

Extrusion Plastometers Cflow and Mflow



Intelligent Testing

1. The Cflow- and Mflow-Extrusion Plastometers – another step towards better test results

With the Cflow- and Mflow-Extrusion Plastometers Zwick goes one step ahead in achieving the most accurate and dependable test results.

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.



Easy filling of the barrel with the portioning gage

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.

What distinguishes both instruments from products in the market today?

- Innovative temperature management system with thermally matched heating chamber and 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.
- Ergonomical 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, complete system check using test granulate, temperature measurement using thermometers, and checking diameter of orifices or barrel using gages.

The Mflow also offers:

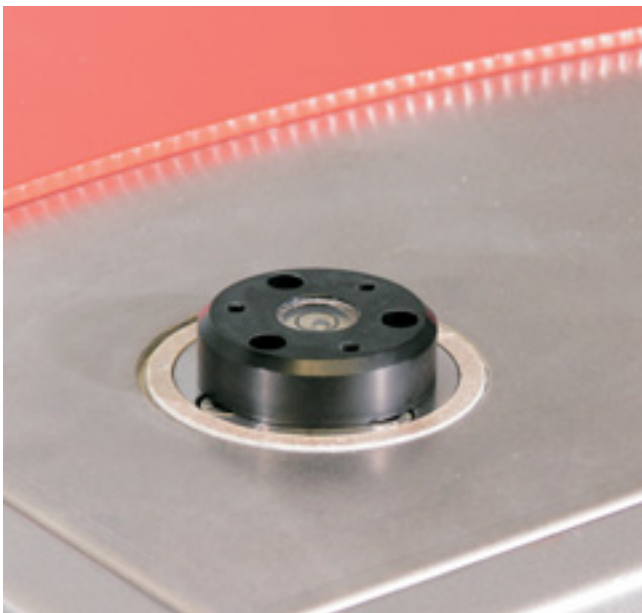
- Operation with a PC encompasses all of the advantages of *testXpert*[®]: up to six instruments can be operated with one PC. The traceability of the results and additional processing with *testXpert*[®]-LIMS (Laboratory Information Management System) makes it possible to carry out statistical control over time.
- The instrument's unique operating 'map control' can automatically set the test parameters so that measurement errors are minimised and independently 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 addition to the control possibilities mentioned above, the travel of the piston can be measured with a distance gage.



The Mflow extrusion plastometer – an instrument with a modular concept

The Melt Flow Test

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



Bubble level for exact alignment

The accuracy requirements and test methods are fixed in 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 a precision balance. The test result is the extruded mass per 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 cutting times are 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 a motorised extrudate cutter is recommended.

- **Method B: Melt Volume Rate (MVR)**

The extrusion plastometer must be equipped with a piston travel sensor for this method. The MVR result is the material volume extruded per time unit and is given in $\text{cm}^3/10 \text{ min}$. It is calculated from the travel which the test piston has moved during a specific time unit.

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.



The Cflow extrusion plastometer – effective, efficient and easy to operate

Testing of standard plastics

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



Extrudate cutter, operated automatically

• 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 standard ASTM D 1238 recommends 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

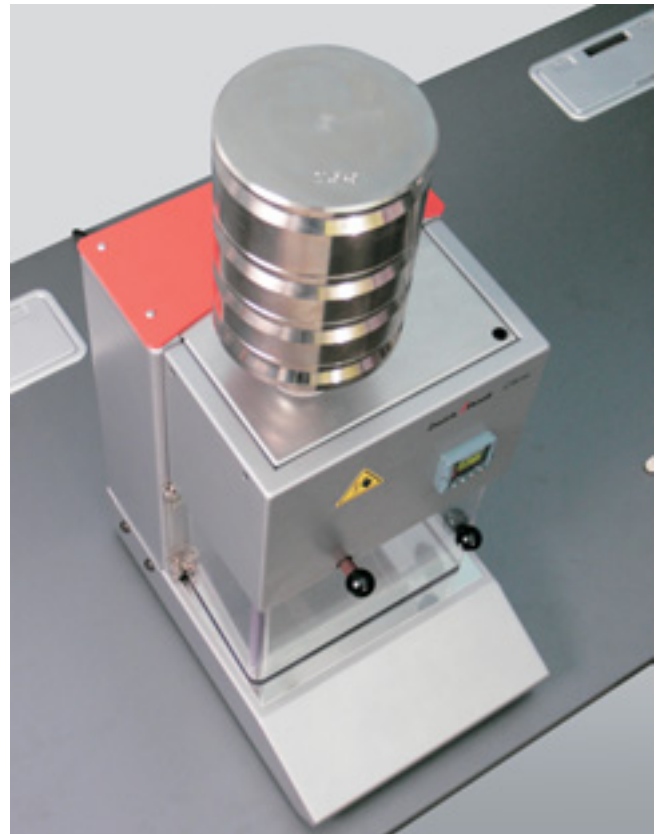
With some polyolefins, it is normal to give the MVR value for various loading stages to determine the Flow Rate Ratio (FRR). With simple and traditional Extrusion Plastometers several barrel fillings are necessary for these measurements. Instruments which are equipped with automatic load changing units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

