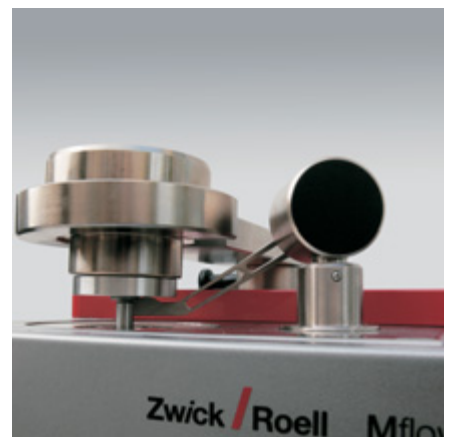


Extrusion Plastometers Cflow and Mflow



Intelligent Testing

1. The Cflow and Mflow Extrusion Plastometers – precise test results and a pleasure to use

With the latest Cflow and Mflow Extrusion Plastometers, Zwick has targeted each specific user group and gone one step further in achieving the most accurate and dependable test results.



The Cflow Extrusion Plastometer – precise MFR testing

The Cflow is a compact instrument for measuring the flow properties of plastics to Method A. It has been developed mainly for plastic processors where flow property testing is not so frequently carried out and where the connection to a PC is not required.

The Mflow is a modular instrument with which the mass and volume flow rates can be determined. This new product line offers many different options starting with an exceptional value for money instrument up to sophisticated and fully customised versions.



The Mflow Extrusion Plastometer – an instrument with a modular concept

What distinguishes both instruments from existing products in the market today?

- Innovative temperature management system with thermally matched heating chamber and extrusion barrel. The design of the temperature chamber ensures that heat energy is generated precisely where it is needed. This ensures an excellent temperature distribution over the entire barrel length, without the need to use two temperature controllers.
- Ergonomic styling enables fatigue free and fast operation.
- The operator can easily check the complete instrument using standard equipment to ensure that perfect results are achieved every time. For example, system check using test granulate, temperature measurement using thermometers, and checking diameter of orifices or extrusion barrel using plug gages.



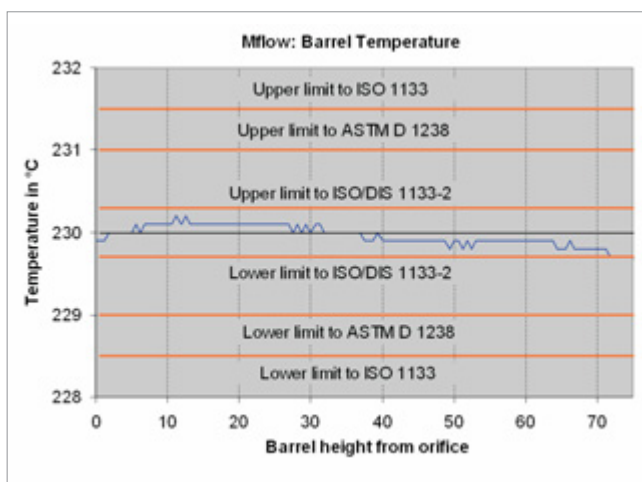
Easy filling of the extrusion barrel with the measuring spoon

The Mflow also offers:

- Operation with a PC encompasses all of the advantages of *testXpert*® II and up to six instruments can be operated with one PC. The traceability of the results and additional processing with *testXpert*® II-LIMS (Laboratory Information Management System) makes it possible to carry out statistical control over time.
- The instrument's automatic adaptive parameter configuration can automatically set the test parameters so that measurement errors are minimised and independent of the material currently being tested.
- For tests to Method B (MVR), piston travel and time measurements are required. Both measurements are determined synchronously with the new Mflow electronic controller, greatly reducing time-travel errors.
- With PC-operation and for tests to Method B, the Mflow gives a travel-time diagram for effective control of the measurement process.
- In order to check the piston travel Zwick supplies three control gages.

Innovative temperature control for a very good temperature distribution

Instead of traditional heating sleeves Zwick Extrusion Plastometers use heating elements which have been adapted especially to the thermal requirements of test barrel and instrument casing. This allows the heating power to be applied optimally where it is required and thereby a very good spatial and time temperature distribution is achieved.

