Initiators for Thermoplastics

Nouryon

Nouryon Creates Everyday Essentials

Nouryon is your partner in essential solutions for a sustainable future

We are a global, specialty chemicals leader. Markets and consumers worldwide rely on our essential solutions to manufacture everyday products, such as personal care, cleaning goods, paints and coatings, agriculture and food, pharmaceuticals, and building products. Furthermore, the dedication of approximately 8,200 employees with a shared commitment to our customers, business growth, safety, sustainability and innovation has resulted in a consistently strong financial performance. We operate in over 80 countries around the world with a portfolio of industry-leading brands.

Within our Polymer Specialties business, we produce everyday essentials for the global polymer, recycling and polymer processing industries. We are among the world's leading producers of organic peroxides, metal alkyls and organometallic specialties, which are essential ingredients for the thermo-plastic, composite and rubber indus-tries. We are widely known for our world-class products, including Laurox®, Trigonox®, Perkadox® and brands.

Trigonox®

A global partner

Our manufacturing sites and distribution centers are found all around the globe. Our global distribution network allows us to deliverour products to you anywhere in the world. That's how we ensure security of supply and easy access to quality products wherever you are.

All our sites are ISO 9001 and ISO 14001 certified to ensure the highest product quality and strict compliance with environmental regulations. We continually invest in manufacturing techniques, high quality standards, safety, innovation, active technical support and a reliable supply chain.

Contributing to a Sustainable Future

We partner with our customers, suppliers and employees to deliver innovative solutions, drive progress and create a safe and sustainable today and tomorrow for everyone.

Our 'Commitment to a Sustainable Future,' is based on three pillars:

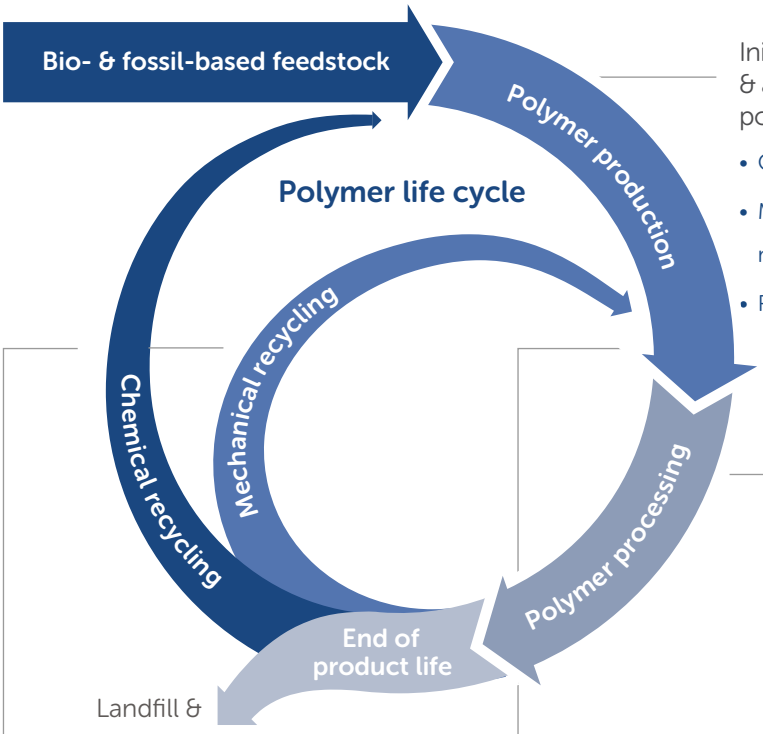
IMPROVE	GROW	ENGAGE
Improve our safety and environmental performance	Innovate to create Sustainable Solutions, enabling customers to be more sustainable	Engage with customers, suppliers, employees, and society to drive progress
Key sustainable development goals:	Key sustainable development goals:	Key sustainable development goals:

Our effort to **IMPROVE** our environmental performance includes ambitious targets:

Safety ambition: zero injuries and harm
2030
By the end of 2030, we have targeted reducing our absolute Scope 1 & 2 Greenhouse Gas (GHG) emissions by **40%**, vs. a 2019 base year
By the end of 2030, we have targeted reducing our total waste intensity by **10%**, and water consumption intensity by **10%**, vs. a 2019 base year
2050
By 2050, we aspire to be a **net zero** organization

Enabling the Polymer Cycle

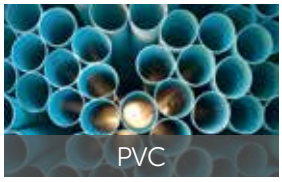
Building on a sustainability driven strategy. We provide essential ingredients to enable the polymer cycle.



Initiators, co-catalysts & additives to produce polymers

- Organic peroxides
- Metal alkyls & complex metalorganics
- Reactor additives


PP LDPE HDPE


PVC


EPS


Acrylic resins

Curatives & additives to create products

- Organic peroxides
- Polymer & processing additives

Modifiers to upgrade polymer properties

- Organic peroxides


Modified polymers


Crosslinked PE


Rubber goods


Composites

Recycling of Polyolefins

We are unique at being the only producer of a full product portfolio for recyclers that allows tuning of the MFI of polypropylene in both directions: UP and DOWN.

With our technology recyclers have the opportunity of producing a large range of recycled polypropylene products for the most diverse applications, expanding their market reach to high-end applications for which virgin PP was usually preferred.

We continuously develop new products and innovate to meet the needs of the recycling market.

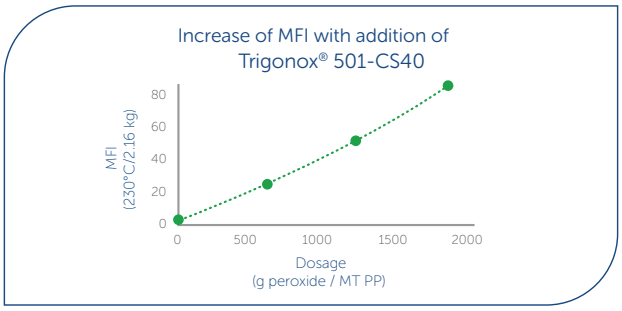
MFI UP ⇧	
Product	physical form
Trigonox® 501	liquid
Trigonox® 301	liquid, granules
Trigonox® 101	liquid, granules
Perkadox® 14	flakes, powder, granules
MFI DOWN ⇩	
Perkadox® PM	granules

Our latest innovations for upcycling of polypropylene

Go UP with the MFI of polypropylene Trigonox® 501-CS40 for consistent quality

Recycled Polypropylene (PP) is produced from feedstock with different Melt Flow Indexes resulting in flucuating quality of recycled PP, causing instability during processing at converters.

Our last generation vis-breaking peroxide Trigonox® 501-CS40 is used in the reactive extrusion of recycled PP to achieve a higher MFI and a narrower Molecular Weight Distribution. This results in constant and reproducible recycled PP quality.

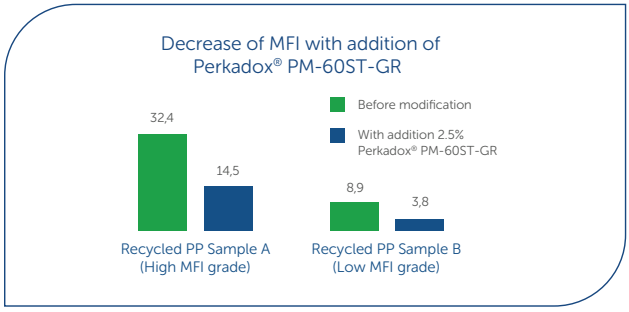


Trigonox® 501-CS40 is superior to traditional vis-breaking peroxides (i.e., Trigonox® 101, Perkadox® 14); in fact, it shows a 60% reduction in the Volatiles Organic Compounds produced during extrusion and can be stored at room temperature.

Go DOWN with the MFI of polypropylene Perkadox® PM-60ST-GR for high melt strength

Most of the properties of recycled plastics are inferior to virgin plastics due to exposure to UV and sunlight during the article's use and lifetime.

We have patented a new technology in which Perkadox® PM-60ST-GR is used in the reactive extrusion of recycled PP to decrease the MFI to levels similar to virgin polymer. This is known as upcycling of plastics.



