NETZSCH

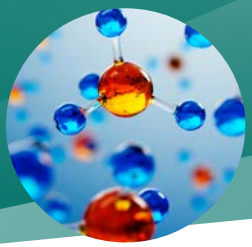
Proven Excellence.

Rosand Series

Proven Excellence in Rheology

Analyzing & Testing

The Importance of Rheology



Phase Behaviour, Microstructure, Molecular Weight, Compatibility

Formulation, Fillers, Additives

Kinexus Prime
Rotational Rheometer

PERFORMANCE

Product Application, Spreadability, Aesthetics, Mouthfeel, Levelling, Sag Resistance, Tack, Adhesion

In-Use Processes, Product Dispensing, Pouring, Sprayability

Rotational and Capillary Rheology

WITH OVER 14 DECADES OF SHEAR RATE

Processing, Extruding, Injection Moulding

Rosand
Capillary Rheometer

THE HEART OF FORMULATION AND PRODUCTION

Product Appearance, Particle Suspending Capability, Stability, Homogeneity

FROM FORMULATION AND PROCESSING TO END-USE PRODUCT PERFORMANCE

Powerful Floor Standing Capillary Rheometers for Research and Product Development

Flexible measurement capabilities for materials under high pressure and high shear rate extrusion

Since its launch, the Rosand RH7 and RH10 have set new standards in research level capillary rheometry. Today, the Rosand is used in hundreds of research laboratories around the world for a range of applications including polymers, foods, coatings and ceramics.

Continuous development of the original design and its operating software has produced a generation of floor standing capillary units with market leading performance characteristics and capabilities.

The current RH7 and RH10 models, which differ in their maximum force range and speed, retain the robust *H* frame design principle, which lies at the heart of the instruments' ability to operate under high loading conditions.

A new digital drive system gives the RH7 and RH10 unsurpassed performance in terms of speed control, accuracy, and dynamic operating range. This hardware is supported by the latest generation of Windows™ based software, Flowmaster, with many experimental possibilities.

Rosand RH2000

Advanced Benchtop Capillary Rheometers for Research, Product Development and Quality Control

Wide range of shear rates for correlation with real material processing conditions, in one compact system

The Rosand RH2000 series of benchtop capillary rheometers are compact systems capable of most testing requirements encountered in capillary rheometry.

The series is available in both single bore or twin bore configurations. The RH2000 incorporates many of the features and attributes found in the floor standing models (Rosand RH7/RH10).

A digital drive system gives the RH2000 series unsurpassed speed control, accuracy, and dynamic operating range.

It also comes with the latest generation of Windows™ based software, Flowmaster, offering many experimental possibilities.

Capillary Rheometer

HOW THE SYSTEM WORKS

The Rosand high pressure capillary rheometer systems enable controlled extrusion (by volumetric flow) of a sample through a high precision die of known dimensions. This enables characterization of material flow properties, typically under conditions of high force (or pressure) and/or high shear rate. Using the twin bore barrel option and a *zero length* die configuration allows, simultaneous determination of shear viscosity and extensional (elongational) viscosity as a function of shear (or deformation) rate can be measured.

A capillary rheometer system comprises several key components to enable robust, reliable and accessible rheological measurements for a particular sample or application:

Capillary Rheometer Base Unit

Includes the barrel with bore(s) to load the sample – the bore diameter and barrel material must be compatible with the material(s) under test. The base unit also includes a head component, which has a mechanical connection to the pistons and are used to extrude the sample. Key system functions of drive force and piston speed range are controlled by the base unit.

Die and Pressure Transducer Combination

The die is mounted at the bottom of the barrel bore, with its dimensions defining the applied shear field. A melt pressure transducer is inserted in the barrel to measure the resultant pressure at the die entrance as the material is extruded. The die dimensions and pressure transducer range must be appropriate to the sample type and test under consideration.

Temperature and/or Environmental Control Options

Accurate control of barrel temperature is essential considering rheological properties are a strong function of temperature. For thermally-sensitive materials, thermal equilibrium times and inert test environments are critical considerations to ensure reliable data.

