Product Data Sheet

Trigonox® 239

Product description
Cumyl hydroperoxide, 45% solution in solvents

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CH₃
\[\text{C} \text{—O—OH}\]
CH₃
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Molecular weight: 152.2
Active oxygen content peroxide: 10.51%
Actual product: 4.73%
CAS No.: 80-15-9
EINECS/ELINCS No.: 210-254-7
TSCA status: listed on inventory

Specifications
Appearance: Clear liquid
Color: 250 Pt-Co max.
Assay: 45%

Characteristics
Density, 20°C: 1.040 g/cm³
Viscosity, 20°C: 5 mPa.s

Storage
Due to the relatively unstable nature of organic peroxides a loss of quality can be detected over a period of time. To minimize the loss of quality, AkzoNobel recommends a maximum storage temperature \(T_s\) max.) for each organic peroxide product.

For Trigonox 239 \(T_s\) max. = 25°C

When stored under the recommended storage conditions, Trigonox 239 will remain within the AkzoNobel specifications for a period of at least 3 months after delivery.

Thermal stability
Organic peroxides are thermally unstable substances, which may undergo self-accelerating decomposition. The lowest temperature at which self-accelerating decomposition of a substance in the original packaging may occur is the Self-Accelerating Decomposition Temperature (SADT). The SADT is determined on the basis of the Heat Accumulation Storage Test.

For Trigonox 239 SADT: 55°C

Major decomposition products

Acetophenone, phenylisopropanol, methane, water

Packaging and transport

The standard packaging is a 30 l HDPE can (Nourytainer®) for 30 kg peroxide solution.

Both packaging and transport meet the international regulations. For the availability of other packed quantities contact your AkzoNobel representative.

Trigonox 239 is classified as Organic peroxide type F; liquid, Division 5.2; UN 3109.

Safety and handling

Keep containers tightly closed. Store and handle Trigonox 239 in a dry well-ventilated place away from sources of heat or ignition and direct sunlight. Never weigh out in the storage room.

Avoid contact with reducing agents (e.g. amines), acids, alkalis and heavy metal compounds (e.g. accelerators, driers and metal soaps).

Please refer to the Material Safety Data Sheet (MSDS) for further information on the safe storage, use and handling of Trigonox 239. This information should be thoroughly reviewed prior to acceptance of this product.

The MSDS is available at www.akzonobel.com/polymer.

Applications

Trigonox 239 is a peroxide mixture based on cumene hydroperoxide. Trigonox 239 is especially developed for the cure of vinylester or phenacryl resins in combination with a cobalt accelerator.

Trigonox 239 can successfully be used instead of generally applied keton peroxides like Butanox® LPT with the following features:

- No ‘gassing’ after the peroxide is mixed in the preaccelerated vinylester resin. This phenomenon is very often recognized as a disadvantage of ketone peroxides in vinylester resins
- The use of an amine accelerator is in general not necessary to achieve a good cure
- A fast cure in thin coatings and laminates up to a thickness of approx. 6 mm
- A low peak exotherm in thick laminates.

Dosage

Depending on working conditions, the following peroxide and accelerator dosage levels are recommended:

Trigonox 239 2 - 3 phr
Accelerator NL-51P 0.2 - 1 phr

phr = parts per hundred resin
The cure characteristics of *Trigonox* 239 have been determined in comparison with the for this application area generally applied peroxide *Butanox* LPT in the 2 commonly used vinylester resins:

Vinylester resin I = bisphenol A based type
Vinylester resin II = novolak based type

**Gel times at 20°C**

<table>
<thead>
<tr>
<th></th>
<th>Vinylester resin</th>
<th>Trigonox 239</th>
<th>Butanox LPT</th>
<th>Accelerator NL-51P (6% cobalt)</th>
<th>Dimethylaniline (DMA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td>2</td>
<td>2</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td></td>
<td>2</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td></td>
<td>2</td>
<td>0.5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Gel time at 20°C (min.)

<table>
<thead>
<tr>
<th></th>
<th>Vinylester resin I</th>
<th>28</th>
<th>18</th>
<th>32</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vinylester resin II</td>
<td>15</td>
<td>10</td>
<td>22</td>
<td>12</td>
</tr>
</tbody>
</table>

Long gel times of several hours, which can be necessary for filament winding operations, can easily be obtained by the extra addition of Promotor C as inhibitor.

<table>
<thead>
<tr>
<th></th>
<th>Vinylester resin</th>
<th>Trigonox 239</th>
<th>Butanox LPT</th>
<th>Accelerator NL-51P</th>
<th>Promotor C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td>2</td>
<td>2</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td></td>
<td>2</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td></td>
<td>2</td>
<td>0.5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Gel time at 20°C (min.)

<table>
<thead>
<tr>
<th></th>
<th>Vinylester resin I</th>
<th>28</th>
<th>90</th>
<th>260</th>
<th>32</th>
<th>90</th>
<th>360</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vinylester resin II</td>
<td>15</td>
<td>120</td>
<td>400</td>
<td>22</td>
<td>90</td>
<td>390</td>
</tr>
</tbody>
</table>

**Cure of 1 mm pure resin layer at 20°C**

Cure experiments have been performed in 1 mm pure resin layers at 20°C. The development of the hardness is expressed as the time to reach a Persoz hardness of 60 and 120 s. respectively.

