Ultimate Flexibility
enhance your material development
Reasons for choosing a HAAKE PolyLab System

If comprehensive material characterization during the development of innovative polymer products is important to you, our solutions open many possibilities with the flexible, open-concept Thermo Scientific™ HAAKE™ PolyLab™ System torque rheometer platform.

The Thermo Scientific HAAKE PolyLab is a measuring mixer and extruder system that meets today’s – and future – quality control (QC) and research and development (R&D) needs. The modular torque rheometer can be connected to an interchangeable mixer, single-screw extruder, or conical and parallel twin-screw extruder. Combining proven technology, state-of-the-art hardware and software with an easy-to-use interface – that’s the future of polymer processing, today.

The HAAKE PolyLab System is offered as a bench-top version (HAAKE PolyLab QC) and as a floor standing device (HAAKE PolyLab OS).

The highly flexible HAAKE PolyLab OS offers a range of drive-units for all the different demands in the R&D environment. A wide selection of processing units covers even the most complex processes. The floor standing processing units can be connected to the drive-unit without any bolting and wiring. A quick-connector minimizes the risk of connection failures. By providing a safe and efficient fast way of changing your system’s configuration in seconds.

As the name implies, the HAAKE PolyLab QC is designed for quality control applications, where reliable day-in day-out work and repetitive operation is required. Installation of the compact drive unit requires very limited lab space, while the wide selection of processing units facilitates a range of standard analytical applications for modern polymer processing work.

<table>
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<th>Power</th>
<th>Speed Range</th>
<th>Torque</th>
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<tr>
<td>RheoDrive 7 OS</td>
<td>7 kW</td>
<td>280 rpm</td>
<td>300 Nm</td>
</tr>
<tr>
<td>RheoDrive 16 OS</td>
<td>16 kW</td>
<td>550 rpm</td>
<td>400 Nm</td>
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<tr>
<td>PolyLab QC</td>
<td>3.8 kW</td>
<td>200 rpm</td>
<td>300 Nm</td>
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</table>
Rheodrive
The basic drive unit of the Thermo Scientific HAAKE PolyLab system includes all elements of a torque rheometer needed to drive the measuring system (precise speed controller) and to monitor the torque (accurate torque sensor) needed to process the test material.

- **Modularity**
  System architecture is based on an open industry standard for flexible connection of different sensors and systems
- **Ease of operation**
  Fast and simple connection of measuring attachments without changing application and operating software
- **Remote controller**
  Operate the system from a distance and observe the entire test from a different location

Measuring system
The measuring systems are connected quickly to the RheoDrive and are equipped with a specific measuring, control and evaluation technology for the particular application. Movable measuring attachments facilitate:

- **Handling**
  Of heavy and hot parts (mixers, extruders, dies)
- **Integrated heating & cooling**
  To reduce plug-in connectors and thus the risk of wrong connections
- **Quick adaptation**
  Of the system to simulate new process designs

True "plug & measure" Concept through multifunctional coupling in mechanical and electrical respects with an automatic software recognition system

Investment into the future
Open device concept ensures adaptability to future development needs

Peripheral devices
Peripheral devices such as feeding systems, application-specific screws, mixer rotors or extruder downstream equipment (Post-Ex) combine different modules to a complete downsized production line for the testing or small-scale production of new materials:

- **Extrudate cooling baths**
- **Take-off units**
- **Blown film unit tower**
- **Inspection systems**
- **Feeders**
- **Pelletizers**
- **Melt pumps**
- **Capillary rheometer**
The HAAKE PolyLab
Laboratory Mixer

Rheomix

A typical mixer test is run at a defined rotor speed (shear rate). The material's response to the shear is recorded as torque and displayed versus time. As a material's properties are very sensitive to temperature, the mixer chamber is separated into different sections. These are individual temperature-controlled by the HAAKE PolyLab system.

The recorded “Rheogram” (torque and melt temperature vs. time at constant speed) is characteristic for different material types and blends. The mixer test is used as a fingerprint in quality control for outgoing and incoming product inspections.

Typical applications are:

- Testing the melting and degradation behavior of polymer melts
- Quantifying viscosity when adding nano particles or other additives
- Testing gelation and plastification behavior of PVC dry-blends
- Measuring the flow and curing behavior of thermo setting plastics
- Characterizing the influence of different additives such as carbon black, fillers lubricants, accelerators and sulfur for rubber mixtures
- Measuring the stable torque in regard to individual and combined influences of fillers and additives such as stabilizers, lubricants and color pigments
- Testing polymer mixtures of high performance plastics to check processability
- Performing electric conductivity measurements for rubber mixtures
- Recording the vulcanizing behavior of elastomers

