Porosity Test Using High Voltage

Search for pores and defects in linings and coatings made of enamel, lacquer, rubber and bitumen as well as in containers made of GFK and other synthetics.

FISCHER is a leading multi-national company in the field of electronic coating thickness measurement and materials testing instruments. The company is able to recommend the best coating thickness measuring instrument for any application, due to the company's extensive experience in this field. The wide range of instruments includes models for coating thickness measurements according to the X-ray fluorescent, Beta Backscatter, magnetic induction, eddy current and coulometric methods. Additionally, the program includes instruments for measuring micro-hardness, ferite content, and porosity testing. FISCHER is active around the world. Instruments manufactured by our company are used in many countries. FISCHER has subsidiaries in eight different countries.

Active Around the World

FISCHERSCOPE® X-Ray to measure the coating thickness according to the X-ray fluorescence method.

The high quality standard of FISCHER instruments is the result of our efforts to provide the very best instrumentation to our customers.

FISCHER is a reliable and competent partner offering expert advice, extensive service, and training seminars.

Today, FISCHER instruments are used successfully in all technological fields of industry and research.

FISCHERSCOPE® H100 to determine the universal hardness HU of thin coatings and films.

Micro hardness measurement unit DUALSCOPE® MP40 with probe ED10 to measure coating thickness on ferromagnetic, as well as non-ferromagnetic materials with automatic recognition and selection of the measurement method.

Micro hardness measurement unit FISCHERSCOPE® H100 to determine the universal hardness HU of thin coatings and films.

DUALSCOPE® MP40 with probe ED10 to measure coating thickness on ferromagnetic, as well as non-ferromagnetic materials with automatic recognition and selection of the measurement method.

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Applications, Test

Applications
To protect objects made of steel or metal, they are coated with corrosion resistant materials such as rubber, synthetics or enamel. The protective coatings must be tight, that is, free of pores cracks or embedded foreign objects, to keep aggressive materials from the carrier material that is in danger of corrosion. Fine pores or cracks cannot be entirely avoided with any coating process.

With the POROSCOPE® HV20 and the POROSCOPE® HV20D, even pores and cracks not visible to the eye can be found and accounted for in electrically non-conducting protective coatings.

• A frequent application is the pore test in containers lined with enamel or synthetics, such as:
  - mineral oil tanks,
  - agitator tanks,
  - pipelines,
  - boilers,
  - heat exchangers.
This is the ideal application for the POROSCOPE® HV20.
• Coatings and materials that tend to electrostatic charging are generally not suited for pore testing with high voltages using conventional methods due to their electrostatic charging. Now, even these coatings and materials can be tested for pores with the POROSCOPE® HV20D. This instrument will not result in erroneous functions due to electrostatic charging of the material. For example, condenser or packaging film made of synthetic materials can be tested for pores. One of the reversing rollers of the foil plant can be used as the electrically conducting base, or samples can be mounted on metal plates for the test.

Test
Required equipment:
• Test instrument POROSCOPE® HV20 (or HV20D)
• Ground connection cable
• Test head with test head cable
• Electrode (screws onto test head)

The suitable test voltage is set according to the disruptive strength and thickness of the coating. The specimen is grounded and the electrode is moved slowly across the surface to be measured. The voltage drops briefly when the electrode passes a defective spot, a sparkover as well as an acoustical signal indicate the pore. For the test, the surface must be dry; there should be no condensation on the coated surface. A moisture film would dissipate the voltage immediately; the test voltage would not build up and the test would not be possible. Electronic test voltage monitoring provides a signal when the test voltage drops below the required minimum voltage.

Test of the interior coating of a pipe with the POROSCOPE® HV20 using a rotating electrode on a rot-extension system.

The test instruments POROSCOPE® HV20 and HV20D are equipped with electronic test voltage monitoring. A green LED on the instrument indicates that the set test voltage is present at the electrode. The green LED extinguishes when the voltage falls by more than 5% below the nominal value.

Poroscopy and HV20D

Description HV20 and HV20D
The LCD display shows the high voltage in kV that is present directly at the electrode. Test voltage is continuously adjustable. The high voltage is generated in the test head. The electrical energy at the test electrode is designed such that the max. short circuit current will not exceed 25 mA. The DC test voltage at the electrode can be switched on and off from the test head.

Pore indication
The pore indication occurs optically through red LEDs at the test head and the test instrument as well as through an acoustical signal at the test head. The pore detection sensitivity is selectable with both instruments. The size of the voltage drop at which pores should be detected can be set.