Capable of achieving shear rates up to 10^8 s^{-1}

1. Piston
2. Barrel
3. Electrical Heaters
4. Temperature Control
5. Pressure Transducers
6. Dies
7. Dual Bore Barrel
8. Die Holder
9. Transducer Mount
10. Piston Tips

THE IMPORTANCE OF RHEOLOGY

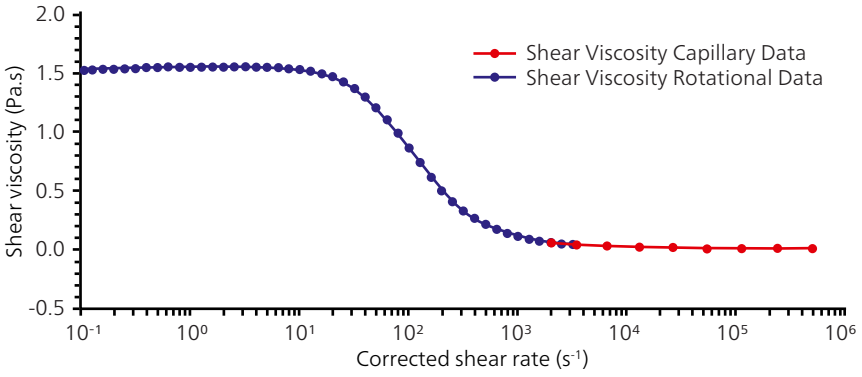
Measurements in capillary rheometers are often used to understand material behaviour during processing, and to a smaller extent, during the application of the product – depending on the shear rates applied.

From Production to Application – NETZSCH Rheometers Can Do it All!

Shower gels like many other personal care products are complex systems consisting of water, surfactants and other additives encapsulating the smell, color and shelf life into the product. This is because a shower gel is not only designed as a body wash, but also to provide a certain sensory experience.

Viscosity affects both the user perception on quality in addition to the cleansing efficiency. These properties can be best characterized and correlated to the subjective experience using a rotational rheometer, such as the Kinexus Prime range of rheometers. In addition to packaging and dispensing from its bottle, the shower gel also needs to have certain flow characteristics. It needs to be amenable to fast, efficient pumping and conveying for short packaging times, in addition to flowing easily from the bottle on demand during application. For the latter, viscosity measurements at high shear rates are needed to understand the flow behavior during production. Thus, capillary rheometers such as the Rosand RH2000 or RH7/10 are utilized to provide the necessary insights for production optimization.

The following graph shows the viscosity as a function of shear rate of a shower gel. The blue dots are the Kinexus measurements at low shear rates and the red dots represent the Rosand measurements at much higher shear rates. Due to the low viscosity of the product at high shear rates, the energy needed to pump the product during packaging is low and the conveying pipe system can be long without the need for high pressures.



Viscosity measurement of a shower gel at room temperature over a wide shear rate range utilizing both a Rosand capillary rheometer as well as a Kinexus rotational rheometer

Similar examples would be the ink jetting during printing or the injection molding of plastic materials. The viscosity at high shear rates is needed to design these materials and optimize the processes and machines for high quality and energy efficiency. This information can only be obtained with a capillary rheometer from our Rosand line of rheometers.

Features of Rosand Rheometers

Rosand Twin Bore Principle

Rosand capillary rheometers were the first to introduce the twin bore measurement principle to the commercial market. Simultaneous measurements can be made on both long and short dies to determine the inlet pressure drop at the die and, therefore, absolute viscosity, using the Bagley method. More commonly, Rosand *zero length* dies are used to directly measure the inlet pressure drop and measure the extensional viscosity using the Cogswell method.

The twin bore technique gives obvious experimental advantages including improved throughput, since both experiments are preheated simultaneously. Alternatively, the software can be configured to run a two material test which allows measurement of the viscosity of two different materials simultaneously.

Bi-Modal Speed Control

Bi-modal digital speed control technology has been developed for the latest generation of capillary rheometers. The technology uses different speed control algorithms suited to high and low speed operation to optimize performance. This gives the rheometer an impressive dynamic range in speed control. In practice, the lower limit is determined only by long experimental times at low shear rates but a dynamic range in speed of in excess of 400,000:1 is available if required. This greatly enhances the system's flexibility and means that a wider range of shear rates can be covered using any particular die.

RH7/RH10

Rigid *H* Frame Design

The *H* frame design principle provides a vertical stiffness well in excess of that achievable with cantilever or *C* frame designs. The frame is effectively rigid at loads well in excess of the 100 kN measurement limit. This is an important consideration in transient tests such as PVT, which rely upon compliance free measurement for accurate volume determination.

Integral Fume Chamber with Extraction

For operator safety, the RH7 and RH10 are equipped with a safety interlocked fume chamber with fan extraction of the gases to a vent at the back of the rheometer unit. An extractor fan is also situated below the rheometer barrel.

Floor Standing Design

The floor standing design allows for an open architecture below the barrel and heater assembly. This space can be used to accommodate other experimental options such as die swell measurement, a slot die and haul-off (melt strength).

RH2000

Rigid Frame Design

Rigid one-piece cantilever frame design provides extreme mechanical strength and stiffness for a compact benchtop unit.

Swivel Head Design

A unique, safety interlock protected, swivel design means that the actuated part of the rheometer can be moved to one side affording ease of access for cleaning and sample loading.