Special piston and barrel for testing of plastics containing fluorin

Various plastics containing fluorin, e.g. PTFE, generate hydrofluoric acid which corrodes the material of the piston and barrel. A piston and barrel made of a special steel alloy are used for this type plastic.

Testing of humidity sensitive and thermal plastics which quickly degrade

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. An optional nitrogen envelope around the test barrel prevents the direct contact of the material with the surrounding air. The test is then performed in exactly defined time sequences which are recorded by the Software. The extrusion plastometer fulfills special requirements regarding spatial and time temperature distribution within the test barrel.



Extrusion Plastometer Cflow

Testing of PVC

Testing of PVC is defined in ASTM D 3364. A longer orifice with a cone shaped orifice entrance (25.43 / 2.095 mm), is required, as well as a special test weight of 20 kg.

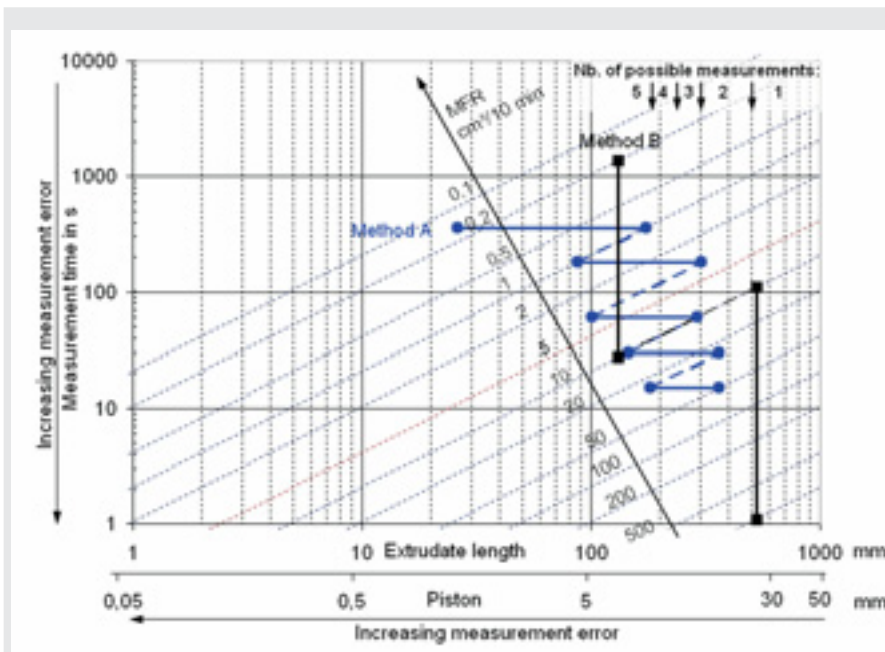
2. Technical characteristics of the extrusion plastometer

Automatic, operating map controlled parameter setting

For testing to ASTM D 1238 method A, specific test times are called for, whilst tests to method B are to be performed with fixed test travels of 6.35 mm (1/4") or

