ThermoFisher SCIENTIFIC

Mixer and extruder system

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 and latest energy efficient drive technology—that's the future of polymer processing today.

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

OS

- Convenient
- Multipurpose
- Applicable for a wide range of research and development tasks
- Compounding

- Modular
- Common software platform
- Rheology

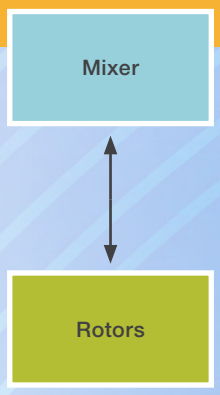
QC

- Economical solutions
- Reliable, day in and day out
- For dedicated applications
- Small footprint—compact design to fit into quality control environments

As the name implies, the HAAKE PolyLab QC is designed for quality control applications where reliable day-in-day-out work and repetitive operation are 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.

Technical Specifications	Power	Speed Range	Torque
RheoDrive 7 OS	7 kW	280 rpm	300 Nm
RheoDrive 16 OS	16 kW	550 rpm	400 Nm
PolyLab QC	3.8 kW	200 rpm	300 Nm

The HAAKE PolyLab System



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**
  The system architecture is based on an open industry standard for the 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.
- **Service & reliability**
  Reduce downtimes with remote diagnostics and have the ability to change out components with pre-calibrated replacements.
- **Return on investment (ROI)**
  Time-saving instrument usage and meaningful results relative to the application increase product quality and reduce development time.

Measuring system

The measuring systems are connected quickly to the RheoDrive and are equipped with 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**
  The open device concept ensures adaptability to future development needs

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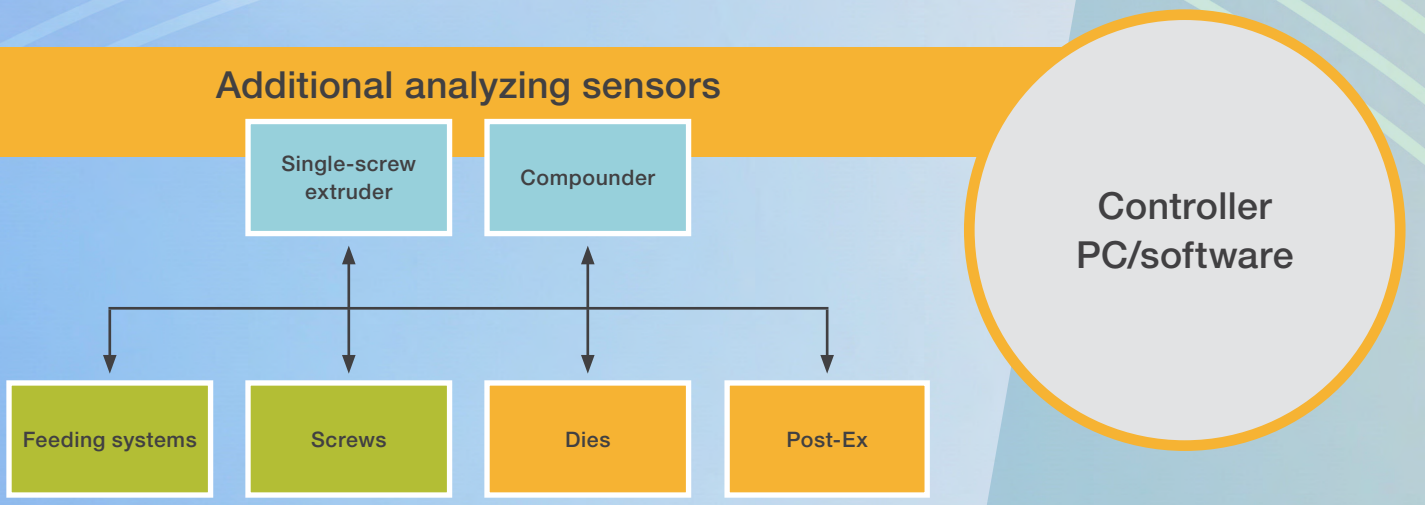

Peripheral devices

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

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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 of 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 nanoparticles 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.

