Essential ingredients for PVC production

TrigonoX®, Perkadox®, Laurox®, Active®, DCloud®, Ethapol® and Noxol®
Polyvinyl chloride (PVC) is everywhere in modern society and in a wide variety of applications, including products we use every day like pipes, windows, siding and flooring. It is produced through the polymerization of vinyl chloride monomer with the help of an organic peroxide initiator. Nouryon is the largest global producer of polymerization initiators to produce PVC offering a wide range of products. Our well-known brands are: Trigonox®, Perkadox® and Laurox®.

A special fast peroxide, Trigonox 187, is used in the Continuous initiator Dosing (CiD) technology that increases PVC output, improves process safety and the resin quality.

Nouryon also offers various secondary suspending agents, which are used to control PVC porosity. This includes solvent-based products and aqueous emulsions. Brand names are Active, DCloud and Ethapol. A specific Ethapol (MPG) is used as anti-foaming agent.

Moreover, Nouryon is a global leader in antifouling agents, branded Nokol and Everplus, which are used to prevent the reactor fouling and polymer buildup in the polymerization process.

Nouryon has a strategic focus on the PVC industry, having global production assets and a dedicated R&D laboratory. Technical support is provided by a technical staff having significant PVC technology experience and know-how.

Polymerization initiators for PVC

Organic peroxides are used as single initiator or in a combination of initiators to optimize the polymerization rate. The most important criteria for selecting the right initiator are peroxide reactivity, physical form and regulatory status. Most solid and liquid peroxides also are available as water-based suspensions and emulsions with improved safety characteristics.

Food contact approved water-based peroxide suspensions and emulsions have been developed by Nouryon to serve the European PVC industry, whereas new methanol-free peroxide emulsions have been developed to serve the US PVC industry. Such water-based peroxide formulations are intrinsically safer than solvent based ones.

