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# Extrusion Measuring Device

## Method: Capillary Extrusion

Type EXTRA.02

## Operating Manual/Equipment Documentation

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## 1. Description

### 1.1 Extrusion rate measurement

A nozzle with a specified diameter and length is screwed onto the opened cartridge tip. With a punch, the product is loaded in the cartridge via the rear end lid with a defined force for a specified time. The extruded quantity is weighed and recorded as a product parameter. The measurement method is based on the fact that viscous liquids resist extrusion through a capillary with a specified cross-section and length with a velocity-dependent resistance, which is determined by the shear viscosity of the medium. The result depends on the shear viscosity value at a defined compressive load (a point on the shear viscosity curve of the capillary rheometer). This makes it easy to check filled cartridges.

### 1.2 Measuring instrument concept

The extruding piston load is carried out by a constant mass, which enables a precise pressure load and thus a force curve over the adjustable measuring time. The product to be measured is pressed out via an extrusion nozzle screwed onto the cartridge tip. A scale is positioned underneath the cartridge to measure the amount extruded. The cartridge holder prevents the cartridge jacket from expanding and defines the pressure in the cartridge via the diameter. At the same time, the defined expansion of the cartridge jacket minimizes the friction of the end cap.

In order to keep system-related measurement deviations small, especially with older cartridges, the "pre-pressing" function can be used to avoid solidified mass or air at the nozzle tip or a breakaway effect of the end finish cap.

The squeezing force is generated by a moving mass and thus enables a high degree of accuracy and consistency of the test sequence. The measuring time begins after the pressure has been built up. At the end of the set test time, the squeezing pressure is terminated by lifting off the mass. A scale is used to determine the amount squeezed out.

The system is controlled via an embedded PC integrated into the device with real-time control and a 6.4" TFT monitor as well as special input keys. Certain functions can be set with a mouse that can be connected via the USB interface. An Ethernet interface is available for data communication.

### 1.3 Influencing factors and assessment of the measurement results

The aim is to determine a product characteristic value for the reliable characterization of a product property, which is independent of boundary conditions of the measurement setup. The following points influence the test result and must be considered when assessing the measurement:

- The friction of the end lid of the cartridge is low in relation to the pressure and is neglected. If higher breakaway forces are to be expected in the rear resting position, this effect can be excluded via the pre-press function.
- the test force creates a constant squeezing pressure in the cartridge, which determines the extrusion rate. The pressure is calculated using the function  $p = F/A$ . During the printing phase, the casing of the cartridge is expanded to the inner diameter of the cartridge holder of 50.65 mm. Differences in the wall thickness of the cartridges influence the punch printing surface A and thus the extrusion pressure p at a constant pressing force F.
- The degree of filling of the cartridge influences the pressure build-up and pressure release behavior during the pressing process. Due to compressibility and cartridge expansion, the pressure build-up speed is slower with full cartridges than with partially filled cartridges. Pressure relief with slightly greater friction on the end cover is also slower with full cartridges, as more compression volume is available.
- The design and tolerance of the extrusion nozzle largely determines the extrusion rate. The type of nozzle must be specified. Standard: diameter 3 mm, length 10 mm, inlet and outlet rectangular and sharp-edged.
- Measuring time: The measurement time begins when the pressure on the cartridge is completely built up and ends when the load mass is lifted. Pressure build-up and pressure relief are not considered.
- The weighing tolerance is determined by the scale used and can be selected according to your needs.

## 2. Startup

The tester is supplied with a cartridge holder, standard extrusion nozzle, instruction manual and power cord. For wading purposes, a protective sleeve is supplied as a replacement for the cartridge holder. The device is attached to a pallet and is secured for transport.

The Extrusion Rate Meter is a precision measuring device and must not be exposed to major shocks. It is designed for a long service life with consistent measurement quality.

**ATTENTION:**

**Check the device for transport damage!**

**Only connect the device to a properly grounded socket!**

**Housing parts may only be removed by a specialist!**

### 2.1 Installation

The device is transportable and designed to be placed on a table.

**Caution:** The load capacity of the table must be designed for the device mass of approx. 230 kg.

**Procedure:**

1. Remove the device from the packaging.
2. Inspect the device for damage in transit
3. Place the device horizontally on a suitable table at the measuring location, no attachment is required.
4. Before connecting the device, the transport locking wood pieces of the load weights must be removed.
5. Plug the device into a properly grounded outlet using the supplied power cord.

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## 2.2 Starting up

The tester is calibrated and tested before shipping. To launch the extrusion rate meter, please perform the following steps:

1. Turn on the power button on the control panel.
2. Immediately after powering on, the Linux RT operating system and the control software start. The position of the squeezing punch is displayed graphically on the monitor.
3. Once the cartridge holder is latched in, the squeezing punch is automatically positioned in the rear end position. If the cartridge holder is not latched, the movement of the punch is blocked for safety reasons.
4. After positioning the squeezing punch in the rear end position, the measuring device is ready for operation.
5. After 10 minutes, the load mass goes into a safety position. The compound is placed on a crossbar and the tension belt is relieved. After pressing any button, the load mass is unlocked again.

## 3. Operation

The user is guided by a control panel with screen and function keys.  
The measurement process is fully automated.

The individual operating steps:

### 3.1 Prepare the cartridge with the squeezing nozzle

### 3.2 Perform Measurement

### 3.3 Removing the cartridge

### 3.4 Configuration

#### 3.1 Prepare the cartridge with the squeezing nozzle:

Preparation of the filled cartridge for measurement:

The sealed tip of the cartridge is opened with a suitable cutting tool. The opening cross-section should be at least 4 mm in diameter to avoid measurement errors.