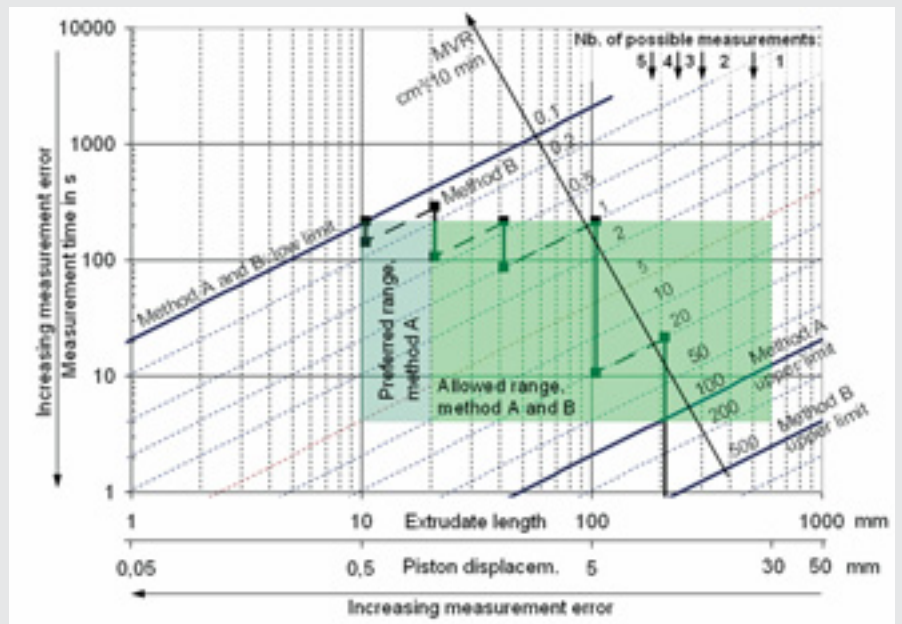
25.4 mm (1"). Alternative Standards such as ISO 1133 prescribe time-travel data fields or different test travels (method B) from 0.5 to 10 mm.

Tests to ISO 1133 offer many more options for setting the test parameters than ASTM D1238 because of the definition of the data fields.



ASTM D 1238-operating map - time related (Method A), travel related (Method B)

ISO1133-operating map shows the allowed test parameter settings



Therefore when testing to ISO, it is much more difficult to select optimum test parameters with the least systematic test uncertainties.

The prior diagrams show the relationship between the specifications in the Standards, the test parameter setting, and the test uncertainties' tendencies: If a given material of an MVR value of 10 should be tested, ISO 1133 allows the test parameters to be set within the field „Allowed range, method A and B“. Additionally, minimum piston travel is prescribed (line profile „Method B“). Only the range left from this line profile may be used for parameter setting and preferably the range along the dotted line „MVR = 10“. Under these conditions and, using a piston travel of 6 to 8 mm, a test would consist of 5 individual measurements (darts on top left of the diagram). The higher the piston travel would be set, the less test uncertainties would occur, but under condition of less individual measurements. As for tests to ASTM D 1238, the test parameter setting is similar.

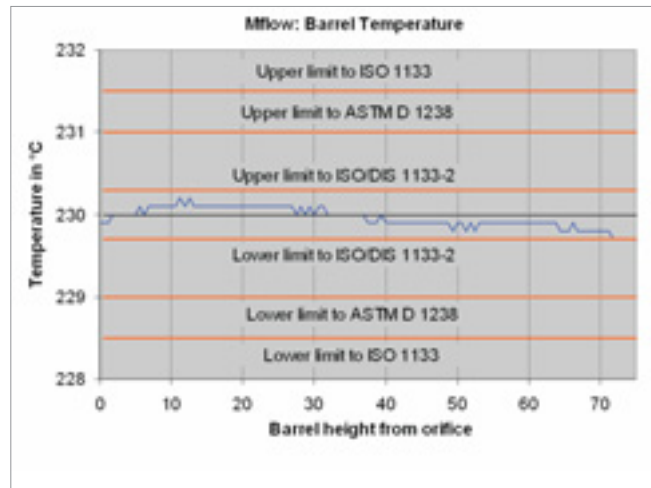
With all Zwick extrusion plastometers the test, or cutting times, and the test travel can be selected directly by the operator and the test is then performed.