Test voltage monitoring
The test instruments POROSCOPE® HV20 and HV20D are equipped with electronic test voltage monitoring. A green LED on the instrument indicates that the set test voltage is present at the electrode. The green LED extinguishes when the voltage falls by more than 5% below the nominal value.

Features
• Low-energy, and therefore safe, high voltage.
• High voltage generation in the test head.
• Two test head versions with test voltage ranges: 0.3 to 3 kV and 2.5 to 25 kV can be connected.
• Extensive electrode selection
• Continuously adjustable test voltage.
• Display of the test voltage that is present directly at the electrode.
• Electronic test voltage monitoring.
• Optical indication at the test head and the test instrument when a pore is detected. Additionally, an acoustical signal will sound at the test head.
• The pore detection sensitivity is adjustable. Depending on the setting, pores are indicated at short 20 to 50% voltage drops.
• Battery or line operation (switchable).
• Connector for external 12 V voltage supply.
• Connector for external On/Off switch of test voltage and isolated relay contacts to control acoustic signals or pulse counters.

Measurement Method, Features

Measurement Method
The test method is based on the fact that all electrically insulating coating materials have a much higher disruptive strength than air. Pore detection occurs at the defective spots through a spark-over (short circuit) between the test electrode and the conducting base. A defective spot may be a thin air channel (pore, crack) or a coating that is too thin over the conducting base underneath.

Test of the enamel coating of a boiler using the POROSCOPE® HV20.

The suitable test voltage is set according to the disruptive strength and thickness of the coating. For the test, the surface must be dry; there should be no condensation on the coated surface. A moisture film would dissipate the voltage immediately; the test voltage would not build up and the test would not be possible. Electronic test voltage monitoring provides a signal when the test voltage drops below the required minimum voltage.
Applications, Test

Applications
To protect objects made of steel or metal, they are coated with corrosion resistant materials such as rubber, synthetics or enamel. The protective coatings must be tight, that is, free of pores cracks or embedded foreign objects, to keep aggressive materials from the carrier material that is in danger of corrosion. Fine pores or cracks cannot be entirely avoided with any coating process.

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A frequent application is the pore test in containers lined with enamel or synthetics, such as:
- mineral oil tanks, agitator tanks, pipelines, boilers, heat exchangers.

This is the ideal application for the POROSCOPE® HV20.

- Coatings and materials that tend to electrostatic charging are generally not suited for pore testing with high voltages using conventional methods due to their electrostatic charging.

Now, even these coatings and materials can be tested for pores with the POROSCOPE® HV20D. This instrument version will not result in erroneous functions due to electrostatic charging of the material. For example, condenser or packaging film made of synthetic materials can be tested for pores. One of the reversing rollers of the foil plant can be used as the electrically conducting base, or samples can be mounted on metal plates for the test.

Test

Required equipment:
- Test instrument POROSCOPE® HV20 (or HV20D)
- Ground connection cable
- Test head with test head cable
- Electrode (screws onto test head)

The suitable test voltage is set according to the disruptive strength and thickness of the coating. The specimen is grounded and the electrode is moved slowly across the surface to be measured. The voltage drops briefly when the electrode passes a defective spot, a sparkover as well as an optical and acoustical signal indicate the pore. For the test, the surface must be dry; there should be no condensation on the coated surface. A moisture film would dissipate the voltage immediately; the test would not be possible. Electronic test voltage monitoring provides a signal when the test voltage falls below the required minimum voltage.

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The test method is based on the fact that all electrically insulating coating materials have a much higher disruptive strength than air. Pore detection occurs at the defective spots through a spark-over (short circuit) between the test electrode and the conducting base. A defective spot may be a thin air channel (pore, crack) or a coating that is too thin over the conducting base underneath.

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- High voltage generation in the test head.
- Two test head versions with test voltage ranges: 0.3 to 3 kV and 2.5 to 25 kV can be connected.
- Extensive electrode selection
- Continuously adjustable test voltage.
- Display of the test voltage that is present directly at the electrode.
- Electronic test voltage monitoring.
- Optical indication at the test head and the test instrument when a pore is detected. Additionally, an acoustical signal will sound at the test head.
- The pore detection sensitivity is adjustable. Depending on the setting, pores are indicated at short 20 to 50% voltage drops.
- Battery or line operation (switchable).
- Connector for external 12 V voltage supply.
- Connector for external On/Off switch of test voltage and isolated relay contacts to control acoustic signals or pulse counters.

Description HV20 and HV20D

The LCD display shows the high voltage in kV that is present directly at the electrode. Test voltage is continuously adjustable.

The high voltage is generated in the test head. The electrical energy at the test electrode is designed such that the max. short circuit current will not exceed 25 mA. The DC test voltage at the electrode can be switched on and off from the test head.