Rheological measurements made easy

Controlled extrusion of a sample through a high precision die of known dimensions

Configuration Options

The Rosand capillary rheometers can be configured with a variety of options to provide complete measurement solutions across all applications.

High Force

Extends the maximum force (summed over both barrels if applicable) to 20 kN for the RH2000. The RH7 and RH10 have forces of 50 and 100 kN, respectively.

High Speed

An option for the RH2000. It extends the upper speed limit of the unit to 1200 mm/min for high shear rate measurement with no loss in speed sensitivity or available force. The high speed option is fully compatible with the high force option.

Barrel Materials and Dimensions

For aqueous or aggressive materials, stainless steel or Hastelloy barrels are available in place of the standard Nitrided steel version. The wide dynamic range in speed means that the standard 15 mm diameter barrel is suitable for the vast majority of testing applications. However, barrels are available with 9.5 mm, 12 mm, 19 mm and 24 mm bores as an option.

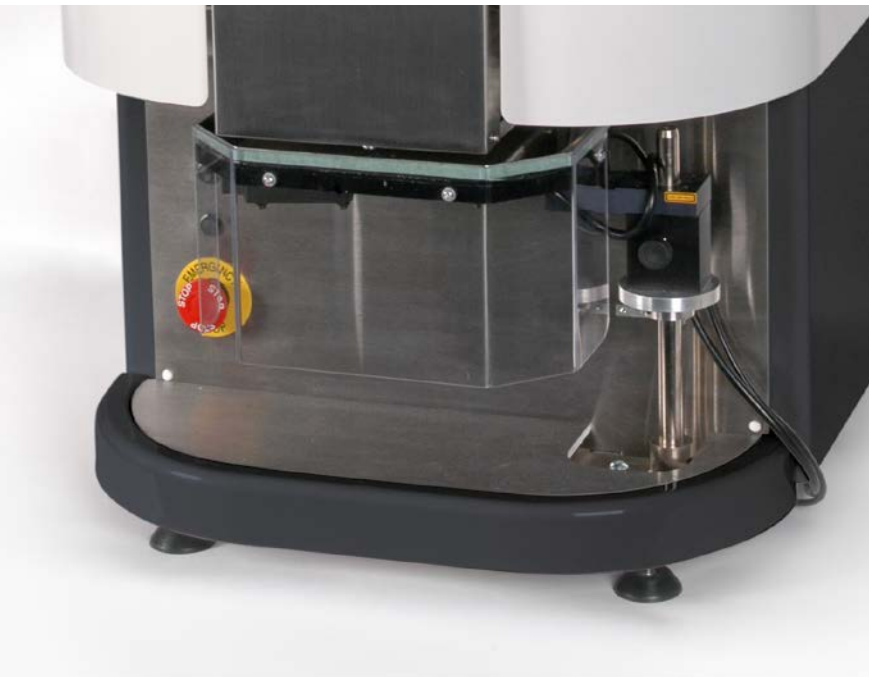
Low Temperature

For applications that require sub-ambient measurements, a special cooling coil option is available.

Capillary and *zero-length* orifice dies

An advanced, supporting toolbox now includes a new optimized cleaning set that dramatically reduces instrument down time.

Accessories



Several accessories are available to suit particular applications and enhance the testing capability of the base units.

Main Accessories for the RH2000:

- Alternative test dies
- Alternative pressure transducers
- Nitrogen purge
- Die and melt cutters
- Laser die swell measurement

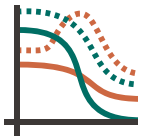
Several accessories are available to suit particular applications or enhance the testing capability of the base units.

Main Accessories for RH7 and RH10:

- Alternative test dies
- Alternative pressure transducers
- Nitrogen purge
- *Tragethon* haul-off (melt strength)
- Melt tension apparatus with automatic spooling
- Laser die swell measurement
- Slot die assembly
- PVT test
- Die and melt cutters

Continuous development of the Rosand Flowmaster software has produced a comprehensive data acquisition and analysis package. Flowmaster offers a wide range of measurement options in multiple languages with an extensive help system.