The HAAKE PolyLab Laboratory Mixer

Technical specifications	Rheomix 600	Rheomix 610	Rheomix 540
Chamber volume (gross)	120 cm^3	120 cm^3	120 cm^3
With Rotor (net)	70–100 cm^3	70–100 cm^3	71 cm^3 (Delta)
Max. torque	160 Nm	160 Nm	160 Nm
Temperature control	Electrical / air cooling	Liquid / circulator	Electrical / air cooling
Temperature control zones	3	3	3
Solenoids for automatic cooling	1	—	1
Max. temperature	400 °C	350 °C	400 °C
Max rotor speed	250 1 / min[1]	250 1 / min[1]	250 1 / min[1]
Heat cap, over all	3350 W	Depending on circulator	3350 W
Contr. Thermocouples	3	3	3
Melt thermocouples	1	1	1
Feeding device optional	Manual ram / pneumatic ram	Pneumatic ram	Manual ram / pneumatic ram
Material	1.4301 stainless steel	1.4301 stainless steel	1.4301 stainless steel
Gear rate	3:2 (option 2:3)	3:2 (option 2:3)	3:2 (option 2:3)
Loading ø	32 mm	32 mm	32 mm
Coding (auto detection)	✓	✓	✓
Overload protection	Electrical (maximum torque control or cut-off)		

[1] with PolyLab QC 200 1 / min

Rheomix 600 / 610

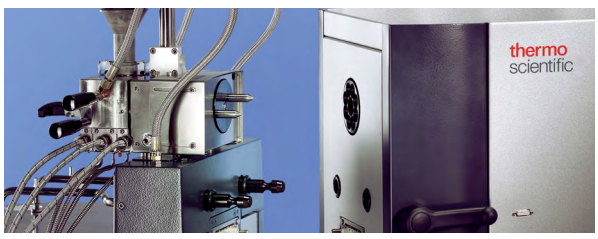
The Thermo Scientific HAAKE Rheomix 600 is the standard internal, intensive mixer used for a wide range of applications, particularly for testing thermoplastics. The mixing chamber is electrically heated and air-cooled, and the front and back plates are electrically heated as well.

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.

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
- Removeable 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

Rheomix 540



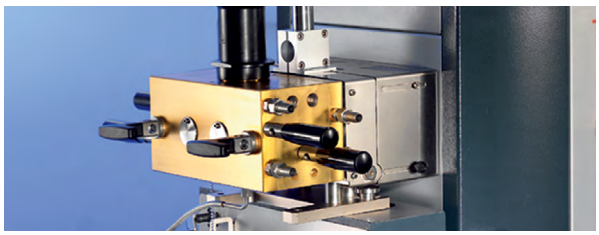
The internal mixer Thermo Scientific HAAKE Rheomix 540 is specially designed for testing the behavior of thermosetting compounds with respect to flow and rate of cure.

In comparison to the standard internal mixers, its bowl and rotors have a conical surface in the axial direction. Their conicity is counter-directed. This guarantees problem-free cleaning of the hardened sample.

Technical specifications	Rheomix 3000	Rheomix 3010	PlanetMix 500 OS
Chamber volume (gross)	625 cm^3	625 cm^3	2500 cm^3
With Rotor (net)	300–450 cm^3	300–450 cm^3	
Max. torque	300 Nm	300 Nm	50 m
Temperature control	Electrical / air cooling	Liquid / circulator	Liquid / circulator
Temperature control zones	3	3	
Solenoids for automatic cooling	1	—	
Max. temperature	400 °C	350 °C	150 °C
Max rotor speed	250 1 / min[1]	250 1 / min[1]	250 1 / min[1]
Heat cap, over all	3720 W	Depending on circulator	Depending on circulator
Contr. Thermocouples	3		
Melt thermocouples	1	1	1
Feeding device optional	Manual ram / pneumatic ram	Manual ram / pneumatic ram	
Material	1.4301 stainless steel	1.4301 stainless steel	1.4301 stainless steel
Gear rate	3:2 (option 2:3)	3:2 (option 2:3)	07:03
Loading ø	55 mm	55 mm	
Coding (auto detection)	✓	✓	✓
Overload protection	Electrical (maximum torque control or cut-off)		

