Accelerated Cable Aging at 500Hz,

“Time is Money”

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Accelerated Aging:

- To intensify certain parameters to accelerate aging, in order to reach the same degree of aging in a short time, as usually will be obtained under service conditions during cable life.
- Any parameter and any acceleration degree is permitted, as long as the aging mechanism, remains unchanged.
- No difference should be made between “natural” and “unnatural” parameters and conditions.
Accelerated aging method should be decisive in a reasonable period of time:

- Good cables are good
- Bad cables are bad
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical stress</td>
<td>no clear relation</td>
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<tr>
<td>Mechanical Stress</td>
<td>no clear relation</td>
</tr>
<tr>
<td>Temperature</td>
<td>opposite relation</td>
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<tr>
<td>Temperature gradient</td>
<td>different aging mech</td>
</tr>
<tr>
<td>Chemical condition of water</td>
<td>no clear relation</td>
</tr>
<tr>
<td>Frequency</td>
<td>clear relation</td>
</tr>
</tbody>
</table>
- CENELEC, 2 year
- 500 Hz, 3000 hours, 4 months
- cable length: 60 m, without outer coverings
- conditioning: under water 80 degree C, 1 month
- water: tap water + additives, Ph 6.5-7.5
- temperature: 30 degree C
- voltage: 2.5 Uo
- frequency: 50Hz or 500 Hz
- duration: 3000 hours or 2 years
- requirements: step test (Uo/5min) on 5m samples

all withstand 14kV/min > 73% withstand 18kV/min > 40% withstand 22kV/min
Test results on the same cable that has been aged in the field:

- 50 Hz 3000h
- 500 Hz 3000h
- field aged 12y
- unaged

Tests results of bad (standard compound) and good (WTR) cable for both 50Hz and 500 Hz
63 % breakdown values in kV/mm for a bad cable
Water tree lengths in micrometer for a bad cable

- Max bow-tie trees
- Max vented trees

- Unaged
- 50 Hz, 2.5 Uo, 3000 h
- 500 Hz, 2.5 Uo, 3000 h
- Service, 10 y
breakdown stress level [kV/mm]

- A: 50 Hz 3000 h
- A: 50 Hz 2 y
- B: 500 Hz 3000 h
- B: 50 Hz 2 y
breakdown stress level [kV/mm]

- A: 500 Hz 3000 h
- A: 50 Hz 2 y
- B: 500 Hz 3000 h
- B: 50 Hz 2 y

max. water tree size in micrometer

1000
Test experience in the NL

- Since 1997, 500 Hz aging is an alternative in the Dutch specification of MV cables (NEN 3620)
- 500 Hz aging is also part of CENELEC HD 605
- Positive experience
- Growing interest for 500Hz testing within CENELEC
Conclusions

• Same aging mechanism for 60Hz and 500 Hz
• 6 times shorter duration of test
• Reliable 500 Hz generator available
• 5 years positive experience in the NL
• Growing interest for 500Hz testing