FLOWMASTER SOFTWARE

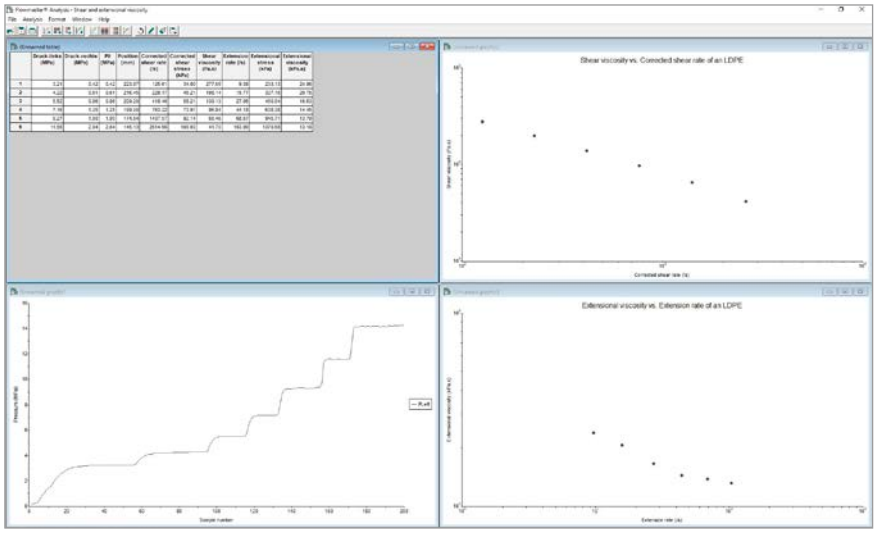


Software Modules and Analysis Functions Included

- Constant shear test
- Extensional test
- Manual control
- Flow/no flow
- Non-Newtonian index
- Bagley correction by orifice die and extrapolation methods
- Rabinowitsch correction
- Hagenbach correction for fluid inertia
- Cogswell convergent flow model and extensional viscosity assessment
- Extensive plot and print options
- Data export

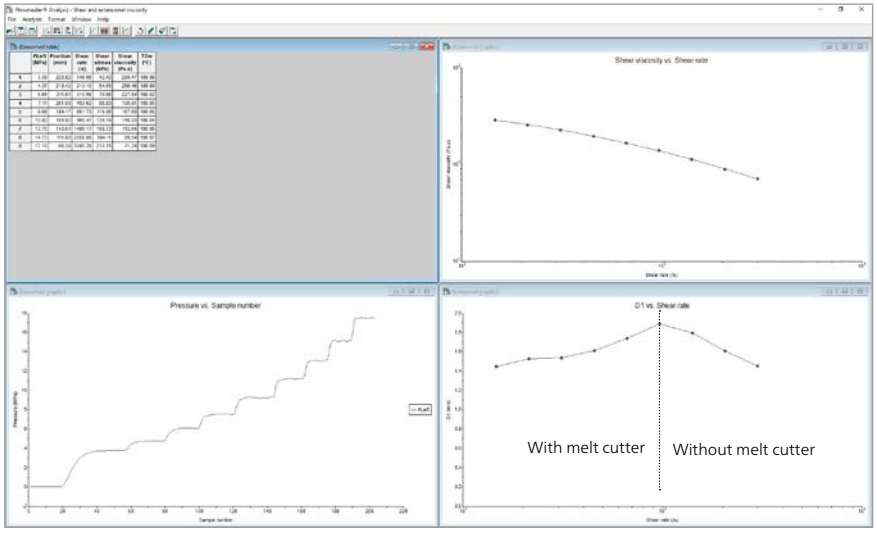
Software Options

- Wall slip analysis (Mooney)
- Melt fracture/flow instability
- Die swell
- Material degradation/ thermal stability
- Low-speed degradation
- Eta-0 (Intrinsic Melt Viscosity)
- Stress relaxation
- Low-level scripting



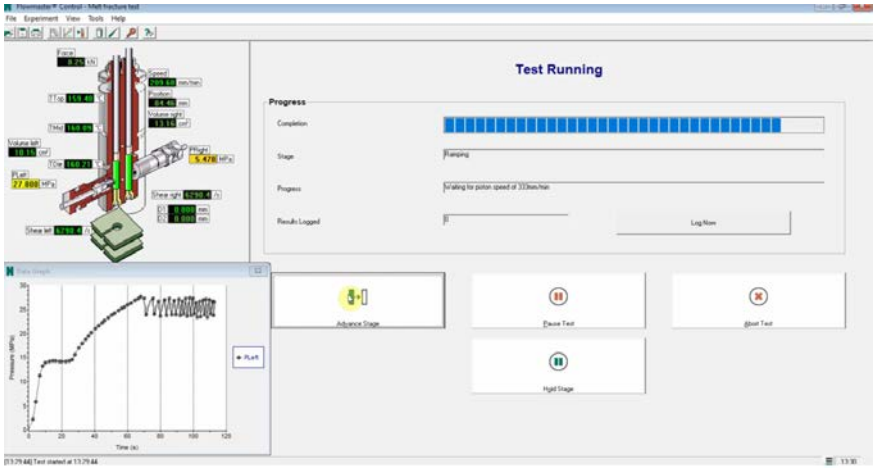
Constant Shear and Extensional Tests

Measurement of shear or extensional stress and shear or extensional viscosity as a function of shear rate. Extensional tests are carried out with an orifice die.



Die Swell and Melt Cutter

Measurement of the extrudate diameter close to the die exit. Directly interfaced with the control software and die swell is stored as part of the measurement data file.