With the use of Perkadox® PM-60ST-GR the melt strength, elasticity and mechanical propertie of recycled PP are greatly improved, allowing higher recycled content and use of recycled PP in new applications (i.e., foaming, thermoforming).

Innovation

As an innovative company we have a range of new, high-value products and technologies that serve your current and future needs. These innovations provide you with all kinds of benefits ranging from lower production costs to higher production output, and increased safety of your operations.

CiD technology for PVC

We have developed a new technology to improve the production efficiency and product quality of PVC. Continuous Initiator Dosing (CiD) using Nouryon's Trigonox® 187 product line can increase the output of any PVC production plant by 10-40%. In addition, product quality and safety of PVC production is improved together with energy savings and reduced CO_2 emissions.

New peroxide formulations for PVC

New innovative peroxide suspensions and emulsions have been developed to serve the current and future needs of the PVC industry. These new peroxide formulations improve sustainability and safety during the production of PVC. Food contact-approved peroxide formulations have been developed by Nouryon to serve the European PVC industry, whereas new methanol-free peroxide formulations have been developed to serve the US PVC industry.

These newly developed peroxide formulations are also intrinsically safer than solvent-based formulations and provide safer transport, safer storage and safer use. Trigonox® 187-W40 is an example of the innovative new peroxide emulsions product line, which is directly suited for use in combination with Nouryon's CiD Technology.

Innovative new IBC solution: less waste, less handling and storage

We now offer highly concentrated Type F organic peroxides in unique composite Intermediate Bulk Containers (IBC's). These provide our customers with improved safety, easier storage as well as handling advantages.

Innovative alternative to azo initiators

We have developed an attractive alternative for azo initiators. Trigonox® 421, one of our recent innovations in organic peroxides, is a new initiator for acrylics polymerization and the production of polymer polyols.
This new peroxide is a better handling and eco-premium alternative to azo initiators as it is free of toxic decomposition products. Furthermore, it is an easy dosing liquid providing handling advantages during production.
Trigonox® 421 product is used as a drop-in alternative for 2,2'-Azodi(isobutyronitrile) (AIBN).

Polymer modification: CR-PP

We have developed and patented Trigonox® 501-CS40 peroxide that is used for controlled rheology polypropylene (CR-PP). This new peroxide brings remarkable advantages for polypropylene producers. The Trigonox 501 product line is food-contact approved, and provides low volatiles, good organoleptics and a cost benefit to the production of CR-PP grades.

Circular polymers and recycling

Managing polymer waste is becoming one of the top priorities for the polymer industry. Nouryon has traditionally been supplying products that are used in the recycling of polymer waste streams. Our products can be used to adjust the melt index of recycle material. Organic peroxides can also act as compatibilizer in a mixed polymer recycle supply.
As an industry leader in sustainability, we strive to jointly develop solutions that further increase the efficiency of recycling processes (see page 5).

Trigonox®

Polymerization Initiators

Laurox®, Perkadox®, Trigonox® brands

Our range of organic peroxides for the manufacture of polyvinyl chloride (PVC), low density polyethylene (LDPE), acrylics, styrenics, controlled-rheology polypropylene (CR-PP), and other thermoplastics is the world's largest. We cover classes such as peroxy(di)carbonates, diacyl peroxides, peroxyketals, peroxyesters, dialkyl peroxides and hydroperoxides. In addition we supply azo (N-N) and carbon-carbon (C-C) initiators. You name it, we produce it.

Our products find use in a huge range of industrial and consumer goods. These include window frames, piping systems, food containers, automotive parts, cosmetic bottles, children's toys, carry bags or as insulation in electrical cables. Look around you and chances are you'll see Nouryon's influence.

Organic peroxides are also important materials in pharmaceutical and fine chemical synthesis or as active pharmaceutical ingredient (API). In fact, some of the world's best selling API's are synthesized using our products.

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 organic peroxides, we're happy to meet with you to discuss your requirements.

We are able to supply a wide range of initiators to meet all requirements with respect to area of application, polymerization temperature, rate of radical formation and storage facilities.

Listed are the highest concentrations of formulations

Please visit us at nouryon.com for complete product listings. Formulations in solvents or water or concentrations other than those indicated, as well as unique custom blends of various peroxides can be made available. However, safety characteristics and the appropriate environmental and transportation regulations have to be taken into account. Whatever your particular requirements, we can develop the product to match.

Scan QR code to watch our short video on how we help make polymers

Your Safety is our Priority

Nouryon is recognized as the global leader in organic peroxide safety. Our proven success in safely handling organic peroxides is due to our long-term commitment to developing and maintaining high safety standards. We at Nouryon always place safety as our top priority.

Sharing our experience in safety is one of the most important resources we offer. Through our safety programs we provide expert advice on the handling of our products including:

- classroom review of safety and handling of organic peroxides
- consultation on storage and dosing facility design
- demonstrations on the safe use, handling and control of organic peroxides

Our Safety Research Laboratory in Deventer, The Netherlands is heavily involved in R&D, ensuring the development of safe products and processes. Studies are carried out, in order to provide a high level of safety in manufacturing, handling and transport of dangerous goods.

In general organic peroxides are thermally unstable compounds, decomposing at relatively low temperatures. However, knowledge of proper handling techniques, carefully designed facilities and thorough training of personnel can overcome the hazards. Personnel who understand and pay proper attention will be able to handle organic peroxides confidently and safely.

Storage temperatures

SADT: Self-Accelerating Decomposition Temperature

The SADT is the lowest temperature at which self-accelerating decomposition may occur with a substance in the packaging as used in transport. Transportation temperatures are derived from the SADT according to the recommendations by the United Nations Committee of Experts on the Transport of Dangerous Goods.

T_s max.

The T_s max. given in the product list on pages 12-21 is the recommended maximum storage temperature at which the product is stable and quality loss will be minimal.

T_s min.

A minimum storage temperature (T_s min.) is given if phase separation, crystallization or solidification of the product is known to occur below the temperature indicated. We recommend that you store the product above the Ts min. indicated for quality and in some cases safety reasons.

T_{em}: Emergency temperature

The T_{em} is derived from the SADT and is the temperature at which emergency procedures must be implemented.

T_c: Control temperature

The T_c is also derived from the SADT and is the maximum temperature at which the product can be safely transported. A T_c is not required if the SADT exceeds 50°C.

Both the T_{em} and T_c are related to safety and do no apply to product quality. To maintain product quality the recommended storage temperatures (T_s min. and max.) have to be observed.

UN Numbers

All products accepted for transport are assigned to generic entry numbers according to classification principles as described in the recommendations by the United Nations Committee of Experts on the Transport of Dangerous Goods. An explanation of all relevant UN numbers is given in Table 1.

Survey of thermal stability

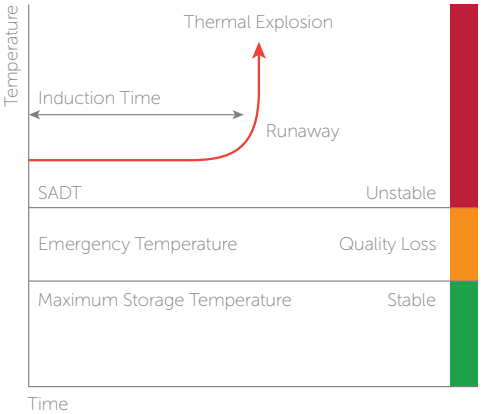


Table 1. Classification of organic peroxides

UN NO.	CLASSIFICATION	NOURYON HAZARD RATING	MAXIMUM CONTAINER SIZE
3103	type C; liquid	High	50 kg (110 lb)
3104	type C; solid		
3113	type C; liquid, temperature controlled		
3114	type C; solid, temperature controlled		
3105	type D; liquid	Medium	50 kg (110 lb)
3106	type D; solid		
3115	type D; liquid, temperature controlled		
3116	type D; solid, temperature controlled		
3107	type E; liquid	Low	400 kg (880 lb)
3117	type E; liquid, temperature controlled		
3108	type E; solid	Low	400 kg (880 lb)
3109	type F; liquid	Very low	IBC's / Tanks
3110	type F; solid		
3119	type F; liquid, temperature controlled		
3120	type F; solid, temperature controlled		
None	Non-dangerous good	No	Unrestricted
SELF-REACTIVE SUBSTANCES			
3234	type C; solid, temperature controlled	High	50 kg (110 lb)
3226	type D; solid	Medium	50 kg (110 lb)
3236	type D; solid, temperature controlled		

Scan QR code to watch our short video on how our safety services can support you.