The PolySoft OS Mixer Software

The monitor software allows access to all control functions and measured data in the “Run Mode”. It also defines the manual setup of the measuring systems if not automatically recognized. This operation is used to find optimum process parameters (speed, temperature) for new and unknown materials. If the response of the test material is understood, a test procedure can be programmed to run measurements automatically using the mixer or capillary software with integrated data evaluation. Different user level settings can be defined to set up tests or only to run measurements.
**Rheomix 600/610**

The Thermo Scientific™ HAAKE™ Rheomix™ 600 is the standard internal, intensive mixer used for a wide range of applications, particularly for testing thermoplastics. The mixing chamber is electrically heated and air cooled, the front and back plate are electrically heated as well. It features:

- Three-section mixing chamber – Enabling simple and rapid testing and cleaning
- Three independent heating zones
- Fast loading facilities – Suitable for all usual forms of material such as powder, pellets, chips and strips
- Removable loading chute
- High temperatures – Also suitable for engineering plastics such as LCP and PEEK
- Removable rotors – Thus simplifying cleaning
- Replaceable bearing bushes – Easy to exchange on site

The HAAKE Rheomix 610 is identical to HAAKE Rheomix 600 in construction and function but with thermal liquid temperature control. It performs well in the temperature range below 100 °C.

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**Rheomix 540**

The internal mixer Thermo Scientific™ HAAKE™ Rheomix™ 540 is specially designed for testing the behavior of thermosetting compounds with respect to flow and rate of cure. In comparison to the standard internal mixers its bowl and rotors have a conical surface in axial direction. Their conicity is counter directed. This guarantees problem-free cleaning of the hardened sample.

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**Technical Specifications**

<table>
<thead>
<tr>
<th>Technical Specifications</th>
<th>Rheomix 600</th>
<th>Rheomix 610</th>
<th>Rheomix 540</th>
<th>Rheomix 3000</th>
<th>Rheomix 3010</th>
<th>PlanetMix 500 OS</th>
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<td>Liquid/Circulator</td>
<td>Electrical/ Air cooling</td>
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</tr>
</tbody>
</table>
|                         | electrical (maximum torque control or cut-off) | 1 with PolyLab QC 200 1 / min

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**PlanetMix 500 OS**

The Thermo Scientific™ HAAKE™ PlanetMix™ 500 OS planetary mixer with planetary rotor is designed for mixing and testing of solid powders with liquids. Typical applications are:

- Determination of plasticizer absorption in PVC dry blends preparation of a PVC paste for testing purposes under controlled conditions
- For tests according to DIN 54800 / DIN 54802 / ISO 4612

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The HAAKE PolyLab Compounder and Feeding System

The Concept

The continuous compounding of polymers, technical ceramics and foodstuffs whilst mixing in various additives at specific points along the extruder barrel is an established technique used in the production process in many branches of industry. We manufacture laboratory-scale compounders with conical and parallel screw design which are able to simulate this process. Used in combination with the HAAKE PolyLab System, rheological and substance-specific characteristics can be examined and new formulations can be proofed and tested. The type of measuring compounders determines the usage of the HAAKE PolyLab System for your application.

The Application

Because of its conical design the Twin Screw Compounder Thermo Scientific™ HAAKE™ Rheomex™ CTW100 realizes very short dwell times and avoids dead volume. This leads to its strength in the following typical applications:

• Processing of thermal critical compounds
• Development of new PVC compounds
• Mixing in of processing additives
• Blending of polymers with greatly different viscosity

Screws with different geometries foresee an application oriented setup for:

• Testing standard polymer melts with regard to plasticizing and compounding – Standard screws
• Special homogenization applications under high shear – Mixing screws
• Venting of critical compounds – Ventiing screws

Also the screw design is variable and with individual elements for conveying, mixing and kneading, the screws can be adapted to process tasks like:

• Compounding of polymers
• Masterbatch production
• Compounding of low sample volume material (e.g., PEK < DVT)

The parallel mini-compounder Thermo Scientific™ HAAKE™ Rheomex™ PTW16 with its unique modular design is an ideal addition to the HAAKE twin screw family for running lab scaled compounding and blending tests. Already a small sample volume enables the R&D to run process like tests in a very early stage of formulation development. The split-barrel design with top half lifting upwards enables the inspection of the filled screws for studying:

• Melting behavior
• Incorporation of additives
• Color dispersion

The parallel, segmented compounder Thermo Scientific™ HAAKE™ Rheomex™ PTW24 with its modular barrel design enables an optimal adaption to the application. Because of this versatile flexibility R&D work can be carried out in laboratory quantities as well as pilot plant applications with higher throughput rates. Barrel segments of the following design are available:

• Open barrels, for the feeding, venting and liquid injection
• Closed barrels segments, for conveying, shearing, mixing and pressure build-up
• Split feed segments for horizontal feeding

The screw geometry with

• Conveying elements of different length and design
• Kneading elements
• Distributive mixing elements will be setup on a hexagonal shaft, according to the desired processing task

Combined with the measuring capabilities of the PolyLab System a wide field of applications can be offered like:

• Standard compounding and compound development
• Recycling and masterbatch production
• Rheology studies
• Reactive extrusion

Design and optimization of the cylinder construction and screw geometry

Data base in which known applications are documented

Screw design software to document the recommended screw design

Sensors

For measuring the melt temperature and pressure. The pressure sensors are coded so that the system automatically sets the measuring range and calibration routines.