[1] with PolyLab QC 200 1 / min

Rheomix 3000 / 3010



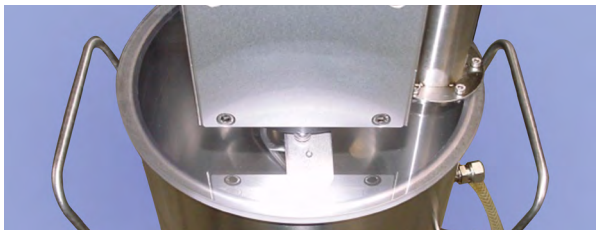
The Thermo Scientific HAAKE Rheomix 3000 enables production of small batches simultaneous recording of torque and mass temperature (due to its larger chamber volume). Due to its high torque capability, it is ideal for applications in the rubber industry, such as testing of the melting and scorch behavior of rubber compounds. The mixing chamber is electrically heated and air-cooled, and the front and back plates are electrically heated as well.

It features:

- Three-section mixing chamber—enabling simple and rapid testing
- Three independent heating zones
- Removable rotors—thus simplifying cleaning
- Rotors with different geometries can also be installed depending on the particular application
- Replaceable bearing bushes—easy to exchange on site

The HAAKE Rheomix 3010 is identical to HAAKE Rheomix 3000 in construction and function but with thermal liquid temperature control. It performs well in the temperature range below 100 °C.

PlanetMix 500 OS



The Thermo Scientific HAAKE PlanetMix 500 OS planetary mixer with the 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

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 designs, 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
  - Venting screws

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 the top half lifting upwards enables the inspection of the filled screws for studying:

- Melting behavior
- Incorporation of additives
- Color dispersion

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., PEEK + CNT)

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 lengths and design
- Kneading elements
- Distributive mixing elements will be set up 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

The accessories and support

The main concept of the Rheomex twin screw family is application-orientated. Further support is available from our experts in the form of:

- Design and optimization of the cylinder construction and screw geometry
- Database 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, and 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 the 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 HAAKE PolyLab Compounder and Feeding System

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.

Technical specifications		Rheomex PTW16/25 OS	Rheomex PTW16/40 OS
Barrel	Design	Parallel, horizontally split	Parallel, horizontally split
	Length	25 x D	40 x D
	Diameter	16 mm	16 mm
	Segmentation	Elements with L = 4 x D	Elements with L = 4 x D
	Material	Nitrided EN40B (1.8515) Other materials on request	Nitrided EN40B (1.8515), other materials on request
	Measuring ports	(1 / 2” UNF)	(1 / 2” UNF)
	Feed section	Cooled (air or liquid)	Cooled (air or liquid)
	Additional venting / feeding ports	2 top	3 top
	Liquid feeding	Option	Option
	Integrated heating / cooling zones	7	10
	Cooling	Convection	Convection
Screws	Design	Parallel, segmented	Parallel, segmented
	Alignment	Intermeshing, co-rotating	Intermeshing, co-rotating
	Do / Di ratio	1.73	1.73
Functions	Additional heating zones (for dies, etc.)	2	2
	Overload protection	Electronical & mechanical	Electronical & mechanical
	Maximum torque	130 Nm	130 Nm
	Maximum operating temperature	400 °C (optional 450 °C)	400 °C (optional 450 °C)
	Maximum operating pressure	100 bar	100 bar
	Feeding	Volumetric / gravimetric feeders	Volumetric / gravimetric feeders
	Typical output (material dependant)	0.2 to 15 kg / h	0.2 to 15 kg / h
	Maximum speed	1100 rpm	1100 rpm
Dimensions	Weight (net)	Approx. 170 kg	Approx. 170 kg
	Length / Width / Height	1100 x 450 x 1200 mm	1100 x 450 x 1200 mm
	Mains connection	Via PolyLab drive unit	Via PolyLab drive unit
Options		15 L / D extension Liquid cooling Additional feeding ports	Liquid cooling Additional feeding ports