Packaging

We continuously develop new and innovative packaging making logistics more efficient and improving safety standards even beyond existing transport regulations. From bottles to tank trucks we offer a variety of packaging options for both liquid and solid organic peroxides.

Liquid organic peroxides

Liquid peroxides from Nouryon are available in packages shown in Table 2. Package sizes expressed in gallons are only available in North America.

We also understand the need to innovate our packaging. For instance our Nourytainer®. Developed by Nouryon it is recognized as the world's benchmark in liquid organic peroxide packaging. Nouryon also was the first organic peroxide producer to introduce intermediate bulk containers (IBC's). And we're continually looking for new ways to optimize safe transport, handling and storage of organic peroxides.

Most recently we've led the way with our new composite IBC's for dilute type F organic peroxides. Due to their weight and dimensions, these IBC's offer benefits in safety and handling during transport and storage while giving all the advantages of our stainless steel containers. The specially designed lid, used as a emergency vent, is an Nouryon invention. In addition, they are readily available and have a lower environmental impact.

The Nouryon development of a cooled trailer with IBC's connected to a manifold eliminates the in-house handling and transport of IBC's. Organic peroxide formulations can be directly pumped into storage tanks by a leak-free, dry-break connection. All unloading facilities are present on the trailer.

Our continuous investment in refrigerated trucks, bulk tankers and dedicated reefers (refrigerated containers) specifically designed to safely transport our products is another demonstration of our commitment to security of supply.

Solid initiators

Standard packages for our solid initiators are shown in Table 3.

Most solid initiators are packaged in polyethylene bags inside non-returnable corrugated boxes. The number of bags per box varies, depending on the weight of initiator per bag.

For the availability of our products in IBC's, bulk or non-standard packages, please consult your Nouryon account manager.

Scan QR code to watch our short video on safe supply of organic peroxides in composite IBCs

Table 2. Standard packages for liquid peroxides

PACKAGE	VOLUME	NET WEIGHT	COMMENTS
Bottle	1 gallon	7-8 lb	packaged as 4 polyethylene bottles per non-returnable carton
HDPE can	20-30 liter (5.3-8 gallon)	15-25 kg (6.8-11.3 lb)	single component, polyethylene container (Nourytainer®)
Drum	15 gallon	100 lb	returnable polyethylene drum
	55 gallon	300-410 lb	polyethylene or steel drum
	200 liter	150 kg	steel drum
	220 liter	165-190 kg	returnable polyethylene drum
IBC	1000 liter	800-1000 kg	recollectable composite container (for emulsions and suspensions)
	1000 liter	700-1000 kg	recollectable, conductive composite container
	1250 liter	850-1100 kg	reusable stainless steel container
	330 gallon	2000 lb	reusable stainless steel container
Tank truck	20 m^3 7000 gallon	varies with product	for transport of bulk shipments of dilute type F organic peroxides

Table 3. Standard packages for solid initiators

PACKAGE	NET WEIGHT	COMMENTS
Carton	varies with product	polyethylene bags inside non-returnable cardboard box
Crate	varies with inner package	polyethylene bags inside returnable plastic crate
Drum	20-25 kg (45-55 lb)	fiber drum

Different solutions in dilluted peroxide formulations (see tables on page 14-29)

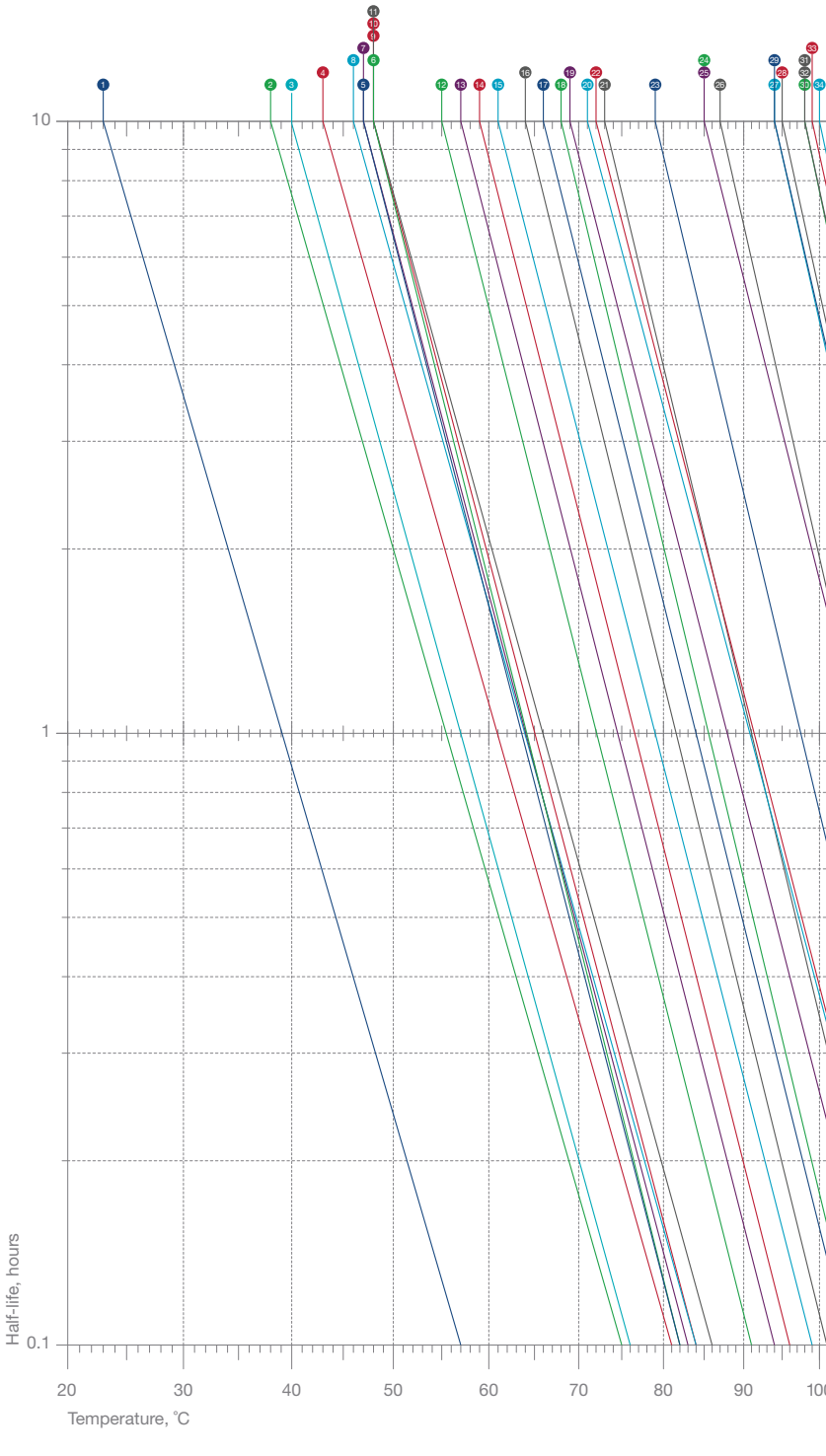
In diluted peroxide formulations the letter 'C' refers to Isododecane which is used exclusively in Europe, Middle East, India and Africa.

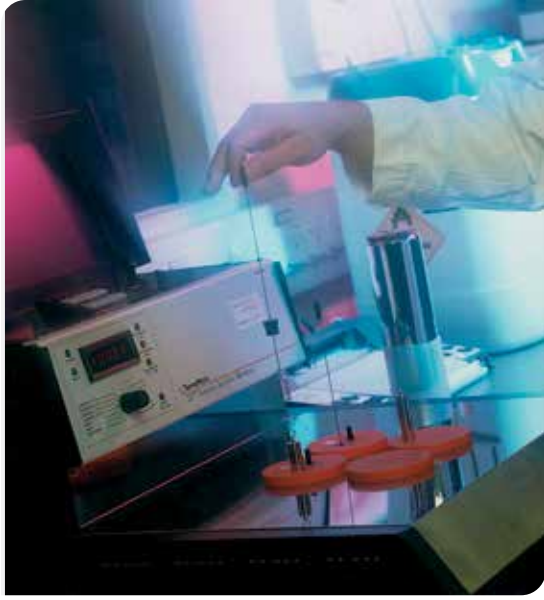
In the America's 'odorless mineral spirits' is used and products are indicated with "CH" to distinguish the different solvent.