The extrusion nozzle is screwed onto the cartridge. To prevent contamination of the nozzle, a 50 µm PE film can be clamped between the cartridge tip and the extrusion nozzle. Extrusion printing destroys the film in the extrusion cross-section.

The cartridge is inserted into the cartridge holder and latched into the measuring device. A start of the measuring device is only possible if a cartridge holder or the service element is latched on. The latching function is monitored by a sensor.

#### 3.2 Perform Measurement



After the cartridge has been positioned in the device, the measurement can begin.

The measurement time is set via the + or – button. The measurement is started either with "pre-pressing" or with "measuring" directly. With the pre-press function, undesirable defects caused by solidified mass at the nozzle tip or solidification at the end cover can be ruled out. The mass, which has been pressed out by pre-pressing, is removed. The mass extruded with the "Measuring" function is weighed on a suitable scale and the extrusion rate of the mass is determined.

The position of the squeezing punch is graphically displayed on the screen.

With the "Down" and "Up" buttons, the punch position can be changed manually. If the "Open" button is pressed during the measuring or pre-pressing process, the measurement or pre-pressing is aborted.

If no further measurement is carried out within 10 minutes, the flange mass moves to the securing position, which can be removed by pressing any button.

The pre-pressing time is preset to 0.5 sec. This time can range from 0.5 ... 10 seconds. To change it, plug in a computer mouse to the USB port on the left side of the device and press the arrow keys on the TFT panel next to the time display.

### **3.3 Removing the cartridge**

At the end of the measurement, the cartridge is removed from the measuring device and the extrusion nozzle is unscrewed. The extrusion nozzle must be cleaned before the next series of tests in order to avoid vulcanization with narrowing of the cross-section. The use of a PE film avoids coarser soiling.

### **3.4 Configuration**

The automated measurement sequence is configured on the control panel of the screen. The following parameters can be set on the measuring device:

|                    |                                                   |
|--------------------|---------------------------------------------------|
| Pre-pressing time: | (0.5 to 10 $\pm 0.01$ ) sec<br>Increments 0.5 sec |
| Measurement:       | (1 to 30 $\pm 0.01$ ) sec<br>Increment 1 sec      |

## 4. Maintenance

### 4.1 Maintenance work

The carrying strap for moving the moving mass must be replaced every 5 years to eliminate the risk of cracking due to ageing.

In addition to general cleaning of the squeezing punch, the device is designed to be maintenance-free.

### 4.2 Calibration / Adjustment

The decisive factor for the use of a test device is the quality of the measurement result. Two methods are used to verify the quality of the measurement, which have a decisive influence on the measurement reliability in testing technology.

#### Calibrate

Calibrating measuring instruments means comparing them with verifiably known physical quantities and documenting the result. If the result is not within the tolerable range of the measuring device, adjustment or adjustment is required.

According to DIN ISO 9000ff, measuring equipment must be continuously monitored. Monitoring shall be ensured by traceability for all measurements and calibrations to national standards. This procedure is necessary for a measuring device to measure tolerances not only with the highest precision, but also at a verifiable level. Faulty measuring standards subsequently lead to incorrect settings on the measuring device and undetectable systematic measurement errors.

#### Calibration periods

The calibration of measuring instruments is usually carried out at intervals of 0.5 to 2 years. Shorter intervals are not necessary, as no discernible deviations are to be expected during this period. By checking the mass, the squeezing force is controlled. The measurement time is determined by the system time of the control processor.

#### 4.1.1 Calibration Process

The calibration requires compliance with the specifications in the manufacturer's test certificate M according to DIN 55350 Part 18. The calibration is carried out with special calibration tools by qualified personnel. The individual values stated in the test report (point 4.4) must be adhered to in order to ensure the accuracy of the measurement results.

## 4.3 Calibration dates

Customer-specific information about calibration dates

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## 4.4 Calibration Certificates / Test Reports

Filing of calibration certificates and test reports

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## 5. Error handling

Error handling requires the chronological recording of the errors that have occurred and the measures to be taken to correct them. A suitable list is provided in Appendix E "Equipment History" in this Instruction Manual. With consistent recording, the quality of the test equipment can be proven in a very simple way.

### 5.1 Error states

#### 5.1.2 Device not operational

Check power supply (100 ... 240 V ~ 50 ... 60 Hz) and the fuse (3.15A)  
Will the measurement screen be displayed after turning it on?  
Is the cartridge holder clicked in correctly? (Position is monitored by sensor)  
Does the tracking compound move to the starting position? (see screen)

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## 6.Options

### 6.1 Accessories

#### 6.1.1 Standard Accessories

- Operating instructions
- Power cord
- Standard extrusion nozzle made of 1.4301
- Cartridge carrier
- Protective sleeve for service work

#### 6.1.2 Additional Components

- Scales
- Extrusion nozzles as required
- Cartridge carrier as required

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## 6.2 Interfaces (PC, printer, host,...)

The device is controlled via an embedded PC and has various interfaces for communication:

- Ethernet RJ45
- USB

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## **6.3 Software modules**

### **6.3.1 Standard**

### **6.3.2 Add-on modules**

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## 6.4 Hardware for displaying and recording measurement results

## **Appendix A**

### **Specifications**

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## **Appendix B**

### **Drawings / Illustrations**

## **Appendix C**

### **EC Declaration of Conformity**

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## Appendix D

### Standards / Bibliography

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## Appendix E

**Device history (orders / changes / errors etc.)**

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## Appendix F

**General. Information/Publications/...**

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## Appendix G

### Brochures/device information