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 samples 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 well defined to facilitate the processing of thermally critical polymers such as rigid PVC compounds.

Rheomex PTW24/28 OS	Rheomex PTW24/40 OS	Rheomex CTW100 OS	Rheomex CTW100 QC
parallel, horizontally split	parallel, horizontally split	conical	conical
28 x D	40 x D	300 mm	300 mm
24 mm	24 mm	31.8 / 20 mm (rear / front)	31.8 / 20 mm (rear / front)
Elements with L= 4 x D / 8 x D	Elements with L= 4xD / 8xD	—	—
Hardened, nitrided D2 (1.2379), other materials on request	Hardened, nitrided D2 (1.2379), other materials on request	Plasma nitrated, abrasion resistant	Plasma nitrated, abrasion resistant
(1 / 2” UNF)	(1 / 2” UNF)	6 x (1 / 2” UNF)	6 x (1 / 2” UNF)
Cooled (liquid)	Cooled (liquid)	Cooled (air or liquid)	Cooled (air or liquid)
2 Top, (1 Side optional)	3 Top, (2 side optional)	venting optionable	venting optionable
Option	Option	—	—
7	10	3	3
Internal water circuit	Internal water circuit	Air	Air
Parallel, segmented	Parallel, segmented	Conical	Conical
Intermeshing, co-rotating	Intermeshing, co-rotating	Intermeshing, counter-rotating	Intermeshing, counter-rotating
1.77	1.77	—	—
2	2	3	Via PolyLab QC
Electronical & mechanical	Electronical & mechanical	Electronical	Electronical
170 Nm	170 Nm	200 Nm	200 Nm
400 °C (optional 450 °C)	400 °C (optional 450 °C)	450 °C	450 °C
100 bar	100 bar	700 bar	700 bar
Volumetric / gravimetric feeders	Volumetric / gravimetric feeders	Hopper / volumetric feeder	Hopper / volumetric feeder
0.5 to 50 kg / h	0.5 to 50 kg / h	0.2 to 10 kg / h	0.2 to 10 kg / h
560 rpm / 1100 rpm*	560 rpm / 1100 rpm*	250 rpm	200 rpm
Approx. 320 kg	Approx. 320 kg	Approx. 115 kg	Approx. 45 kg
1450 x 500 x 1280 mm	1450 x 500 x 1280 mm	800 x 500 x 1150 mm	800 x 400 x 250 mm
Via PolyLab drive unit	Via PolyLab drive unit	Via PolyLab drive unit	Via PolyLab drive unit
Additional feeding ports	Additional feeding ports	Backforce sensor	Backforce sensor