Dies

For testing the flow characteristics (rheological dies) and for producing profiles like flat films, blown films, rod and multi strands, wires, filaments as well as screen life tests.

Post-Ex

For taking off the extrudate directly from the die under controlled conditions.

Feeding devices

Funnel type hoppers

For free-flowing powders or pellets

Gravimetric and volumetric single- and twin-screw feeders with exchangeable feed-screws and feeding-tubes.

For precise feeding of powdery test substances and pellets

Force feeders for materials which do not exhibit uniform flow.

Compounding and Rheology

We offer unique technology to combine the twin screw extruders with special sensors to study rheological properties of the polymer melt during processing. This results in information about the:

• Viscosity, flow behavior
• Compound formulation
• Blend ratio
• Extrusion and injection molding processability
• Morphology
• Recycling capabilities
• Influence of the screw design on the viscosity

The Accessories and Support

We manufacture laboratory-scale compounders with conical and parallel screw design which are able to simulate this process. Used in combination with the HAAKE PolyLab System, rheological and substance-specific characteristics can be examined and new formulations can be proofed and tested. The type of measuring compounders determines the usage of the HAAKE PolyLab System for your application.
### Technical Specifications

#### Rheomex PTW16 OS

The Thermo Scientific™ HAAKE™ Rheomex™ PTW16 OS is used for research, development, quality control, and small-scale production. A horizontally split barrel, of 25:1 L/D, can be changed to 40:1 with a bolt-on, "plug and play" extension.

The barrel has a lift-off top half for easy access to the screws, for easy cleaning and configuration changes. The segmented top barrel half is constructed in modules and is easy to reconfigure. Barrel segments are available for feeding solids and liquids or for venting. Academic customers are using the HAAKE Rheomex PTW16 OS twin-screw extruders in research and teaching laboratories, where many different small samples can be prepared in a short time with minimum product waste.

#### Rheomex PTW24 OS

With sample outputs up to 50 kg/h, the Thermo Scientific™ HAAKE™ Rheomex™ PTW24 OS twin-screw extruder is ideal for test sample and small-scale manufacturing. This flexible extruder is easy to operate, simple to clean, and can be configured for the most challenging applications.

The horizontally split barrel, up to 40:1 L/D, is hinged for easy access to the screws. A simple screw removal device promotes quick and easy cleaning and configuration changes. The barrel is constructed in segmented modules that can be reconfigured to suit a variety of polymer processes. Replaceable barrel liners can be made from special materials for aggressive applications. Barrel segments are available for feeding solids and liquids or for venting. Secondary feeders and vacuum pumps can also be incorporated into the system.

#### Rheomex CTW100 OS/QC

The Thermo Scientific™ HAAKE™ Rheomex™ CTW100 is a conical, counter-rotating twin-screw compounder in lab scale. This extruder can be used for a wide range of tasks in laboratories and pilot plants, when used together with specially designed screws of dedicated geometries.

The special design of this twin-screw extruder provides a positive material displacement from the hopper to the die and thus high levels of pressure. The throughput time is very short and can be very well defined to facilitate processing of thermally critical polymers such as rigid PVC compounds.

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### Rheomex PTW16/25 OS

- **Design**: parallel, horizontally split
- **Length**: 25 x D
- **Diameter**: 16 mm
- **Material**: nitrided EN40B (1.8515), other materials on request
- **Measuring ports**: 1 (1/2" UNF)
- **Feed section**: cooled (air or liquid)
- **Liquid feeding**: Convection
- **Cooling**: Convection
- **Screws**: Design: parallel, segmented, Alignment: intermeshing, co-rotating, Dv/Di ratio: 1.73
- **Functions**: Additional heating zones (for dies, etc.): 2
- **Overload protection**: electronic & mechanical
- **Maximum torque**: 130 Nm
- **Maximum operating temperature**: 400 °C (optional 450 °C)
- **Maximum operating pressure**: 100 bar
- **Feeding**: volumetric/gravity feeders
- **Typical output (material dependent)**: 0.2 to 15 kg/h
- **Maximum speed**: 1100 rpm
- **Weight**: approx. 170 kg
- **Length/Width/Height**: 1100 x 450 x 1200 mm
- **Options**: 15 L/D extension, Liquid cooling, Additional feeding ports