The Mflow can, in addition, automatically and quickly select the test parameters within the instrument's and the Standard's operating map. With this operating map control, the test parameters which will give the least systematic test errors are automatically selected, depending on the expected MVR. Each test will be performed with the best possible test accuracy without exceeding the prescribed time and piston travel limits given in the standards. The parameters, which are automatically found during a test, can be stored in the instrument and are available for future tests.

In addition to the standardised status data fields, innate data fields can be defined. The test accuracy and the number of measurements per filling are always in a fixed area.

Innovative temperature control for extremely good temperature distribution

Zwick does not use traditional heating sleeves which require several temperature regulators and lead to uneven heat distribution.



The temperature distribution complies to ISO/CD 1133-2

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 an extremely good spatial and time temperature distribution is achieved.

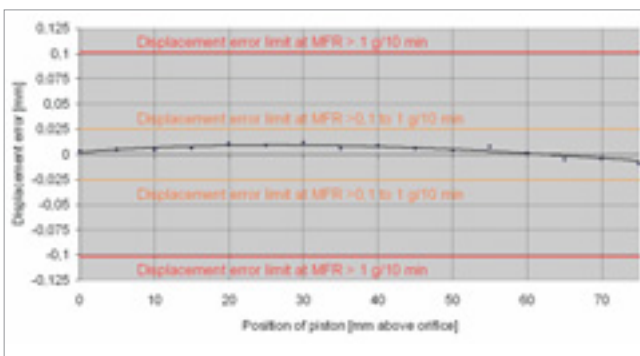
Precision testing units for travel and time and for precise MFR and MVR values.

A accurate travel sensor ensures consistent and precise measurement of the piston travel during the MVR determination. The touching point is very close to the test piston which greatly minimises any possible error.



Mflow: its extensometer measures with high precision

In method B, the accuracy of the flow rate determination depends on the synchronisation of the time-travel data pairs and from the accuracy of the time determination. Since both test dimensions: time and travel are available in digital form from the beginning, an analog-digital conversion, with its inherent time delays, is not required. This prevents any possible synchronisation errors. The use of quartz crystal time measurement also allows measuring on materials with higher flow rates.