Organic peroxide suspensions and emulsions are supplied in HDPE cans or in stainless steel and composite IBCs. Bulk transport of peroxide emulsions is carried out by a temperature controlled manifold trailer equipped with multiple stainless-steel IBCs allowing direct transfer to a (refrigerated) storage tank.
<table>
<thead>
<tr>
<th>PRODUCT NAME*</th>
<th>CHEMICAL NAME</th>
<th>PHYSICAL FORM</th>
<th>ASSAY (%)</th>
<th>ACTIVE OXYGEN (%)</th>
<th>TS MIN (°C)</th>
<th>TS MAX (°C)</th>
<th>T (°C) FOR T ½ = 1.0 H</th>
<th>SADT (°C)</th>
<th>PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRIGONOX 187-W40</td>
<td>Disobutyl peroxyde</td>
<td>Emulsion in water and methanol</td>
<td>40</td>
<td>3.68</td>
<td>-30</td>
<td>-25</td>
<td>39</td>
<td>0</td>
<td>HDPE can, IBC</td>
</tr>
<tr>
<td>TRIGONOX 193-C75</td>
<td>3-hydroxy-1,1-dimethylbutyl peroxyneodecanoate</td>
<td>Solution in odourless mineral spirits</td>
<td>75</td>
<td>4.16</td>
<td>-20</td>
<td>51</td>
<td>10</td>
<td>HDPE bottle</td>
<td></td>
</tr>
<tr>
<td>TRIGONOX 99-C75</td>
<td>Cumyl peroxyneodecanoate</td>
<td>Solution in odourless mineral spirits</td>
<td>75</td>
<td>3.92</td>
<td>-20</td>
<td>56</td>
<td>10</td>
<td>HDPE can</td>
<td></td>
</tr>
<tr>
<td>TRIGONOX 99-WEI50</td>
<td></td>
<td>Emulsion in water and (m) ethanol</td>
<td>50</td>
<td>2.61</td>
<td>-25</td>
<td>-20</td>
<td>56</td>
<td>5</td>
<td>IBC</td>
</tr>
<tr>
<td>TRIGONOX 423-C70</td>
<td>1,1,3,3-Tetramethylbutyl peroxyneodecanoate</td>
<td>Solution in odourless mineral spirits</td>
<td>70</td>
<td>3.73</td>
<td>-15</td>
<td>57</td>
<td>15</td>
<td>HDPE can</td>
<td></td>
</tr>
<tr>
<td>TRIGONOX 423-W50</td>
<td></td>
<td>Emulsion in water and methanol</td>
<td>50</td>
<td>2.66</td>
<td>-20</td>
<td>-15</td>
<td>57</td>
<td>15</td>
<td>HDPE can, IBC</td>
</tr>
<tr>
<td>TRIGONOX 123-C75</td>
<td>tert-Amyl peroxyneodecanoate</td>
<td>Solution in odourless mineral spirits</td>
<td>75</td>
<td>4.64</td>
<td>-25</td>
<td>-15</td>
<td>61</td>
<td>20</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX SBP(S)</td>
<td>Di-sec-butyl peroxydicarbonate</td>
<td>Liquid</td>
<td>98</td>
<td>6.69</td>
<td>-20</td>
<td>63</td>
<td>0</td>
<td>HDPE bottle</td>
<td></td>
</tr>
<tr>
<td>TRIGONOX SBP(S)-C60</td>
<td></td>
<td>Solution in odourless mineral spirits</td>
<td>60</td>
<td>4.10</td>
<td>-20</td>
<td>63</td>
<td>0</td>
<td>HDPE bottle</td>
<td></td>
</tr>
<tr>
<td>PERKADOX 16(S)</td>
<td>Di(4-tert-butylcyclohexyl) peroxydicarbonate</td>
<td>Powder</td>
<td>96</td>
<td>3.83</td>
<td>20</td>
<td>64</td>
<td>40</td>
<td>Carton</td>
<td></td>
</tr>
<tr>
<td>PERKADOX 16-W25-G81</td>
<td></td>
<td>Suspension in water</td>
<td>25</td>
<td>1.00</td>
<td>0</td>
<td>20</td>
<td>64</td>
<td>40</td>
<td>HDPE can, IBC</td>
</tr>
<tr>
<td>TRIGONOX EHPS</td>
<td>Di(2-ethylhexyl) peroxydicarbonate</td>
<td>Liquid</td>
<td>98</td>
<td>4.53</td>
<td>-20</td>
<td>64</td>
<td>0</td>
<td>HDPE can</td>
<td></td>
</tr>
<tr>
<td>TRIGONOX EHPS(C75)</td>
<td></td>
<td>Solution in odourless mineral spirits</td>
<td>75</td>
<td>3.46</td>
<td>-25</td>
<td>-15</td>
<td>64</td>
<td>5</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX EHP-W(E)60</td>
<td></td>
<td>Emulsion in water and (m) ethanol</td>
<td>60</td>
<td>2.77</td>
<td>-25</td>
<td>-15</td>
<td>64</td>
<td>5</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX 23</td>
<td>tert-Butyl peroxyneodecanoate</td>
<td>Liquid</td>
<td>95</td>
<td>6.22</td>
<td>-30</td>
<td>-10</td>
<td>64</td>
<td>15</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX 23-C75</td>
<td></td>
<td>Solution in odourless mineral spirits</td>
<td>75</td>
<td>4.91</td>
<td>-20</td>
<td>-10</td>
<td>64</td>
<td>20</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX 23-WEI50</td>
<td></td>
<td>Emulsion in water and (m) ethanol</td>
<td>50</td>
<td>3.27</td>
<td>-25</td>
<td>-10</td>
<td>64</td>
<td>15</td>
<td>HDPE can, IBC</td>
</tr>
<tr>
<td>PERKADOX 24-FL</td>
<td>Dicetyl peroxydicarbonate</td>
<td>Flakes</td>
<td>94.5</td>
<td>2.65</td>
<td>20</td>
<td>65</td>
<td>40</td>
<td>Carton</td>
<td></td>
</tr>
<tr>
<td>PERKADOX 24L</td>
<td>Powder</td>
<td>91</td>
<td>2.55</td>
<td>20</td>
<td>65</td>
<td>40</td>
<td>Carton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERKADOX 24-W35</td>
<td>Suspension in water</td>
<td>35</td>
<td>0.98</td>
<td>0</td>
<td>15</td>
<td>65</td>
<td>40</td>
<td>HDPE can</td>
<td></td>
</tr>
<tr>
<td>PERKADOX 26</td>
<td>Dimyristyl peroxydicarbonate</td>
<td>Flakes</td>
<td>96</td>
<td>2.98</td>
<td>15</td>
<td>65</td>
<td>35</td>
<td>Carton</td>
<td></td>
</tr>
<tr>
<td>TRIGONOX 425-C75</td>
<td>1,1,3,3-Tetramethylbutyl peroxyxypivalate</td>
<td>Solution in odourless mineral spirits</td>
<td>75</td>
<td>5.21</td>
<td>-25</td>
<td>-15</td>
<td>66</td>
<td>20</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX 125-C75</td>
<td>tert-Amyl peroxyxypivalate</td>
<td>Solution in odourless mineral spirits</td>
<td>75</td>
<td>6.37</td>
<td>-30</td>
<td>-10</td>
<td>72</td>
<td>25</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX 125-W40</td>
<td></td>
<td>Emulsion in water and methanol</td>
<td>40</td>
<td>3.40</td>
<td>-25</td>
<td>-10</td>
<td>72</td>
<td>25</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX 25-C75</td>
<td>tert-Butyl peroxyxypivalate</td>
<td>Solution in odourless mineral spirits</td>
<td>75</td>
<td>6.89</td>
<td>-15</td>
<td>-5</td>
<td>75</td>
<td>20</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX 36-C75</td>
<td>Di(3,5,5-trimethylhexa-nonyl) peroxide</td>
<td>Solution in odourless mineral spirits</td>
<td>75</td>
<td>3.82</td>
<td>-10</td>
<td>0</td>
<td>77</td>
<td>20</td>
<td>HDPE can</td>
</tr>
<tr>
<td>TRIGONOX 36-W50</td>
<td></td>
<td>Emulsion in water and methanol</td>
<td>50</td>
<td>2.54</td>
<td>-22</td>
<td>0</td>
<td>77</td>
<td>25</td>
<td>HDPE can, IBC</td>
</tr>
<tr>
<td>LAUROX</td>
<td>Dilauroyl peroxide</td>
<td>Flakes</td>
<td>99</td>
<td>3.97</td>
<td>30</td>
<td>79</td>
<td>50</td>
<td>Carton</td>
<td></td>
</tr>
<tr>
<td>LAUROX W40 (1-GD4)</td>
<td></td>
<td>Suspension in water</td>
<td>40</td>
<td>1.61</td>
<td>0</td>
<td>20</td>
<td>79</td>
<td>50</td>
<td>HDPE can, IBC</td>
</tr>
</tbody>
</table>