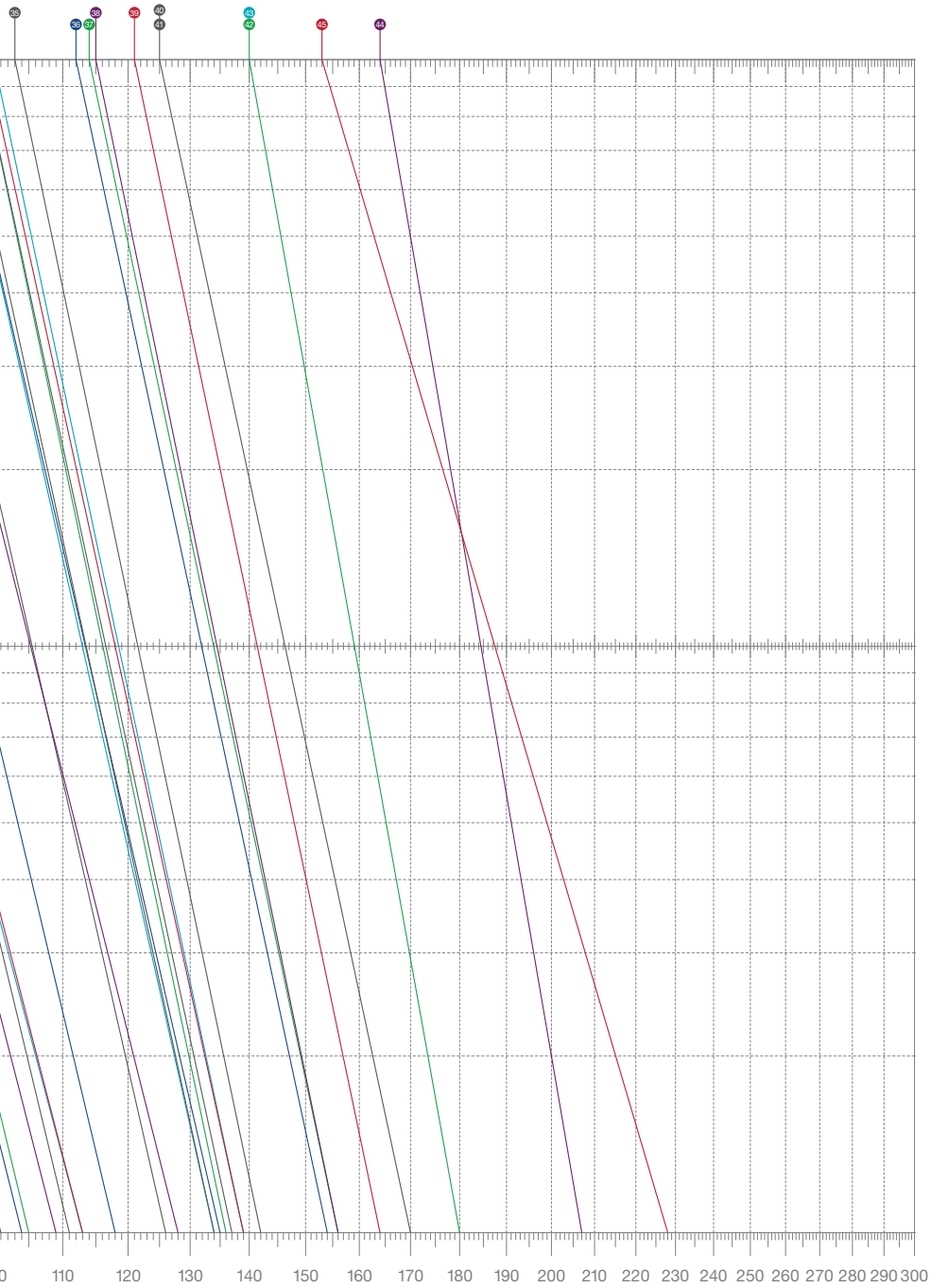
In Asia our odorless mineral spirits' based products are indicated by "CL".

Half-life Chart

	PRODUCT NAME	CHEMICAL NAME
1	TRIGONOX 187	Diisobutyryl peroxide
2	TRIGONOX 99	Cumyl peroxyneodecanoate
3	TRIGONOX 423	1,1,3,3-Tetramethylbutyl peroxyneodecanoate
4	TRIGONOX 123	tert-Amyl peroxyneodecanoate
5	TRIGONOX SBP	Di-sec-butyl peroxydicarbonate
6	PERKADOX 16	Di(4-tert-butylcyclohexyl) peroxydicarbonate
7	TRIGONOX EHP	Di(2-ethylhexyl) peroxydicarbonate
8	TRIGONOX 23	tert-Butyl peroxyneodecanoate
9	PERKADOX 24	Dicetyl peroxydicarbonate
10	PERKADOX 26	Dimyristyl peroxydicarbonate
11	TRIGONOX 425	1,1,3,3-Tetramethylbutyl peroxypivalate
12	TRIGONOX 125	tert-Amyl peroxypivalate
13	TRIGONOX 25	tert-Butyl peroxypivalate
14	TRIGONOX 36	Di(3,5,5-trimethylhexanoyl) peroxide
15	LAUROX	Dilauroyl peroxide
16	PERKADOX AIBN	2,2'-Azodi(isobutyronitrile)
17	PERKADOX AMBN	2,2'-Azodi(2-methylbutyronitrile)
18	TRIGONOX 141	2,5-Dimethyl-2,5-di(2-ethylhexanoylperoxy)hexane
19	TRIGONOX 421	1,1,3,3-Tetramethylbutyl peroxy-2-ethylhexanoate
20	TRIGONOX 121	tert-Amyl peroxy-2-ethylhexanoate
21	PERKADOX L	Dibenzoyl peroxide
22	TRIGONOX 21	tert-Butyl peroxy-2-ethylhexanoate
23	TRIGONOX 41	tert-Butyl peroxyisobutyrate
24	PERKADOX ACCN	1,1'-Azodi(hexahydrobenzonitrile)
25	TRIGONOX 29	1,1-Di(tert-butylperoxy)-3,3,5-trimethylcyclohexane
26	TRIGONOX 122	1,1-Di(tert-amylperoxy)cyclohexane
27	TRIGONOX 22	1,1-Di(tert-butylperoxy)cyclohexane
28	TRIGONOX 131	tert-Amylperoxy 2-ethylhexyl carbonate
29	TRIGONOX 42	tert-Butyl peroxy-3,5,5-trimethylhexanoate
30	TRIGONOX D	2,2-Di(tert-butylperoxy)butane
31	TRIGONOX BPIC	tert-Butylperoxy isopropyl carbonate
32	TRIGONOX 117	tert-Butylperoxy 2-ethylhexyl carbonate
33	TRIGONOX 127	tert-Amyl peroxybenzoate
34	TRIGONOX F	tert-Butyl peroxyacetate
35	TRIGONOX C	tert-Butyl peroxybenzoate
36	PERKADOX BC	Dicumyl peroxide
37	PERKADOX 14	Di(tert-butylperoxyisopropyl)benzene(s)
38	TRIGONOX 101	2,5-Dimethyl-2,5-di(tert-butylperoxy)hexane
39	TRIGONOX B	Di-tert-butyl peroxide
40	TRIGONOX 301	3,6,9-Triethyl-3,6,9-trimethyl-1,4,7-triperoxonane
41	TRIGONOX 501	1,2,4,5,7,8-Hexoxonane, 3,6,9-trimethyl-3,6,9-tris(Et and Pr)
42	TRIGONOX TMBH	1,1,3,3-Tetramethylbutyl hydoperoxide
43	TRIGONOX K	Cumyl hydroperoxide
44	TRIGONOX A	tert-Butyl hydroperoxide
45	TRIGONOX TAHP	tert-Amyl hydroperoxide







Kinetic Data

With the exception of hydroperoxides, the half-life is determined by differential scanning calorimetry-thermal activity monitoring (DSC-TAM) of a dilute solution of the initiator in monochlorobenzene. Kinetic data of the decomposition of hydroperoxides in monochlorobenzene are determined titrimetrically.