<table>
<thead>
<tr>
<th></th>
<th>Vinylester resin I</th>
<th>100</th>
<th>100</th>
<th>100</th>
<th>100</th>
<th>100</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vinylester resin II</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Trigonox 239</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Butanox LPT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Accelerator NL-51P</td>
<td>1</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Dimethylaniline (DMA)</td>
<td>0.1</td>
<td></td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gel time at 20°C (min.)

<table>
<thead>
<tr>
<th></th>
<th>Vinylester resin I</th>
<th>18</th>
<th>16</th>
<th>10</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vinylester resin II</td>
<td>1.25</td>
<td>1.75</td>
<td>&lt;&lt;1</td>
<td>&lt;&lt;1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.75</td>
<td>2.50</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Time to reach a Persoz hardness of 60 s. (hours) 1.25 1.75 <<1 <<1

Time to reach a Persoz hardness of 120 s. (hours) 1.75 2.50 <1 <1

Residual styrene content after a cure time at 20°C of 24 hours (%)

|          | 7.7 | 10.5 | 1.2 | 4.4 |

24 weeks (%)

|          | 4.0 | 6.2 | 0.6 | 2.3 |

4 weeks + 8 h 80°C (%)

|          | 0.1 | 0.1 | 0.1 | 0.1 |
Cure of 4 mm laminates at 20°C

4 mm laminates have been made with a 450 g/m² chopped strand mat. The glass content in the laminates is 30% (w/w).

The following parameters were determined:
- Time-temperature curve.
- Speed of cure expressed as the time to achieve a Barcol hardness (934-1) of 0-5 and 25-30 respectively.
- Residual styrene content after 24 h at 20°C and subsequent postcure of 8 h at 80°C.

Vinylester resin I 100 100
Vinylester resin II 100 100
Trigonox 239 2 2
Butanox LPT 2 2
Accelerator NL-51P (6% Cobalt) 1 0.5 0.5 0.3
Dimethylaniline (DMA) 0.1 0.1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Vinylester resin I</th>
<th>Vinylester resin II</th>
<th>Trigonox 239</th>
<th>Butanox LPT</th>
<th>Accelerator NL-51P</th>
<th>Dimethylaniline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gel time  (min.)</td>
<td>27 32 16 15</td>
<td>99 88 35 21</td>
<td>43 38 68 122</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to Peak (min.)</td>
<td>1.5 2.5 &lt;1 &lt;1</td>
<td>5 30 &lt;1 &lt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak exotherm (°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to Barcol 934-1 of 0-5 (hours)</td>
<td>1.5 2.5 &lt;1 &lt;1</td>
<td>5 30 &lt;1 &lt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-30 (hours)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual styrene content after a cure of 24 h at 20°C (%)</td>
<td>7.0 8.0 1.8 1.0</td>
<td>0.12 0.25 0.2 0.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>plus a postcure of 8 h at 80°C (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cure of 10 mm laminates at 20°C

10 mm laminates have been made with a 450 g/m² chopped strand mat. The glass content in the laminates is 30% (w/w).

The following parameters were determined:
- Time-temperature curve.
- Speed of cure expressed as the time to achieve a Barcol hardness (934-1) of 0-5 and 25-30 respectively.
- Residual styrene content after 24 h at 20°C and subsequent postcure of 8 h at 80°C.

Vinylester resin I 100 100
Vinylester resin II 100 100
Trigonox 239 2 2
Butanox LPT 2 2
Accelerator NL-51P (6% Cobalt) 0.25 0.15 0.2 0.2
Dimethylaniline (DMA) 0.05 0.15
Gel time at 20°C (min.) 44 45 30 30
Time temperature curves

Time temperature curves have been determined at 20°C in 30 mm and 50 mm thick castings, with a diameter of 100 mm, based on a 1:1 mixture of vinylester resin/quartz flour.

The results can be used as an indication for the cure characteristics of thick laminates.

Vinylester resin I 100 100
Vinylester resin II 100 100
Quartz flour 100 100 100 100

*Butanox LPT* 2 2
*Trigonox 239* 2 2

Accelerator NL-51P (6% Co) 0.2 0.5 0.2 0.2
Dimethylaniline (DMA) 0.1 0.15

Gel time in the pure resin (min.) 30 30 28 30

30 mm thick castings

Time-temperature curve
Gel time (min.) 21 19 17 24
Time to Peak (min.) 69 100 24 42
Peak exotherm (°C) 113 89 144 130

50 mm thick castings

Time-temperature curve
Gel time (min.) 14 17 17 28
Time to Peak (min.) 59 70 29 49
Peak exotherm (°C) 136 110 150 130

- Gel time in 15 gram pure resin.
- Time-temperature curves in resin/quartz flour mixtures.
**Pot life at 20°C**

The pot life of a mixture peroxide/vinylester resin will vary considerably with the temperature, the peroxide addition level, the type of the vinylester resin involved and the batch size. The following indication for the pot life at 20°C in a 25 kg batch of non-pre-accelerated vinylester resin can be given.

<table>
<thead>
<tr>
<th>Vinylester resin</th>
<th>100</th>
<th>100</th>
<th>100</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigonox 239</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butanox LPT</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pot life at 20°C (days)

<table>
<thead>
<tr>
<th>Vinylester resin I</th>
<th>30</th>
<th>23</th>
<th>5</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinylester resin II</td>
<td>25</td>
<td>17</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

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