# Crosslinking peroxides for elastomers and thermoplastics

## Perkadox® and Trigonox®

Nouryon

# A complete range of crosslinking peroxides

Nouryon's range of organic peroxides for the crosslinking of elastomers and thermoplastics is very extensive. Companies all over the world depend on our Trigonox® and Perkadox® organic peroxide brands. Why? Because they are an important ingredient in the production of everything from hi-tech automotive parts such as hoses and belts to shoe soles and power distribution cables.

Examples include:

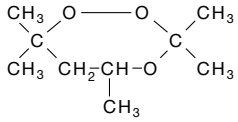
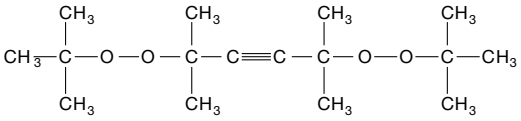
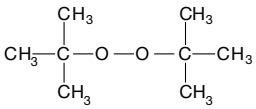
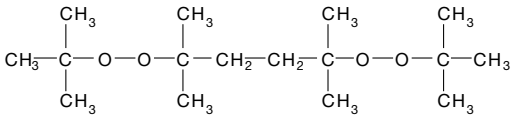
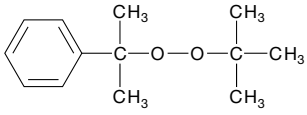
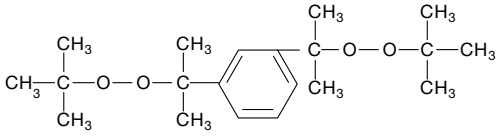
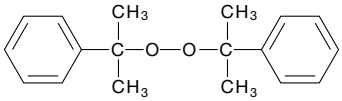
- **Trigonox® 311**
  PEX pipes, rotomolding
- **Trigonox® 145**
  PEX pipes, rotomolding
- **Trigonox® 101**
  PEX pipes, polymer modification, technical rubber goods
- **Trigonox® T**
  wire & cable (DPI - Direct Peroxide Injection)
- **Perkadox® 14**
  wire & cable, technical rubber goods, footwear
- **Perkadox® BC**
  wire & cable, footwear, technical rubber goods
- **Trigonox® 117 and Trigonox® 131**
  for EVA and POE encapsulant films
- **Trigonox® 29**
  for fast on-set of cure
- **Perkadox® PM-50S-PS and Perkadox® PD-50S-PS**
  extruded silicone rubber articles such as silicone rubber cable, seals & tubes

Much of our success is due to our philosophy of creating close partnerships with our customers. What do you want to achieve? From optimizing applications, improving efficiencies, resolving difficulties or even developing new crosslinking peroxides, we're happy to meet with you to discuss your requirements.

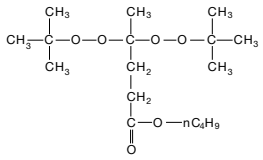
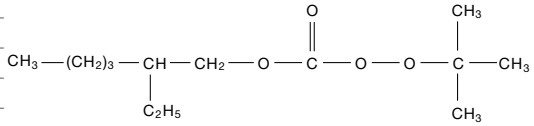
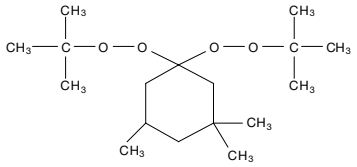
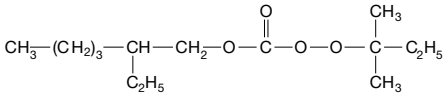
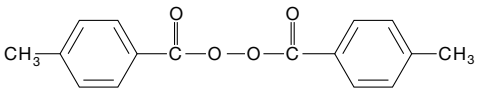
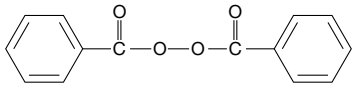
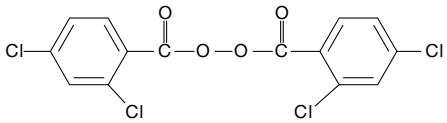
This product guide provides an overview of our main, commercially available crosslinking peroxides. We invite you to visit us at www.nouryon.com for complete product listings.

Formulations with phlegmatizers and carriers or concentrations other than those indicated, as well as unique custom made peroxide compositions can be made available with due observance of safety characteristics and the appropriate environmental and transportation regulations. Whatever your particular requirements, we can develop the product to match.

