample rack PG 30, 63 positions
LMVZ 964	Sample rack PGH 30, 43 positions max. 160 °C
EG 066	Sample bottles with thread GL 32 for PG 30, 30 ml
EZV 104	Connection screw cap with hole, 1 for each EG 066
EDF 124	Sealing rings for EZV 104, 50 units
EDF 092	Small aluminum plates for EG 066, 1,000 units



LMVZ 947

Additional accessories

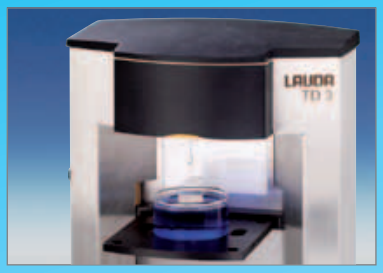
Cat. No.	Description
EBE 038	Operating unit for VAS
EBE 037	Heating block for dosing syringe UD 442 or UD 556
LMVZ 958	Insert filter incl. 100 small filter plates EZ 209
EZ 209	Small filter plates for LMVZ 958, 100 units
LMVZ 157	Vacuum pump, controlled



EBE 038 LMVZ 958 EZ 209

LAUDA TD

Tensiometer for measuring surface and interfacial tension



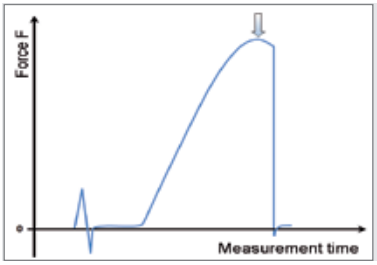
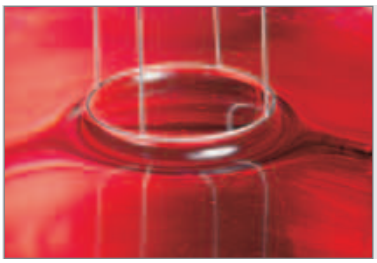
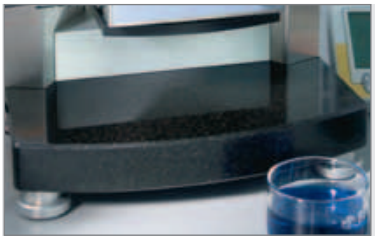
Application examples

- Determining the aging of insulating oils via interfacial tension
- Inspection of cleaning water by determining the surface tension
- Characterization of surfactants for detergents and cosmetics

Compact, flexible, precise

The LAUDA **TD tensiometers** perform measurements with the Du Noüy ring and Wilhelmy plate according to international standards. Thanks to the powerful load cell with significantly advanced measuring range, it is also possible to determine the densities according to the Archimedes' principle as well as to measure small weights. The measuring table with sample plate can be moved smoothly without any jerking motions in order to, for example, place the Wilhelmy plate on the sample surface or find the maximum force during ring measurement. The tensiometers come in a new design and are equipped with some unique technical features. As such, the world's smallest thermostat, the LAUDA PTT Peltier thermostating unit can be easily incorporated into the device. Surface and interfacial tensions can be easily measured, precisely and repeatably calculated, displayed, printed, saved and transferred to the computer with a single keystroke.

Your advantages at a glance

	The TD advantages	Your benefits
	• Command remote control	• Disruption-free operation during the measurement • Everything at a glance • Data storage included • Intuitive user operation • Measurement at the touch of a button
	• Automatic maximum detection	• Accurate recording of measurements • No manual scanning necessary • Repeat measurements without lamella break
	• Automatic measurement value correction according to Zuidema and Waters	• No subsequent corrections necessary • Researching in tables not necessary • Display of the actual measured value in mN/m
	• Granite base plate on the TD 3 • Level and adjustable feet	• Measured value stability through shock absorption • High stability • Exact horizontal alignment
	• Integrable PTT Peltier thermostating unit with stirrer function • External Pt100 probe • Adjustable magnetic stirrer integrated	• Space-saving and very fast thermostating of the sample in the measuring instrument • Temperature regulation in the sample liquid • Display of the actual sample temperature • Fast homogenization of the probe before measuring

TD 1 C
Ring/Plate tensiometer

In the large work area which can be accessed from all sides of the instrument, various conventional sample beakers with diameters up to 8 cm can be used. The thermostating of the sample can, for example, be done using the LAUDA PTT Peltier thermostating unit. On the high-resolution display of the Command remote control, the wetting force increase when removing the ring can be traced and the maximum force set without breaking the lamella. The value shown as the maximum is automatically corrected according to Zuidema and Waters and thus corresponds to the surface tension of the measured liquids in mN/m. At the touch of a button, the measured value, together with all the parameters, can be temporarily saved or exported directly to an optional logging printer.

Ring/Plate tensiometer TD 1 C
with Command remote control

Special features:

- Advanced measurement area up to 300 mN/m or 5 g
- Automatic maximum detection
- Output of the measured values to optional printer at the touch of a button
- Automatic measurement value corrections according to Zuidema and Waters
- Semi-automatic calibration in three accuracy levels with calibration weights
- Input of ring/plate dimensions possible
- Storage of up to 500 measurement results with parameters
- Numeric, user-defined sample designation

Included accessories:
Measuring ring according to Du Noüy (2-legged) · calibration weight 500 mg · plunger (glass) · tweezers · set of sample beakers (10 units) · plastic case · Command remote control · Power adapter

Additional accessories:
PTT (Peltier thermostating unit with stirrer function) · measuring ring according to Du Noüy (4-legged) · measuring plate according to Wilhelmy · calibration weight with DKD certificate 500 mg · matrix printer

Technical features		TD 1 C
Mode: Surface/Interfacial tension	mN/m	Measurement range: 0...300 (ring method); Resolution ±0.1
Mode: Density measurement	g/l	Measurement range: 0...2,000; Resolution: ±1
Mode: Weight measurement	mg	Measurement range: 0...5,000; Resolution: ±1
Sample designation		Numeric (0...999)
Measurement value storage	Results	Max. 500, with date and time
Table movement	manual	Using rotary knob
Maximum detection		Automatic
Ring correction		Automatic according to Zuidema and Waters
Control and evaluation		Command unit (control, display, documented data storage); printer (optional)
Ambient temperature range	°C	10...40
Power consumption	W	10
Dimensions (WxDxH)	mm^3	250x120x300
Weight	kg	ca. 5.0
Cat. No. 100…240 V; 50/60 Hz		LMT 847

TD 3
Ring/Plate tensiometer

With the LAUDA TD 3, the measurement samples in the range from 5 to 80 °C can be thermostated extremely quickly and conveniently with the smallest of space requirements. The tensiometer serves to determine the surface/interfacial properties of organic and inorganic liquids (liquid/liquid or liquid/gas), dispersions, and emulsions (among others, for developing surface active substances like surfactants and emulsifiers) as well as for confirming their presence in waste water and other water samples. The integrated micro-controller takes care of the table positioning, maximum recognition and measurement data correction for the user. The program repeats measurements until such a time as the measurement value stability as set by the user has been reached and then calculates the static surface or interfacial tension. The measurements can be executed completely independently of the user and are more precise than the most important standards demand. As such, the equipment satisfies all of the requirements of the stringent GLP guidelines. In addition, both liquid density and low weights can be easily determined.

Ring/Plate tensiometer TD 3
with Command remote control

Special features:

- Automatic maximum detection and maximum scanning
- Output of the measured values to optional printer or data transfer to PC via RS 232C
- Automatic measurement value corrections according to Zuidema and Waters
- Statistical check of the measurement value stability
- Storage of up to 500 measurement results with parameters
- Numeric, user-defined sample designation
- Granite base plate for vibration absorption and increasing stability
- Background lighting of the measuring chamber
- Waiting period prior to start of measurement can be programmed (ASTM D971)

Included accessories:

Measuring ring according to Du Noüy (2-legged) · calibration weight 500 mg · plunger (glass) · tweezers · set of sample beakers (10 units) · plastic case · Command remote control · power adapter

Additional accessories:

PTT (Peltier thermostating unit with stirrer function) · measuring ring according to Du Noüy (4-legged) · measuring plate according to Wilhelmy · calibration weight with DKD certificate 500 mg · matrix printer · data transfer software for PC

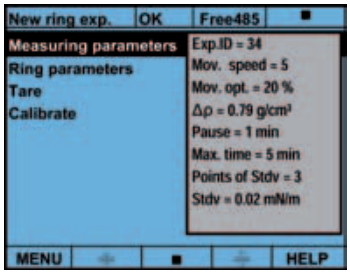
Technical features		TD 3
Mode: Surface/Interfacial tension	mN/m	Measurement range: 0...300 (ring method); 0...999 (plate method); Resolution: ±0.01
Mode: Density measurement	g/l	Measurement range: 0...2,000; Resolution: ±1
Mode: Weight measurement	mg	Measurement range: 0...5,000; Resolution: ±0.1
Temperature range (PTT)	°C	5…80 (±0.1)
Magnetic stirrer		Integrated into PTT, adjustable (10 levels)
Table movement	mm/s	0.1…1 (10 levels)
Maximum detection		Automatic
Ring correction		Automatic according to Zuidema and Waters
Interface		RS 232, Command remote control
Control and evaluation		Command unit (control, display, documented data storage) PC data transfer (optional); printer (optional)
Ambient temperature range	°C	10…40
Power consumption	W	10
Dimensions (WxDxH)	mm	245x205x335
Weight	kg	9.5
Cat. No. 100…240 V 50/60 Hz		LMT 850

Command remote control

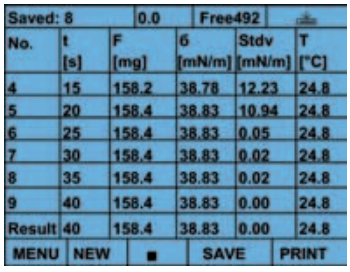
The practical LAUDA Command remote control has a large display and can be operated without any lengthy instruction. It enables the remote operation of the TD 1 C and TD 3, e.g. outside of an fume hood and prevents disruptive repercussions on the measuring unit during input.