Pore indication
The pore indication occurs optically through red LEDs at the test head and the test instrument as well as through an acoustical signal at the test head. The pore detection sensitivity is selectable with both instruments. The size of the voltage drop at which pores should be detected can be set.

Test voltage monitoring
The test instruments POROSCOPE® HV20 and HV20D are equipped with electronic test voltage monitoring. A green LED on the instrument indicates that the test voltage is present at the electrode. The green LED extinguishes when the voltage falls by more than 5% below the nominal value.
Technical Data, Content of Shipment, Order Information

Technical Data
Voltage supply/charge voltage for installed battery (12 VDC): 220 VAC / 50 ... 60 Hz
Battery operation: about 2 h continuous operation
Battery monitoring: green LED on the test instrument lights, when the battery voltage is no longer sufficient to maintain the set test voltage
Test voltage (continuously adjustable range): Test head HV3PK: 0.3 ... 3 kVDC
Test head HV20PK: 2.5 ... 25 kVDC

Dimensions [mm]
Test instruments: Test head HV3PK: 0.3 ... 3 kVDC
Test head HV20PK: 2.5 ... 25 kVDC

Ordering Information HV20 and HV20D

Test instruments

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>POROSCOPE™ HV20</td>
<td>Portable direct current pore</td>
<td>601-933</td>
</tr>
<tr>
<td></td>
<td>test instrument</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with continuously adjustable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>test voltage</td>
<td></td>
</tr>
<tr>
<td>POROSCOPE™ HV20D</td>
<td>Portable direct current pore</td>
<td>602-734</td>
</tr>
<tr>
<td></td>
<td>test instrument</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with continuously adjustable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>test voltage</td>
<td></td>
</tr>
</tbody>
</table>

Test head cable
Connecting cable between test instrument and test head.

Test heads for HV20 and HV20D

Depending on the application, the desired electrode can be screwed onto the test head.

<table>
<thead>
<tr>
<th>Type</th>
<th>Test voltage</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test head HV3PK</td>
<td>0.3 ... 3 kV</td>
<td>601-935</td>
</tr>
<tr>
<td>Test head HV20PK</td>
<td>2.5 ... 25 kV</td>
<td>601-934</td>
</tr>
</tbody>
</table>

Test voltage display
- LCD
- Fails by more than 5% below nominal

Test voltage display error:
- ≤ 5 %
- Pore indication:
  - acoustic: Alarm signal at test head optical: red LED at test head and instrument
- Pore detection sensitivity:
  - detection threshold settable between 20 and 50% voltage drop

Test voltage monitoring:
- green LED, extinguishes when voltage falls by more than 5% below nominal value

Environmental conditions during operation:
- 0 ... +40 ºC (32 ... +104 ºF) and
- 0 ... 60 % RH, no condensation on test surface

Storage temperature:
- 0 ... +60 ºC (32 ... +140 ºF)

Standards:
- Instrument safety: VDE 0411/1, pasture fence ordinance
- DIN 55670, DIN 28055-2, DIN 4753-3

Selection table for flat, sweeper, circular ring and roller electrodes

<table>
<thead>
<tr>
<th>Flat electrodes</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Dimensions [mm]</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZH2a</td>
<td>600-690</td>
<td>≈ 180</td>
<td>80 x 140 (3.2 x 5.5&quot;)</td>
<td>with replaceable rubber trimming</td>
</tr>
<tr>
<td>ZH2b</td>
<td>600-692</td>
<td>≈ 200</td>
<td>80 x 250 (3.2 x 9.8&quot;)</td>
<td>with replaceable rubber trimming, can be pivoted and secured on all sides using a ball joint</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sweeper electrodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order no.</td>
</tr>
<tr>
<td>ZH6a</td>
</tr>
<tr>
<td>ZH6b</td>
</tr>
<tr>
<td>ZH6c</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circ. ring electrodes</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Pipe ID [mm]</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZH7a</td>
<td>600-736</td>
<td>200</td>
<td>100 (4&quot;)</td>
<td></td>
</tr>
<tr>
<td>ZH7b</td>
<td>600-737</td>
<td>220</td>
<td>133 (5.2&quot;)</td>
<td></td>
</tr>
<tr>
<td>ZH7c</td>
<td>600-738</td>
<td>250</td>
<td>159 (6.3&quot;)</td>
<td></td>
</tr>
<tr>
<td>ZH7d</td>
<td>600-739</td>
<td>300</td>
<td>220 (8.7&quot;)</td>
<td></td>
</tr>
<tr>
<td>ZH7e</td>
<td>600-740</td>
<td>400</td>
<td>273 (10.7&quot;)</td>
<td></td>
</tr>
<tr>
<td>ZH7f</td>
<td>600-741</td>
<td>600</td>
<td>324 (12.8&quot;)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Roller electrode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order no.</td>
</tr>
<tr>
<td>ZH10a</td>
</tr>
</tbody>
</table>

Electrodes, Order Information

Electrodes for HV20 and HV20D

Overview of the various electrodes.

a) Sweeper electrode  b) Flat electrode  c) Roller electrode  d) Rotating electrodes for tests inside pipes  e) Circular ring electrode for tests on the outside walls of pipes

Suitable electrodes are available for every application. The desired electrode is simply screwed onto the test head.