The tables in this catalog list the temperatures at which the half-lives are 0.1 hour, 1.0 hour and 10 hours.

The half-life can be calculated from the Arrhenius equation

$$kd = A \cdot e^{-Ea/RT} \text{ and } t1/2 = \ln 2/kd$$

The Arrhenius frequency factor (A) and activation energy (Ea) are given in the tables on pages 14-29.

The residual concentration of the initiator can be calculated by means of the equation

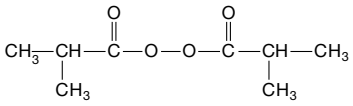
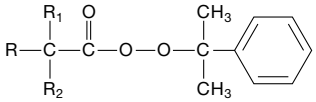
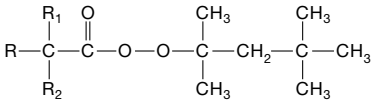
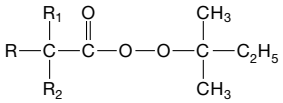
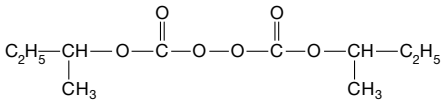
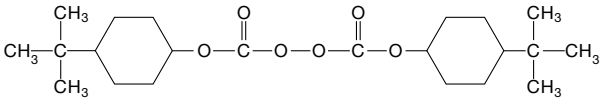
$$[I] = [I0] \cdot e^{-kd \cdot t}$$

The initiators in the tables on pages 12-21 are arranged in descending order of activity, based on the 1.0 hour half-life temperature.

k_d = rate constant for the initiator dissociation in s^{-1}
A = Arrhenius frequency factor in s^{-1}
E_a = Activation energy for the initiator dissociation in J/mole
R = 8.3142 J/mole.K
T = temperature in K
$t_{1/2}$ = half-life in s

$[I_0]$ = original initiator concentration
[I] = initiator concentration at time t
t = time measured from the start of decomposition in s

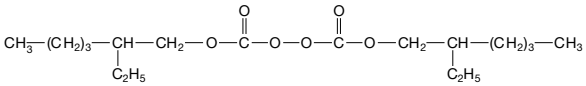
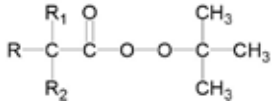
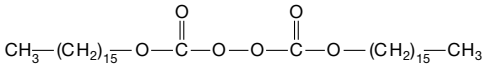
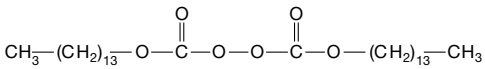
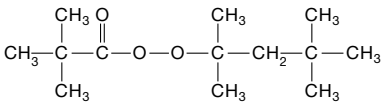
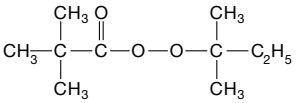
Our Polymerization Initiators

PRODUCT NAME	CHEMICAL NAME [CAS NUMBER]	GENERAL DATA		
		Molecular weight	Assay (%)	Active oxygen (%)
	Diisobutyryl peroxide [3437-84-1]	174.2		9.18
TRIGONOX 187-C30*			30	2.76
TRIGONOX 187-W40			40	3.68
	Cumyl peroxyneodecanoate [26748-47-0]	306.4		5.22
TRIGONOX 99-C75*			75	3.92
TRIGONOX 99-W50			50	2.61
	1,1,3,3-Tetramethylbutyl peroxyneodecanoate [51240-95-0]	300.5		5.32
TRIGONOX 423-C70*			70	3.73
TRIGONOX 423-W50			50	2.66
	tert-Amyl peroxyneodecanoate [68299-16-1]	258.4		6.19
TRIGONOX 123-C75*			75	4.64
	Di-sec-butyl peroxydicarbonate [19910-65-7]	234.2		6.83
TRIGONOX SBP			98	6.69
TRIGONOX SBPS			98	6.69
	Di(4-tert-butylcyclohexyl) peroxydicarbonate [15520-11-3]	398.5		4.01
PERKADOX 16S			96	3.85
PERKADOX 16			95.5	3.83
PERKADOX 16-W75			75	3.01
PERKADOX 16-W40			40	1.61

* see explanation on page 11
** not listed on TSCA

Physical form	STORAGE DATA T_s max. (°C)	T_s min. (°C)	KINETIC DATA T (°C) FOR T1/2 0.1 h	1.0 h	10 h	A (1/s)	E_a (kJ/mole)	SAFETY DATA SADT (°C)	T_{em} (°C)	T_c (°C)	UN No.	STANDARD PACKAGE TYPE See also page 11
			57	39	23	3.37E+14	109.06					
in hydrocarbon solvent	-20							0	-10	-20	3115	HDPE can
emulsion in water and methanol	-25	-30						0	-10	-20	3119	HDPE can
	-25	-30						-5	-15	-25	3119	IBC
			75	56	38	3.12E+14	114.59					
in hydrocarbon solvent	-20							10	0	-10	3115	HDPE can
emulsion in water and methanol	-20	-25						5	-5	-15	3119	IBC
			76	57	40	3.98E+14	115.79					
in hydrocarbon solvent	-15							15	5	-5	3115	HDPE can
emulsion in water and methanol	-15	-20						15	5	-5	3119	HDPE can / IBC
			81	61	43	1.47E+14	114.38					
in hydrocarbon solvent	-15	-25						20	10	0	3115	HDPE can
			82	63	47	3.19E+15	123.85					
liquid	-20							0	-10	-20	3113	HDPE bottle
liquid	-20							0	-10	-20	3113	HDPE bottle
			82	64	48	7.44E+15	126.39					
powder	20							40	35	30	3114	carton
powder	20							40	35	30	3114	carton
wet powder or cake	20							40	35	30	3114	carton
suspension in water	15	0						40	35	30	3119	HDPE can / IBC

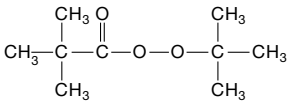
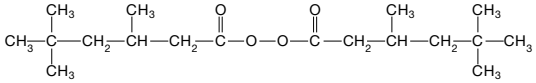
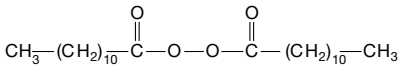
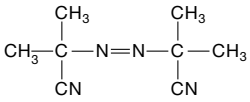
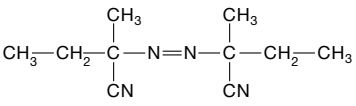
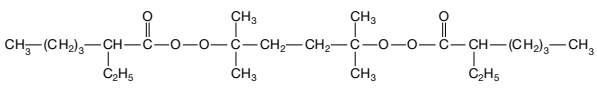
Our Polymerization Initiators

PRODUCT NAME	CHEMICAL NAME [CAS NUMBER]	GENERAL DATA		
		Molecular weight	Assay (%)	Active oxygen (%)
	Di(2-ethylhexyl) peroxydicarbonate [16111-62-9]	346.5		4.62
TRIGONOX EHP-C75*			75	3.46
TRIGONOX EHP-W60			60	2.77
TRIGONOX EHP-W40S			40	1.85
TRIGONOX EHPS			98	4.53
TRIGONOX EHPS-C75*			75	3.46
	tert-Butyl peroxyneodecanoate [26748-41-4]	244.4		6.55
TRIGONOX 23			95	6.22
TRIGONOX 23-C50*			50	3.27
TRIGONOX 23-W50			50	3.27
	Dicetyl peroxydicarbonate [26322-14-5]	570.9		2.80
PERKADOX 24-FL			94.5	2.65
PERKADOX 24L			91	2.55
PERKADOX 24-W35			35	0.98
	Dimyristyl peroxydicarbonate [53220-22-7]	514.8		3.11
PERKADOX 26			96	2.98
	1,1,3,3-Tetramethylbutyl peroxypivalate [22288-41-1]	230.3		6.95
TRIGONOX 425-C75*			75	5.21
	tert-Amyl peroxypivalate [29240-17-3]	188.3		8.50
TRIGONOX 125-C75*			75	6.37