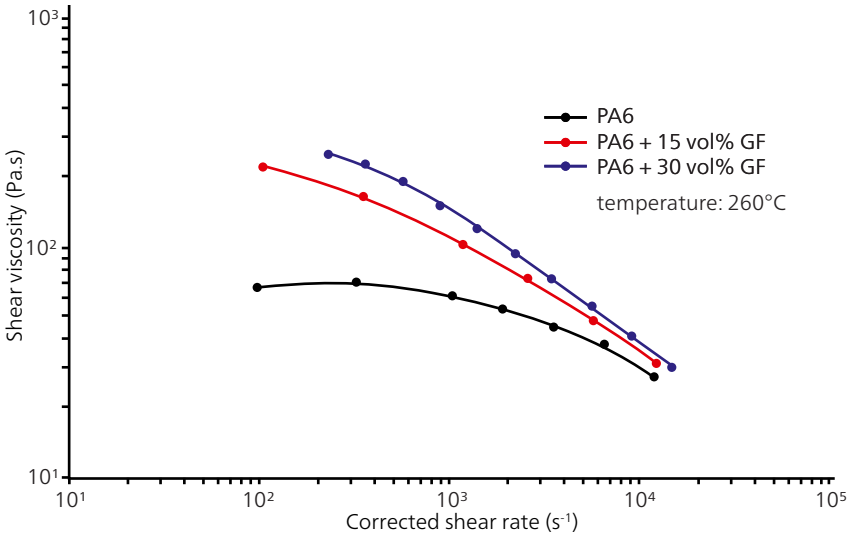
Melt Fracture/Flow Instability

Accelerated shear rate ramp with continuous monitoring of the pressure to detect flow instabilities, such as melt fracture which may occur during flow through a capillary die.

Applications

Optimizing Part Design of Technical Plastic Parts

The majority of technical parts made out of plastics are reinforced with fibers to enhance their mechanical performance. While these fillers improve the products, they change the flow behavior of the material by increasing the viscosity. This knowledge is crucial for material selection to ensure the appropriate performance and machine availability. It is also necessary during mold and part design, for example, to achieve the desired flow length and completely fill the part. The extent of viscosity variation is shown in the following example. Here, the viscosity of various PA6 grades commonly used in automotive applications were measured using a Rosand RH2000 rheometer.



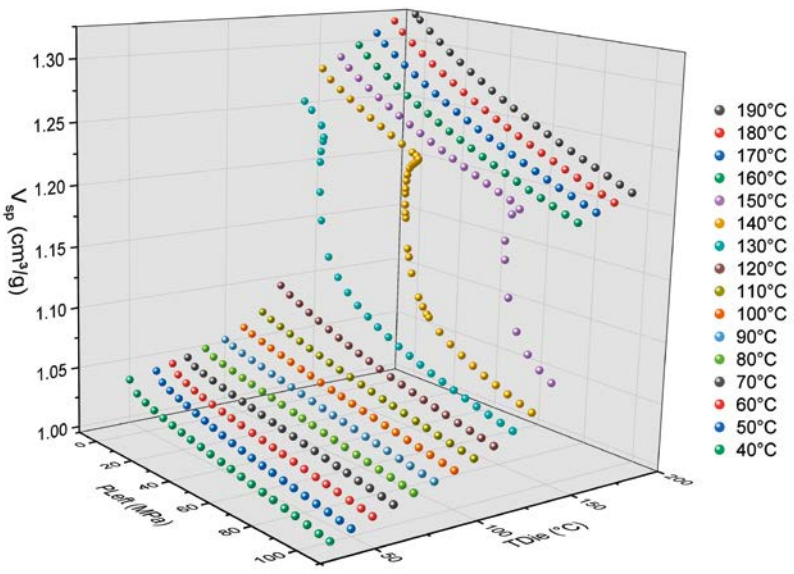
Viscosity measurement of PA6 at 260°C with and without glass fibers (15 and 30 vol%) at high shear rates used in injection molding

The measurement shows the expected viscosity increase with increasing filler content, which has consequences for processing these materials. The greater the viscosity, for example, the higher the pressure required during molding or the lower the achievable flow length. Therefore, these measurements can be used to compare materials and design specific flow properties. They can also be used in plastics flow simulation during material selection, in addition to part and mold design to prevent unnecessary reworking of the mold, etc. thereby reducing production efficiency.

