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Chlorine Resistance
of Plastic Pipes

Tests in accordance with:

Temporary, defined loading of pipes under specified conditions and subsequent evaluation with analytic methods, such as OIT measurements and IR microscopy.

Solving complex questions in connection with chlorine resistance within the scope of research projects.

As the largest plastics institute in Germany we offer practical solutions – tailored exactly to your requirements. For the past 50 years now we have seen ourselves as a partner to the plastics industry providing extensive system expertise:
By means of Testing and Quality Assurance we support your product policy, supplying you with valuable arguments for your key markets. With more than 10,000 participants each year, we are the market leader for Training and the Transfer of Knowledge in the field of plastics. Our Research division bets on the development and improvement of production technologies in line the market requirements. With the Certification of Management Systems we offer you the best prerequisite for efficiency and economic success.

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New test facilities

Reliable partners at SKZ! The managing directors from left to right: Dr.-Ing. Peter Heidemeyer (Research), Robert Schmitt (Certification), Prof. Dr.-Ing. Martin Bastian (Chief Executive Officer), Dr.-Ing. Gerald Aengenheyster (Product Quality), Harald Huberth (Training)
Motivation

Chlorine is used both in the field of drinking water disinfection and the disinfection of water distribution systems. This involves an accelerated ageing of the polymer and possibly a reduced service life of the plastic pipes.

The German Drinking Water Regulation stipulates a minimum concentration of 0.1 mg/l of free chlorine after the treatment and permits a maximum addition of 0.3 mg/l. In the field of water distribution systems, the DVGW worksheet W 291 allows chlorine concentrations of up to 50 mg/l for the intermittent disinfection. Being a strong oxidizing agent, chlorine affects the failure behaviour of the plastic pipes. In combination with factors such as temperature, pressure, pH-value, flow-through rate and oxygen content of the water the time-to-failure is possibly considerably shorter than in the respective hydrostatic long-term internal pressure tests without the influence of chlorine, which are performed as a standard for evaluating the lifetime of plastic pipes.

Since today plastic pipes have to fulfill high requirements in terms of their service life (50 or even 100 years), it is important to assess the relevant products also in view of their chlorine resistance. For this reason within the scope of a joint project with company IPT a testing machine was developed which is designed to determine the chlorine resistance of pipes under operating conditions in an accelerated way.

Chlorine test unit

- integrated osmosis device to generate constant initial quality of the test water
- chlorine electrolysis unit to generate a hypochloric acid
- test circuit with maximum pressure of 16 bar and maximum temperature of 120 °C
- 3 test specimens with different test pressures and flow-through rates
- active control of pH-value and chlorine concentration
- control of oxidation reduction potential (ORP), conductivity and oxygen content of the test water
- failure detection for each individual test specimen
- pipe dimensions of up to a maximum external diameter of 32 mm

Range of possible test parameters

<table>
<thead>
<tr>
<th>test parameter</th>
<th>ASTM F 2023-05</th>
<th>NSF P 171-99</th>
<th>test unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorine concentration</td>
<td>2.5–5.0 ± 0.3 mg/l</td>
<td>4.3 ± 0.3 mg/l</td>
<td>0–100 ± 0.2 mg/l</td>
</tr>
<tr>
<td>temperature</td>
<td>95, 105, 115 ± 2 °C</td>
<td>95, 105, 115 ± 1 °C</td>
<td>20–120 ± 1 °C</td>
</tr>
<tr>
<td>pressure</td>
<td>± 0.2 bar</td>
<td>± 0.5 %</td>
<td>2–16 ± 0.2 bar</td>
</tr>
<tr>
<td>pH</td>
<td>6.5–8.0 ± 0.2</td>
<td>6.8 ± 0.2</td>
<td>6.8 ± 0.2</td>
</tr>
<tr>
<td>flow rate</td>
<td>0.24/min</td>
<td>0.4/min</td>
<td>0.2–1.15/min</td>
</tr>
<tr>
<td>ORP</td>
<td>&gt; 825 ± 30 mV</td>
<td>± 10 mV</td>
<td>0–1000 ± 1 mV</td>
</tr>
<tr>
<td>oxygen content</td>
<td>–</td>
<td>–</td>
<td>0–20 ± 0.1 mg/l</td>
</tr>
<tr>
<td>conductivity</td>
<td>–</td>
<td>–</td>
<td>0–2500 ± 1 μS/cm</td>
</tr>
</tbody>
</table>

Example

- time-to-failure of pipes made of polypropylene random copolymer (PP-R)
- quasi-brittle failure (2nd branch of creep curve)
- chlorine concentrations between 0 and 50 mg/l
- for comparison hydrostatic long-term internal pressure test and minimum time-to-failure according to DIN 8075

Effect of chlorine concentration on the time-to-failure of pipes made of PP-R