[1] Trigonox® B has a boiling point of 110°C and a flash point of 1°C. Therefore, this product is not recommended for standard rubber.

| Product name | Chemical name [CAS no.] | General data | | | Processing data | |
|---|---|---|---|---|---|---|
| | | Mol. weight | Assay (%) | Main carrier / solvent | Safe processing temperature (°C) | Typical crosslink temperature (°C) |
| | 3,3,5,7,7-Pentamethyl-1,2,4-trioxepane [215877-64-8] | 174.3 | | | 180 | 220 |
| Trigonox 311 |  | | 95 | | | |
| | 2,5-Dimethyl-2,5-di(tert-butylperoxy)hexyne-3 [1068-27-5] | 286.4 | | | 145 | 185 |
| Trigonox 145-E85 |  | | 85 | mineral oil | | |
| | Di-tert-butyl peroxide [110-05-4] | 146.2 | | | 145 | 180 |
| Trigonox B [1] |  | | 99 | | | |
| | 2,5-Dimethyl-2,5-di(tert-butylperoxy)hexane [78-63-7] | 290.4 | | | 135 | 175 |
| Trigonox 101 |  | | >92 | | | |
| Trigonox 101-50D-PD | | | 50 | silica | | |
| Trigonox 101-45B-GR | | | 45 | calcium carbonate | | |
| Trigonox 101-45D-PD | | | 45 | silica | | |
| Trigonox 101-45S-PS | | | 45 | silicone oil | | |
| | tert-Butyl cumyl peroxide [3457-61-2] | 208.3 | | | 135 | 175 |
| Trigonox T |  | | 95 | | | |
| | Di(tert-butylperoxyisopropyl)benzene [25155-25-3; 2212-81-9] | 338.5 | | | 135 | 175 |
| Perkadox 14S-(FL) |  | | 98 | | | |
| Perkadox 14-40B-PD/GR-S | | | 40 | calcium carbonate | | |
| Perkadox 14-40K-PD-S | | | 40 | clay | | |
| Perkadox 14-EP40 | | | 40 | POE, calcium carbonate | | |
| | Dicumyl peroxide [80-43-3] | 270.4 | | | 130 | 170 |
| Perkadox BC-FF |  | | 99 | | | |
| Perkadox BC-40B-PD/GR | | | 40 | calcium carbonate | | |
| Perkadox BC-40K-PD | | | 40 | clay | | |
| Perkadox BC-40S-PS | | | 40 | silicone oil | | |
| Perkadox BC-EP40 | | | 40 | POE, calcium carbonate | | |

PD = powder
GR = granules
PS = paste
MB = EPR bound
EP = POE bound
FL = flakes
FF = Free Flowing Crystals

| Product name | Chemical name [CAS no.] | General data | | | Processing data | |
|---|---|---|---|---|---|---|
| | | Mol. weight | Assay (%) | Main carrier / solvent | Safe processing temperature (°C) | Typical crosslink temperature (°C) |
| | Butyl 4,4-di(tert-butylperoxy)valerate [995-33-5 ] | 334.5 | | | 125 | 160 |
| Trigonox 17-40B-PD/GR |  | | 40 | calcium carbonate | | |
| Trigonox 17-40MB-GR | | | 40 | EPR, calcium carbonate | | |
| | tert-Butylperoxy 2-ethylhexyl carbonate [34443-12-4] | 246.3 | | | 120 | 150 |
| Trigonox 117 |  | | >98 | | | |
| | 1,1-Di(tert-butylperoxy)-3,3,5-trimethylcyclohexane [6731-36-8] | 302.5 | | | 115 | 145 |
| Trigonox 29-40B-PD/GR-E |  | | 40 | calcium carbonate | | |
| Trigonox 29-40MB-GR-E | | | 40 | EPR, calcium carbonate | | |
| | tert-Amylperoxy 2-ethylhexyl carbonate [70833-40-8] | 260.4 | | | 110 | 140 |
| Trigonox 131 |  | | >94 | | | |
| | Di(4-methylbenzoyl) peroxide [895-85-2] | 270.3 | | | 85 | 110 |
| Perkadox PM-50S-PS |  | | 50 | silicone oil | | |
| | Dibenzoyl peroxide [94-36-0] | 242.2 | | | 85 | 105 |
| Perkadox L-50S-PS |  | | 50 | silicone oil | | |
| | Di(2,4-dichlorobenzoyl) peroxide [133-14-2] | 380.0 | | | 75 | 90 |
| Perkadox PD-50S-PS |  | | 50 | silicone oil | | |