### Rheomex PTW16/40 OS

- **Design**: parallel, horizontally split
- **Length**: 4 x D
- **Diameter**: 16 mm
- **Material**: nitrided EN40B (1.8515), other materials on request
- **Measuring ports**: 1 (1/2" UNF)
- **Feed section**: cooled (air or liquid)
- **Liquid feeding**: Convection
- **Cooling**: Convection
- **Screws**: Design: parallel, segmented, Alignment: intermeshing, co-rotating, Dv/Di ratio: 1.77
- **Functions**: Additional heating zones (for dies, etc.): 2
- **Overload protection**: electronic & mechanical
- **Maximum torque**: 130 Nm
- **Maximum operating temperature**: 400 °C (optional 450 °C)
- **Maximum operating pressure**: 100 bar
- **Feeding**: volumetric/gravity feeders
- **Typical output (material dependent)**: 0.2 to 15 kg/h
- **Maximum speed**: 1100 rpm
- **Weight**: approx. 170 kg
- **Length/Width/Height**: 1100 x 450 x 1200 mm
- **Options**: 15 L/D extension, Liquid cooling, Additional feeding ports

### Rheomex PTW24/28 OS

- **Design**: parallel, horizontally split
- **Length**: 28 x D
- **Diameter**: 24 mm
- **Material**: thru hardened, nitrided D2 (1.2379), other materials on request
- **Measuring ports**: 1 (1/2" UNF)
- **Feed section**: cooled (liquid)
- **Liquid feeding**: Option
- **Cooling**: Option
- **Screws**: Design: parallel, segmented, Alignment: intermeshing, co-rotating, Dv/Di ratio: 1.77
- **Functions**: Additional heating zones (for dies, etc.): 3
- **Overload protection**: electronic & mechanical
- **Maximum torque**: 170 Nm
- **Maximum operating temperature**: 400 °C (optional 450 °C)
- **Maximum operating pressure**: 100 bar
- **Feeding**: volumetric/gravity feeders
- **Typical output (material dependent)**: 0.5 to 50 kg/h
- **Maximum speed**: 560 rpm / 1100 rpm*
- **Weight**: approx. 330 kg
- **Length/Width/Height**: approx. 1450 x 500 x 1280 mm
- **Options**: 15 L/D extension, Liquid cooling, Additional feeding ports

### Rheomex PTW24/40 OS

- **Design**: parallel, horizontally split
- **Length**: 40 x D
- **Diameter**: 24 mm
- **Material**: thru hardened, nitrided D2 (1.2379), other materials on request
- **Measuring ports**: 1 (1/2" UNF)
- **Feed section**: cooled (liquid)
- **Liquid feeding**: Option
- **Cooling**: Option
- **Screws**: Design: parallel, segmented, Alignment: intermeshing, co-rotating, Dv/Di ratio: 1.77
- **Functions**: Additional heating zones (for dies, etc.): 3
- **Overload protection**: electronic & mechanical
- **Maximum torque**: 170 Nm
- **Maximum operating temperature**: 400 °C (optional 450 °C)
- **Maximum operating pressure**: 100 bar
- **Feeding**: volumetric/gravity feeders
- **Typical output (material dependent)**: 0.5 to 50 kg/h
- **Maximum speed**: 560 rpm / 1100 rpm*
- **Weight**: approx. 330 kg
- **Length/Width/Height**: approx. 1450 x 500 x 1280 mm
- **Options**: 15 L/D extension, Liquid cooling, Additional feeding ports

### Rheomex CTW100 OS

- **Design**: conical
- **Alignment**: intermeshing, co-rotating
- **Cooling**: internal water circuit
- **Screws**: Design: conical, Alignment: intermeshing, counter-rotating
- **Functions**: Additional heating zones (for dies, etc.): 3
- **Overload protection**: electronic
- **Maximum torque**: 200 Nm
- **Maximum operating temperature**: 450 °C
- **Maximum operating pressure**: 700 bar
- **Feeding**: hopper/volumetric feeder
- **Typical output (material dependent)**: 0.2 to 10 kg/h
- **Maximum speed**: 200 rpm
- **Weight**: approx. 43 kg
- **Length/Width/Height**: approx. 800 x 400 x 250 mm
- **Options**: Backforce sensor

### Rheomex CTW100 QC

- **Design**: conical
- **Alignment**: intermeshing, counter-rotating
- **Cooling**: internal water circuit
- **Screws**: Design: conical, Alignment: intermeshing, counter-rotating
- **Functions**: Additional heating zones (for dies, etc.): 3
- **Overload protection**: electronic
- **Maximum torque**: 200 Nm
- **Maximum operating temperature**: 450 °C
- **Maximum operating pressure**: 700 bar
- **Feeding**: hopper/volumetric feeder
- **Typical output (material dependent)**: 0.2 to 10 kg/h
- **Maximum speed**: 200 rpm
- **Weight**: approx. 43 kg
- **Length/Width/Height**: approx. 800 x 400 x 250 mm
- **Options**: Backforce sensor
HAAKE Rheomex
The proven single-screw laboratory extruders deliver reliable data captured during the extrusion process to verify process parameters (speed, energy, temperature) for unknown materials or to manufacture smaller quantities of a new polymer as strands, sheet, pellets, blown films. The extruders are equipped with measuring ports for melt pressure and melt temperature to study the process parameters along the extruder barrels. A variety of screw geometries to customize the extrusion process with different compression ratios and mixing sections are available.