Sweeper electrodes:
- Pore testing of large-area enamel, rubber and synthetic coatings.

Flat electrode with replaceable rubber tongue:
- Pore testing of paint coatings.
- Roller electrode:
  - Pore testing of foils.
  - Circular ring electrodes:
    - Pore testing of exterior pipe walls.
    - The circular ring electrodes swing open for easy placement around a pipe.
    - Rotating electrodes:
      - Pore testing of interior pipe walls.
      - Flat electrode with replaceable rubber tongue: Pore testing of paint coatings.
      - Roller electrode: Pore testing of foils.

Description
- Connecting cable between test instrument and test head.
- Pore detection sensitivity: detection threshold settable between 20 and 50% voltage drop
- Test voltage display error: ≤ 5 %
- Pore indication:
  - acoustic: Alarm signal at test head optical: red LED at test head and instrument
- Pore detection sensitivity:
  - detection threshold settable between 20 and 50% voltage drop
- Test voltage monitoring:
  - green LED, extinguishes when voltage falls by more than 5% below nominal value
- Environmental conditions during operation:
  - 0 ... +40 ºC (32 ... +104 ºF) and
  - 0 ... 60 % RH, no condensation on test surface
- Storage temperature:
  - 0 ... +60 ºC (32 ... +140 ºF)
- Standards:
  - Instrument safety: VDE 0411/1, pasture fence ordinance
  - DIN 55670, DIN 28055-2, DIN 4753-3

Ordering Information HV20 and HV20D

Test instruments

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>POROSCOPE™ HV20</td>
<td>Portable direct current pore</td>
<td>601-933</td>
</tr>
<tr>
<td></td>
<td>test instrument</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with continuously adjustable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>test voltage</td>
<td></td>
</tr>
<tr>
<td>POROSCOPE™ HV20D</td>
<td>Portable direct current pore</td>
<td>602-734</td>
</tr>
<tr>
<td></td>
<td>test instrument</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with continuously adjustable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>test voltage</td>
<td></td>
</tr>
</tbody>
</table>

Test head cable
Connecting cable between test instrument and test head.

Test heads for HV20 and HV20D

Depending on the application, the desired electrode can be screwed onto the test head.

<table>
<thead>
<tr>
<th>Type</th>
<th>Test voltage</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test head HV3PK</td>
<td>0.3 ... 3 kV</td>
<td>601-935</td>
</tr>
<tr>
<td>Test head HV20PK</td>
<td>2.5 ... 25 kV</td>
<td>601-934</td>
</tr>
</tbody>
</table>

Please find the electrode selection and the respective accessories on the subsequent pages.
Technical Data

Voltage supply/charge voltage for installed battery (12 VDC):
220 VAC / 50 ... 60 Hz

Battery operation:
about 2 h continuous operation

Battery monitoring:
green LED on the test instrument lights, when the battery voltage is no longer sufficient to maintain the set test voltage

Test voltage:
(continuously adjustable range):
Test head HV3PK: 0.3 ... 3 kVDC
Test head HV20PK: 2.5 ... 25 kVDC

Dimensions [mm]:
Test instruments: 14 x 70 x 220 (0.55' x 2.8' x 8.7')
Test heads: length: 360 (14.2'); max. ø 114 (4.5')

Weight:
Test instruments: 2 kg
Test heads: 0.8 kg

Test voltage display:
LCD

Test voltage display error:
< 5 %

Pore indication:
asymmetrical: Alarm signal at test head optical: red LED at test head and instrument

Pore detection sensitivity:
detection threshold settable between 20 and 50% voltage drop

Test voltage monitoring:
green LED, extinguishes when voltage falls by more than 5% below nominal value

Environmental conditions during operation:
0 ... +40 ºC (32 ... +104 ºF)

Storage temperature:
on test surface
0 ... +40 ºC (32 ... +104 ºF) and
during operation:
value falls by more than 5% below nominal

Test voltage monitoring:
green LED on the test instrument lights, when the battery voltage is no longer sufficient to maintain the set test voltage

Ordering Information HV20 and HV20D

Test instruments:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>POROSCOPE HV20</td>
<td>Portable direct current pore test instrument with continuously adjustable test voltage.</td>
<td>601-933</td>
</tr>
<tr>
<td>POROSCOPE HV20D</td>
<td>Portable direct current pore test instrument with continuously adjustable test voltage. Specifically designed for testing materials that are easily charged electrostatically.</td>
<td>602-704</td>
</tr>
</tbody>
</table>

Ground connection cable
with ground clip to ground the carrier material of the test specimen.