*(Listed are the highest concentrations of formulations available; lower concentrations may also be available – depending on region)*
Continuous Initiator Dosing

Continuous Initiator Dosing (CiD) is a revolutionary concept which increases PVC production capacity by 20-40% while making the PVC process intrinsically safer. In addition to improving PVC quality and consistency, CiD helps to reduce costs. CiD has already been implemented successfully at several production locations around the world.

In traditional PVC production the reactor is loaded with the raw material VCM monomer and water in the first step of the process. Then the total amount of organic peroxides needed for the polymerization is added. The temperature is increased, and the peroxides initiate the polymerization reaction.

During the reaction, a lot of heat is produced, and the capacity of the reactor is determined by the maximum cooling capacity.

With CiD, the heat production in the reactor is controlled by the quantity of peroxide dosed throughout the polymerization process. To achieve this, a control valve is installed and a special fast peroxide, Trigonox 187, is used. As a result, the cooling capacity is optimized, and the batch time is reduced, increasing the overall capacity. The reaction can be stopped and restarted at any time by simply interrupting or restarting the peroxide dosing.

During the polymerization process a minimum peroxide level is present at any time ensuring intrinsic process safety.

Nouryon provides licenses for the use of the patented CiD technology and supports production test runs with mobile initiator dosing units.
Secondary suspending agents

Nouryon offers a wide range of polyvinyl alcohol (PVA) secondary suspending agents, which are used to control PVC porosity and to improve drying and stripping. This includes solvent based products and aqueous emulsions.

The Active 45/Ethapol 55 range contains solvents. The DCloud and Ethapol water-based suspending agents can be charged to a hot PVC reactor. In combination with organic peroxide emulsions they provide excellent PVC characteristics and reduced 'fish eye' levels. In addition, water-based suspending agents are environmentally friendly due to the absence of an organic solvent. Ethapol MPG is a secondary PVA, which also has excellent antifoaming properties. Antifoaming agents are essential for optimal performance of a PVC reactor preventing foaming in both the reactor and PVC stripping sections.

Our suspending agents can be supplied in drums, intermediate bulk containers (IBC’s), bulk truck containers (BTC’s) and bulk ISO containers (BIC’s).