Simulation Data for Accelerated Development and Improved Part Quality

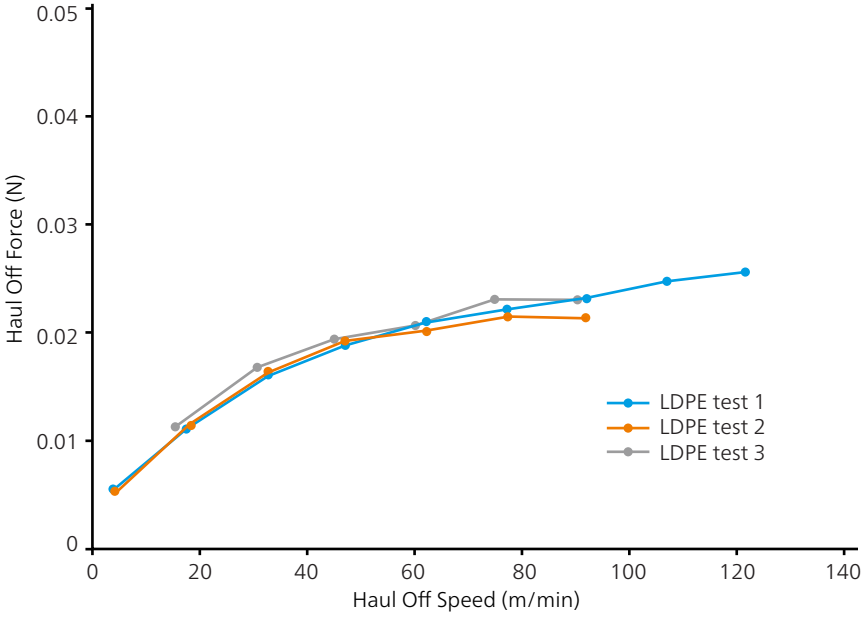
The use of simulation software to study the filling and cooling segments of the injection molding process is gaining importance. While flow curves (see page 14) are needed to predict mold filling, the cooling and accompanied shrinkage behavior can only be modelled with high quality Pressure-Volume-Temperature (PVT) data.

The graph to the right shows the PVT data of a HDPE measured with a Rosand RH10. This data enables prediction of the melt volume during filling. In addition, cooling under changing pressure conditions and mold sealing and ejection can also be determined. Isothermal compressibility of the material at different temperatures can also be deduced from such measurements.



Pressure-Volume-Temperature (PVT) data graph of a HDPE measured by isothermal compression, which yields both shrinkage and compressibility information as a function of pressure and temperature

Extensional Properties – Not Just a Scientific Problem to Solve



Haul-Off measurement on LDPE showing the increase in draw force as a function of draw speed

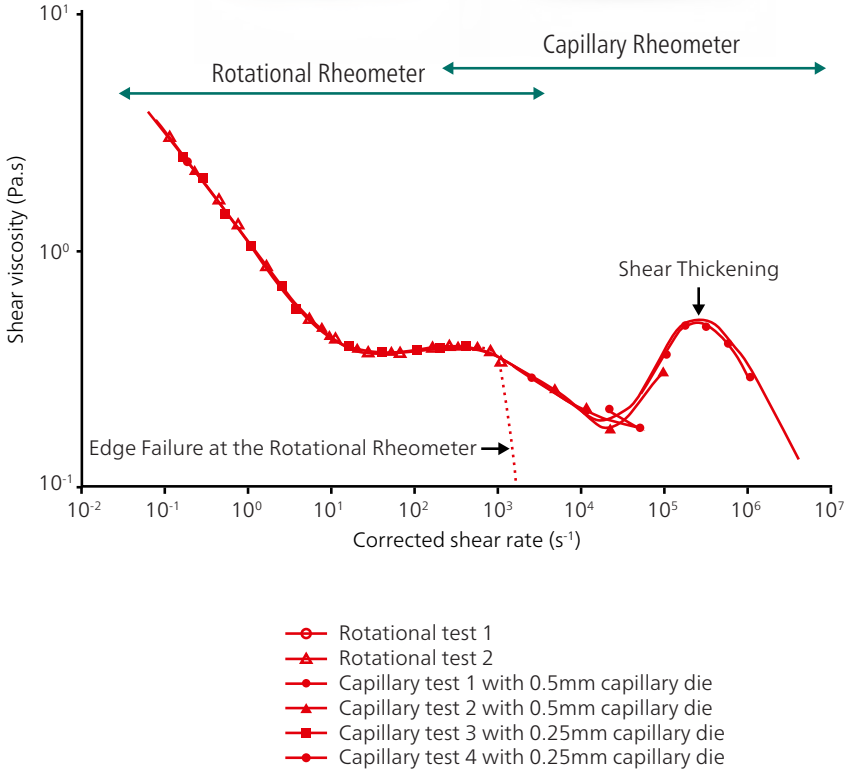
Commonly during discussions the term "viscosity" is used synonymously with shear viscosity, because it is often the property of interest. A significant number of plastic products, such as packaging, properties such as extensional viscosity and the draw down ratio is also of great importance. These properties enable prediction of fiber breakage in spinning, sagging or a parison in film blowing, bubble stability during foam extrusion or simply mixing efficiency inside an extruder barrel. A Haul-Off system positioned after the capillary exit, connected to the extrudate, enables measurement of the extensional properties of the melt. This is done by drawing a vertical melt strand at a constant speed or a defined accelerating velocity. The example to the left shows a Haul-Off measurement on a LDPE material typically used in flexible packaging.