Easy selection of the measuring method
Direct selection of the method (density, plate, ring, and weight measurement) with just a few keystrokes. Positioning of the sample table via keystroke (with TD 3). Display of measuring status.

Clear input of measuring parameters
Easy input of all of the necessary measuring parameters, clearly laid out on a single page. Dimensions of the measuring elements, the ring and the plate, can be corrected and adjusted.



Automatic real-time logging
Running measurements can be compared in real-time with already saved measurement series. Transfer to PC possible. Logging of the individual measuring times, the maximum forces, corrected measuring values in mN/m, and the standard deviation (with TD 3).

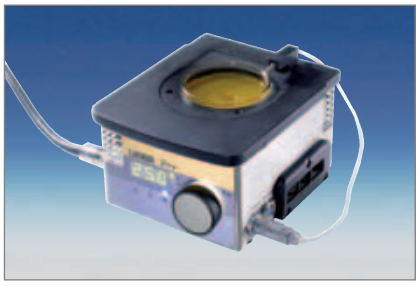


TD accessories

Thermostating and stirring block

With the PTT the sample can be brought to the precise required sample temperature in an easy and very quick way. The adjustable, integrated stirrer helps when it comes to quickly establishing constant temperatures and homogenization process.

Cat. No.	Description
LMTZ 831	PTT Peltier thermostating unit with integrated magnetic stirrer
HF 513	Holding plate for mounting to the TD 1 C
EZ 265	PTFE Stirrer (included in LMTZ 831)
HGH 188	Transparent plastic cover with opening (included in LMTZ 831)
UD 711	Pt100 temperature probe (included in LMTZ 831)



LMTZ 831, UD 711

TD accessories

Measuring rings and measuring plate

Cat. No.	Description
EZ 141	Measuring ring according to Du Noüy, 2-legged (included in LMT 847 and LMT 850)
EZ 250	Measuring ring according to Du Noüy, 4-legged
EZ 251	Measuring plate according to Wilhelmy

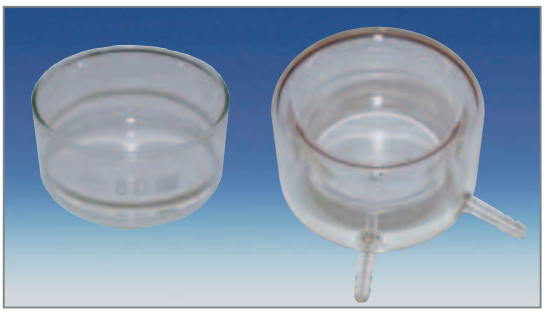
EZ 250 EZ 251

Calibration weights

Cat. No.	Description
EZ 033-1	Calibration weight, 500 mg (included in LMT 847 and LMT 850)
EZ 033-2	Calibration weight with DKD certificate, 500 mg

Vessels

Cat. No.	Description	Suitable for
EG 004	10 Beakers for density measurements	TD 1 C , TD 3
EG 010	10 Sample beakers, 8 cm ø, not temperature-adjustable	TD 1 C
EG 011	10 Sample beakers, 6 cm ø (included in LMT 847 and LMT 850)	TD 1 C , TD 3
EG 009	10 Sample beakers, 5 cm ø	TD 1 C
EG 047-1	Double-walled glass thermostating vessel, height 30 mm	TD 1 C
EG 047-2	Glass cover for thermostating vessels	TD 1 C



EG 010 EG 047-1

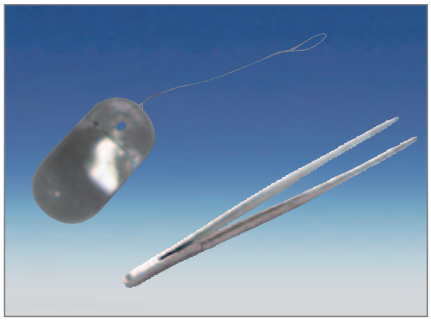
Burner

For cleaning ring/plate

Cat. No.	Description
EZ 286	Gas burner
EZ 045	Spirit burner

Additional accessories

Cat. No.	Description
UD 320	Glass plunger (included in LMT 847 and LMT 850)
UD 578	Digital temperature probe for TD 3
LDTM 2017	Software for data transfer between PC and TD 3
EKS 037	RS 232 connection cable for TD 3
EZ 034	Tweezers (included in LMT 847 and LMT 850)
EZ 158	Plastic case (included in LMT 847 and LMT 850)

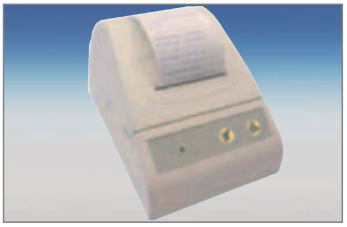


UD 320 EZ 034

Printer

For logging data

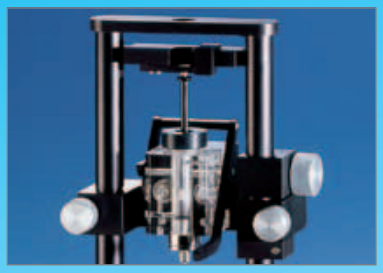
Cat. No.	Description
LMC 819	Matrix printer
EAZ 034	Print ribbon
EAZ 035	10 Paper rolls

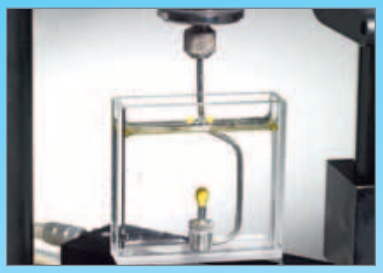


LMC 819

LAUDA TVT

Drop volume tensiometer for measuring surface and interfacial tension





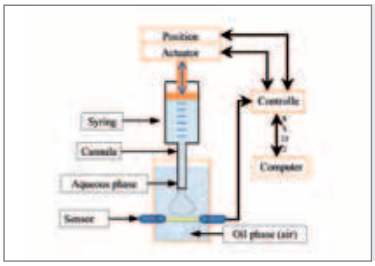
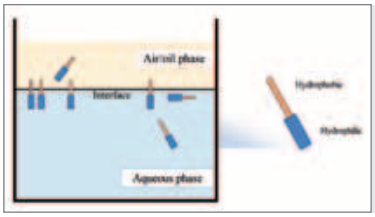
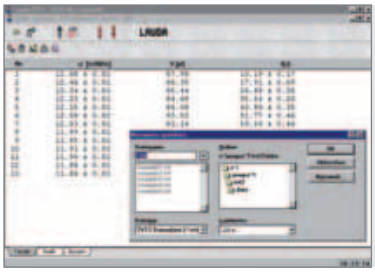
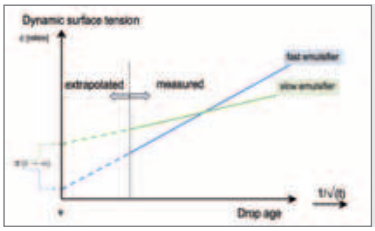
Application examples

- Dynamic surface tension of surfactant-carrying solutions, oils and highly viscous liquids
- Emulsifier screening
- Dispersions like paint, lacquers and foodstuffs
- Adsorption kinetics of “moderately faster“ surfactants
- Determining concentration with medium surfactant content
- Aging effects of oils, especially with insulating oils
- Wetting agent concentration of galvanic solutions

Highly precise measurement, low sample volume requirements, modern electronics

LAUDA **drop volume tensiometers** serve to measure the surface and interfacial tension of liquids. The method is especially suited to determining dynamic interfacial tensions. Here, the volume of a drop detaching from the needle is measured very precisely. The surface/interfacial tension is derived from this depending on whether the drop forms in air or in a second non-miscible phase (oil). This measurement principle is in an easy-to-operate measuring unit using precision mechanics and modern electronics. The micro-liter-precise drop formation ensures the outstanding precision and reproducibility of the measured values. With the highly stable Phase-Locked Loop (PLL) speed controller of the direct-current motor, drops can be formed with a lifespan from one second up to a number of hours without vibrations. The analysis of these effects is especially important when it comes to time-limited surfactant effects, like, for example, with quick coating processes, drop formation, wetting processes or with emulsion stability.