Test head cable
Connecting cable between test instrument and test head.

Test heads for HV20 and HV20D

Depending on the application, the desired electrode can be screwed onto the test head.

<table>
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<td>Test head HV20PK</td>
<td>2.5 ... 25 kV</td>
<td>601-934</td>
</tr>
</tbody>
</table>

Electrodes, Order Information

Suitable electrodes are available for every application. The desired electrode is simply screwed onto the test head.

Sweeper electrodes: Pore testing of large-area enamel, rubber and synthetic coatings.

Flat electrode with replaceable rubber tongue: Pore testing of paint coatings.

Roller electrode: Pore testing of foils.

Circular ring electrodes: Pore testing of exterior pipe walls. The circular ring electrodes swing open for easy placement around a pipe.

Rotating electrodes: Pore testing of interior pipe walls.

Up to an inside diameter of 125, the rotating electrodes look like bottlebrushes. The brush bristles in the center are made of fine bronze spring wire; the nylon bristles in the front and back help to center the brush in the pipe.

Tests on the inside of pipes up to a length of 12 m (47') are possible using suitable rod systems. Rod pieces coated with synthetic material are combined to the desired lengths. Inserting centering devices prevents sagging of the rod. The rod system together with the inserted centering devices is also used for the voltage supply of the rotating electrode.

Selection table for flat, sweeper, circular ring and roller electrodes

<table>
<thead>
<tr>
<th>Flat electrodes</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Dimensions [mm]</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZH2a</td>
<td>600-690</td>
<td>≈ 180</td>
<td>80 x 140 (3.2 x 5.5&quot;)</td>
<td>with replaceable rubber trimming</td>
</tr>
<tr>
<td>ZH2b</td>
<td>600-692</td>
<td>≈ 180</td>
<td>80 x 250 (3.2 x 9.8&quot;)</td>
<td>with replaceable rubber trimming, can be pivoted and secured on all sides using a ball joint</td>
</tr>
</tbody>
</table>

Sweeper electrodes

<table>
<thead>
<tr>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Dimensions [mm]</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZH6a</td>
<td>600-695</td>
<td>≈ 200</td>
<td>150 (5.9&quot;)</td>
</tr>
<tr>
<td>ZH6b</td>
<td>600-686</td>
<td>≈ 200</td>
<td>250 (9.8&quot;)</td>
</tr>
<tr>
<td>ZH6c</td>
<td>600-697</td>
<td>≈ 200</td>
<td>300 (11.8&quot;)</td>
</tr>
</tbody>
</table>

Circ. ring electrodes

<table>
<thead>
<tr>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Pipe ID [mm]</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZH7a</td>
<td>600-736</td>
<td>200</td>
<td>108 (4.3&quot;)</td>
</tr>
<tr>
<td>ZH7b</td>
<td>600-737</td>
<td>220</td>
<td>133 (5.2&quot;)</td>
</tr>
<tr>
<td>ZH7c</td>
<td>600-738</td>
<td>250</td>
<td>159 (6.3&quot;)</td>
</tr>
<tr>
<td>ZH7d</td>
<td>600-739</td>
<td>300</td>
<td>220 (8.7&quot;)</td>
</tr>
<tr>
<td>ZH7e</td>
<td>600-740</td>
<td>400</td>
<td>273 (10.7&quot;)</td>
</tr>
<tr>
<td>ZH7f</td>
<td>600-741</td>
<td>600</td>
<td>324 (12.8&quot;)</td>
</tr>
</tbody>
</table>

Roller electrode

<table>
<thead>
<tr>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Oper. width [mm]</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZH10a</td>
<td>603-118</td>
<td>406.6</td>
<td>150 (5.9&quot;)</td>
</tr>
</tbody>
</table>
### Selection table for rotating electrodes and thread reducers