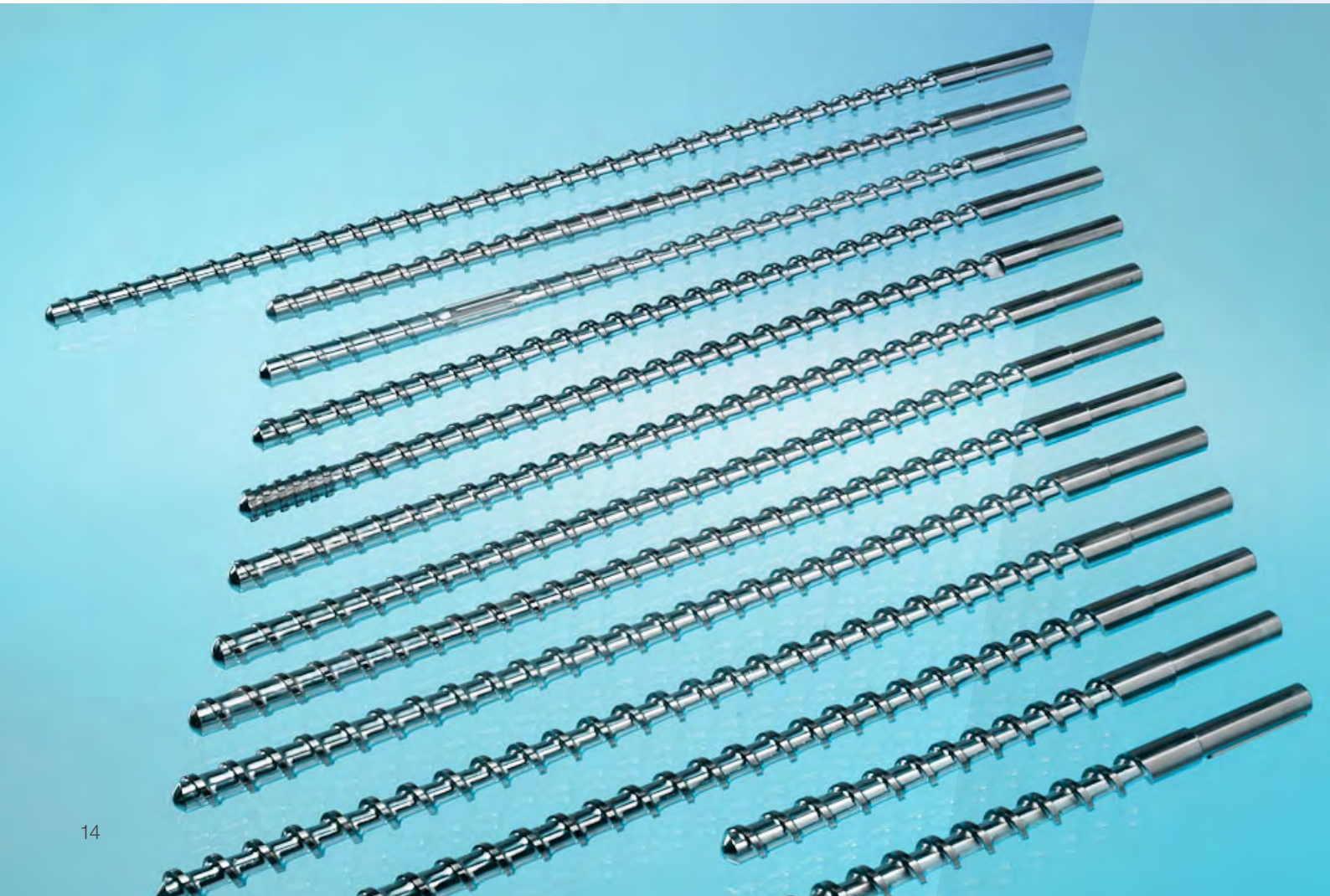
* Depending on selected RheoDrive type.

The HAAKE PolyLab Single-Screw Extruder

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, sheets, pellets, and 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. A variety of screw geometries are available to offer a mix 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.



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 the 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 be filled once the workflow is started. Before the actual tests start, 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 a selectable header and columns is produced.

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 HAAKE PolyLab Single-Screw Extruder

Rheomex 19/10 OS

The length/diameter ratio (L/D) of 10/1 of this extruder sensor means that a short sample resident time within the extruder is possible when using the Thermo Scientific HAAKE Rheomex 19/10 OS. This means that materials with a high shear sensitivity and plastifying substances, such as thermosets, can be extruded.