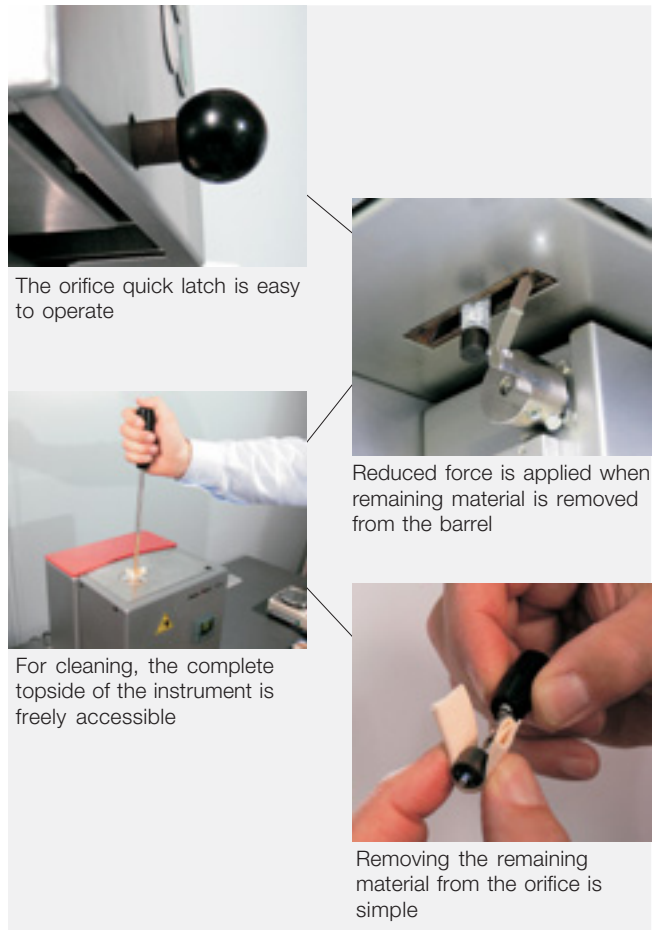


Mflow: Measuring uncertainties are definitely within the given limits

Simplified cleaning and removal of remaining material

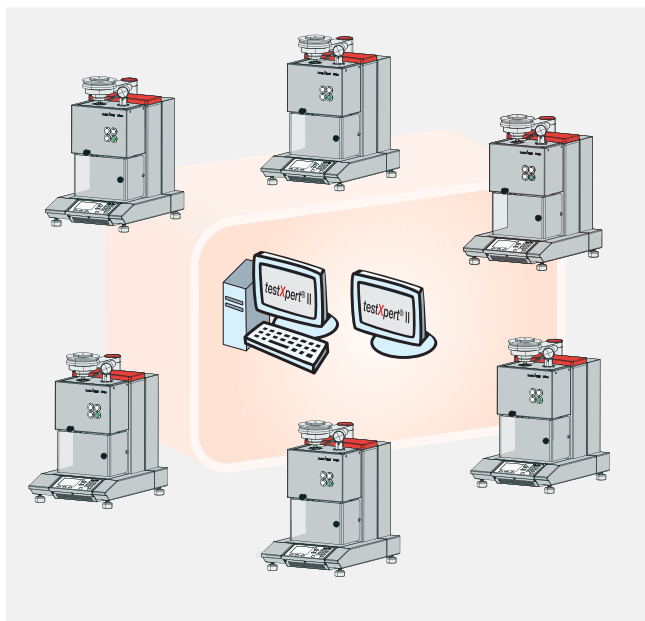
The orifice quick latch is located on the lower side of the barrel. After pulling the latch, the orifice is free from below and can be easily removed.

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.



Management of several Mflow Extrusion Plastometers with one PC

Up to six Mflow instruments can be controlled from one PC with the multi-instrument operation under *testXpert*® II. Central operation and results storage from one work place optimizes laboratory space and allows a fast overview of all tests running.



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

Under *testXpert*®, up to six instruments can be operated from one PC using a USB interface. 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 secure

With more than 10,000 successful installations, *testXpert*® is already established as the worlds leading materials and component testing software. Building on this experience, we have developed a further innovation leap with the new software generation for materials testing: *testXpert*® II.

We guarantee the dependability of our products and services under the brand – Made in Germany. Certification to ISO 9001 with inclusion of all company processes, including software development, indicates the quality oriented focus of Zwick. This process has been validated by well-known companies according to FDA, ISO and other guidelines. This means that the highest standards of quality are guaranteed. *testXpert*® II is secure.

Automatic bubble detection with *testXpert*® II

Gas inclusions in the fused plastic material cannot absolutely be 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 by an outlier test and then be excluded. Consequently, often a repetitive, time consuming, second barrel filling had to be tested.

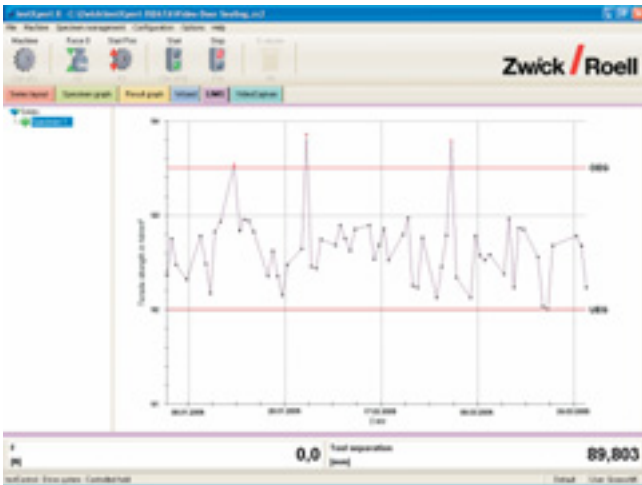
testXpert® II is intelligent: Since the piston speed is controlled in a method B test, the quick piston travel, where gas inclusions occur, is automatically recognized. This quick piston travel is now excluded from the test result evaluation. The remaining curve is completely available for test result evaluation. When this method is used, repeat measurements are no longer necessary.



A bubble is recognized and eliminated from the valid travel

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.



Process control diagram shows the process quality

This solution which is fully integrated in testXpert® II and 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 all done automatically by testXpert® II and all data, even from several instruments, is stored for later access and analysis in a data bank.