Special rheological slit-, rod- and x-dies allow the determination of shear and elongation viscosity at defined shear rates. Thermo offers a variety of screw geometries to customize the extrusion process with different compression ratios, venting and mixing sections. Wear-reduced screws and barrels increase the lifetime of the system.

Typical applications for single-screw extruders:
- Testing melting behavior
- Testing individual and combined influences of additives (stabilizer, lubricant) and functional additives (antioxidation, UV-stabilizers, pigments and fillers)
- Processability of newly developed materials
- Manufacturing homogeneous melts
- Manufacturing films, foils, strands and profiles for optical and mechanical testing as well as outdoor exposure tests
- Measuring rheological behavior (viscosity, elasticity)
- Foam extrusion
- Extrusion of PVC compounds
- Blown films
- Cast films and sheet
- Extrusion of ceramic materials or PIM-compounds
- Rheological testing with special dies

The PolySoft OS Extruder software
PolySoft extruder software is for defined extruder tests in up to 50 steps with different times, screw speeds and temperatures for each step. Thresholds for torque, pressure and temperature can be activated to proceed with the next step. The data collection includes an average determination in certain intervals to reduce amount of data points.

The workflow structure of the test starts with the device manager for the hardware to select the extruder, screw, die and sensors. In the next section data for the protocol can be predefined and mandatory fields, for example batch number and operator can be selected which have to filled once the workflow is started. Before the actual tests starts the extruder is checked for temperature equilibrium. If the temperatures are within the defined limits the different steps of the test are executed. When the test is finished the data are stored automatically and if desired a preview and print of the results is possible. Also a data export to ASCII or Microsoft Excel® with selectable header and columns is produced.
**The HAAKE PolyLab Extruder**

### Technical Specifications

#### Rheomex 19/10 OS
- **Length:** 10 L/D
- **Material:** Standard Stainless Steel No.1.8550, nitrided
- **Wear- / Chemical resistance (optional):** Bimetal
- **Integrated heating / cooling zones:** 1 / 1
- **Solenoids for air cooling:** 1
- **Feed zone cooling:** –
- **Feed section:** Feed section 22 x 35 mm
- **External temperature zone:** 2
- **Maximum light depth:** 3.75 mm
- **Sensor ports 1/2” 20 UNF:**
  - Standard, at barrel end: up to 2
  - Optional at L/D 17: up to 2
- **Functionality:**
  - Coding (auto detection): x
  - Overload protection: Maximum torque: 160 Nm, Maximum operating temperature: 450 °C
- **Max. Troughput:** 10 kg/h (depending on material)

#### Rheomex 19/10 OS rubber
- **Length:** 10 L/D
- **Material:** Stainless Steel No.1.8550, nitrided
- **Wear- / Chemical resistance (optional):** Bimetal
- **Integrated heating / cooling zones:** 1 / 1
- **Solenoids for air cooling:** 1
- **Feed zone cooling:** –
- **Feed section:** Feed section 22 x 35 mm
- **External temperature zone:** 2
- **Maximum light depth:** 3.75 mm
- **Sensor ports 1/2” 20 UNF:**
  - Standard, at barrel end: up to 2
  - Optional at L/D 17: up to 2
- **Functionality:**
  - Coding (auto detection): x
  - Overload protection: Maximum torque: 160 Nm, Maximum operating temperature: 450 °C
- **Max. Troughput:** 10 kg/h (depending on material)

#### Rheomex 19/25 OS
- **Length:** 25 L/D
- **Material:** Standard Stainless Steel No.1.8550, nitrided
- **Wear- / Chemical resistance (optional):** Bimetal
- **Integrated heating / cooling zones:** 1 / 1
- **Solenoids for air cooling:** 1
- **Feed zone cooling:** –
- **Feed section:** Feed section 22 x 35 mm
- **External temperature zone:** 2
- **Maximum light depth:** 3.75 mm
- **Sensor ports 1/2” 20 UNF:**
  - Standard, at barrel end: up to 2
  - Optional at L/D 17: up to 2
- **Functionality:**
  - Coding (auto detection): x
  - Overload protection: Maximum torque: 160 Nm, Maximum operating temperature: 450 °C
- **Max. Troughput:** 10 kg/h (depending on material)