<table>
<thead>
<tr>
<th>Pipe ID inside [mm]</th>
<th>Rotating electrode</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Length [mm]</th>
<th>Thread reducer</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>ID [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 (0.31&quot;)</td>
<td>ZH3y</td>
<td>600-713</td>
<td>8</td>
<td>250 (9.84&quot;)</td>
<td>-</td>
<td>-</td>
<td>8-0.31&quot;</td>
<td></td>
</tr>
<tr>
<td>9 (0.35&quot;)</td>
<td>ZH3z</td>
<td>600-714</td>
<td>10</td>
<td>500 (19.69&quot;)</td>
<td>-</td>
<td>-</td>
<td>9-0.35&quot;</td>
<td></td>
</tr>
<tr>
<td>10 (0.39&quot;)</td>
<td>ZH3a</td>
<td>600-699</td>
<td>10</td>
<td>1000 (39.37&quot;)</td>
<td>-</td>
<td>-</td>
<td>10-0.39&quot;</td>
<td></td>
</tr>
<tr>
<td>11-12 (0.43-0.47&quot;)</td>
<td>ZH3b</td>
<td>600-700</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11-12</td>
<td></td>
</tr>
<tr>
<td>13-14 (0.51-0.55&quot;)</td>
<td>ZH3c</td>
<td>600-701</td>
<td>40</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>13-14</td>
<td></td>
</tr>
<tr>
<td>15-16 (0.59-0.63&quot;)</td>
<td>ZH3d</td>
<td>600-702</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15-16</td>
<td></td>
</tr>
<tr>
<td>18-20 (0.71-0.79&quot;)</td>
<td>ZH3e1</td>
<td>600-703</td>
<td>60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18-20</td>
<td></td>
</tr>
</tbody>
</table>

### Selection table for rods and centering devices

<table>
<thead>
<tr>
<th>Pipe ID inside [mm]</th>
<th>Rod system</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Length [mm]</th>
<th>Centering device</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>ID [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 (0.31&quot;)</td>
<td>ZH8c</td>
<td>600-715</td>
<td>30</td>
<td>250 (9.84&quot;)</td>
<td>ZH4a1</td>
<td>600-724</td>
<td>5</td>
<td>13-14 (0.51-0.55&quot;)</td>
</tr>
<tr>
<td>9 (0.35&quot;)</td>
<td>ZH8d</td>
<td>600-716</td>
<td>60</td>
<td>500 (19.69&quot;)</td>
<td>ZH4a2</td>
<td>600-735</td>
<td>3</td>
<td>9-10 (0.35-0.39&quot;)</td>
</tr>
<tr>
<td>10 (0.39&quot;)</td>
<td>ZH8e</td>
<td>600-717</td>
<td>120</td>
<td>1000 (39.37&quot;)</td>
<td>ZH4a3</td>
<td>600-726</td>
<td>6</td>
<td>15-16 (0.59-0.63&quot;)</td>
</tr>
</tbody>
</table>

### Options, Order Example

#### Options for HV20 and HV20D

<table>
<thead>
<tr>
<th>Type</th>
<th>Order no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustical signal generator HV20</td>
<td>602-219</td>
<td>External acoustical signal generator. Can be connected to test instrument or distribution box HV20. Length of connecting cable: 5 m (19.68&quot;)</td>
</tr>
<tr>
<td>Pulse counter HV20</td>
<td>602-275</td>
<td>6-digit pore counter. Can be connected to test instrument or distribution box HV20. Length of connecting cable: 1 m (39.37&quot;)</td>
</tr>
<tr>
<td>External start switch HV20</td>
<td>602-369</td>
<td>External On/Off side switch for the high voltage. Can be connected to test instrument or distribution box HV20. Length of connecting cable: 10 m (393.7&quot;)</td>
</tr>
<tr>
<td>Distribution box HV20</td>
<td>602-238</td>
<td>For simultaneous connection of the acoustical signal generator HV20, the pulse counter HV20 and the external start switch HV20 as well as other external components for display, etc. of the pore information. Can be connected to the test instrument. Length of the connecting cable: 0.2 m (7.87&quot;)</td>
</tr>
<tr>
<td>Additional grounding POROSCOPE® HV20</td>
<td>602-554</td>
<td>Metallic wrist band to be clipped to the test head for additional grounding. Prevents electrostatic charging of the operator, especially when working with gloves or when working on a floor that can easily become electrostatically charged.</td>
</tr>
</tbody>
</table>

#### Ordering Examples

**Example 1:** Test system for testing enamel coatings

<table>
<thead>
<tr>
<th>Order no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>601-933</td>
<td>Ground connection cable HV20-EK/15</td>
</tr>
<tr>
<td>601-934</td>
<td>Sweeper electrode ZH6b</td>
</tr>
<tr>
<td>601-940</td>
<td>Additional grounding POROSCOPE® HV20</td>
</tr>
</tbody>
</table>