Your advantages at a glance

The TVT advantages	Your benefits
	• Drop volume method for precise measurement of surface and interfacial tension • Measurement range: 100 to 0.1 mN/m	• Flexible device for a variety of applications • Characterization of multiple emulsifiers, for which the ring/plate technology cannot be used
	• Dynamic surface and interfacial tension depending on the drop age across a wide range	• Quick overview of adsorption behavior of amphiphilic molecules on surfaces and interfaces
	• Extremely robust and controlled via intuitive Windows software • Temperature control with LAUDA thermostats	• Can also be operated by untrained staff • No particular requirements of setup area • Automatic recording of temperature independence
	• Different views of the measurement curves and fitting of polynomial functions for analyzing the measurement data	• Physically founded extrapolations beyond the measurement range to compare with other methods
	• Various syringes and needle combinations • Special needles for rising drops or glass needles • Easy replacement and cleaning	• Flexible and fast switching between applications • Optimization of the measurement process • Particle-holding and critical samples also measurable, e.g. crude oils and strong acids. • Insensitive measuring element, no annealing necessary
	• Gas-proof closing of the system • Liquid-thermostated measuring cell and dosing syringe	• Safe measurements of volatile and/or toxic substances • Exact thermostating at the measuring cell using LAUDA thermostats

TVT 2
Drop volume tensiometer

Drop by drop, the LAUDA TVT 2 measures the very small dynamic interfacial tension just as precisely as it does the surface tension of highly viscous samples. Individual drop measurements of up to 100 drops are possible. Time-critical functions, like drop monitoring and speed check, can be transferred from the PC to a powerful micro-processor. The TVT 2 consists of a measuring console and control panel. The core of the electronic part is made up of a micro-processor for controlling the discharge speed, the counting of the encoder pulses, and communications. LEDs and pictograms show the current status of the unit. The measuring console includes the easy-to-replace, temperature-adjustable syringe, the light sensor, a high-resolution travel sensor, and the precision mechanics for drop formation.

Drop volume tensiometer TVT 2 with control panel

Special features:

- Positioning accuracy in the micro-meter range
- Variable control of the feed rate by a factor of 300 using a Phase-Locked Loop (PLL) speed controller
- Automatic adaptation of the light sensor's intensity to the used liquids
- Quasi-static mode for very high surface ages
- Simple connection to LAUDA thermostats for thermostating and software-controlled recording of the temperature dependency
- Less than 1 ml sample necessary to record a measuring curve

Included accessories:

Software · syringe 2.5 ml · standard needle 1.38 mm · glass cell · thermostating block · cell handling tool · plastic case

Additional accessories:

Syringes · needles · temperature-stable glass cells · reverse measuring set · temperature probe · thermostats

Technical features		TVT 2
Measurement 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
Absolute precision		Approx. 0.5 % of the end value of the 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…90
Interface		RS 232
Dimensions TVT 2 Measuring console (WxDxH)	mm	220x240x555
Dimensions TVT 2 Controller (WxDxH)	mm	340x270x105
Weight TVT 2 Measuring console	kg	8.0
Weight TVT 2 Controller	kg	4.2
Power consumption	W	0.5
Cat. No. 80…230 V; 50/60 Hz		LMT 833 and LMT 935

TVT 2 accessories

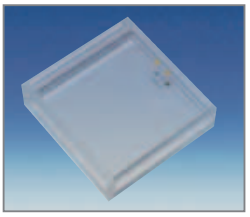
Syringes

Cat. No.	Description
EGP 009	Syringe, 250 µl
EGP 010	Syringe, 500 µl
EGP 006	Syringe, 1 ml
EGP 007	Syringe, 2,5 ml (included in LMT 935)
EGP 008	Syringe, 5 ml

EGP 006 EGP 008 EGP 007

Cuvettes

Cat. No.	Description
EGG 011	Cuvette, standard (included in LMT 833)
EGG 013	Cuvette, increased stability against thermal shock
UD 329	Cell handling tool (included in LMT 833)



EGG 011

Needles

Cat. No.	Description
EGZ 005	Standard needle SK 1, 1.38 mm
EGZ 004	Standard needle SK 2, 1.05 mm
EGZ 006	Standard needle SK 3, 1.70 mm
EGZ 007	Standard needle SK 4, 0.63 mm
HX 453	Standard needle SK 5, 1.50 mm, glass

EGZ 007 EGZ 006 HX 453

Reverse measuring set

Cat. No.	Description
LMTZ 908	Reverse measuring set consisting of:
HX 410	Needle adapter
HX 381	Reverse needle UK 1, 1.38 mm A
HX 380	Reverse needle UK 2, 1.05 mm A
HX 382	Reverse needle UK 3,1.70 mm A
HX 441	Reverse needle UK 4, 0.63 mm A

LMTZ 908

Thermostating and temperature control

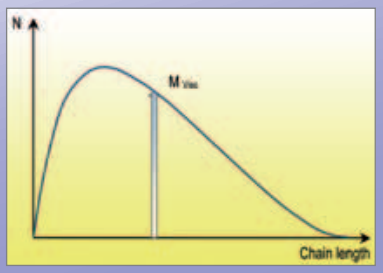
Cat. No.	Description
LCK 1910	ECO cooling thermostat RE 415 S*, 230 V; 50 Hz**
LRZ 913	RS 232/485 plug-in for temperature control
EKS 089	USB-connection cable for ECO
US 055	Temperature probe for measuring cell

* When not using the temperature probe or temperature control, other thermostats can also be used.
** Other power supply variants on request

LCK 1910

Applications – Polymers

Solution viscosity – Quality feature of plastics

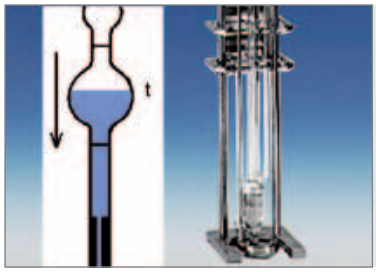
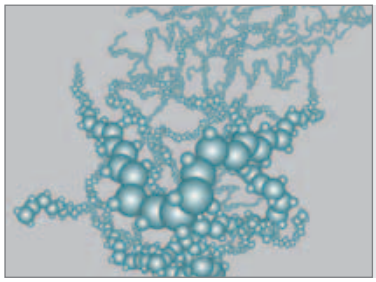


Application examples

- Technical polymers, e.g. polyamides and polyurethane
- Transparent polymers, e.g. PET, plexiglas and polycarbonate
- Polyolefins, PE and PP, polyvinyl chloride and others
- Medicinal polymers for surgery and hyaluronic acids
- Cellulose and quality papers for transformers or similar

Determining solution viscosity as a measure for the medium molecular mass of a polymer is one of the most tried-and-tested methods and the most sensitive method to evaluate the molecular identity of many plastics. Since the processing and usage properties of the plastic depend strongly on its molecular structure, the quality of the plastics can be easily monitored through the solution viscosity or most of them can be optimized and the necessary figure can be determined from this. Binding standards for the practical execution of viscosity measurement exist for plastics. These determine, for example, solvents, concentration, sample preparation, viscometer type and size, measuring temperature, number and reproducibility of the processing time measurements as well as the type of evaluation. As the measurement result, the relative viscosity is always calculated from the ratio of viscosities of the polymer solution and of the solvent.

Your advantages at a glance

	LAUDA solution viscometer advantages	Your benefits
	• Intuitive measuring principle • LAUDA measuring systems with high degree of automation	• Easy, affordable execution with stopwatch • Parallel measurement positions accelerate the process • Contact with solvents is reduced • Safe operation even by semi-skilled shift workers
	• Supplies important figures quickly for the chain lengths of polymers and their changes	• Comparison of the specifications with current figures in the quality check • Production control in shift operation • Incoming components inspection of raw polymers • Outgoing components inspection of semi-finished products and compounds
	• Sample preparation and principle are determined in a few standards • High selectivity on properties of the polymer chain • Useful tool for polymer research	• Worldwide comparability • Can be carried out everywhere with minimum effort • Results practically uninfluenced by filler materials or additives to the plastic, like, for example, with the melt flow index • High degree of flexibility • Applicable in many ways • Easy to implement
	• In some industries, e.g. automotive, the solution viscosity is required: - Along the entire value-added chain from raw granule to finished part - Selectively for aging and damage	• Compensation for extra effort as competitive advantage • Continuous monitoring during product generation • Analysis of finished product over the entire life-span and recycling

LAUDA Applications – Polymers

Technical polymers

Viscosity number of polyamides (PA) and polybutylene terephthalates (PBT)

In the automotive industry in particular, the trend of replacing metal with high-quality technical plastics continues. Even mechanical motor parts subjected to high thermal stresses are now being manufactured, for example, from reinforced polyamides (PA) or polybutylene terephthalates (PBT).

One of the most important figures for the plastic quality is the viscosity number (reduced viscosity) as a measure for the chain length of basic polymers. The change to polymer chain lengths when manufacturing component parts, e.g. for injection molding or after continuous automobile operation, can be traced using viscosity measurements. The modular system of the automated LAUDA PVS viscosity measuring system offers tailored configurations according to current needs which minimize contact with naturally very aggressive or toxic solvents. The entire analysis process, from preparation to polymer solutions, to sample loading and measurement, all the way to the cleaning of the viscometers, is PC-controlled. The few remaining manual movements can even be performed by semi-skilled shift workers. For occasional inspections, e.g. after processing, there are affordable compact systems (see pages 53 and 57).