<table>
<thead>
<tr>
<th>PRODUCT NAME</th>
<th>CHEMICAL NAME (CAS NR.)</th>
<th>PHYSICAL FORM</th>
<th>SOLVENT-BASED</th>
<th>WATER-BASED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>SOLVENT CONTENT (%)</td>
<td>DoH*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>S-PVC</strong></td>
<td><strong>E-PVC</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>DoH</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Antifouling agents**

Nouryon is the world’s number one supplier of antifouling agents, branded Noxol and Everplus. The products are applied with high pressure steam for coating of the reactor wall or internal parts such as stirrer, baffles, reflux condenser or cooling coils. This coating prevents unwanted PVC formation and deposits.

The Noxol brand is recognized as the worldwide market leader in antifouling. It provides better adhesion to the reactor wall, while its functional groups protect against negative interaction with oxygen. Noxol is known for its light color and transparency, which are the clearest visual distinctions from all other antifouling agents available in the market.

The antifouling agents can be supplied in bottles, drums and intermediate bulk containers (IBC’s). The products are kept under nitrogen atmosphere protecting against oxidation.

<table>
<thead>
<tr>
<th>PRODUCT NAME</th>
<th>CHEMICAL NAME (CAS NR.)</th>
<th>PHYSICAL FORM</th>
<th>MAIN APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>SOLID CONTENT (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>S-PVC</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>DoH</strong></td>
</tr>
</tbody>
</table>

* DoH = Degree of Hydrolysis
Contact us

For product inquiry and ordering information, please contact your Nouryon account manager or regional Nouryon sales office.

**Americas**
**US and other countries**
Citadel Center
131 S Dearborn St, Suite 1000
Chicago IL 60603-5566
USA
T +1 800 828 7929 (US only)
E polymerchemistry.na@nouryon.com

**Europe, India, Middle East and Africa**
**France, Italy, Spain and Portugal**
Autovia de Castelldefels, km 4.65
08820 El Prat de Llobregat
Barcelona
Spain
T +34 933 741991
E polymerchemistry.es@nouryon.com

**Russia and CIS**
Smolnaya Str., 24D,
Commercial Tower Meridian
125445 Moscow
Russia
T +7 495 766 1606
E info.moscow@nouryon.com

**India**
North Block 801, Empire Tower,
Reliable Cloud City Campus,
Off Thane – Belapur Road
Airoli, Navi Mumbai - 400708
India
T +91(0) 22 68426700
E polymerchemistry.mlx@nouryon.com

**Brazil**
Rodavia Nouryon no. 707
Portão A – Planta C
Bairro São Roque da Chave
13295-000 Itupeva - São Paulo
Brazil
T +55 11 4591 8800
E polymerchemistry.sa@nouryon.com

**Mexico**
Av. Morelos No. 49
Col. Tecamachalco
Los Reyes La Paz Estado de Mexico
C.P. 56500 Mexico
T +52 55 5858 0700
E polymerchemistry.mx@nouryon.com

**Middle East**
Silicon park, Building A6
Office no 402, 4th floor
Dubai Silicon Oasis
Dubai
United Arab Emirates
T +971 4 2471500
E communications.me@nouryon.com

**Asia Pacific**
22F, Eco City, 1788 West Nan Jing Road
Shanghai 200040
P.R. China
T +86 21 2220 5000
E polymerchemistry.ap@nouryon.com

**Other countries**
Zutphenseweg 10
7418 AJ Deventer
The Netherlands
E polymerchemistry.nl@nouryon.com

**Additional information**
Product Data Sheets (PDS) and Safety Data Sheets (SDS) for our polymerization initiators are available at polymerchemistry.nouryon.com

All information concerning this product and/or suggestions for handling and use contained herein are offered in good faith and are believed to be reliable. Nouryon Functional Chemicals B.V. however, makes no warranty as to accuracy and/or sufficiency of such information and/or suggestions, as to the product’s merchantability or fitness for any particular purpose, or that any suggested use will not infringe any patent. Nouryon does not accept any liability whatsoever arising out of the use of or reliance on this information, or out of the use or the performance of the product. Nothing contained herein shall be construed as granting or extending any license under any patent. Customer must determine for himself, by preliminary tests or otherwise, the suitability of this product for his purposes. The information contained herein supersedes all previously issued information on the subject matter covered. The customer may forward, distribute, and/or photocopy this document only if unaltered and complete, including all of its headers and footers, and should refrain from any unauthorized use. Don’t copy this document to a website.

Trigonox, Perkadox, Laurox, Noxol, Everplus, Active, DCloud and Ethapol are registered trademarks of Nouryon Functional Chemicals B.V. or affiliates in one or more territories.