* see explanation on page 11

Physical form	STORAGE DATA T_s max. (°C)	T_s min. (°C)	KINETIC DATA T (°C) FOR T1/2 0.1 h	1.0 h	10 h	A (1/s)	E_a (kJ/mole)	SAFETY DATA SADT (°C)	T_{em} (°C)	T_c (°C)	UN No.	STANDARD PACKAGE TYPE See also page 11
			83	64	47	1.83E+15	122.45					
in hydrocarbon solvent	-15	-25						5	-5	-15	3115	HDPE can
emulsion in water and methanol	-15	-25						5	-5	-15	3119	HDPE can
	-20	-25						0	-10	-20	3119	IBC
frozen flakes	-15							5	-5	-15	3120	carton
liquid	-20							0	-10	-20	3113	HDPE can
in hydrocarbon solvent	-15	-25						5	-5	-15	3115	HDPE can
			84	64	46	1.52E+14	115.47					
liquid	-10	-30						15	5	-5	3115	HDPE can
in hydrocarbon solvent	-10	-20						15	5	-5	3119	IBC
emulsion in water and methanol	-10	-25						20	10	0	3119	HDPE can
	-10	-25						15	5	-5	3119	IBC
			84	65	48	3.02E+15	124.30					
flakes	20							40	35	30	3120	carton
powder	20							40	35	30	3120	carton
suspension in water	15	0						40	35	30	3119	HDPE can
			84	65	48	2.82E+15	124.10					
flakes	15							35	25	20	3116	carton
			86	66	48	2.47E+14	117.50					
in hydrocarbon solvent	-15	-25						20	10	0	3115	HDPE can
			91	72	55	4.12E+15	127.76					
in hydrocarbon solvent	-10	-30						25	15	10	3113	HDPE can

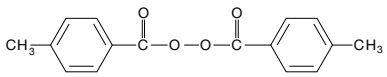
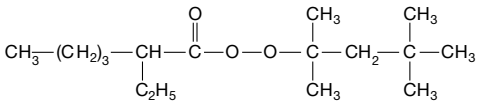
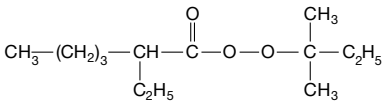
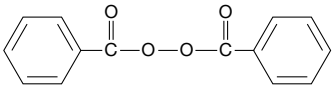
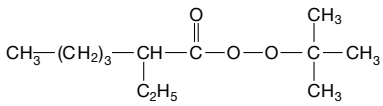
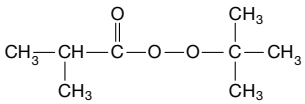
Our Polymerization Initiators

PRODUCT NAME	CHEMICAL NAME [CAS NUMBER]	GENERAL DATA		
		Molecular weight	Assay (%)	Active oxygen (%)
	tert-Butyl peroxypivalate [927-07-1]	174.2		9.18
TRIGONOX 25-C75*			75	6.89
TRIGONOX 25-C40*			40	3.67
TRIGONOX 25-C25*			25	2.30
	Di(3,5,5-trimethylhexanoyl) peroxide [3851-87-4]	314.5		5.09
TRIGONOX 36-C75*			75	3.82
TRIGONOX 36-C50*			50	2.54
TRIGONOX 36-C37.5*			37.5	1.91
TRIGONOX 36-W50			50	2.54
	Dilauroyl peroxide [105-74-8]	398.6		4.01
LAUROX			99	3.97
LAUROX S			99	3.97
LAUROX W-40			40	1.61
	2,2'-Azodi(isobutyronitrile) [78-67-1]	164.2		
PERKADOX AIBN			99	
	2,2'-Azodi(2-methylbutyronitrile) [13472-08-7]	192.3		
PERKADOX AMBN			98	
PERKADOX AMBN-GR			98	
	2,5-Dimethyl-2,5-di(2-ethylhexanoylperoxy)hexane [13052-09-0]	430.6		7.43
TRIGONOX 141			92	6.84

* see explanation on page 11

Physical form	STORAGE DATA T_s max. (°C)	T_s min. (°C)	KINETIC DATA T (°C) FOR T1/2 0.1 h	1.0 h	10 h	A (1/s)	E_a (kJ/mole)	SAFETY DATA SADT (°C)	T_{em} (°C)	T_c (°C)	UN No.	STANDARD PACKAGE TYPE See also page 11
			94	75	57	7.09E+14	123.59					
in hydrocarbon solvent	-5	-15						20	10	0	3113	HDPE can
in hydrocarbon solvent	-5	-20						25	15	10	3119	IBC
in hydrocarbon solvent	-5	-20						15	10	5	3119	Bulk
			96	77	59	2.84E+15	128.34					
in hydrocarbon solvent	0	-10						20	10	0	3115	HDPE can
in hydrocarbon solvent	0	-10						25	15	10	3119	IBC
in hydrocarbon solvent	0	-15						10	5	0	3119	Bulk
emulsion in water and methanol	0	-22						25	15	10	3119	HDPE can / IBC
			99	79	61	3.92E+14	123.37					
flakes	30							50	45	40	3106	carton
powder	30							50	45	40	3106	carton
suspension in water	20	0						50	45	40	3109	HDPE can / IBC
			101	82	64	2.89E+15	130.23					
solid	25							50	45	40	3234	carton / fiber drum
			104	84	66	1.38E+15	128.93					
solid	25							45	40	35	3236	carton
granules	25							45	40	35	3236	carton / fiber drum
			105	86	68	2.19E+15	130.88					
liquid	15	-20						35	25	20	3113	HDPE can

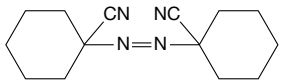
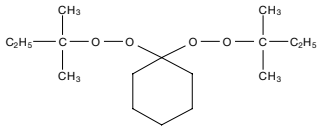
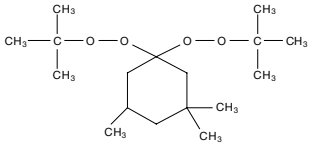
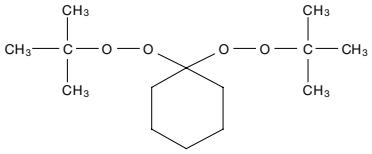
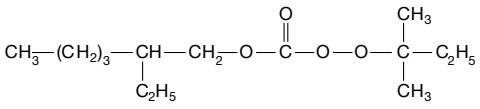
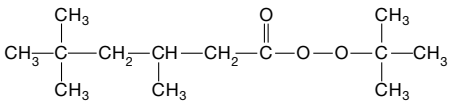
Our Polymerization Initiators

PRODUCT NAME	CHEMICAL NAME [CAS NUMBER]	GENERAL DATA		
		Molecular weight	Assay (%)	Active oxygen (%)
	Di(4-methylbenzoyl) peroxide [895-85-2]	270.3		5.91
PERKADOX PM-W75			75	4.38
	1,1,3,3-Tetramethylbutyl peroxy-2-ethylhexanoate [22288-43-3]	272.4		5.87
TRIGONOX 421			90	5.29
	tert-Amyl peroxy-2-ethylhexanoate [686-31-7]	230.3		6.95
TRIGONOX 121			95	6.60
	Dibenzoyl peroxide [94-36-0]	242.2		6.61
PERKADOX L-W75			75	4.95
PERKADOX L-W40			40	2.64
	tert-Butyl peroxy-2-ethylhexanoate [3006-82-4]	216.3		7.40
TRIGONOX 21S			97	7.17
TRIGONOX 21-C50*			50	3.70
TRIGONOX 21-C30*			30	2.22
	tert-Butyl peroxyisobutyrate [109-13-7]	160.2		9.99
TRIGONOX 41-C50*			50	4.99

* see explanation on page 11

Physical form	STORAGE DATA T_s max. (°C)	T_s min. (°C)	KINETIC DATA T (°C) FOR T1/2 0.1 h	1.0 h	10 h	A (1/s)	E_a (kJ/mole)	SAFETY DATA SADT (°C)	T_{em} (°C)	T_c (°C)	UN No.	STANDARD PACKAGE TYPE See also page 11
			108	88	70	5.11+15	134.4					
powder	40							90			3106	carton
			109	88	69	1.62E+14	123.80					
liquid	5	-20						30	20	15	3115	HDPE can
			111	91	73	1.77E+15	132.11					
liquid	5	-20						35	25	20	3115	HDPE can
			113	91	71	6.94E+13	122.35					
wet powder	40							80			3104	carton
suspension in water	30	0						60			3109	HDPE can
			113	91	72	1.54E+14	124.90					
liquid	10	-30						35	25	20	3113	HDPE can
in hydrocarbon solvent	10	-30						40	35	30	3119	IBC
in hydrocarbon solvent	10	-10						25	20	15	3119	Bulk
			118	98	79	2.07E+15	135.16					
in hydrocarbon solvent	10							30	20	15	3115	HDPE can