#### Rheomex 19/25 QC
- **Length:** 25 L/D
- **Material:** Standard Stainless Steel No.1.8550, nitrided
- **Wear- / Chemical resistance (optional):** Bimetal
- **Integrated heating / cooling zones:** 1 / 1
- **Solenoids for air cooling:** 1
- **Feed zone cooling:** –
- **Feed section:** Feed section 22 x 35 mm
- **External temperature zone:** 2
- **Maximum light depth:** 3.75 mm
- **Sensor ports 1/2” 20 UNF:**
  - Standard, at barrel end: up to 2
  - Optional at L/D 17: up to 2
- **Functionality:**
  - Coding (auto detection): x
  - Overload protection: Maximum torque: 160 Nm, Maximum operating temperature: 450 °C
- **Max. Troughput:** 10 kg/h (depending on material)
**The HAAKE PolyLab Extruder Capillary Rheology**

**The Concept**

A capillary rheometer is the best suited equipment for the measurement of shear viscosity at process-relevant shear rates. The HAAKE PolyLab System has significant advantages when used of polymer materials, because the screw plastification in an extruder is ideally suited for homogeneously preparing the sample material for the rheological measurement.

Rheological characteristics can be measured under actual process conditions when used in conjunction with an extruder sensor and a rheological capillary die.

**The Application**

Rheological behavior is of prime importance with regard to machine and tool design, as well as the optimization of the final product. Polymer materials and other fluids such as ceramic masses are not generally processed to end products in their purest form. It is far more often the case that processing additives, pigments, fillers and modifiers are added to the original material, to give the end product the desired characteristics.

Apart from these additives, the molecular weight and the molecular weight distribution also influence the flow characteristics of the polymer to great extent.

Typical tests include:
- Determining the flow characteristics at differing processing parameters, temperatures and shear rates
- Determining the influence of functional and processing additives on viscosity

**The Technology**

Dependent on the sample material and the desired shear rate range, different capillary die designs can be selected.

**Characteristics common to capillary dies:**
- Possibility of usage at temperatures of up to 480 °C and pressures of up to 700 bar
- Suitable for testing engineering plastics at high temperatures and pressures
- Accurate sensor port size ensures tight fit – Measuring faults due to turbulence are thus avoided

**The Rod Capillary Die**

When using rod capillary dies, the melt pressure is measured just before the capillary entrance.

According to the correction procedure of Bagley, 3 measurements have to be made, using capillaries with different L/D ratios, in order to determine the true shear stress.

The rod capillary die is designed to enable an easy exchange of different capillaries during operation.

Further features include:
- Shear range up to $10^3$ s$^{-1}$
- Wide variety of capillary lengths and diameters
- Flexibility as far as the viscosity and shear range are concerned
- Wear-reduced capillary surface – Can also be used for testing filled polymers and ceramics
- Calibrated capillaries – Reproducibility and comparability are thus greatly improved

**The Slit Capillary Die**

When using slit capillary dies, the melt pressure is measured directly within the capillary.

A special feature of this die is its exchangeable measuring section. Depending on the desired measuring application (viscosity/shear range), different measuring inserts can be selected.

Further characteristics include:
- Shear range up to $10^4$ s$^{-1}$
- Three measuring points for determining the pressure gradient – Non-linear pressure drop can be immediately recognized
- Optimized distance between the die feed section and the first pressure sensor
- Pressure measurement is not carried out until the shear flow is completely laminar – Measuring faults due to turbulence are avoided
- Melt temperature sensor in the shear gap for measuring melt temperature accurately

**The Accessories**

The capillary dies can be adapted to suit specific requirements using the accessories listed below:
- Die ring heater band with control thermocouple, allows operation with vertical and horizontal dies
- This construction avoids cold spots in the transfer section
- Specially adapted pressure sensors for determining the pressure gradient in the capillary system
- Flush-aligned sensors avoid turbulence in the measuring channel

**The PolySoft OS Capillary Rheometry software**

The PolySoft OS Capillary Rheometry software is the perfect tool for the rheological testing of polymer melts and fluid materials using the HAAKE PolyLab OS with laboratory extruder and the rheological capillary dies.

The job stream structure of the software helps the user to pre-define the test procedure.

The software runs and controls the measurement automatically. After the test run, it will do the necessary corrections (Bagley, Weissenberg/Rabinowitch) and allows regression analysis according to well known rheological models (i.e. Ostwald-de Waele, Cross, Carreau, Carreau-Yasuda), to get valuable data for the modeling of flow channels and molds.
## Simulating process conditions in the laboratory

### Different die geometries and Post-Ex equipment

Shaping the hot polymer melt that leaves the extruder can be achieved by appropriate selection of a die from the wide range of geometries available for the HAAKE PolyLab System. Different shapes and sizes are necessary to produce test specimens that can be analyzed further or being used for simulations and testing. Also, testing the processability of a polymer can be conducted in the laboratory environment.