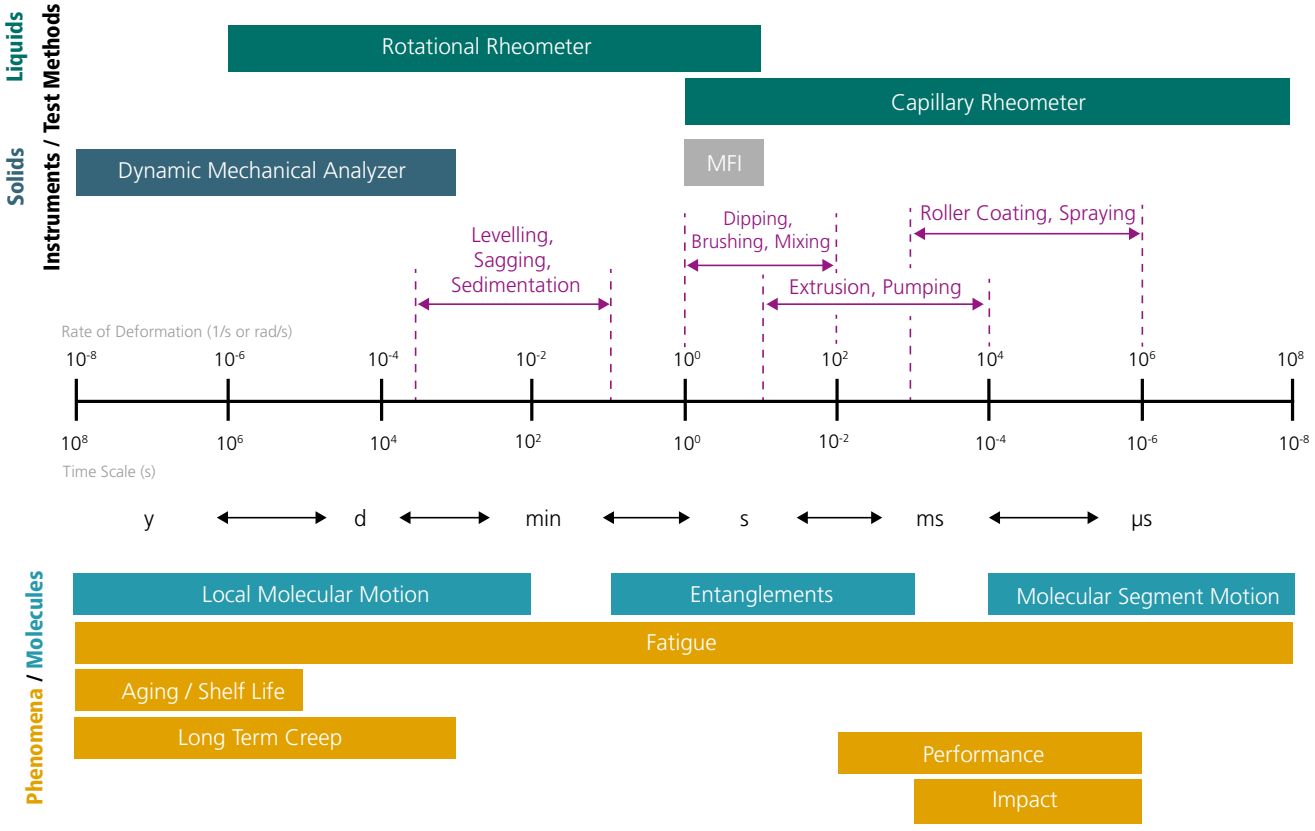
Unmatched Shear Rate Range with Decades of Experience

With over 60 years experience in thermal analysis, NETZSCH uniquely offers solutions in both rotational and capillary rheometry.

In a rotational rheometer, the maximum shear rate is reached if the sample is ejected out of the gap. How to get information about flow behavior if processing requires higher shear rates, such as spraying? The solution is called: a Rosand high pressure capillary rheometer which is capable of achieving shear rates up to 10^8 s^{-1}.

Here, a spray coating substance was measured with both Kinexus and Rosand. At low shear rates, the material is shear-thinning. The faster the product is poured or mixed, the less viscous it is. At the typical shear rates used for spraying (~10^6 s^{-1}), it shows a shear-thickening transition indicating this product is not suitable for spraying applications!