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

- Quick language swapping from German to English
- Input of the Standard to be used and the required characteristic field control
- Input and storage of self-defined characteristic fields
- Manual inputs of test parameters
- Input of the test method to be used (A, B)
- Automatic storage of the parameters used when the instrument is turned off
- Output of test results: individual values and statistical characteristic values (median value, standard deviation, coefficient of variation)

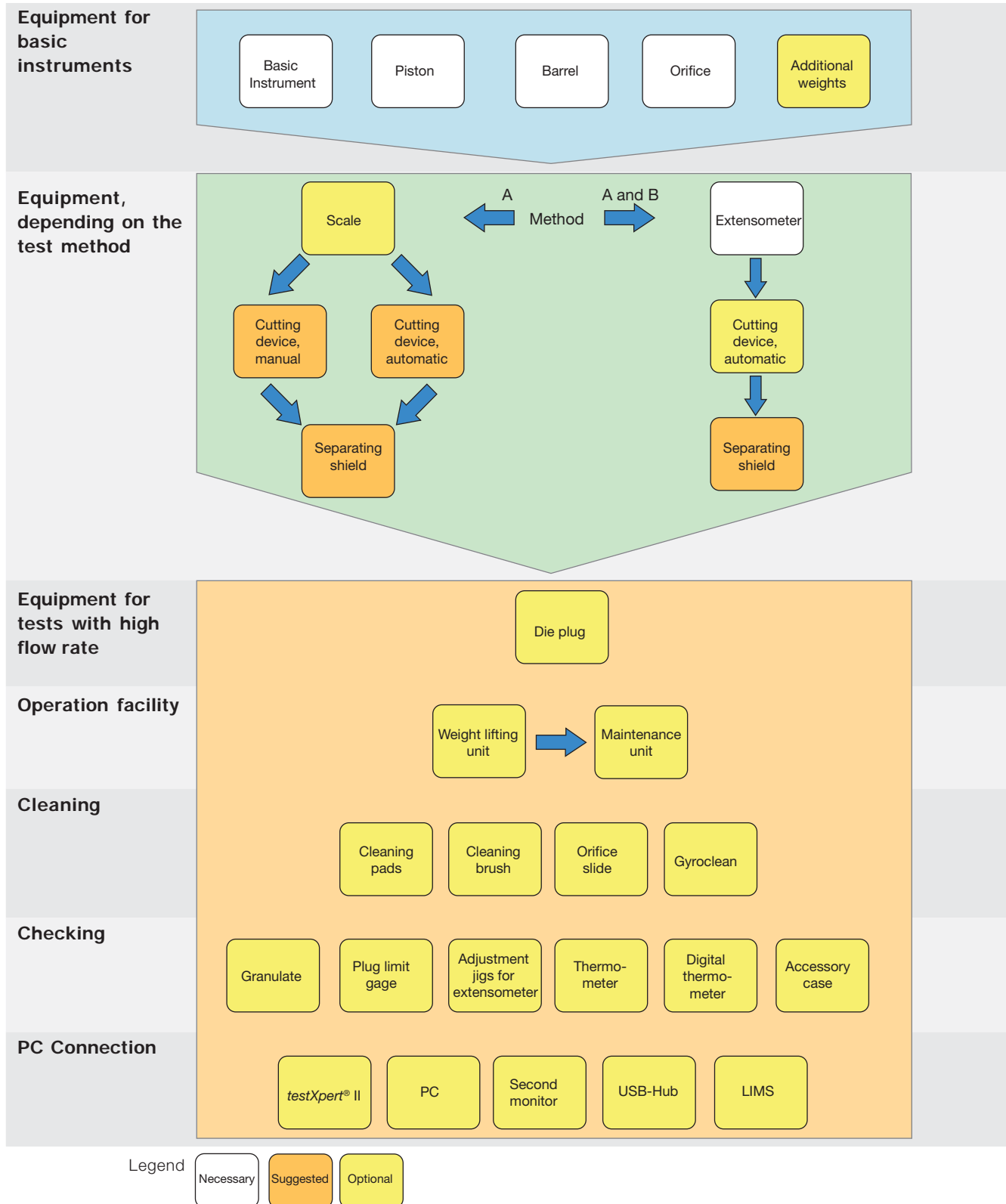


The clearly arranged control panel indicates all parameters and test results

The test instruments

Plastics manufacturers, compounders and processors, test the flow rate with various intensity: Zwick has the correct test instrument, beginning with the manually operated Cflow, the modular, expandable Mflow, or the Extrusion Plastometer Zwick 4106, which is equipped for automatic operation.