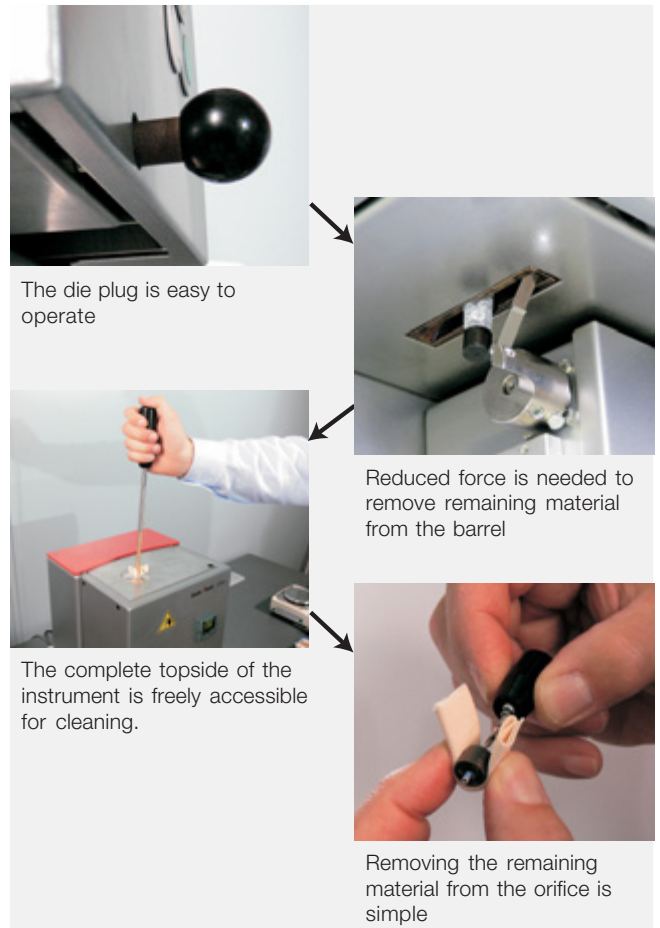


The temperature distribution complies to ISO/CD 1133-2

Simplified cleaning and removal of remaining material

The die plug is located on the lower side of the extrusion barrel. After pulling the die plug, the orifice is free from below and can be easily removed.

It is also easy to push out the orifice and remaining material after a test and the cleaning is simplified because the barrel is accessible throughout.



2. Test methods

The Melt Flow Test

The Melt Flow Test is a simple method for characterising the flow properties of a melted plastic mass. This test method is very widely used, especially for quality control and incoming goods inspections.

The accuracy requirements and test methods are defined by national and international Standards. For example, ISO 1133, JIS K 7210, ASTM D 1238 as general methods and ASTM D 3364 for testing of PVC. In addition there are specific stipulations in materials specification Standards. These Standards define the important elements of a Melt Flow Test Instrument.

The Standards differentiate several test methods:

- **Method A: Melt mass flow rate (MFR)**

In this method, the extrudate is cut off in constant time intervals and the mass is determined with an analytical scale. The test result is the extruded mass per time unit. This is normally given in g/10 min.

The accuracy of the cutting time determines the quality of the determined MFR result. Manual cutting is only recommended when the MFR values are low and the period between cuts is long. If several cuts should be taken from one barrel filling, or if the MFR value is larger than 10 g/10 min, the use of an automatic extrudate cutter is recommended.



With the automatic extrudate cutter, the extrudate can be cut at precise time intervals

- **Method B: Melt volume rate (MVR)**

The extrusion plastometer must be equipped with a travel transducer for this method. The MVR result is the material volume extruded per time unit and is given in cm³/10 min. It is calculated from the travel which the piston has moved during a specific time period.

An important advantage of this method is the omission of the mechanical cutting. With synchronized travel/time test values, a high accuracy can be achieved with short test times and short piston travels. As a result, up to 40 individual measurements are possible from one barrel filling, according to material, accuracy requirements and the MVR results.

Testing of standard plastics

For most non- or slightly corrosive standard plastics such as PE, PP, PC, PS, a piston and extrusion barrel made of a highly wear resistant material, and orifices made from a sintered metal are used.

- **Method C**

Orifices with a height of 8 mm and a bore diameter of 2.095 mm are most often used. For the measurement of MFR values larger than 75 g/10 min, the Standards recommend a „half-height / half bore diameter“ orifice with the specification of 4.00 / 1.050 mm. This is indicated as Method C in ASTM D 1238.

- **Method D to ASTM D 1238: Multiple stage test**

With some polyolefins, it is normal to give the MVR value for various loading stages to determine the Flow Rate Ratio (FRR). With standard Extrusion Plastometers several barrel fillings are necessary for these measurements. Instruments that are equipped with automatic load changing units can measure with several different load stages from one filling (see Product Information Extrusion Plastometer Zwick 4106).