Recommended standards

- DIN EN ISO 307
  Plastics, polyamides – Determination of the viscosity number
- DIN EN 1628-5
  Plastics – Determination of the viscosity of polymers in dilute solution using capillary viscometers – Part 5: Thermoplastic polyester (TP), homopolymers and copolymers

Gear wheel made from fiber glass-reinforced PA

Heavy current plug made from PBT

Typical configuration:

Fully automatic measuring system for parallel measurement of reinforced PA and PBT for up to 100 samples a day

- VAS 1/4 automatic sampler with four measuring stands S 5, two each for PA and PBT samples
- Three VRM 4 S or VRM 4 cleaning modules for cleaning viscometers and dosing syringes
- Sample frame for maximum 35 bottles
- High-quality PV 24 viscothermostat with DLK 10 external cooler
- Ubbelohde glass viscometer of sizes II and Ic (optionally in Micro-Ubbelohde version)
- Online filter for separating glass fibers and undissolved sections (optionally centrifuges)
- Automated sample preparation with filler material correction while using high-quality Mettler weighing balances and dosing units

Transparent polymers

Viscosity number and IV value of polyesters (PC, PMMA, PET)

The mass worldwide pervasiveness of PET bottles and packaging makes recycling a necessity when it comes to protecting the environment and preserving resources. Here, the IV value, usually calculated according to the Billmeyer approximation, is the criterion for the quality of the recyclate and thus vital for further usage. Ideally, alignment with the original value of typically 80 cm³/g should be reached. With the mass-used plastics polycarbonate (e.g. CD-ROM), polymethylmethacrylate PMMA (e.g. Plexiglas) and others, the viscosity number (reduced viscosity) plays a similarly important role in production and re-use.

Even as early as in the production of the raw granule, e.g. polycondensation, the viscosity of the polymer solution is measured. Systems customized to operate in shifts have four to a maximum of eight measuring stations which are equipped with modules for automatic viscometer cleaning. Sample loading is done manually using a syringe or funnel. In 24-hour operation, these systems allow a sample rate of hundreds of samples. The restriction here is the time needed to dissolve the polymer which takes place in the magnetic stirrer at room temperature or at 80 or 130 °C. Here too there are affordable versions for just occasional measurements, e.g. for damage analyses and incoming and outgoing components inspections, which can be converted into fully automatic machines with samplers at later dates.

Recommended standards

- DIN EN 1628-4/-5/-6
  Plastics – Determination of the viscosity of polymers in dilute solution using capillary viscometers – Part 4: Polycarbonate (PC) molding and extrusion materials, Part 5: Thermoplastic polyester (TP) homopolymers and copolymers, Part 6: Methylmethacrylate polymers

Preforms for creating PET bottles. The IV value needs to be at least 70 cm³/g.

Typical configuration:

Measuring system PVS 1/4 with four measuring stands and automatic viscometer cleaning for fast, precise measurement

- PVS 1/4 control unit
- Four measuring stands S 5
- Two VRM 4 cleaning modules for viscometer cleaning
- High-quality PV 24 viscothermostat with DLK 10 external cooler
- Ubbelohde glass viscometer of sizes 0c, I, and Ic (optionally with aspirating tube or in Micro-Ubbelohde version)

Options:

Automated sample preparation while using high-quality Mettler weighing balances and dosing units

LAUDA Applications – Polymers

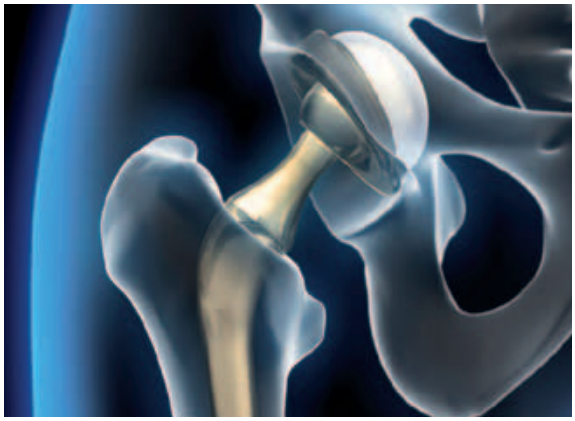
Polyolefins

Molar mass and IV value of polypropylene and polyethylene (UHMWPE)

Plastic wrap, e.g. for packaging and keeping food fresh, are usually made of polyethylene or polypropylene. Depending on the application, the molecular mass can vary quite strongly. As such, ultra-high molecular PE with molar mass >1,000 kg/mol is used in artificial limbs due to their outstanding gliding properties. The polyolefins are distinguished from most chemicals, solvents, and acids by their outstanding resistance to chemicals. For this reason, the solvents Decalin or Tetralin at 135 °C are usually used for solution viscometry. Since polymers quickly flocculate on cooling down, solutions previously were to be filled into the viscometer while hot, as was the solvent used for cleaning. A specially configured PVS system completely avoids contact with hot chemicals. In this case, the weighed samples are directly filled into an Ubbelohde dilution viscometer in the form of granules or powder using a funnel. Then, the PVS program initiates the loading of the exact solvent quantity via special dosing units. Afterwards, a magnetic stirrer which is integrated into the thermostat is used to dissolve the sample at 135 °C and measure it. This is followed by the automatic emptying, cleaning, and drying of the viscometer. Along with the calculation of the IV value according to the Schulz-Blaschke approximation, it can also be determined directly using a dilution series (linear serial regression).

Recommended standard

- DIN EN 1628-3
  Plastics – Determination of the viscosity of polymers in dilute solution using capillary viscometers – Part 3: Polyethylenes and polypropylenes



Using a ball socket for an artificial hip joint of extremely long-chain UHMWPE - with molar masses of up to 6,000 kg/mol.

Typical configuration:

Measuring system PVS 1/2 with two measuring stands, integrated magnetic stirrer, and dosing units. Dissolving PE/PP samples directly in the glass viscometer – Automatic cleaning and recording of concentration series

- PVS 1/2 control unit
- Two measuring stands S 5
- A VRM 4/HT cleaning module for viscometer cleaning with external pump
- High-quality viscothermostat PV 15 operated with silicone oil at 135 °C
- Special Ubbelohde viscometers of size I for dissolving and diluting samples, incl. filter frit
- Integrated two-station magnetic stirrer with control console
- Two dosing units for the solvents Decalin and Tetralin
- Filling funnel for granulate and powder

Polyvinylchloride

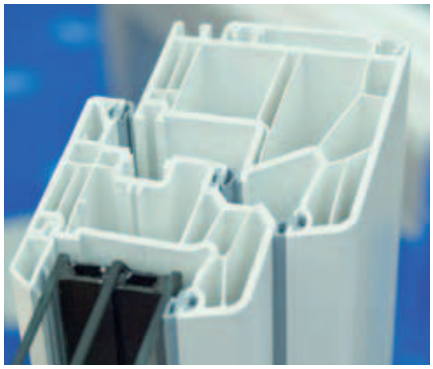
Determining K-value according to Fikentscher

Monitoring the chain length of the basic polymers is essential in order to further improve the quality of PVC as a basic material for window housing, pipes, floor-coverings, containers, and foil as well as for a number of components in the electrics industry. The K-value according to Fikentscher based on the solution viscosity has become accepted as a measure for this. Here, the relatively harmless cyclohexanone serves as a solvent. From production of the rough polymer, to compounding and semi-finished products manufacture by injection-molding technology or extrusion, LAUDA offers PC-controlled K-value measurement, tailored to the current sample rates, from the affordable iVisc measuring system to the fully automated PVS measuring system with sampler.

One version for average sample rates with a good price-performance ratio and great ease-of-use is the two-station measuring system PVS 1/2 with cleaning module based on a Viscotemp 15 viscothermostat. This can easily measure up to four samples per hour. Using a syringe or funnel, the dissolved sample simply needs to be directly inserted into the Ubbelohde which stays in the thermostat. Measuring can then be started. Further process steps (viscometer cleaning and drying) are executed automatically. If desired, sample preparation can also be made automated.

Recommended standards

- DIN EN 1628-2
  Plastics – Determination of the viscosity of polymers in dilute solution using capillary viscometers – Part 2: Poly(vinyl chloride) resins
- DIN EN 922
  Piping and fittings of unplasticized polyvinylchloride (PVC-U) – Preparation of the samples for determining the viscosity number and calculating the K-value



Window frames made from PVC are extremely weather-proof. The ageing can be observed in the deterioration of the K-value.

Typical configuration:

Measuring system PVS 1/2 with two measuring stands and automatic cleaning in the Viscotemp 15 viscothermostat

- PVS 1/2 control unit
- Two measuring stands S 5
- A VRM 4 cleaning module for viscometer cleaning
- Viscotemp 15 viscothermostat with DLK 10 through-flow cooler at 25 °C
- Ubbelohde viscometer of size Ic with connections for emptying and rinsing
- Sample preparation system including balance and dosing unit (see page 51)
- Heated magnetic stirring block for dissolving PVC at 80 °C

LAUDA Applications – Polymers

Medicinal polymers

Molar mass and IV value of hyaluronic acid products and absorbable polymers according to pharmaceutical standards

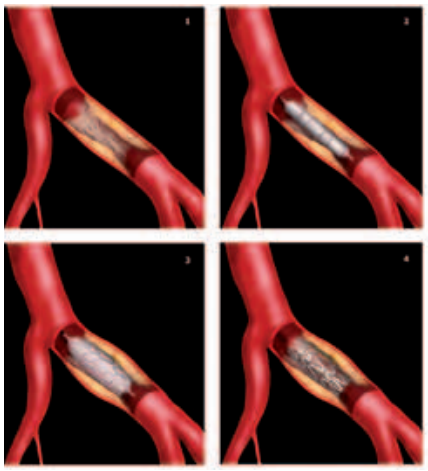
Hyaluronic acid (HA) is a glycosaminoglycan produced naturally in the connective tissue of the body. Hyaluronic acid products serve as a lubricant for joints damaged by arthrosis and are used in nose sprays, eye drops, anti-wrinkle lotions, and in plastic surgery. Aconuresis and vesicoureteral reflux in infants can be treated with this.