The range of dies available for the HAAKE PolyLab System spans from rod dies with different diameters, to adjustable slit dies, Blown film and catheter dies up to fiber and wire coating dies. For the full overview of the available geometries and technical details please refer to the table below.

### Sheet, Tape & Ribbon Die 25/50/100/150

These dies produce sheets of different width and thickness. The optimized flow channel produces a ribbon of homogeneous output. The flexible die lip option enables the on-site adjustment of the sheet thickness as well as an optimization of the diameter.

### Sheet, Tape & Ribbon Die PVC 50/100

Tape, Sheet and Ribbon die recommended for PVC with a fixed gap of 1 mm. The die special short flow channel to minimize the risks of burners.

### Horizontal Rod Die / Vertical Rod Die

The rod die produces a single strand for inspections or pelletizing. The interchangeable nozzles on the horizontal rod die vary not only in diameter but also in length to supply different pressure ranges and die swell information.

### Multistrand Die

Three Strands

In a pelletizing application it is sometimes of great advantage to have a high output rate while maintaining a sort strand and slower output speed. This is the dedicated application of the multi strand die. When combined with the waterbath and pelletizer, one lab-scaled pelletize line can be set up.

<table>
<thead>
<tr>
<th>Technical Specifications</th>
<th>Sheet, Tape &amp; Ribbon Die 25/50/100/150</th>
<th>Sheet, Tape &amp; Ribbon Die PVC 50/100</th>
<th>Horizontal Rod Die / Vertical Rod Die</th>
<th>Multistrand Die Three Strands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extrudate</td>
<td>Sheet</td>
<td>Sheet</td>
<td>Strand</td>
<td>3 Strands</td>
</tr>
<tr>
<td>Material</td>
<td>1.4301</td>
<td>1.2316</td>
<td>1.4571/1.4112</td>
<td>1.4571</td>
</tr>
<tr>
<td>Heater [Watt]</td>
<td>500/1000/1250/1800</td>
<td>400</td>
<td>250/280</td>
<td>160</td>
</tr>
<tr>
<td>Max. Temperature [°C]</td>
<td>420</td>
<td>360</td>
<td>450</td>
<td>450</td>
</tr>
<tr>
<td>Max. Pressure [bar]</td>
<td>–</td>
<td>–</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>Measuring Ports</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Dimensions [mm]</td>
<td>W 25/50/100/150 H 0.2 - 2.5</td>
<td>W 50/100 H 1.0</td>
<td>Ø 1.0/1.5/2.0/3.0/4.0/5.0/6.0</td>
<td>Ø 3 x 3</td>
</tr>
<tr>
<td>Approx. Weight [kg]</td>
<td>3/4.5/10/14</td>
<td>3.5/8</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Order Information</td>
<td>Flexible Gap: 25 mm 50 mm 100 mm 150 mm Gap: 0.2 - 1.2 mm</td>
<td>Fixed Gap: 25 mm 50 mm 100 mm Gap to be specified</td>
<td>PVC Dies: 50 mm 100 mm</td>
<td>2</td>
</tr>
</tbody>
</table>

### Graphical Information

1. Simulating process conditions in the laboratory
2. Different die geometries and Post-Ex equipment
3. Sheet, Tape & Ribbon Die 25/50/100/150
4. Sheet, Tape & Ribbon Die PVC 50/100
5. Horizontal Rod Die / Vertical Rod Die
6. Multistrand Die Three Strands

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The HAAKE PolyLab

Dies

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## The HAAKE PolyLab

### Dies

<table>
<thead>
<tr>
<th>Technical Specifications</th>
<th>Catheter Die</th>
<th>Garvey Die</th>
<th>Wire Coating Die</th>
<th>Blown Film Die</th>
<th>Spinning Die</th>
<th>Filter Die</th>
<th>Pipe &amp; Tubing Die</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extrudate</td>
<td>Tubes</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Material</td>
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<td>1.4305</td>
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<td>1.4112</td>
<td>1.4571</td>
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<td>1.4571</td>
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<tr>
<td>Heater [Watt]</td>
<td>200</td>
<td>250</td>
<td>500</td>
<td>500</td>
<td>280</td>
<td>280</td>
<td>600</td>
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<tr>
<td>Max. Temperature [°C]</td>
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<td>360</td>
<td>450</td>
<td>450</td>
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<td>350</td>
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<tr>
<td>Max. Pressure [bar]</td>
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<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>500</td>
</tr>
<tr>
<td>Measuring Ports</td>
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<td>–</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>–</td>
</tr>
<tr>
<td>Dimensions outlet [mm]</td>
<td>Ø 2.5 - 4.5</td>
<td>Ø 100x62</td>
<td>Ø 140 x 100 x 100</td>
<td>Ø 140 x 100 x 100</td>
<td>Ø 100 x 63 x 75</td>
<td>310 (with adjusting lever) x 100 x 120</td>
<td>Ø 5 - 12 (inner) x 10 to 15 (outer)</td>
</tr>
<tr>
<td>Approx. Weight [kg]</td>
<td>2</td>
<td>2</td>
<td>3.5</td>
<td>3.5</td>
<td>2</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