3. Mflow modules at a glance:



Technical Data of the Mflow Extrusion Plastometers

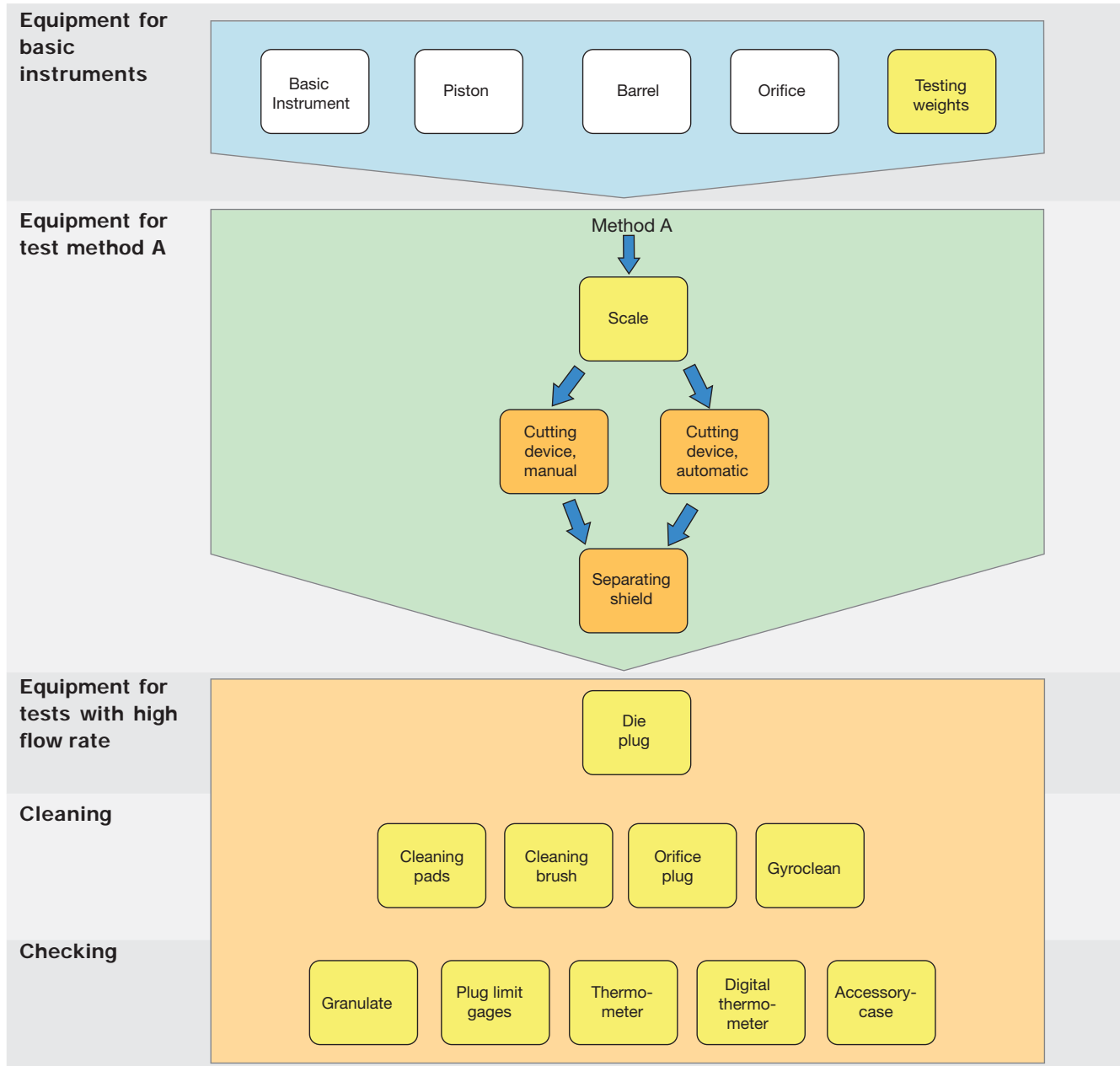
Basic instrument

The Mflow extrusion plastometer in its basis version is equipped for MFR testing to Method A and can be expanded for MVR testing to Method B. The standard delivery of the extrusion plastometers comprises 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 and a filling channel for the granulate are also included. Testing can be performed to the following standards: 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 |