Absorbable polymers are usually polylactides (PLA) which can be broken down into lactates through hydrolysis in the organism. They are used for surgical stitching material, screws, and plates for osteosynthesis and as carriers for medication. With both polymer classes, the molar mass expressed in the form of reduced or intrinsic viscosity is a decisive factor for application and life-span.

As a result of the flexibility and compatibility with GLP and FDA standards, e.g. of software (21-CFR-11), LAUDA PVS systems are used all over the world to check the quality of these products. The automatic control of concentration series and viscometer cleaning make sure of user-independent, reliable, and reproducible determining of the molar masses and their changes.

Recommended standards

- European Pharmacopeia
  Capillary viscometer method, Sodium Hyaluronate
- DIN EN ISO 1628-1
  Plastics – Determination of the viscosity of polymers in dilute solution using capillary viscometers –
  Part 1: General principles



The dissolution of a stent made from PLA is accompanied by the breakdown of polymer chains and thus with a decrease in the viscosity number.

Typical configuration:

Measuring system PVS 1/2 with two measuring stands and automatic cleaning. One measuring stand for HA with magnetic stirrer for dilution series, another for viscosity number of PLA in an ET 15 S viscothermostat

- PVS 1/2 control unit
- Two measuring stands S 5
- A VRM 4 cleaning module for viscometer cleaning with chloroform (PLA) or water and acetone (HA)
- ET 15 S DLK 10 through-flow cooler
- Ubbelohde dilution viscometer of type 0a (HA) and viscometer of size 0c (PLA) with connections for emptying and rinsing
- PC-controlled dosing unit with buffer solution for diluting the HA samples
- Sample preparation system with dosing units and precision balances
- Single-station magnetic stirrer (for positioning underneath)

Cellulose and papers

Degree of polymerization of insulation paper using solution viscosity

Paper and cellulose consist of long chains of polymerized glucose rings. The degree of polymerization (DP value) is directly related to its mechanical strengths, e.g. tensile strength. The DP value of insulating papers is important to the mechanical resistance and, above all, to the short circuit load of transformers. A reduction in the DP value down to between 150 and 200 means the end of the transformer's life-span. The aging speed of the transformer oil is heavily dependent on the temperature and water content in the insulation. With insulating papers and textiles made from cellulose (e.g. cotton), the degree of polymerization is determined by the solution viscosity. Here, the intrinsic viscosity (IV value) correlates with the degree of polymerization (that is, with the chain length). Here, the solution, cupriethylendiamine (CED) is often used, as it caters for a gentle, that is, as non-destructive as possible, development of the cellulose molecules in the solvent.

With the modular PVS systems, the configuration can be tailored precisely to the needs of the user in regard to sample rate and automation requirements, e.g. automatic viscometer cleaning or sample loading. The INV-DLL software delivers the intrinsic viscosity according to the Martin formula, which is used to calculate the degree of polymerization. The systems can also work under extensive oxygen pulping so that the measurement of mildly oxidizing Cuoxam solutions and EWNN solutions is also possible.

Recommended standards

- IEC 60450
  Measuring of the average viscometric degree of polymerization of new and aged cellulosic electrically insulating materials
- DIN 54270-1/-2/-3
  Testing of textiles – Determination of the limit-viscosity of celluloses – Part 1: Principles, Part 2: Cuen-procedure, Part 3: $EWNN_{mod(NaCl)}$-procedure

Short-circuited coils count among one of the most dangerous outages with power transformers. The DP value check ensures the quality of high-grade insulation papers.

Typical configuration:

Measuring system PVS 1/2 with two measuring stands and automatic cleaning in an affordable ET 15 S viscothermostat

- PVS 1/2 control unit
- Two measuring stands S 5
- A VRM 4 cleaning module for viscometer cleaning with water and acetone
- ET 15 S with DLK 10 through-flow cooler
- Micro-Ubbelohde of type Ic (recommended for reducing use of solvents and cleaning agents)
- Viscometer of size I (IEC60450) with connections for emptying and rinsing
- Sample preparation system with dosing units and precision balances (illustration, see page 51)

Additional example configurations like on pages 52 and 53

Applications – Lubricants, oils and fuels

Absolute viscosities and interfacial properties – precisely measured according to international standards

Application examples

Absolute viscosities

- Lubricants and fuels
- Oil production and transport
- Silicone and silicone oils
- Waxes, resins and polyols

Interfacial tensions

- Insulating oils
- Additives for crude oil production and fuels
- Surfactants, e.g. wetting agents, emulsifiers, dispersants

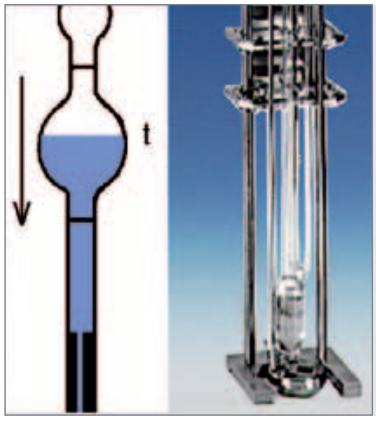
The change in viscosity due to temperature fluctuations is of importance in those places where oils and liquids are produced, pumped, and moved. The minimization of friction losses due to the selection of suitable oils is essential when it comes to the design of machines and pneumatics. As mentioned before, capillary viscometry is the most precise and strictly standardized method to measure absolute viscosities. Measuring routines need to be executed efficiently, quickly, with absolute safety, and reproducibly at any time. With the modular concept of LAUDA, system configurations can be put together which combine the functionalities required for the respective purpose.

Important indicators of oil quality, for example, to check the deterioration of transformer oils, are also the surface tension (ST) to air, but particularly the interfacial tension (IT) to water or aqueous solutions. The surface/interfacial tension also serves to characterize additives for fuels and lubricants or to analyze tertiary crude oil production and all sorts of surfactants, e.g. emulsifiers, wetting agents, etc. Alongside the conventional lamellae tension methods of Du Noüy and Wilhelmy, LAUDA provides the drop volume and bubble pressure methods with which adsorption processes of amphiphilic additives or aging products can also dissolve over time on interfaces.

Your advantages at a glance

LAUDA viscometer advantages

Your benefits



- ASTM D445 DIN 51562
- Intuitive measuring principle
- Unrivalled precision
- Constant calibration not dependent on temperature
- Up to eight parallel measurement positions
- Compatibility

- Easy, affordable execution with stopwatch
- Better than 0.3 per cent guaranteed
- Only one capillary constant from -40 up to 200 °C
- Acceleration of the process
- International comparability independent of the measuring device

- Calculation of the viscosity index according to ASTM D 2270/ISO 2909
- Automatic control of the temperature
- Extreme measurement range from -60 up to 200 °C

- Comparison of the specifications with current figures from the quality check
- Work-free periods can be used for long-term measurements
- Complete viscosity scan possible at all application temperatures

LAUDA tensiometer advantages

Your benefits

- Sensitive to amphilic molecules
- Standardized sensors
- Ring method TD, interfacial tensions
- Drop volume method
- Computer software running Windows

- Low concentration of impurities, additives and aging products detectable
- International comparability
- Provide values in thermodynamic equilibrium
- Provides additional information on adsorption on interfaces
- Flexible experiment running, also for research tasks
- Intuitive operation, high degree of flexibility

LAUDA Applications – Lubricants, oils and fuels

Lubricants and fuels

Viscosity index and kinematic viscosities of SAE/ISO motor oils at application temperatures

The Viscosity Index VI is used as a measure for the temperature dependence of the viscosity with lubricating oils in the area of application. In accordance with ASTM D 2270 or ISO 2909, this is determined from the kinematic viscosities at 40 and 100 °C. Here, oil with the least change in viscosity was assigned a VI value of 100, while that with the largest change was assigned a VI value of 0. With modern synthetic oils or multi-purpose oils the viscosity index can be increased significantly above 100 using additives (VI improvers). The higher the viscosity index of an oil, the less its viscosity changes at different temperatures. This makes the operation of engines, for example, less subject to climatic conditions. In summer, the lubrication effect of such oils is still sufficient, while in winter the oils are not too viscous.

Depending on the sample rate, the LAUDA PVS system provides tailored solutions. As such, a PVS system in a PV 15 viscothermostat can be used to program the necessary temperatures of 40 and 100 °C while measuring the viscosities of the same samples one after the other. The two values, and thus the viscosity index, can be determined significantly quicker when measuring stands in two thermostats are used at fixed temperatures of 40 and 100 °C. This way, oils can be measured using a PVS 1/8, each with four measuring stations at 40 and 100 °C in two thermostats along the entire viscosity range. If equipped accordingly, the glass capillary viscometers are then cleaned and dried automatically.

Recommended standards

- ISO 2909
  Petroleum products – Calculation of viscosity index from kinematic viscosity
- ASTM D 2270
  Standard Practice for Calculating Viscosity Index From Kinematic Viscosity at 40 and 100 °C

The high viscosity index of the motor oil makes sure that your car starts in winter.