Rheomex 19/10 OS rubber

This is an extruder additionally equipped with a separately driven roll feeder, which is designed to facilitate the intake of rubber strips into the feed section and thus make a uniform extrusion of such materials possible. The drive of the roll feeder is independent of the extruder speed and is controlled manually.

Technical specifications		Rheomex 19/10 OS	Rheomex 19/10 OS rubber
Barrel	Length	10 L / D	10 L / D
	Diameter	19.05 mm (3 / 4”)	
	Material standard	Stainless steel No. 1.8550, nitrided	
	Wear / chemical resistance (optional)	Bimetal	
	Integrated heating / cooling zones	1 / 1	1 / 1
	Solenoids for air cooling	1	1
	Feed zone cooling	—	—
	Feed section	Feed section 22 x 35 mm	Feed section 22 x 35 mm
	External temperature zone	2	2
	Maximum flight depth	3.75	3.75
Sensor ports 1/2” 20 UNF	Standard, at barrel end	Up to 2	Up to 2
	Gas injection / venting	—	Optional at L / D 17
Functions	Coding (auto detection)	✓	✓
	Overload protection	Electrical (maximum torque control or cut-off)	
	Maximum torque	160 Nm	160 Nm
	Maximum operating temperature	450 °C	250 °C
	Maximum speed	250 1 / min	250 1 / min
	Maximum operating pressure	700 bar	700 bar
	Feeding	Hopper	Feed roll
	Speed range of roll feeder	—	0–50 rpm
	Backpressure sensor	Optional	Optional
	Max. throughput	10 kg/h (depending on material)	

Rheomex 19/25 OS

The most often used extruder has an L/D of 25/1. It is specially designed for testing the plastification and flow behavior of thermoplastics under process conditions. Adding optional measuring ports with sensors provides useful information during the extrusion process. Special solutions such as chemical or wear resistance are also available to extrude harsh materials.

Rheomex 19/33 OS

The extruder has an L/D ratio of 33/1. It is specially designed for the testing and extrusion of Polyolefines in combination with blowing / foaming agents. Gases for foaming can be injected with a high-pressure valve at an injection port. Due to its four heating / cooling zones, an optimum temperature profile can be set along the barrel.

Rheomex 19/25 QC

For testing the quality and processability of those materials, the single-screw laboratory extruder 19/25 QC is a proven tool. With over 35 years of expertise, we have developed a wide variety of different screw designs that are guaranteed to provide the best performance.

Rheomex 19/25 OS	Rheomex 19/33 OS	Rheomex 19/25 QC
25 L / D	33 L / D	25 L / D
19.05 mm (3 / 4”)		
Stainless steel No. 1.8550, nitrided		
Bimetal		
3 / 3	4 / 4	3 / 1
3	4	1
Water or air	Water or air	Water or air
Feed section 22 x 35 mm	Feed section 22 x 35 mm	
2	2	1 (2 optional)
3.75 mm	3.75 mm	
Up to 6	Up to 8	Up to 6
Optional at L / D 17		
✓	✓	✓
Electrical (maximum torque control or cut-off)		
160 Nm	160 Nm	160 Nm
450 °C	450 °C	450 °C
250 1 / min	250 1 / min	250 1 / min
700 bar	700 bar	700 bar
Hopper	Hopper	Hopper
—	—	—
Optional	Optional	—
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 with 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 a 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 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.