# Recommended dosage levels

| Peroxide | Trigonox® 29-40 | Trigonox® 17-40 | Perkadox® BC-40 | Perkadox® 14-40 | Trigonox® 101-45 |
|---|---|---|---|---|---|
| Safe processing temperature (°C) | 115 | 125 | 130 | 135 | 135 |
| Typical crosslink temperature (°C) | 145 | 160 | 170 | 175 | 175 |
| **Polymer** | **parts of peroxide per 100 parts of polymer** | | | | |
| NR; IR | 2.3 - 4.5 | 2.5 - 5.0 | 2.0 - 4.1 | 1.3 - 2.5 | 1.3 - 2.4 |
| BR | 1.0 - 2.1 | 1.1 - 2.3 | 0.9 - 1.9 | 0.5 - 1.2 | 0.5 - 1.2 |
| CR | 1.1 - 3.0 | 1.3 - 3.3 | 1.0 - 2.7 | 0.6 - 1.7 | 0.6 - 1.6 |
| SBR | 1.9 - 4.1 | 2.1 - 4.6 | 1.7 - 3.7 | 1.1 - 2.3 | 1.1 - 2.2 |
| NBR | 2.6 - 4.5 | 2.9 - 5.0 | 2.4 - 4.1 | 1.5 - 2.5 | 1.4 - 2.4 |
| HNBR [1] | 6.8 - 11.3 | 7.5 - 12.5 | 6.1 - 10.1 | 3.8 - 6.3 | 3.7 - 6.1 |
| POE [1] | 6.8 - 11.3 | 7.5 - 12.5 | 6.1 - 10.1 | 3.8 - 6.3 | 3.7 - 6.1 |
| EPM [1]; EPDM | 6.8 - 11.3 | 7.5 - 12.5 | 6.1 - 10.1 | 3.8 - 6.3 | 3.7 - 6.1 |
| PE | 1.5 - 7.6 | 1.7 - 8.4 | 1.4 - 6.8 | 0.8 - 4.2 | 0.8 - 4.0 |
| CM [1] | 6.8 - 10.6 | 7.5 - 11.7 | 6.1 - 9.5 | 3.8 - 5.9 | 3.7 - 5.7 |
| EVA | 2.6 - 5.3 | 2.9 - 5.8 | 2.4 - 4.7 | 1.5 - 3.0 | 1.4 - 2.9 |
| Q [2] | | | 1.0 - 2.0 | 0.4 - 0.8 | 0.4 - 0.8 |

[1] Addition of a coagent is recommended.
[2] Silicone rubber can also be crosslinked with Perkadox® PD-50S, Perkadox® L-50S and Perkadox® PM-50S. Required amounts of peroxide: 1.1 - 2.3 phr, 0.7 - 1.4 phr and 0.8 - 1.6 phr respectively. Typical crosslink temperatures 90°C, 105°C and 110°C.

# Peroxide versus sulfur crosslinking

Advantages of peroxide crosslinking in comparison to sulfur cure:

- Simple formulation.
- Relatively easy to trace decomposition products
- Storage of the peroxide-containing compound without bin scorch.
- High processing temperature.
- Rapid vulcanization without reversion.
- Good compression set, particularly at elevated temperatures.
- High temperature resistance.
- Limited extractable constituents in final product such as coolant hose.
- No staining of the finished parts.
- No discoloration of crosslinked product by contact with metals and PVC.
- Most peroxides do not cause blooming.
- Co-vulcanization of saturated and unsaturated elastomers.
- Co-vulcanization of elastomers and thermoplastics.
- Copolymerization with polymerizable plasticizers or coagents to give controlled hardness and stiffness, coupled with easy processing.
- Zinc oxide-free formulations possible

Points of attention for peroxide crosslinking:

- Sensitivity to oxygen under curing conditions.
- Certain components of the rubber compound such as:
  - fillers
  - extender oils
  - antioxidants
  - resins

must be selected with care because they may, under certain conditions, interfere with free radicals.

- Usually, tensile and tear strength properties are reduced by about 15%, when compared to a conventional sulfur based crosslinking system.
- Scorch and cure time are less flexible, since they are determined mainly by the temperature.
- During cure, some peroxides may lead to distinct odors.
- Post cure may be necessary.

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# Contact us

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

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## Additional information

Product Data Sheets (PDS) and Safety Data Sheets (SDS) for our polymer crosslinking products are available at nouryon.com