Rosand rheometers aligns with many rheological testing standards such as:

ASTM D 3835
ASTM D5099
ISO 17744
ISO 11443

	Rosand RH2000	Rosand RH7	Rosand RH10
Number of bores	▪ Single bore ▪ Double bore	Double bore	Double bore
Maximum force	12 kN standard (20 kN option)	50 kN	100 kN
Frame stiffness	100 kN	250 kN	250 kN
Maximum speed	600 mm/min standard (1200 mm/min high-speed option)	600 mm/min	1200 mm/min
Dynamic range in speed	200,000:1 (400,000:1 with high speed option)	up to 200,000:1	up to 400,000:1
Speed uncertainty	< 0.1 %	< 0.1%	< 0.1%
Temperature range	Ambient to 400°C (500°C option) 5°C to 300°C (low-temperature cooling coil option)		
Temperature control	< ± 0.1°C	< ± 0.1°C	< ± 0.1°C
Bore diameter	15 mm standard (9.5, 12, 19 and 24 mm bore options)		
Barrel bore length	250 mm	290 mm	290 mm
Barrel material	Nitrided steel standard (Hastelloy or stainless steel options)		
Pressure transducer ranges	30000, 15000, 10000, 5000, 3000, 1500, 1000*, 500* or 250 psi		
Pressure transducer accuracy	± 0.25%	± 0.25%	± 0.25%
Dies	Tungsten carbide, precision ± 5µm		
Die diameter	0.5 to 2 mm (in 0.5 mm increments) and 3 mm standard (other diameters, including fine bore dies, available to special order)		
Height	Rheometer 1.1 m Electronics box 0.65 m	2.45 m	2.45 m
Width	Rheometer 0.55 m (without accessories) Electronics box 0.34 m	715 mm for transport (unpacked), 780 mm with cable connected	715 mm for transport (unpacked), 780 mm with cable connected
Depth	Rheometer 0.65 m (without accessories) Electronics box 0.53 m	765 mm for transport (unpacked), 900 mm with fume extraction	765 mm for transport (unpacked), 900 mm with fume extraction
Weight	Rheometer 120 kg (without accessories) Electronics box 30 kg	350 kg (without accessories)	350 kg (without accessories)
Power requirements	Single phase, AC, 230V ± 10%, 50-60 Hz, 16 A	3-phase, AC, 220 V ± 10%, 16 A	3-phase, AC, 220 V ± 10%, 30 A

* With an accuracy of ± 0.5%

Technical Specifications

Expertise in Service

CLOSE TO OUR WORLDWIDE CUSTOMERS

Our Expertise – Service

All over the world, the name NETZSCH stands for comprehensive support and reliable service, before and after sale. Our qualified personnel from the technical service and application departments are always available for consultation.

In special training programs tailored for you and your employees, you will learn to tap the full potential of your instrument.

To maintain and protect your investment, you will be accompanied by our experienced service team over the entire life span of your instrument.

Our Expertise – Application Laboratories

The NETZSCH Thermal Analysis applications laboratories are a proficient partner for nearly any thermal analysis and rheological issue. Our involvement in your projects begins with proper sample preparation and continues through meticulous examination and interpretation of the measurement results. Our diverse methods and over 30 different state-of-the-art measuring stations will provide ready-made solutions for all your thermal needs.

Within the realm of thermal and rheological analyses and the measurement of thermophysical properties, we offer you a comprehensive line of the most diverse analysis techniques for materials characterization.

Measurements can be carried out on samples of the most varied of geometries and configurations. You will receive high-precision measurement results and valuable interpretations from us in the shortest possible time. This will enable you to precisely characterize new materials and components before actual deployment, minimize risks of failure, and gain decisive advantages over your competitors.

TECHNICAL SERVICE

- Maintenance and Repair
- Software Updates
- Exchange Service
- IQ/OQ Documents
- Calibration Service
- Spare Part Service
- Moving Service

TRAINING

- Online Training Services
- Comprehensive Instrument and Method Training

LABORATORY

- Application Service and Contract Testing

The NETZSCH Group is an owner-managed, international technology company with headquarters in Germany. The Business Units Analyzing & Testing, Grinding & Dispersing and Pumps & Systems represent customized solutions at the highest level. More than 4,000 employees in 36 countries and a worldwide sales and service network ensure customer proximity and competent service.

Our performance standards are high. We promise our customers Proven Excellence – exceptional performance in everything we do, proven time and again since 1873.

When it comes to Thermal Analysis, Calorimetry (adiabatic & reaction), the determination of Thermophysical Properties, Rheology and Fire Testing, NETZSCH has it covered. Our 60 years of applications experience, broad state-of-the-art product line and comprehensive service offerings ensure that our solutions will not only meet your every requirement but also exceed your every expectation.

Proven Excellence.

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