Typical configuration:

Measuring system PVS 1/8 with four + four measuring stands for parallel measuring of viscosities at 40 and 100 °C and calculation of the VI index with automatic viscometer cleaning for oils from 2 to 1,000 mm²/s

- PVS 1/8 control unit
- Eight measuring stands S 5
- Software module VID-DLL
- Four VRM 4 cleaning modules for cleaning the Ubbelohde with two cleaning agents
- Two PV 24 viscothermostats (one at 40 °C with water and DLK 10 cooler and one at 100 °C with thermostating oil)
- Two Ubbelohde glass viscometers each of sizes Ic, II, IIc, III (with aspirating tube)
- Dosing syringes for filling the viscometers

Lubricants and fuels

Low-temperature behavior (paraffin formation) of motor oils, diesel, and kerosene

In modern aviation, extreme requirements are made of both the technology and the materials. At the flying altitudes of today's jets at 10,000 meters, temperatures down to -60 °C are common. Luckily, it is not the passengers who feel the effects of this, but the fuel in the tanks and piping as well as the motor and drive lubricants. As such, it needs to be ensured that their viscosity does not increase to a level over a critical value or that the paraffin begins flocculating as a result of the extreme temperature changes during long flights. For this reason, tests on the viscosity are carried out in the lab in realistic conditions. Of course, the same applies to fuels, and motor and hydraulic oils which are used in polar regions, meaning that viscosity measuring down to -40 °C is also relevant here.

In connection with the powerful DLK 45 through-flow cooler or the Proline RP 890 cooling thermostat, the PVL 15 viscothermostats for two measuring stations and PVL 24 for four measuring stands are designed for working at temperatures down to -40 or -60 °C. The four-fold insulating glass prevents the windows from fogging up and makes sure the viscometers can be seen clearly. With the PVS system, kinematic viscosities at these extreme temperatures can be measured conveniently. The viscometer is cleaned automatically too. The ambient air used in measuring and cleaning can be dried using a connected cooling trap so as to avoid any freezing, especially of the measuring capillaries.

Recommended standards

- ASTM D 2532
  Standard Test Method for Viscosity and Viscosity Change After Standing at Low Temperature of Aircraft Turbine Lubricants
- ASTM D 445
  Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

So that kerosene and lubricants can be safely pumped to the aircraft engines at external temperatures of -60 °C, the viscosity first needs to be inspected at these temperatures. In this respect, LAUDA provides everything from a single source.

Typical configuration:

Measuring system PVS 1/2 with two measuring stands for parallel measurement of viscosities at temperatures down to -40 °C with automatic viscometer cleaning and drying trap for kerosene and other fuels.

- PVS 1/2 control unit
- Two measuring stands S 5
- A VRM 4 cleaning module for cleaning the Ubbelohde with two cleaning agents
- PVL 15 viscothermostat connected to a powerful DLK 45 cooler
- Two Ubbelohde glass viscometers each of sizes Ic, II (with aspirating tube)
- Cooling trap for drying and cleaning the used ambient air

LAUDA Applications – Lubricants, oils and fuels

Insulating oils

Kinematic viscosity and interfacial tension of transformer oils

Transformers are among the most important elements in energy supply. Here, transformer oils are used for insulating and cooling. However, unusual strains, like for example, transient overvoltage, overheating in emergency operation, or disruption to cooling, lead to accelerated deterioration of the oils and a reduced life-span. With the oxidation and deterioration of oils which are heavily stressed or are in use for a number of years, insoluble and polar components build up. By measuring the interfacial tension this build-up in the oil can be detected. This helps to classify the deterioration and remaining life-span of the oil. In the lab report, the interfacial tension is indicated in mN/m. If their value compared either to fresh oil or to the previous sample has decreased significantly, the oil has deteriorated, which means that regeneration or an oil change is necessary. Due to their compact design and intuitive operation using the separate Command remote control, the LAUDA ring tensiometers TD 1 C and TD 3 are best suited for mobile use on location as well.

In Arctic regions, the temperature in a deactivated transformer can sink to -40 °C. Here, the viscosity increases dramatically, sometimes accompanied by paraffin flocculating. This changes the insulating properties with the risk of damage to the transformer. As such, the viscosity at very low temperatures also needs to be measured when formulating the oils. LAUDA provides tailored configurations for this purpose.

Recommended standards

- ASTM D 971
  Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method
- DIN EN 14370
  Surface active agents – Determination of surface tension

The safe operation of power transformers requires highly insulated transformer oils. The interfacial tension to water is a sensitive indicator of premature ageing.

Recommended equipment:

Automatic tensiometer – Ring method according to Du Noüy

- TD 3

Semi-automatic tensiometer – Ring method according to du Noüy

- TD 1 C

Each with:

- PTT Peltier thermostating unit
- Measuring ring (2-legged)
- Density measurement set
- Calibration weight
- Printer and/or data transfer software for PC (TD 3 only)

Suitable configuration for viscosity measurements at low temperatures of -40 °C, see page 59

Oil production

Recovery rate in tertiary oil production with surface active substances

The recovery rate refers to the actually retrieved portion of the total amount of crude oil available at the site of an oil field. In order to increase this portion, the efficiency of so-called tertiary production needs to be improved if relatively simple measures like the injection of water or gas (secondary production) do not lead to any satisfactory increase in the recovery rate. With tertiary production ("Enhanced Oil Recovery" EOR), special measures are taken to further improve recovery from an oil source. An important method of EOR is the injection of aqueous solutions in connection with surface active materials (surfactants).

With the LAUDA drop volume tensiometer TVT 2, along with the surface tension of liquids, the interfacial tension between oil and the rinsing agent can be specified precisely. Here, the dynamic, drop-age-dependent interfacial tension (IT) can be determined down to 0.1 mN/m from the volume of rising crude oil drops. The IT is a measure of the emulsifiability of the oil and thus of the oil's capacity to absorb the rinsing agent. The aim here is to adapt the agent in such a way that the crude oil separates significantly more easily from the solid matter (rocks or similar) and moves more freely through the often very narrow hollow subterranean passages as an emulsion. With the TVT 2, measurements between approx. 60 and 70 °C can be made, which often correspond to the conditions within the drill hole.

Recommended standard

- ISO 9101
  Surface active agents – Determination of interfacial tension – Drop volume method

By injecting special surfactant solutions into exhausted sites, the remaining oil can be separated from the rock.The interfacial tension between the oil and rinsing agent plays a decisive role in the oil's absorbing capacity.

Recommended equipment:

PC-controlled TVT 2 drop volume tensiometer with RE 415 S thermostat and reverse measuring set for rising drops, various syringes and needles for surface and interfacial tension oil measurements

- TVT 2 E
- TVT 2 M

with:

- Syringe 2.5 ml
- Needle 1.039 mm
- Software for Windows PC
- Reverse measuring set
- RE 415 S thermostat with Pt100 probe and RS 232 interface
- Syringes 5 ml and 1 ml
- Standard needles set

LAUDA Applications – Lubricants, oils and fuels

Oil transport

Pumpability of crude oils

Oil pipelines are the arteries of modern civilization. Over thousands of kilometers, through mountains and valleys, they bring crude oil from the ports or production sites to the refineries. As such, the Transalpine Pipeline (TAL) connects the oil harbor of Trieste with refineries in Karlsruhe and Ingolstadt in Germany, crossing the main Alpine ridge at a tunnel height of 1,500 meters. The oil temperature in the different sections between the pumping stations, where the crude oil's transportation is constantly monitored, is correspondingly varied and weather-dependent. The flowability and thus the viscosity of the pumped crude oil is a decisive factor in this. This, in turn, is heavily dependent on the temperature fluctuations as a result of the heights to be surmounted and the prevailing climates, which need to be taken into consideration when calibrating the pumps in the pump stations.

To record viscosity temperature characteristics, LAUDA provides easy-to-use PVS systems with thermostat programming and automatic viscometer cleaning as well as affordable compact systems like the iVisc. The compact Viscocool 6 thermostat is suited as constant temperature equipment.

Recommended standard

- ASTM D 445
  Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

Setting the supply pumps in pipelines depends on the flowability of the oil, which is itself dependent on the temperature. Measuring the viscosity at the expected temperatures provides the necessary input.

Typical configurations:

PVS system with an S 5 measuring stand and temperature programming of 15 to max. 80 °C in the Viscocool 6 viscothermostat with Peltier cooling

- PVS 1/2 control unit
- Software TEMP-DLL
- Measuring stand S 5
- Ubbelohde viscometer type Ic, II
- Viscocool 6 viscothermostat and cover plate
- RS 232 plug-in for Viscocool 6
- PVS 1 system with an S 5 measuring stand and temperature control of 10 to 40 °C in the Viscocool 6 viscothermostat with Peltier cooling

iVisc in the Viscocool 6 viscothermostat with Peltier cooling (manual temperature setting)

- iVisc
- Ubbelohde capillaries of types Ic and II
- Viscocool 6 viscothermostat and cover plate

Waxes, resins, silicone and polyols

Absolute, kinematic, and dynamic viscosities of highly viscous liquids and their temperature dependency

Waxes melt at over 40 °C without decaying and demonstrate significantly decreasing viscosity above the melting point. Synthetic waxes and resins are recovered mainly from crude oil. They are used to manufacture lacquers, soaps, drugs, and turpentine. Liquid silicone is a clear, colorless, neutral, odorless, and hydrophobic liquid with a wide range of viscosity. Among other things, it is used as an anti-foaming agent, hydraulic liquid, mold-release agent, to make items water-repellent, and as an anti-friction agent and lubricant. Silicone liquids of higher viscosity are used as liquids in viscose coupling, as electrical insulating material, heat transfer liquids, and as an absorptive agent. Also referred to as polyols, the polyalcohols are usually highly viscous to solid at room temperature. Polyvinylalcohols (PVA) are reactive, nonhazardous, very good film formers, and serve as thickeners for glues, salves, and emulsifiers, for coating packaging and as filling material and additives for lacquers, motor oils, etc. What the material groups mentioned above have in common is their extremely wide range of viscosity and the strong changes at different temperatures.