Mflow basic instrument with piston and test weight 2.16 kg

Special piston and barrel for testing of plastics containing fluorine

Various plastics containing fluorine, e.g. PTFE, PFA release hydrofluoric acid which corrodes the material of the piston and barrel. A piston and barrel made of a special steel alloy are used to test these types of plastic.



Piston and extrusion barrel for plastics containing fluorine are made of a special steel

Testing of materials sensitive to time temperature history and / or moisture

For materials e.g. PBT, PET or PA, special precautions are required for testing. These materials must be sufficiently dried and placed in the barrel in a dry state. The test is then performed in precisely defined time sequences which are recorded by *testXpert*® II. The Extrusion Plastometer fulfils special requirements regarding temperature distribution with travel and with time inside the extrusion barrel.

Testing of PVC

Testing of PVC is defined in ASTM D 3364. A longer and bevelled orifice (25.4 / 2.095 mm), is required, as well as a specific test weight of 20 kg.

3. Characteristics of the Mflow Extrusion Plastometers

Automatic, adaptive parameter configuration

Automatic, adaptive parameter configuration can be used for MVR (Method B), as well as for MFR (Method A) determination.

Selection of the parameter table:

- The correct parameter table is selected by the operator before start of the test. It contains optimised test parameters for the whole MFR/MVR range.
- Various tables are available

MVR range	Channel	Value	Max. cuts
0.4	time	240 s	5
1.0	travel	2 mm	5
20	travel	5 mm	6
> 20	travel	10 mm	3

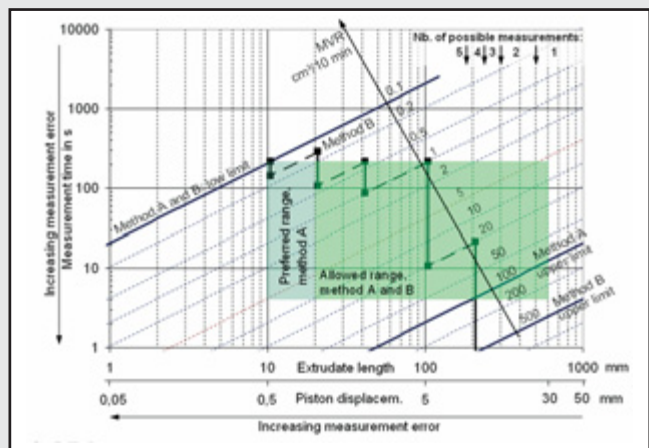
During the test:

- The piston speed is determined by the MFR/MVR of the granulate. The instrument automatically selects the optimum test parameters from the parameter table.



Advantages:

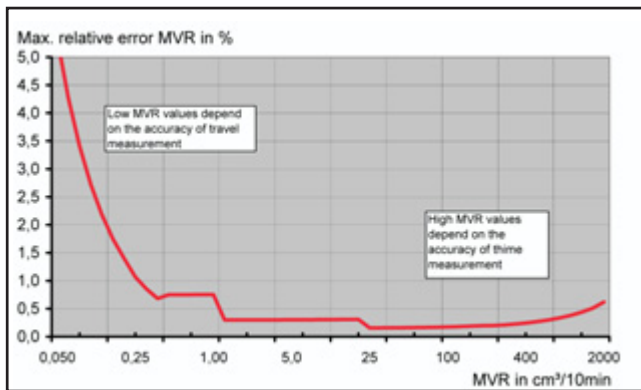
- Test result errors occurring from travel and time measurement are minimized
- Testing of unknown plastic granulate or changing grades can be easily and safely performed
- The operator influence on the results is minimized



Use of the piston travel transducer is required when the Adaptive Parameter Configuration is used. Several sets of parameter tables defined according to different test Standards are available in Stand-Alone operation without PC.

testXpert[®] II enables the use of additional or self-generated, parameter tables.

The correct parameter table is selected by the operator before test start. A pre-programmed parameter table contains optimised test parameters for the MFR/MVR value ranging from zero to infinite.



Calculated relative maximum measurement error of the MVR value, resulting from the error limit of the travel and time measurement at optimised test parameters.

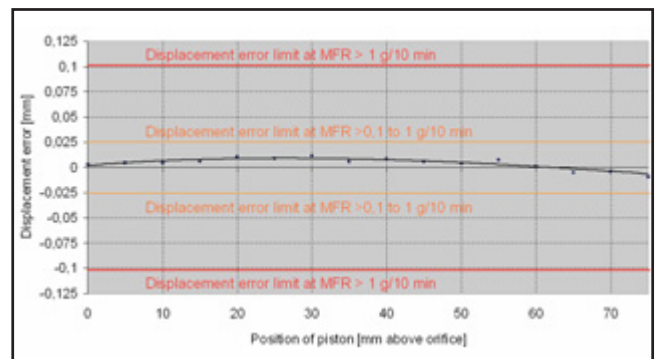
The piston speed is determined by the MFR/MVR value of the plastic. The instrument automatically selects the optimum test parameter from the parameter table and performs the test.