**Example 2:** Test system for testing interior pipe walls

<table>
<thead>
<tr>
<th>Order no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>601-933</td>
<td>Ground connection cable HV20-EK/15</td>
</tr>
<tr>
<td>601-934</td>
<td>Rod system ZH8b</td>
</tr>
<tr>
<td>601-940</td>
<td>Centering device ZH4e</td>
</tr>
<tr>
<td>602-703</td>
<td>Thread reducer M8/M12</td>
</tr>
<tr>
<td>600-722</td>
<td>Elastic spacer ZH9</td>
</tr>
</tbody>
</table>

#### Pipe ID < 13 mm

- Rotating electrode ZH3y, ZH3z
- Rod system ZH8c, d, e
- Centering device ZH42, 4
- Thread reducer M8/M5, M8/M12
- Elastic spacer ZH9
- Test head HV20PK, HV20D

#### Pipe ID > 13 mm

- Rotating electrode ZH3a, ..., k
- Rod system ZH8a, b
- Centering device ZH4a1, 2
- Thread reducer M8/M5, M8/M12
- Elastic spacer ZH9
- Test head HV20PK, HV20D
### Rotating Electrodes, Selection Table

<table>
<thead>
<tr>
<th>Pipe ID [mm]</th>
<th>Rotating electrode Type</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Thread reducer Type</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>ID [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 (0.31&quot;)</td>
<td>ZH3y</td>
<td>600-713</td>
<td>8</td>
<td>M8/M4</td>
<td>600-723</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>9 (0.35&quot;)</td>
<td>ZH3z</td>
<td>600-714</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 (0.39&quot;)</td>
<td>ZH3a</td>
<td>600-699</td>
<td>10</td>
<td>M8/M5</td>
<td>600-721</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>11-12 (0.43-0.47&quot;)</td>
<td>ZH3b</td>
<td>600-700</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>13-14 (0.50-0.53&quot;)</td>
<td>ZH3c</td>
<td>600-701</td>
<td>40</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>15-16 (0.59-0.63&quot;)</td>
<td>ZH3d</td>
<td>600-702</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>18-20 (0.71-0.79&quot;)</td>
<td>ZH3e1</td>
<td>600-703</td>
<td>60</td>
<td>M8/M12</td>
<td>600-722</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>22-25 (0.87-0.98&quot;)</td>
<td>ZH3f1</td>
<td>600-704</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28-30 (1.10-1.18&quot;)</td>
<td>ZH3f2</td>
<td>600-705</td>
<td>220</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33-40 (1.30-1.57&quot;)</td>
<td>ZH3g</td>
<td>600-706</td>
<td>350</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50-65 (1.97-2.56&quot;)</td>
<td>ZH3h</td>
<td>600-707</td>
<td>1300</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 (3.1&quot;)</td>
<td>ZH3i</td>
<td>600-708</td>
<td>1600</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 (3.94&quot;)</td>
<td>ZH3j</td>
<td>600-709</td>
<td>1800</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>125 (4.92&quot;)</td>
<td>ZH3k</td>
<td>600-710</td>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Selection Table for Rotating Electrodes and Thread Reducers

<table>
<thead>
<tr>
<th>Pipe ID [mm]</th>
<th>Rod system Type</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Length [mm]</th>
<th>Centering device Type</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>ID [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 (0.31&quot;)</td>
<td>ZH8c</td>
<td>600-717</td>
<td>30</td>
<td>250 (9.84&quot;)</td>
<td>ZH4z1</td>
<td>600-734</td>
<td>3</td>
<td>9-10 (0.35-0.39&quot;)</td>
</tr>
<tr>
<td></td>
<td>ZH8d</td>
<td>600-718</td>
<td>60</td>
<td>500 (19.69&quot;)</td>
<td>ZH4z2</td>
<td>600-735</td>
<td>11-12 (0.43-0.47&quot;)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZH8e</td>
<td>600-719</td>
<td>120</td>
<td>1000 (39.37&quot;)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 (0.39&quot;)</td>
<td>ZH8a</td>
<td>600-715</td>
<td>250</td>
<td>500 (19.69&quot;)</td>
<td>ZH4a1</td>
<td>600-724</td>
<td>5</td>
<td>13-14 (0.51-0.55&quot;)</td>
</tr>
<tr>
<td></td>
<td>ZH8b</td>
<td>600-716</td>
<td>450</td>
<td>1000 (39.37&quot;)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Options, Order Example