### Order Information
- Catheter diameter up to 4.5 mm
- Tubing die for tubes up to 8 mm
- For wires up to Ø 2.0 mm
- Coating up to 1 mm
- Thickness of coated wire max Ø 4 mm
- Dr: 24 mm
- Dia: 25 mm
- Options: Air Cooling Ring Insert 34/35 mm
- Special geometry for HDPE available
- Number of tubes: 10
- Diameter: 0.2 mm
- Other geometries on request
- Mesh sizes: #1 25 µm
- #2 14 µm

### Graphical Information

- Catheter Die
- Garvey Die
- Wire Coating Die
- Blown Film Die
- Spinning Die
- Filter Die
- Pipe & Tubing Die

The HAAKE PolyLab Dies

- This die for tubes of small diameter and wall thickness is ideal for producing capillary and catheter tubes. The process is supported by an air supply in the inner tube to prevent a collapsing of the small tubes. Also on this die a wide range of diameter and wall thickness is available.

- The garvey die adheres to ASTM D2320 - 96 (2012) and can be used to examine the flow behavior of material, especially rubber, to continuously fill the different angles of the die. Its shape simulates the typical design of tire building blocks such as the thread and apex or parts of the side wall.

- The wire coating die forms a constant coat on wires in different diameters. The die utilizes an adjustable mandrel to provide a fine tuning of the concentricity of the coating. In combination with the wire coating take-off it forms a complete lab-scaled processing unit.

- A ring gap at the top of the die produces a thin-walled tube. The die supplies an adjustable orifice for molten polymer. The inner die tube for air creates the film bubble. The specially designed cooling ring provides an adjustable air curtain and a centered position. For HDPE and LLDPE a special geometry is available. Together with the blown film take-off it forms a complete lab scaled blown film line.

- The spinning die enables the simulation of a fibre spinning process in a lab scale. The standard die extrudes 10 fibres with an initial diameter of 0.2 mm. By exchanging the spinning-plate, other geometries are possible.

- The Filter Test die is suitable for testing colorants in the form of color concentrates (master batches) in all polymers used for extrusion and melt-spinning processes. The design follows the new EN standard 13900-5. The pressure increase before of a standardized melt filter is measured, from which the FPV (Filter Pressure Value) is calculated thus indicating the dispersion quality of the master batch.

- The tubing die is designed for tubes with outer diameters of about 10 to 15 mm.
The HAAKE PolyLab
Post-Ex

The handling of the still hot and formable extruded material is a crucial part of the manufacturing process – it significantly influences the material properties and surface finish. To ensure that material requirements are met, a range of dedicated Post-Ex (post extrusion) equipment is available. It can transport the extruded material downstream and prepare it for further tests.

Besides the defined and reproducible handling of the polymer, the Post-Ex equipment also allows mimicking full scale processes, and can thus be used for small scale production. This is helpful, especially when alterations to the polymer formulation and processing parameters are necessary.

The Post-Ex family includes:
- **Water bath & strand pelletizers**
  - Rapid cool down and defined cutting of polymer strands
- **Conveyor belts**
  - Continuous taking off of profiles
- **Sheet and ribbon take-off**
  - Cooling and controlled taking off of flat films
- **Face cut pelletizer**
  - Optimal cutting for water solvable, elastic, or brittle polymers
- **Take-off systems for blown films and coated wires**
  - Defined cooling and handling
- **Die swell sensor**
  - Information on the elastic characteristics of polymer melts
Customer Services
We are committed to customer support, including specific service products, short response times, and customer-specific solutions. To quickly and flexibly meet our customer's requirements, we offer a comprehensive range of services.

Application Laboratories and Support
Our fully equipped laboratories reflect our application expertise and commitment to innovation. Our laboratories are in constant demand for testing customer samples and developing and optimizing pioneering applications. We also provide a broad range of product and application solutions and our application specialist team is on hand to answer your questions.

Trainings Courses, Seminars and Webinars
We offer our customers a comprehensive training program and selected courses in our international training center in Karlsruhe, Germany. Basic and advanced rheology seminars and training on special applications are held worldwide. In-house seminars are also offered to our customers. Webinars on a regular base extend our training program.