The test results are automatically determined in a way which minimizes the possible error arising from time and travel measurements. This gives the following advantages:

- Testing of unknown plastics granulate or changing grades can be easily and safely performed. Pre-tests are no longer necessary to determine the test parameters.
- If constantly changing plastics or various grades are tested, the test parameters can be determined without using a database.
- The variability in test results from multiple operators is reduced as the test parameters are determined automatically.

Precision travel and time acquisition for precise MFR and MVR results

An accurate travel transducer ensures consistent and precise measurement of the piston travel during the MVR determination. The contact point is very close to the piston center axis which greatly minimises any possible error.



Mflow: The measurement uncertainty is well below the specified limits

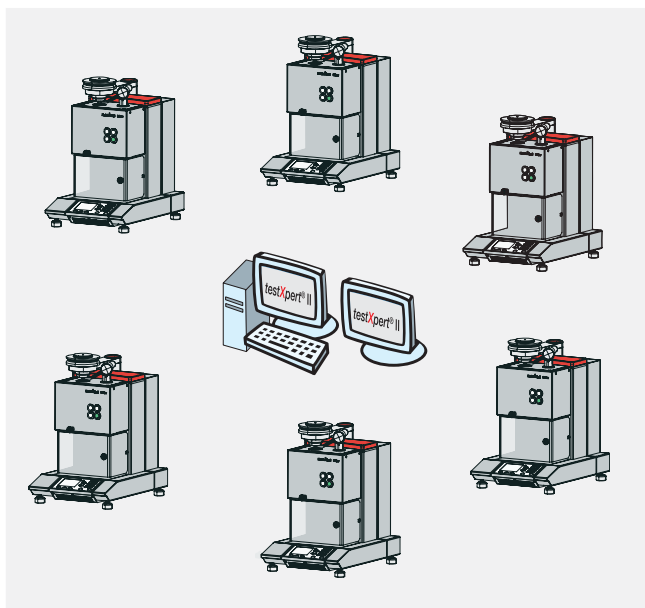
In method B, the accuracy of the flow rate determination depends on the synchronisation of the time-travel data pairs and the accuracy of the time determination. Since both test dimensions (time and travel) are digital in origin, an analog-digital conversion, with its inherent time delays, is not required. This eliminates synchronisation errors. The use of quartz crystal time measurement also allows measurements on granulate with higher flow rates.



Mflow: The digital travel transducer measures the travel very precisely

Management of several Mflow Extrusion Plastometers with one PC

Using just one PC with USB interfaces allows up to six Mflow instruments to be connected and controlled using *testXpert*® II Software. Central operation and results storage from one work place optimizes laboratory space and allows a quick overview of all running tests.



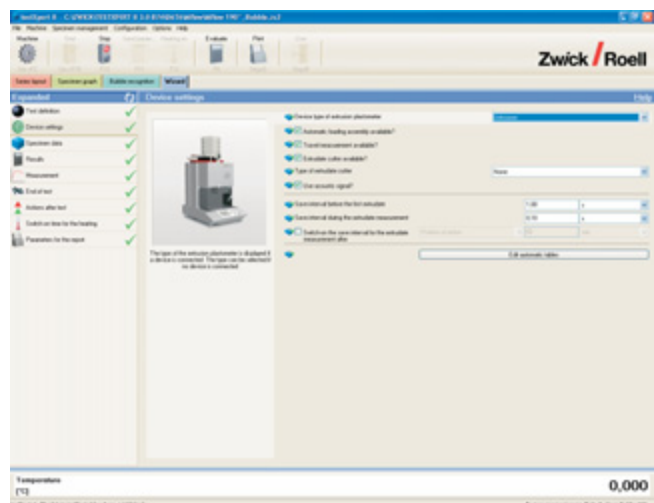
At one glance: 6 Mflow Extrusion Plastometers using a PC and an optional second screen

In addition up to 2 USB-Hubs can be connected to one PC USB port. When selecting the PC it is important to pay attention to the performance characteristics listed in the technical details.

PC-Operation with *testXpert*® II – Intelligent and reliable

With more than 10,000 successful installations, the *testXpert*® software platform is already established as the worlds leading materials and component testing software. Building on this experience, the new generation, *testXpert*® II, provides yet another leap forwards in innovative testing technology.