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 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 rod capillary die

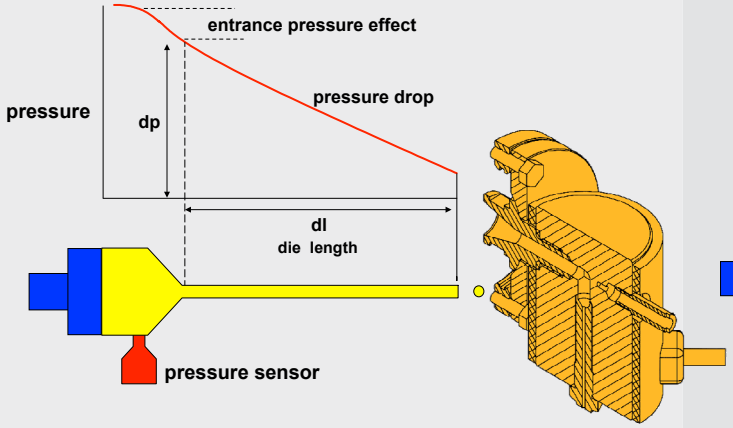
When using rod capillary dies, the melt pressure is measured just before the capillary entrance.

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 10^4 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



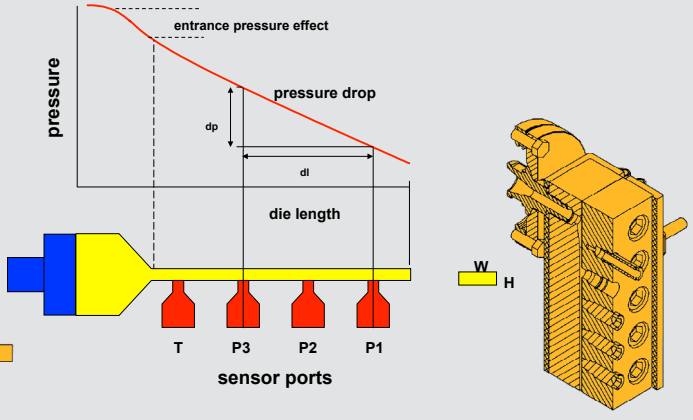
The slit capillary die

Measurement of the pressure gradient and melt temperature is carried out 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 103 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 HAAKE PolyLab Dies

Simulating process conditions in the laboratory
Different die geometries and Post-Ex equipment

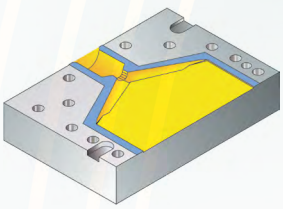
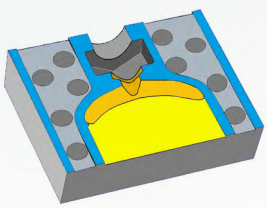
Shaping the hot polymer melt that leaves the extruder can be achieved by the appropriate selection of a die from the wide range of geometries available for the HAAKE PolyLab System. Different shapes and sizes are necessary to produce test specimens that can be analyzed further or being used for simulations 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 span 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 widths and thicknesses. 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 are recommended for PVC with a fixed gap of 1 mm. The die special short flow channel to minimize the risks of burners.

Technical specifications	Sheet, tape & ribbon Die 25 / 50 / 100 / 150	Sheet, tape & ribbon Die PVC 50 / 100
Extrudate	Sheet	Sheet
Material	1.4301	1.2316
Heater (Watt)	500 / 1000 / 1250 / 1800	400
Max. temperature (°C)	420	360
Max. pressure (bar)	—	—
Measuring ports	1	—
Dimensions (mm)	W 25 / 50 / 100 / 150 H 0.2 - 2.5	W 50 / 100 H 1.0
Approx. weight (kg)	3 / 4.5 / 10 / 14	3.5 / 8
Graphical Information		

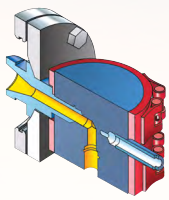
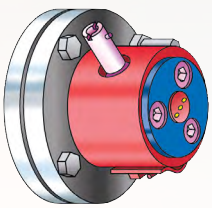
Order Information	Flexible Gap:	Fixed Gap:
	25 mm	25 mm
	50 mm	50 mm
	100 mm	100 mm
	150 mm	Gap: To be specified
	Gap: 0.2 – 1.2 mm	**PVC Dies:**
		50 mm
		100 mm

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 water bath and pelletizer, one lab-scaled pelletize line can be set up.