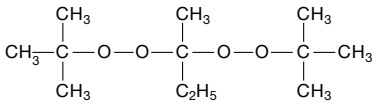
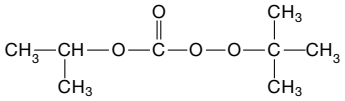
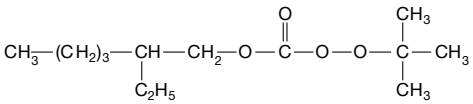
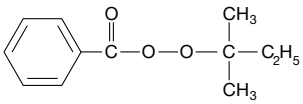
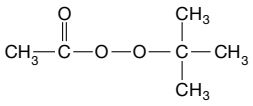
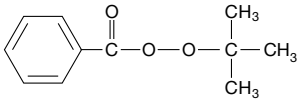
Our Polymerization Initiators

PRODUCT NAME	CHEMICAL NAME [CAS NUMBER]	GENERAL DATA		
		Molecular weight	Assay (%)	Active oxygen (%)
	1,1'-Azodi(hexahydrobenzonitrile) [2094-98-6]	244.3		
PERKADOX ACCN			98	
	1,1-Di(tert-amylperoxy)cyclohexane [15667-10-4]	288.4		11.09
TRIGONOX 122-C80*			80	8.88
	1,1-Di(tert-butylperoxy)-3,3,5-trimethylcyclohexane [6731-36-8]	302.5		10.58
TRIGONOX 29-C90*			90	9.52
TRIGONOX 29-E90			90	9.52
	1,1-Di(tert-butylperoxy)cyclohexane [3006-86-8]	260.4		12.29
TRIGONOX 22-C80*			80	9.83
TRIGONOX 22-E50			50	6.14
	tert-Amylperoxy 2-ethylhexyl carbonate [70833-40-8]	260.4		6.14
TRIGONOX 131			94	5.77
	tert-Butyl peroxy-3,5,5-trimethylhexanoate [13122-18-4]	230.3		6.95
TRIGONOX 42S			97	6.74
TRIGONOX 42-C60*			60	4.17
TRIGONOX 42-C30*			30	2.08

* see explanation on page 11

Physical form	STORAGE DATA T_s max. (°C)	T_s min. (°C)	KINETIC DATA T (°C) FOR T1/2 0.1 h	1.0 h	10 h	A (1/s)	E_a (kJ/mole)	SAFETY DATA SADT (°C)	T_{em} (°C)	T_c (°C)	UN No.	STANDARD PACKAGE TYPE See also page 11
			123	103	85	1.10E+16	142.19					
powder	35							80			3226	fiber drum
			126	106	87	3.29E+15	139.46					
in hydrocarbon solvent	30							55			3103	HDPE can
			128	105	85	7.59E+13	127.52					
in hydrocarbon solvent	25							60			3103	HDPE can
solution in mineral oil	25							60			3103	HDPE can
			134	113	94	3.47E+15	142.40					
in hydrocarbon solvent	25							60			3103	HDPE can
solution in mineral oil	25							70			3105	HDPE can
			134	113	95	2.22E+16	148.41					
liquid	20							55			3105	HDPE can
			135	114	94	1.94E+15	140.78					
liquid	25	-20						55			3105	HDPE can
in hydrocarbon solvent	25	-25						55			3109	IBC
in hydrocarbon solvent	25	-20						45	40	35	3119	Bulk
	25	-20										

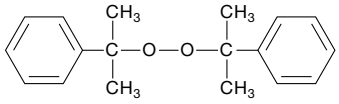
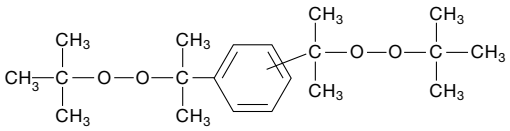
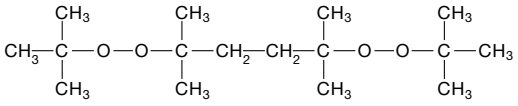
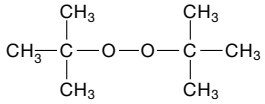
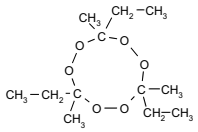
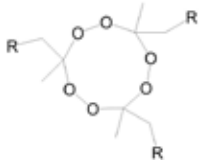
Our Polymerization Initiators

PRODUCT NAME	CHEMICAL NAME [CAS NUMBER]	GENERAL DATA		
		Molecular weight	Assay (%)	Active oxygen (%)
	2,2-Di(tert-butylperoxy)butane [2167-23-9]	234.3		13.66
TRIGONOX D-C50*			50	6.83
	tert-Butylperoxy isopropyl carbonate [2372-21-6]	176.2		9.08
TRIGONOX BPIC-C75*			75	6.81
	tert-Butylperoxy 2-ethylhexyl carbonate [34443-12-4]	246.3		6.49
TRIGONOX 117			95	6.17
	tert-Amyl peroxybenzoate [4511-39-1]	208.3		7.68
TRIGONOX 127			94	7.22
	tert-Butyl peroxyacetate [107-71-1]	132.2		12.11
TRIGONOX F-C50*			50	6.05
	tert-Butyl peroxybenzoate [614-45-9]	194.2		8.24
TRIGONOX C			98	8.07
TRIGONOX C-C75*			75	6.18

* see explanation on page 11

Physical form	STORAGE DATA T_s max. (°C)	T_s min. (°C)	KINETIC DATA T (°C) FOR T1/2 0.1 h	1.0 h	10 h	A (1/s)	E_a (kJ/mole)	SAFETY DATA SADT (°C)	T_{em} (°C)	T_c (°C)	UN No.	STANDARD PACKAGE TYPE See also page 11
			136	116	98	9.30E+16	154.08					
in hydrocarbon solvent	30							70			3103	HDPE can
			137	117	98	2.49E+16	150.15					
in hydrocarbon solvent	25	-20						70			3103	HDPE can
			137	117	98	4.07E+16	151.72					
liquid	20							60			3105	HDPE can
			139	118	99	8.38E+15	147.02					
liquid	20							60			3103	HDPE can
			139	119	100	1.57E+16	149.36					
in hydrocarbon solvent	10	-15						70			3103	HDPE can
			142	122	103	2.23E+16	151.59					
liquid	25	10						60			3103	HDPE can
in hydrocarbon solvent	25	0						60			3105	HDPE can

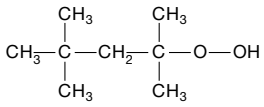
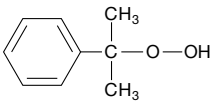
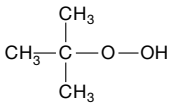
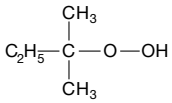
Our Polymerization Initiators

PRODUCT NAME	CHEMICAL NAME [CAS NUMBER]	GENERAL DATA		
		Molecular weight	Assay (%)	Active oxygen (%)
	Dicumyl peroxide [80-43-3]	270.4		5.92
PERKADOX BC-FF			99	5.86
	Di(tert-butylperoxyisopropyl)benzene [25155-25-3]	338.5		9.45
PERKADOX 14S			96	9.08
PERKADOX 14S-FL			96	9.08
	2,5-Dimethyl-2,5-di(tert-butylperoxy)hexane [78-63-7]	290.4		11.02
TRIGONOX 101			92	10.14
TRIGONOX 101-20PP			20	2.20
TRIGONOX 101-7.5PP-BD			7.5	0.83
TRIGONOX 101-E70			70	7.71
	Di-tert-butyl peroxide [110-05-4]	146.2		10.94
TRIGONOX B			99	10.83
TRIGONOX B-C90*			90	9.85
TRIGONOX B-C30*			30	3.28
	3,6,9-Triethyl-3,6,9-trimethyl-1,4,7-triperoxonane [24748-23-0]	264.3		18.16
TRIGONOX 301			41	7.45
TRIGONOX 301-20PP			8	1.45
	1,2,4,5,7,8-Hexoxonane, 3,6,9-trimethyl-3,6,9-tris (Et and Pr) [1613243-54-1]	-		17.8
TRIGONOX 501-CS40			40	7.14