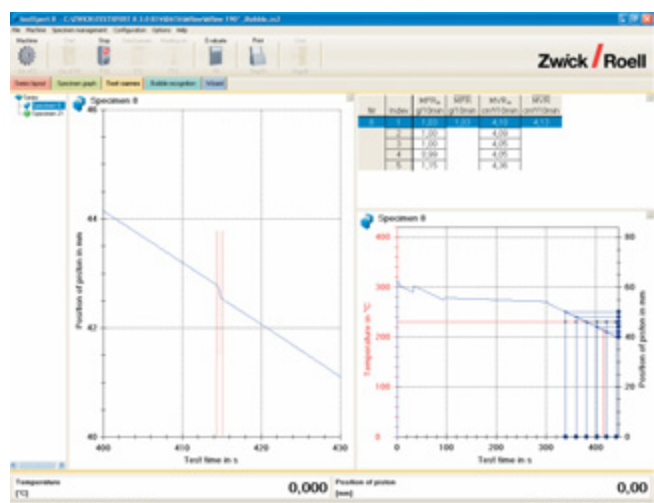
„Made in Germany“ identifies our products and services as reliable and dependable. All our process including software development are certified according to ISO 9001. These processes have also been independently validated by well-known companies according to FDA, ISO and other guidelines. This means that the highest standards of quality are guaranteed, and you can fully depend on *testXpert*® II.



Quick and easy setting of the test parameters

Automatic bubble detection with *testXpert*® II

Air bubbles in the molten plastic material cannot be completely avoided. They cause a sudden increase of the piston speed in a short time interval and significantly falsify the test result. Up to now, such false test results could only be recognized as a statistical outlier and then excluded. Consequently, it was often necessary, but time consuming, to make another barrel filling and carry out a repeat test.

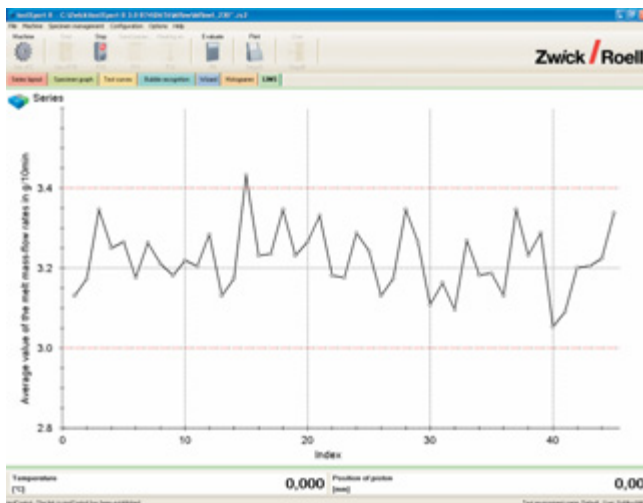


A bubble is recognized and eliminated from the valid travel

testXpert[®] II is intelligent: Since the piston speed is controlled in a method B test, the erroneous piston travel caused by an air bubble is automatically recognized and eliminated from the result evaluation. The remaining curve is then used for test result evaluation. When this method is used, and especially for ASTM Standards, valid test results can still be achieved and so repeat tests are avoided.

testXpert[®] II LIMS

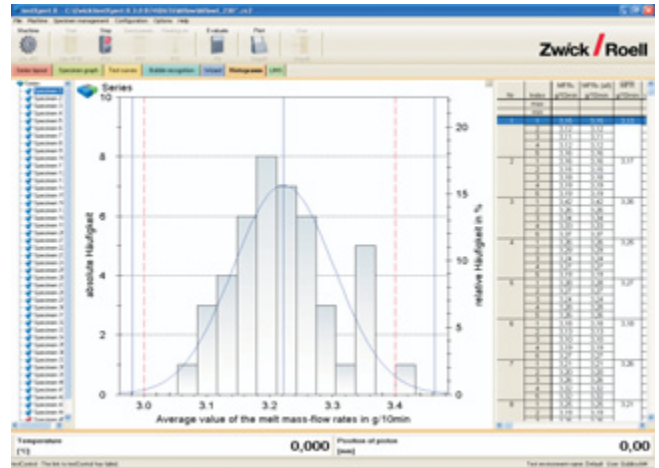
Only *testXpert*[®] II offers an integrated Laboratory-Information-Management-System. A very powerful data bank is available for managing the test results in order to create and archive long-term statistics. Reports can be configured for several comprehensive test series.