| Technical data of the instruments | |
|---|---|
| General | |
| Power consumption | 500 W |
| Compressed air, oiled, dry (Option for pneumatical 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, allequipment 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 laboratory/analysis balance 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 change in the area of 0 to 75 mm over the orifice in the temperature range of 125°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) | 0.05 s using automatic 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 |
| Computer configuration for multiple instrument operation on one PC via USB-Hub - max. 6 Mflow per PC are possible. | |
| Available RAM-working storage, minimum | 1.53 GB |
| Tact frequency | 3 GHz |
| Number of occupied PC-USB-slots per 3 Mflow-instruments | 1 |

4. Cflow modules at a glance:



Technical data of the Cflow Extrusion Plastometers

Basic instrument

The Cflow extrusion plastometer is designed for MFR testing to Method A. The standard delivery of the extrusion plastometers comprises 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 and a filling channel for the granulate. Testing can be performed to the following standards: 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 |

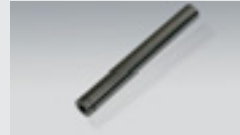
| Technical data of the instruments | |
|--|---|
| General | |
| Power consumption | 500 W |
| Weight | 46.6 kg |
| Dimensions: Height x Width x Depth | 850 x 270 x 400 mm |
| Keypad | Pressure point - plastic foil keypad |
| Display | alphanumeric, back-lit |
| Operational ranges | |
| Test loads | 0.325 up to 21.6 kg |
| Temperature range | +125 up to +450 °C |
| Error limits | |
| Temperature change in the area of 0 to 75 mm over the orifice in the temperature range of 125°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) | 0.05 s using automatic cutter |

5. Accessories for the Cflow and Mflow Extrusion Plastometers

Barrels

- For fluorine-free plastics
- For fluorine-containing plastics

Can be easily changed in minutes.



Pistons

- For fluorine-free plastics
- For fluorine-containing plastics

With heat-insulated mass.



Orifices

to ISO 1133 and ASTM D 1238

- For fluorine-free plastics
- For fluorine-containing plastics

to ASTM D 3364

For tests on PVC.

to BS 2787-7, Method 720 A

For tests to method A.



Orifice plug

For tests on high flow rate plastics.



Extrudate cutter, manual operation

For tests to method A.

To cut a sample in one turn.



Extrudate cutter, automatic operation

For tests to method A or B.

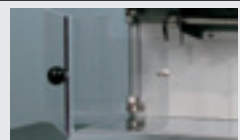
Fits best for test to method A in short time distances.



Protective door

Fits together with extrudate cutters.

Protects the operator from sputtered specimen cuts.



Additional weights

To load steps according to standards.

The weights are easy to handle, as the max. weight is approx. 6,6 kg.



Balances

Laboratory- and analysis balances are available.

Balances can be connected to the Mflow as well as to a PC under *testXpert*®.



Further accessories

- Test granulates for checking the plastometer
- Plug limit gages for checking orifices or barrel
- Funnel and dosing spoon for granulates
- Cleaning pads and -brushes for the barrel
- Cleaning drills for orifices
- Gyroclean – electrically operated cleaning instrument for barrels
- Control thermometers
- Protective gloves and spectacles
- Accessory-case, empty, with accessory insert for gages etc.

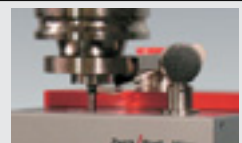


The following accessories are only available for the Mflow:

Extensometer

For tests to Method B.

High precision extensometer, simple to attach.



Pneumatic weight lifting unit

To release the operator from heavy lifting.

Can be retro fitted at any time.



Accessories for PC operation

- *testXpert*® II Software
- *testXpert*® II LIMS Software for Laboratory data acquisition
- Hub(s) to connect 3 (6) Mflows to one PC
- Additional 2nd screen when operating several Mflow plastometers





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