Along with precise viscosity measurement and thermostating across the entire range of application, the LAUDA PVS system also offers the automation convenience necessary in shift work. Highly viscous samples can be dosed automatically, diluted with suitable solvents, and extracted. Afterwards, the viscometers are cleaned and dried without having to be taken out of the thermostat.

Recommended standards

- ASTM D 445
  Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- DIN 51562
  Measurement of kinematic viscosity by means of the Ubbelohde viscometer

The flowability of waxes, resins, silicone, and polyols changes dramatically with temperature. Viscosity measurements provide the quantitative data for this.

Typical configuration:

PVS 1/4 system with four S 5 measuring stands in the Viscotemp 24 viscothermostat from 20 to 100 °C, manual dosing using syringe, automatic viscometer cleaning for the viscosity range of 2 to a maximum of 3,000 mm²/s

- PVS 1/4 control unit
- Software module TEMP-DLL
- Four S 5 measuring stands
- Ubbelohde viscometer type Ic, II, III, IV (with tubing for filling, diluting, and extraction)
- Two VM 4/HT cleaning modules
- Two external VRP pumps
- Special sample locks for samples with high viscosity
- Viscotemp 24 viscothermostat and cover plate
- RS 232 interface for Viscotemp 24
- External DLK 10 cooler for T<40 °C

A version with a sampler is illustrated on page 50.

Standards (selection)

Principles - Glass capillary viscometry

Standard	Principles - Glass capillary viscometry	From
DIN 51562	Measurement of kinematic viscosity by means of the Ubbelohde viscometer –	
	Part 1: Viscometer specification and measurement procedure	1999
	Part 2: Micro-Ubbelohde viscometer	1988
	Part 3: Viscosity relative increment at short flow times	1985
	Part 4: Viscometer calibration and determination of the uncertainty of measurement	1999
ASTM D 445	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)	2012
ASTM D 446	Standard Specifications and Operating Instructions for Glass Capillary Kinematic Viscometers	2007
DIN EN ISO 3104	Petroleum products – Transparent and opaque liquids – Determination of kinematic viscosity and calculation of dynamic viscosity	1999
ISO 3105	Glass capillary kinematic viscometers – Specifications and operating instructions	2007

Principles - Tensiometry

Standard	Principles - Tensiometry	From
ASTM D 971	Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method	2012
ISO 9101	Surface active agents – Determination of interfacial tension – Drop volume method	2011
DIN EN 14210	Surface active agents – Determination of interfacial tension of solutions of surface active agents by the stirrup or ring method	2007
DIN EN 14370	Surface active agents – Determination of surface tension	2007
ISO 6889	Surface active agents – Determination of interfacial tension by drawing up liquid films	2004

Solution viscometry - Polymers

Standard	Solution viscometry - Polymers	From
DIN EN ISO 1628	Plastics – Determination of the viscosity of polymers in dilute solution using capillary viscometers –	
	Part 1: General principles	2009
	Part 2: Poly(vinyl chloride) resins	1998
	Part 3: Polyethylenes and polypropylenes	2010
	Part 4: Polycarbonate (PC) molding and extrusion materials	1999
	Part 5: Thermoplastic polyester (TP), homopolymers and copolymers	1998
	Part 6: Methyl methacrylate polymers	1990
DIN EN ISO 307	Plastics - Polyamides – Determination of viscosity number	2007
DIN 54270	Testing of textiles – Determination of the limit-viscosity of celluloses, principles	1997
ASTM D 789	Standard Test Methods for Determination of Solution Viscosities of Polyamide (PA)	2007
ASTM D 4243	Standard Test Method for Measurement of Average Viscometric Degree of Polymerization of New and Aged Electrical Papers and Boards	2009
ASTM D 2857	Standard Practice for Dilute Solution Viscosity of Polymers	1995
ASTM D 1601	Standard Test Method for Dilute Solution Viscosity of Ethylene Polymers	2004
ASTM D 4603	Standard Test Method for Determining Inherent Viscosity of Poly(Ethylene Terephthalate) (PET) by Glass Capillary Viscometer	2003
ASTM D 1243	Standard Test Method for Dilute Solution Viscosity of Vinyl Chloride Polymers	1995
ASTM D 3591	Standard Test Method for Determining Logarithmic Viscosity Number of Poly(Vinyl Chloride) (PVC) in Formulated Compounds	2011
IEC 60450	Measurement of the average viscometric degree of polymerization of new and aged cellulosic electrically insulating materials	2008

Viscosity of lubricants and fuels

Standard	Viscosity of lubricants and fuels	From
DIN 51563	Testing of Mineral Oils and Related Materials - Determination of Viscosity Temperature Relation – Slope m	2011
DIN ISO 2909	Petroleum products – Calculation of viscosity index from kinematic viscosity	2004
ASTM D 2270	Standard Practice for Calculating Viscosity Index From Kinematic Viscosity at 40 and 100 °C	2010
ASTM D 2532	Standard Test Method for Viscosity and Viscosity Change After Standing at Low Temperature of Aircraft Turbine Lubricants	2010

Material properties (selection)

Liquid properties of pure organic solvents/water

Substance	Temperature °C	Density g/cm³	Viscosity mPa s	Viscosity mm²/ s	ST mN/m	IT/H_2O
Water	20	0.9982	1.002	1.004	72.8	n.n.
	25	0.9971	0.890	0.893	72.0	n.n.
	30	0.9957	0.798	0.801	71.2	n.n.
	40	0.9923	0.653	0.658	69.6	n.n.
Methanol	25	0.791	0.55	0.69	22.1	n.n.
Ethanol	20	0.789	1.20	1.52	22.0	n.n.
Hexane	20	0.660	0.33	0.49	18.4	51.0
Heptane	20	0.684	0.41	0.60	19.7	51.2
Octane	20	0.703	0.54	0.77	21.6	51.3
Nonane	20	0.718	0.71	0.99	22.9	51.8
Decane	20	0.730	0.92	1.26	23.9	52.1
Dodecane	20	0.751	1.35	1.80	25.4	52.4
Chloroform	15	1.489	0.60	0.40	27.2	36.1
Hexanol	20	0.814	5.90	7.25	25.8	6.8
Octanol	20	0.827	8.20	9.92	27.5	8.5
Benzol	20	0.877	0.65	0.74	28.9	35.0
Toluol	20	0.867	0.59	0.68	28.5	36.1

ST: Surface tension IT: Interfacial tension

Viscosity levels of oil products

Substance	Temperature °C	Viscosity mm²/ s	Temperature °C	Viscosity mm²/s
Cylinder oil (filtered)	40	200	100	20
Cylinder oil (used)	40	400	100	25
Soybean oil	20	65	90	8
(Bio) diesel	20	4-6	40	2-4
Kerosene	-20	8-9	20	2
Gasoline	20	0.5		
Heavy crude oil	20	600	40	130

Viscosity figures of plastics

Substance	Temperature °C	Red. viscosity cm³/g	Solvent	Standard
Polyamides	25	120...320	Sulfuric acid 96 %	ISO 307
Polybutylene terephthalate	25	90...170	Dichlorbenzene/Phenol	ISO 1628/5
Polyethylene terephthalate	25	60...140	Dichlorbenzene/Phenol	ISO 1628/5
Polycarbonate	25	40...80	Dichlormethane	ISO 1628/4
Polyethylene MD, HD	135	120...500	Decalin	ISO 1628/3
Polyethylene UHMM	135	1,800...4,000	Decalin	ISO 1628/3
Polypropylene	135	100...500	Decalin	ISO 1628/3
Polymethylmethacrylate	25	40...90	Chloroform	DIN 1628/6
Polyvinylchloride	25	40...80*	Cyclohexanon	ISO 1628/2

* K-value according to Fikentscher

LAUDA Glossary

21 CFR-11
The technical and organizational requirements which need to be satisfied in order to be allowed to use electronic data and documentation in development, licensing, and production instead of paper are set down in Guideline 21 CFR part 11, initiated by the American authority, the FDA.

Adsorption
This refers to the accumulation of (amphiphilic) molecules on surfaces and interfaces of liquids and solids. This generally leads to a reduction in the surface and interfacial tension.

Billmeyer formula (IV value according to Billmeyer)
Serves the approximate calculation of intrinsic viscosity of polyesters and others. No additional polymer figures required.

$$\nu_{int} = \frac{1}{4}\,\nu_{red} + \frac{3\ln \nu_{rel}}{4C}$$

Bubble pressure tensiometers
These determine the interfacial tension of liquids using the pressure in gas or air bubbles which are created in the liquid to be measured in a capillary with known dimensions. This method is not suited for determining interfacial tensions between liquid phases.