The long term statistics shows process trend

This solution which is fully integrated in *testXpert*[®] II allows:

- A complete evaluation of materials even as time shifted tests
- Long term statistics and trends concerning MFR or MVR
- Histogram function



The histogram shows the result distribution

With these tools, quick and efficient median values and scatter of test batches can be displayed. This is done automatically by *testXpert*[®] II and all data, even from several instruments, is stored in a data bank for later access and analysis.

The measurement electronics offer convenient operation even in the Stand-Alone version:

- Quick language swapping
- Input of the Standard to be used and the required Adaptive Parameter Configuration
- Manual input of test parameters
- Input of the test method to be used (A, B)
- Automatic storage of the parameters when the instrument is turned off
- Output of test results: individual values and statistical characteristic values (median value, standard deviation, coefficient of variation)



The clearly arranged control panel indicates all parameters and test results

4. Technical data of the Extrusion Plastometers

For a quick orientation we marked the item numbers with a red dot.

Cflow Extrusion Plastometer

The Cflow Extrusion Plastometer is designed for MFR testing to Method A. Tests according to the following Standards are possible: Method A to ISO 1133, ASTM D 1238, ASTM D 3364, JIS K 7210.

Cflow Extrusion Plastometer		
Supply voltage	220 to 240 V, 50/60 Hz	100 to 127 V, 50/60 Hz
Item number	•004949	•004950

In the **scope of supply** of the Extrusion Plastometers are test weights (325 g and 2.16 kg), cleaning accessories (cleaning rod, cleaning brush, cleaning pads, orifice cleaning drill Ø 2.095 mm) for extrusion barrel and orifice, test granulate and a filling channel for the granulate.

Technical data of the instruments	
General	
Power consumption	500 W
Weight	46.6 kg
Dimensions: Height x Width x Depth	850 x 270 x 400 mm (incl. weights, all equipment included)
Display	Double-spaced, actual / set value temperature display, back-lit
Operational ranges	
Test loads	0.325 up to 21.6 kg
Temperature range	+125 up to +400 °C
Error limits	
Temperature accuracy in the area of 0 to 75 mm over the orifice in the temperature range of 190°C to 300 °C	< 0.3 °C with distance and with time, acc. to ISO/CD 1132-2
Temperature display resolution	0.1 °C
Error limit of time measurement (Method A)	±0.02 s using automatic extrudate cutter

Mflow Extrusion Plastometer

The Mflow Extrusion Plastometer in its basic version is equipped for MFR testing to Method A and can be expanded for MVR testing to Method B. Tests according to the following Standards are possible: Methods A and B to ISO 1133, ASTM D 1238, ASTM D 3364, JIS K 7210.

Mflow Extrusion Plastometer		
Supply-voltages	220 to 240 V, 50/60 Hz	100 to 127 V, 50/60 Hz
Item number	•001320	•001328

In the **scope of supply** of the Mflow Extrusion Plastometers are USB-cable, test weights (325 g and 2.16 kg), cleaning accessories (cleaning rod, cleaning brush, cleaning pads, orifice cleaning drill Ø 2.095 mm) for barrel and orifice, test granulate and a filling channel for the granulate.

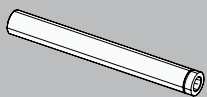
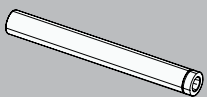
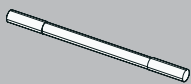
Technical data of the instruments	
General	
Power consumption	500 W
Compressed air, oiled, dry (Option for pneumatic weight lifting unit)	6 - 10 bar
Weight	70.6 kg (all equipment included)
Dimensions: Height x Width x Depth	930 x 360 x 520 mm (incl. weights, all equipment included)
Keypad	Pressure point – plastic foil keypad
Display	LCD-Graphic display, back-lit
Number of parameter sets storable	35
Interfaces	<ul style="list-style-type: none"> • USB for connecting PC • RS 232-interface for raw data export, data output: serial number, specimen number, number of cuttings, density (operator input), density at test temperature, total weight of extrudate, MFR median value, MVR median value, MFR and MVR individual values • RS 232-interface to connect a analysis scale from the Zwick product range
Operational ranges	
Test loads	0.325 up to 21.6 kg
Temperature range	+50 up to +450 °C
Error limits	
Temperature accuracy in the area of 0 to 75 mm over the orifice in the temperature range of 50°C to 450°C	< 0.3 °C with distance and with time, acc. to ISO/CD 1132-2
Temperature display resolution	0.1 °C
Error limit of time measurement (Method A)	±0.02 s using automatic extrudate cutter
Error limit of time measurement (Method B)	±0.001 s
Error limit of travel measurement (Method B)	±0.02 mm (ISO 1133) or ±0.4 % of 6.25 mm (ASTM D 1238)
Resolution of the travel measurement (Method B)	< 0.005 mm
Multiple instrument operation on one PC	
Available minimum RAM	1.54 GB
Processor	3 GHz
Up to 6 Mflow Extrusion Plastometers can be connected to one PC.	