#### Options for HV20 and HV20D

<table>
<thead>
<tr>
<th>Type</th>
<th>Order no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustical signal generator HV20</td>
<td>602-219</td>
<td>External acoustical signal generator. Can be connected to test instrument or distribution box HV20. Length of connecting cable: 5 m (16.85&quot;).</td>
</tr>
<tr>
<td>Pulse counter HV20</td>
<td>602-275</td>
<td>6-digit pore counter. Can be connected to test instrument or distribution box HV20. Length of connecting cable: 1 m (39.37&quot;).</td>
</tr>
<tr>
<td>External start switch HV20</td>
<td>602-369</td>
<td>External On/Off side switch for the high voltage. Can be connected to test instrument or distribution box HV20. Length of connecting cable: 10 m (393.7&quot;).</td>
</tr>
<tr>
<td>Distribution box HV20</td>
<td>602-238</td>
<td>For simultaneous connection of the acoustical signal generator HV20, the pulse counter HV20 and the external start switch HV20 as well as other external components for display, etc. of the pore information. Can be connected to the test instrument. Length of the connecting cable: 0.2 m (7.87&quot;).</td>
</tr>
<tr>
<td>Additional grounding</td>
<td>602-554</td>
<td>Metallic wrist band to be clipped to the test head for additional grounding. Prevents electrostatic charging of the operator, especially when working with gloves or when working on a floor that can easily become electrostatically charged.</td>
</tr>
</tbody>
</table>

#### Ordering Examples

**Example 1:** Test system for testing enamel coatings

<table>
<thead>
<tr>
<th>Test instrument POROSCOPE® HV20</th>
<th>601-933</th>
<th>Ground connection cable HV20-EN/15</th>
<th>601-938</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test head HV20PK</td>
<td>601-934</td>
<td>Sweeper electrode ZH6b</td>
<td>600-696</td>
</tr>
<tr>
<td>Test head cable HV20-AK/1</td>
<td>601-940</td>
<td>Additional grounding POROSCOPE® HV20</td>
<td>602-554</td>
</tr>
</tbody>
</table>

**Example 2:** Test system for testing interior pipe walls

<table>
<thead>
<tr>
<th>Test instrument POROSCOPE® HV20</th>
<th>601-933</th>
<th>Ground connection cable HV20-EN/15</th>
<th>601-938</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test head HV20PK</td>
<td>601-934</td>
<td>Rod system ZH6b</td>
<td>600-760</td>
</tr>
<tr>
<td>Test head cable HV20-AK/1</td>
<td>601-940</td>
<td>Rod system ZH6b</td>
<td>600-760</td>
</tr>
<tr>
<td>Rotating electrode ZH3e1</td>
<td>600-703</td>
<td>Centering device ZH4a1</td>
<td>600-731</td>
</tr>
<tr>
<td>Thread reducer M8/M12</td>
<td>600-722</td>
<td>Elastic spacer ZH9</td>
<td>600-720</td>
</tr>
</tbody>
</table>

### Elastic spacers suitable for all test head types

<table>
<thead>
<tr>
<th>Type</th>
<th>Order no.</th>
<th>Weight [g]</th>
<th>Length [mm]</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZH9</td>
<td>600-720</td>
<td>145</td>
<td>160 (6.3&quot;)</td>
<td>Avoids tilting when inserting into greater pipe depths</td>
</tr>
</tbody>
</table>
FISCHER is a leading multi-national company in the field of electronic coating thickness measurement and materials testing instruments. The company is able to recommend the best coating thickness measuring instrument for any application, due to the company’s extensive experience in this field. The wide range of instruments includes models for coating thickness measurements according to the X-ray fluorescent, Beta Backscatter, magnetic induction, eddy current and coulometric methods. Additionally, the program includes instruments for measuring micro-hardness, ferrite content, and porosity testing. FISCHER is active around the world. Instruments manufactured by our company are used in many countries. FISCHER has subsidiaries in eight different countries.

Active Around the World

FISCHERSCOPE® X-Ray to measure the coating thickness according to the X-ray fluorescence method.

The high quality standard of FISCHER instruments is the result of our efforts to provide the very best instrumentation to our customers.

FISCHER is a reliable and competent partner, offering expert advice, extensive service, and training seminars.

Today, FISCHER instruments are used successfully in all technological fields of industry and research.

DUALSCOPE® MP40 with probe ED10 to measure coating thickness on ferromagnetic, as well as non-ferromagnetic materials with automatic recognition and selection of the measurement method.

Micro hardness measurement unit FISCHERSCOPE® H100 to determine the universal hardness HU of thin coatings and films.

Porosity Test Using High Voltage

Search for pores and defects in linings and coatings made of enamel, lacquer, rubber and bitumen as well as in containers made of GFK and other synthetics.