Technical specifications	Horizontal rod die / Vertical rod die	Multistrand die Three strands
Extrudate	Strand	Sheet
Material	1.4571 / 1.4112	1.2316
Heater (Watt)	250 / 280	400
Max. temperature (°C)	450	360
Max. pressure (bar)	700	—
Measuring ports	2	—
Dimensions (mm)	Ø 1.0 / 1.5 / 2.0 / 3.0 / 4.0 / 5.0 / 6.0	Ø 3 x 3
Approx. weight (kg)	2	2
Graphical Information		

The HAAKE PolyLab Dies

Catheter die

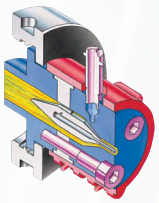
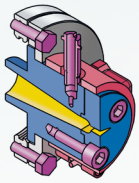
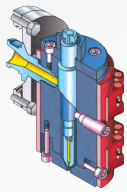
This die for tubes of small diameter and wall thickness is ideal for producing capillary and catheter tubes. The process is supported by an air supply in the inner tube to prevent a collapsing of the small tubes. Also, on this die, a wide range of diameters and wall thicknesses are available.

Garvey Die

The Garvey die adheres to ASTM D2320 - 96 (2012) and can be used to examine the flow behavior of the 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.

Wire coating die

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.

Technical specifications	Catheter die	Garvey die	Wire coating die
Extrudate	Tubes	Garvey profile	—
Material	1.4571	1.4305	1.4571
Heater (Watt)	200	250	500
Max. temperature (°C)	450	360	450
Max. pressure (bar)	700	700	700
Measuring ports	—	—	2
Dimensions (mm)	Ø 2.5 - 4.5	Ø 100 x 62	Ø 140 x 100 x 100
Approx. weight (kg)			
Graphical Information			
Order Information	Catheterdiameter 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

Blown film die

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.

Spinning die

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

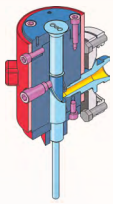
Filter die

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 a standardized melt filter is measured, from which the FPV (Filter Pressure Value) is calculated, thus indicating the dispersion quality of the master batch.

Pipe & tubing die

The tubing die is designed for tubes with outer diameters of about 10 to 15 mm.

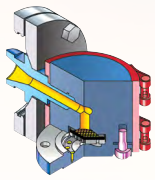
Blown film die	Spinning die	Filter die	Pipe & tubing die
—	—	—	Tubes
1.4112	1.4571	1.4112	1.4571
500	280	280	600
450	450	450	350
700	700	350	500
2	2	2	—
Ø 140 x 100 x 100	Ø 100 x 63 x 75	310 (with adjusting lever) x 100 x 120	Ø 5 - 12 (inner) 10 to 15 (outer)



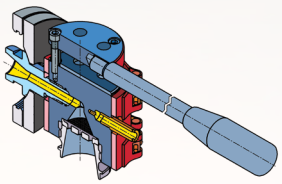
Di: 24 mm
Da: 25 mm

Options:

Air Cooling Ring
Insert 34 / 35 mm
Special geometry for HDPE available

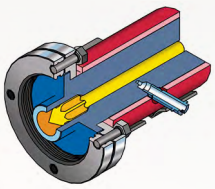


Number of holes: 10
Diameter: 0.2 mm
Other geometries on request



Mesh sizes:

#1 25 µm
#2 14 µm



Di: 5 mm to 12 mm
Da: 10 mm to 15 mm
Standard Di / Da: 9 / 12 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
- Spooler for 3D filament and melt pump
- 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.

Training courses, seminars, and webinars

We offer our customers a comprehensive training program and selected courses at 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.

Learn more at **thermofisher.com/polylab**