CMC measurement
This is the determining of a surfactant concentration at which the aggregation of the surfactant molecules begins to form micelles (CMC concentration). It is determined from the dependence of the concentration of the surfactant in the solution and the surface tension.

Contact angle/Contact angle measurement
This 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 the surface energy.

Correction according to Harkins and Jordan
Harkins and Jordan generated tables for the correction of the ring-measured surface and interfacial tension. These values are standardized.

Correction according to Zuidema and Waters
Zuidema and Waters generated a polynomial for the correction of the ring-measured surface and interfacial tension.

Critical Micelle 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 micelle 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 diffusion of the molecules in the observed material. In tensiometry, the diffusion coefficient refers to the measured liquid.

Drop volume tensiometers
These determine the surface/interfacial tension of liquids at the moment of drop separation, from the volume of the drop that is formed in air or in an indissoluble phase. The densities of the phases concerned must be known in order to determine the surface/interfacial tension from the drop volume measured.

Du-Noüy ring
This is a measuring body made of a platinum-iridium alloy to determine surface/interfacial tension from the tensile force of an attacking lamella produced by this body using a ring/plate tensiometer.

Dynamic interfacial/surface tension
This is the measurable reduction in interfacial/surface tension due to the adsorption of surface active substances

Dynamic measuring methods (tensiometry)
These determine the surface and interfacial tension which is dependent on the surface age.

Dynamic viscosity
This is the viscosity coefficient material to shear flows between transverse stress t and velocity gradient D in $\tau = \eta\, D$ and has the mPas unit (previously Centipoise, cP).

Emulsion
This is a disperse system consisting of water or an aqueous solution and an organic liquid immiscible with water. The emulsified or inner phase is present in the form of small droplets. These are surrounded by the coherent or outer phase.

FDA
Short for "United States Food and Drug Administration". It prescribes binding guidelines for the development and production of pharmaceutical products with international validity.

Glass viscometer
Viscometers made from glass, with different designs, standardized in ISO 3105. The most commonly used for automatic measurements is the Ubbelohde version with ventilation pipe.

GLP
Short for "Good Laboratory Practice". Specifications initiated by the American authority, the FDA, for laboratories and producers (e.g. of pharmaceuticals) regarding how tests and measurements are to be cleanly planned, performed, and monitored. The guidelines have a legal character in many countries.

Hagen-Poiseull's Law (fundamental equation of capillary viscometry)
Viscometry in capillary viscometers is based on this. If the differential pressure is generated by a height difference in front of and behind the capillaries, then $\nu_{kin} = k \times t$, (k: capillary constant, t: measured run of a defined liquid volume) applies. With very short times, the non-dissipated kinetic energy must be taken into consideration (kinetic energy/Hagenbach correction).

Huggins formula (IV value according to Huggins)
Serves the approximate calculation of intrinsic viscosity of, for example, polystyrenes and other polymers. KH is an additional polymer-dependent constant.

$$\nu_{int} = \frac{\sqrt{1+4K_H\,\nu_{spec}} - 1}{2CK_H}$$

Inherent viscosity (logarithmic viscosity number)
This is the natural logarithm of the relative viscosity in relation to the concentration C of the separated material $\nu_{red} = \ln \nu_{rel} / C$; Unit: $cm^3/g = 100\ dl/g$

Interfacial energy
This is the sum of free energy of all the molecules found in the interface between different materials. The interface between a liquid and a gas is called the surface and the corresponding energy from this space is the surface energy.

Interfacial tension
This is the work that must be done to increase the interface of the liquid by one surface area unit ($1\ m^2$). This is equivalent to the specific interfacial energy.

Intrinsic viscosity (limiting viscosity number, Staudinger Index, IV value)
This is the limiting value of the reduced/inherent viscosity for the case of infinitely strongly diluted solvents at dissipating transverse stresses:

$$\nu_{int} = \lim_{C \to 0} \nu_{red} \quad \text{bzw.} \quad \nu_{int} = \lim_{C \to 0} \nu_{inh}$$

It is determined by measuring the ν_{red} as a function of the concentration and extrapolation on C = 0. For many polymers, there are approximation conditions based on the measurement of only one concentration usually specified in standards.

Kinematic viscosity
Describes the quotient of the dynamic viscosity by the density: $\nu_{kin} = \eta / \rho$ and has the unit mm^2/s (formerly: centistokes, cst).

Kinetic energy correction (Hagenbach correction)
With short flow times, this is a correction necessary to be made to Hagen-Poiseull's Law and takes into consideration the kinetic energy in a capillary viscometer which is not converted into frictional heat.

Corrected viscosity $\nu = k\,(t - \Delta t)$

Correction factor acc. to Hagenbach $\Delta t = \frac{E}{kt^2}$

Correction factor ISO 1628/6: $\Delta t = k / t - \nu_{ref}\,(t)$

K-value (according to Fikentscher)
A relative measurement for the molar mass traditionally used for PVC and PVA.

$$K = 1000\ \frac{a\text{-}1+\sqrt{1+\left(\frac{2}{C}+2+a\right)a}}{150+300C}$$

with: $a = 1{,}5 \log\nu_{rel}$

LIMS
Abbreviation for Laboratory Information Management System. This describes a system for the control and management of laboratory data, which is determined by various measuring devices.

Mark-Houwink formula
This provides the relation between medium molar mass (weight means) of the dissolved polymer chains and the intrinsic viscosity. For the absolute molar mass, the proportional constant K and the exponent a need to be entered. These depend on the polymer and the solvent, and can be found in the references.

$$M = \left(\frac{\nu_{int}}{k}\right)^{\frac{1}{a}}$$

Martin formula (IV value according to Martin)
This serves the approximate calculation of intrinsic viscosity of, for example, cellulose and other polymers. K is an additional constant dependent on the polymer.

$$\log\nu_{red} = \log\nu_{int} + k\nu_{int}\,C$$

Peltier thermostating
This is an alternative to conventional thermostating which is based on the Peltier effect. Here, two semi-conductors with different conduction bands are brought into contact with each other. If electricity is conducted through this array, electrons will be pumped on one side to a higher energy level. The heat energy extracted during this brings about a cool-down. On the other side, the electrons fall back down to the starting level and release heat again. By reversing the direction of electric current, both cooling and heating are possible. Peltier elements only operate electrically, that is, there are no moving components, gases, or liquids. The limited degree of efficiency has proven itself to be disadvantageous in a number of concepts.

Plate method according to Wilhelmy
This is used to measure the surface tension with the aid of 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 behavior, the plate can only be used for interfaces under certain limitations.

Reduced viscosity (viscosity number)
This is the specific viscosity in relation to the concentration C of the separated material.
$\nu_{red} = : \nu_{sp} / C$; Unit: $cm^3/g = 100$ dl/g

Relative viscosity
This is the ratio of the dynamic viscosity η of the solvent to that of the solvent η_0.
In the case of strongly diluted solvents, this corresponds almost to the ratio of the kinematic viscosities: $\nu_{rel} = \eta / \eta_s \approx \nu / \nu_s$

Ring method according to Du-Noüy
This is used to measure the surface/interfacial tension with the aid of a standardized ring with a ring/plate tensiometer. The ring is submerged in the liquid and then extracted. A liquid lamella forms during this, which is stretched to the maximum. The surface and interfacial tension is calculated from the resulting force. Then, the determined value still needs to be corrected.

Ring/Plate tensiometers
These measure the force with which a lamella attacks a Du-Noüy ring or Wilhelmy plate. This is used to calculate the surface/interfacial tension between liquid phases.

Schulz-Blaschke (IV value according to Schulz-Blaschke)
Serves the approximate calculation of intrinsic viscosity of cellulose, polyolefins, and other polymers. K_1 is an additional constant dependent on the polymer.

$$K = \frac{\nu_{red}}{1+K_1 C\nu_{red}}$$

Solomon-Ciuta formula (Solomon-Ciuta)
This serves the approximate calculation of intrinsic viscosity of PMMA and other polymers. No additional polymer figures required.

$$\nu_{int} = \frac{\sqrt{2\,(\nu_{red}\,C - \ln\nu_{rel})}}{C}$$

Specific viscosity (relative viscosity increase)
This is the relative viscosity minus one: $\nu_{sp} = \nu_{rel} - 1$

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

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

Surfactant
This is a surface-active substance. The prerequisite for this activity is an asymmetric structure of the surfactant molecules, 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
This is a disperse system, that is, a fine, but not molecular distribution of a solid body in a liquid.

Viscosity
This is the measure for how fluidly a liquid flows. The greater the viscosity, the thicker the liquid.

Viscosity index (for mineral oil products)
This is calculated according to ISO 2909 and ASTM D 2270 from the viscosities measured at the two different temperatures 40 and 100 °C. It is a measure of the temperature behavior of different oils. The higher the viscosity index of an oil, the less its viscosity changes at different temperatures.

Wilhelmy plate
Standardized plate, usually made of a platinum alloy. It is used to measure the surface tension with ring/plate tensiometers. The plate material has been chosen so that the contact angle with the measuring liquid can equal zero. Optimum cleaning, e.g. through annealing, is preconditioned.

Our product lines:

Thermostats · Circulation chillers · Water baths
Process cooling systems · Heat transfer systems · Secondary circuit systems
Viscometers · Tensiometers

5-310-e-3/10.13 · Subject to technical changes.

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