5. Accessories

Accessories for Mflow and Cflow Extrusion Plastometers

Extrusion barrels

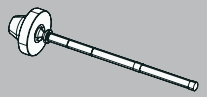
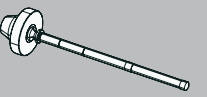
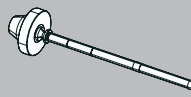
An extrusion barrel must be selected depending on the material that is to be tested. Cleaning pads and a cleaning piston are supplied to clean the extrusion barrel.

		
Extrusion barrel for fluorine-free plastics	Extrusion barrel for fluorine-containing plastics	Plug gage
Inner dia. 9.55 mm Accurately machined hole Wear-resistant	Inner dia. 9.55 mm Accurately machined hole	For checking the barrels 9.55 ± 0.025 mm With material and waste side Incl. manufacturer's declaration
•001331	•001345	•325569

Pistons

At least one piston must be selected depending on the materials that are to be tested.

If testing should be performed to ISO 1133-1997, a piston with non-rounded edge (sharp-edge) is required:

		
Piston for fluorine-free plastics	Piston for fluorine-containing plastics	Piston for fluorine-free plastics, sharp-edge
According to ISO 1133 Weight 0.325 kg Wear-resistant	According to ISO 1133 Weight 0.325 kg	According to ISO 1133-1997 Weight 0.325 kg Wear-resistant
•001336	•001340	•001350

Orifices

At least one pair of orifices (2 pieces) must be selected depending on the materials that are to be tested.

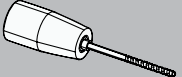
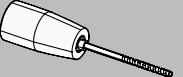
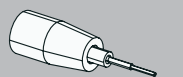
			
Sintered material orifices	Sintered material orifices	Sintered material orifices	Sintered material orifices
Inner dia. 2.095 mm Acc. to ISO 1133 Wear-resistant, for fluorine-free and fluorine-containing plastics Length: 8 mm	Inner dia. 1.05 mm Acc. to ISO 1133 Wear-resistant, for fluorine-free and fluorine-containing plastics Length: 4 mm	Inner dia. 1.18 mm Acc. to BS 2782-7, Method 720A-1997 Wear-resistant, for fluorine-free and fluorine-containing plastics Length 8 mm	Inner dia. 2.095 mm Acc. to ASTM D 3364 For PVC tests Length 25.4 mm
Scope of supply: 2 pieces •312342	Scope of supply: 2 pieces •325554	Scope of supply: 2 pieces •001351	Scope of supply: 2 pieces •373757

Checking of orifice diameter

		
Plug gage dia. 2.095 ± 0.005 mm	Plug gage dia. 1.180 ± 0.005 mm	Plug gage dia. 1.050 ± 0.005 mm
With material and waste side Incl. manufacturer's declaration	With material and waste side Incl. manufacturer's declaration	With material and waste side Incl. manufacturer's declaration
•325560	•325558	•325556

Cleaning tools for orifices




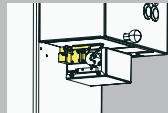
For the sintered metal orifice with dia. 2.095 mm a cleaning drill is included in scope of supply.

		
Cleaning drill for orifice dia. 2.095 mm	Cleaning drill for orifice dia. 1.05 mm	Orifice cleaning pin dia. 1.18 mm
•001365	•001440	•001367




Extrudate cutters and orifice plug

We recommend the manual extrudate cutter for cutting intervals longer than one minute. However for short cutting intervals the automatic extrudate cutter would be the right solution to get a precisely timed cut.

The orifice plug prevents the early flow of the plastic material when testing with high flow rates (> 10 cm³ / 10 min at a load of 0.375 kg). For the use of the orifice plug an extrudate cutter is necessary.

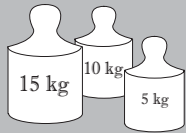
			
Extrudate cutter to Mflow and Cflow	Extrudate cutter to Mflow	Extrudate cutter to Cflow	Orifice plug to Mflow and Cflow
Manually operated	Automatically operated Automatic control of the time interval or manually by pushbutton	Automatically operated Automatic control of the time interval or manually by pushbutton	For tests on high flow rate plastics
•001371	•001377	•010864	•012728

Scales for measuring the weight of the extrudate at Method A

		
Analytical scale Mettler	Analytical scale Kern	Stopwatch
Max. 51 g Scale reading / Repeatability 0.1 mg Linearity ±0.2 mg Housing (WxHxD): 245 x 344 x 321 mm RS 232 interface is required for connection to PC With internal calibration weight	Max. 83 g Scale reading / Repeatability 0.1 mg Linearity ±0.2 mg Housing (WxHxD): 225 x 330 x 315 mm RS 232 interface is required for connection to PC	For Cflow. For measuring the pre-heat time and test duration
•318230	•014720	•316663

Test weights

The Mflow and Cflow can be fitted with test weights depending on the type of plastics that is to be tested.