* see explanation on page 11

Physical form	STORAGE DATA T_s max. (°C)	T_s min. (°C)	KINETIC DATA T (°C) FOR T1/2 0.1 h	1.0 h	10 h	A (1/s)	E_a (kJ/mole)	SAFETY DATA SADT (°C)	T_{em} (°C)	T_c (°C)	UN No.	STANDARD PACKAGE TYPE See also page 11
			154	132	112	9.24E+15	152.67					
crystals	30							75			3110	carton
			156	134	114	7.65E+15	152.69					
solid	30							80			3106	HDPE drum
flakes	20							80			3106	carton
			156	134	115	1.68E+16	155.49					
liquid	40	10						80			3103	HDPE can / HDPE drum
on polypropylene, beads	30							70			3108	carton
on polypropylene, beads	30							70			none	carton
solution in mineral oil	40	5						75			3109	HDPE can/IBC
			164	141	121	4.20E+15	153.46					
liquid	40	-30						80			3107	HDPE can / steel drum
in hydrocarbon solvent	40	-25						75			3109	IBC
in hydrocarbon solvent	40							65			3109	Bulk
			170	146	125	1.02E+15	150.23					
in hydrocarbon solvent	40	10						110			3105	HDPE can
on polypropylene, beads	40							90			3110	carton
			170	146	125	1.09E+15	150.60					
in hydrocarbon solvent	40	-25						110			3105	HDPE can

Our Polymerization Initiators

PRODUCT NAME	CHEMICAL NAME [CAS NUMBER]	GENERAL DATA		
		Molecular weight	Assay (%)	Active oxygen (%)
	1,1,3,3-Tetramethylbutyl hydoperoxide [5809-08-5]	146.2		10.94
TRIGONOX TMBH-L			90	9.85
	Cumyl hydroperoxide [80-15-9]	152.2		10.51
TRIGONOX K-90			90	9.46
TRIGONOX K-80			80	8.94
	tert-Butyl hydroperoxide [75-91-2]	90.1		17.75
TRIGONOX A-80			80	14.20 **
TRIGONOX A-W70			70	12.43
	tert-Amyl hydroperoxide [3425-61-4]	104.1		15.36
TRIGONOX TAHP-W85			85	13.06

* see explanation on page 11

** Contains 12.5% Di-tert-butyl peroxide (DTBP), total act. O 15.57%

Physical form	STORAGE DATA		KINETIC DATA T (°C) FOR T1/2					SAFETY DATA				STANDARD PACKAGE TYPE
	T_s max. (°C)	T_s min. (°C)	0.1 h	1.0 h	10 h	A (1/s)	E_a (kJ/mole)	SADT (°C)	T_{em} (°C)	T_c (°C)	UN No.	See also page 11
			180	159	140	1.90+18	181.99					
liquid	25	-5						60			3105	HDPE can
			195	166	140	1.15E+12	132.56					
solution in aromatic solvent mixture	40	-30						75			3109	HDPE can
								70			3109	IBC
solution in aromatic solvent mixture	40	-30						75			3109	HDPE can
			207	185	164	3.18E+17	186.01					
solution in water and DTBP *	40	0						90			3103	HDPE can
solution in water	35	0						80			3109	HDPE can / HDPE drum
	35	0						70			3109	steel IBC
	35	0						65			3109	plastic IBC
	35	0						55			3109	Bulk
			228	190	153							
solution in water	30	-5						80			3109	HDPE drum

Trigonox® 501

The next generation

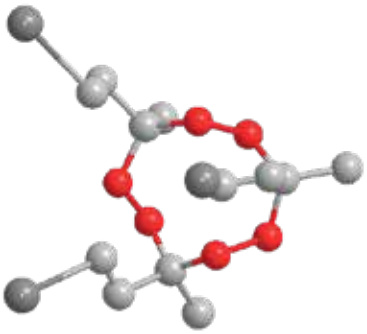
We master science and technology to develop sustainable, innovative solutions that benefit our customers. For example, Trigonox® 501-CS40 peroxide, the most effective organic peroxide for Controlled Rheology Polypropylene (CR-PP) available in the market. This Nouryon invention offers several advantages over commonly used modifiers.

Why was this new product developed?

With the ever-larger size of PP production plants there is an increasing need for post reactor modification of PP, allowing for tailor made grades to be produced. Controlled Rheology Polypropylene is one of the best-known modified PP grades, and it finds use in many applications such as packaging, fibers and nonwovens. None of the current peroxides that are used for this application is ideal: they suffer from specific disadvantages such as high volatile generation, poor organoleptic properties, complex handling and safety issues, and high cost.

Trigonox® 501-CS40 is a drop-in replacement for Trigonox® 301

Trigonox® 501-CS40 peroxide is the next generation of organic peroxides for use in CR-PP. It addresses the industry-wide need to reduce Volatile Organic Compounds (VOC's) in CR-PP resin by generating significantly lower amount of VOC's than other commonly used peroxides.



Trigonox® 501-CS40 peroxide also shows excellent organoleptic properties and has been approved for food contact applications by both BfR and FDA. Quite uniquely, Trigonox® 501-CS40 product does not require any temperature conditioning for storage, which simplifies daily operations. And last but not least, Trigonox® 501-CS40 product is cost effective and helps to reduce production costs for CR-PP grades.

Trigonox® 421

For a sustainable night's rest

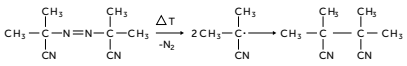
As a company of innovation we have a stream of new, high-value products and technologies, including our latest generation Trigonox® 421 organic peroxide for acrylic polymerization and polymer polyols production. Polymer polyols are used for foams used in e.g. upholstery and matrasses.

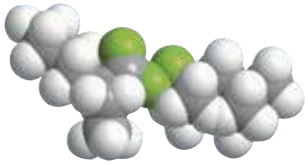
Trigonox® 421 peroxide is an eco-premium alternative to commonly use azo initiators.

- TMSN free
- No toxic decomposition products
- Drop-in replacement for AIBN and AMBN
- Easy to dose liquid

A new azo alternative

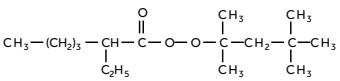
AIBN [2,2'-Azodi(isobutyronitrile)] is used in many polymerization processes. Upon decomposition the toxic tetramethylsuccinonitrile (TMSN) is formed. In answer to this problem Nouryon has developed Trigonox® 421, peroxide making TMSN history.
On a yearly basis some 4,000 tons of TMSN are produced through the decomposition of AIBN:





Azo initiators and more specifically AIBN is used for its unique properties. Upon decomposition it generates 100% selective C-centered radicals. Compared to aggressive, O-centered radicals, that are generally formed by organic peroxides, these C-centered radicals allow for much better molecular weight control. This is mainly caused by the lower level of branching generated. This is specifically important for applications as high solid acrylic resins and polymer polyols.

Contrary to AIBN 1,1,3,3-tetrametylbutyl peroxy-2-ethylhexanoate (Trigonox® 421 product) does not generate toxic by-products:



Unlike most other peroxides, Trigonox® 421, upon decomposition, almost exclusively generates selective C-radicals. It is therefore, just like AIBN, specially suitable for those applications where control of branching and molecular weight is important. Meanwhile Trigonox® 421 product has replaced AIBN already in many commercial applications, proving the above concept in practice.

Another benefit of Trigonox® 421 peroxide is that it is liquid. It is, therefore, much easier to dose in industrial batch- and continuous processes.

In summary:

- Trigonox® 421 is a drop-in replacement for AIBN
- Trigonox® 421 generates no toxic decomposition products
- Trigonox® 421 is liquid, therefore easy to dose

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Additional information

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

For information on our antifouling and secondary suspending agents please contact us. On request we also provide specific publications on the use and the safe handling and storage of our products.

Nouryon