Test weights for obtaining a test load of

5 kg	5 kg 10 kg	5 kg 10 kg 15 kg 21.6 kg	1 kg	1.05 kg	1.2 kg	3.8 kg	12.5 kg ⁽¹⁾	20 kg ⁽²⁾ (ASTM D 3364)
•001380	•001381	•001443	•001385	•001386	•001387	•001459	•001389	•008077

⁽¹⁾ Requires test weights with test load 5 kg and 10 kg (Item number 001381).

⁽²⁾ Requires test weights with test load 5, 10, 15 and 21.6 kg (Item number 001443).

Safety

To protect the operator against spattering specimen pieces, we recommend a protective shield.



Protective shield

For extrudate cutter, automatically operated

•001379



Protective shield

For extrudate cutter, manually operated

•004996



Safety glasses

•001405



Pair of protective gloves

Heat insulating

•001403

Temperature control instrument and calibration



Digital temperature instrument

Temperature range -199.99 °C ... 850°
Resolution < 200 °C: 0.01 °C
Resolution > 200 °C: 0.1 °C
Temperature probe PT 100

•001393



Factory calibration

For digital temperature control instrument

•001391

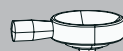


DKD works calibration certificate

For digital temperature control instrument

•001471

Additional accessories



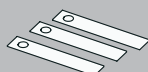
Measuring spoon and funnel

•001400



Accessory case

•001408



Spare cutters

10 pieces
For extrudate cutters

•312340



Test granulate

For checking the instrument
500 ml
190 °C/5 kg
230 °C/2.16 kg

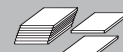
•001407



Cleaning brushes

10 pieces

•001409



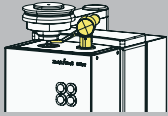
Cleaning pads

5000 pieces

•001402

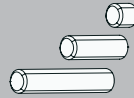
Accessories for the Mflow Extrusion Plastometers

Travel measurement



Piston travel transducer

For tests to ISO 1133-Method B and ASTM D 1238 Method B
 •001395



Control gages

For checking the piston travel transducer for 10, 30, and 50 mm
 •001396

Pneumatic weight lifting unit

For reduced workload, a pneumatic weight lifting unit can be added to lift and lower the weights without using muscle power. The use of the lifting unit requires a

compressed air connection (see technical data). When using test weights with test loads 5 kg, 10 kg, 12.5 kg, 15 kg, 20 kg and 21.6 kg in combination with the Mflow we recommend the pneumatic weight lifting unit.



Pneumatic weight lifting unit

Required dry, oiled air
 •001472

Maintenance unit for weight lifting unit

For drying and oiling of non-conditioned compressed air
 •004854

Multiple instrument operation with up to 6 Mflow with one PC

If several Mflow instruments should be connected to one PC, one *testXpert*® II Test Program is required for each instrument. When the PC is installed, the performance

characteristic „Multiple instrument operation with Mflow instruments“ is activated via a multiple licensing. A maximum of 3 Mflow instruments can be connected to a PC via a USB-Hub. If two USB-Hubs are used, up to 6 Mflow instruments can be operated with one PC.



USB-Hub, 4 Ports

Uses 1 USB-Port on PC, for connection of 4 instruments
 Scope of supply: USB-Hub, power supply unit 5 V / 2.5 A, connecting cable 1 m
 •004882

PC operation

For PC operation a PC and a *testXpert*® II test software are necessary. The PC can be supplied by the end-user or it can be ordered from the Zwick program.

testXpert® II

testXpert® II Test Programs

<i>testXpert</i> ® II Basic Program for testing instruments	•014985
<i>testXpert</i> ® II Master Test Program for determination of the melt flow rate - The following options are integrated in this Master Test Program: Layout Editor, Result Editor, Export Editor, Channel Editor and Report Editor	•006755
<i>testXpert</i> ® II Standard Test Program for determination of the melt flow rate - To ISO 1133, methods A and B, and ASTM D 1238, methods A to C	•006751
<i>testXpert</i> ® II LIMS: Administration of test results	•374058



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