Gel coated cast polymer

Application data and cure data

Nouryon is the world's leading producer of organic peroxides for the curing of thermoset resins, coatings and specialty monomers. We're home to the best known brands in the thermoset market. Examples include Butanox®, Cadox®, Perkadox® and Trigonox®. We also have a whole range of specialty auxiliary products, such as cobalt free accelerators to meet specific production requirements.

This application guide provides an introduction to our thermoset product portfolio and can help you find a suitable curing system for your specific application. If you need more detailed information please contact your account manager or customer service representative. Sharing our thermoset experience is one of the biggest resources we offer.

Process equipment

Cast polymer is a general term that refers to pre-cast resin/filler composites. Cultured marble, cultured granite, and cultured onyx are types of cast polymer that reproduce the look of the natural stone. Solid surface products are also a type of cast polymer, but utilize high performance resins that do not require gel coating and are addressed in a separate solid surface application guide. Gel coats are also addressed in a separate application guide. The purpose of this guide is to provide a brief exposure to common peroxides used in the matrix part of a cast polymer application.

A metal or composite mold is gel coated and allowed to partially cure. Separately, a pre-promoted general purpose or swing resin is combined with pigments, fillers, and an organic peroxide to form a flowable slurry called a matrix. The matrix is poured into the gel coated molds to form the desired product shape. Once the molds are filled, the material is consolidated using vibration that removes voids and produces a homogeneous matrix.

Reason for our products

- High quality
- Good after sales and technical service
- Intensive safety research
- Worldwide distribution
- Customized application research: special formulated products for an optimal performance in this application
- Leading edge technology for Cobalt-free curing systems

General composition

10-40 wt% Orthopthalic or similar unsaturated polyester resin
90-60 wt% Filler (sand, CaCO3, ATH, etc.)

Cure temperature

Ambient : 20-40°C
Post cure: 54°C-82°C

Main products

Sink basins, vanity tops, sanitary ware, bath tubs, floor tile, wall panels, fireplace surrounds

Cure system design

Selection of the initiator should be dependent upon the resin reactivity, filler loading, part thickness, temperature, and part geometry. Higher resin reactivity, lower filler loadings, and thicker parts contribute to higher exotherms and faster cure. Cadox M-50a is the most common initiator providing a balance of quick gel time and cure. Typical dosing rates are 1.0-3.0 phr (per hundred resin) which is equal to the wt% of peroxide based on amount of the matix resin.

PRODUCT NAME	DESCRIPTION	PEROXIDE CONTENT	ACTIVE OXYGEN (%)	TS, MAX. °F (°C)	SADT °F (°C)	NFPA CLASS	STANDARD PACKAGES
Cadox M-50a	High reactive Methyl Ethyl Ketone Peroxide (MEKP) for matrix	35	8.9	86 (30)	[3]140 ([3]60)	III**	4x8# Carton
Cadox D-50	Medium reactive Methyl Ethyl Ketone Peroxide for GC & matrix	35	8.9	86 (30)	[3]140 ([3]60)	III**	4x8# Carton
Cadox L-50a	Low reactive Methyl Ethyl Ketone Peroxide (MEKP) for GC	35	8.9	86 (30)	[3]140 ([3]60)	III**	4x8# Carton
Cadox LPT	Long Processing Time MEKP for GC & matrix	35	8.5	86 (30)	[3]140 ([3]60)	III**	40# Container
Cadox M-30a	Lower Concentration M-50a for summer molding conditions	20	5.3	86 (30)	[3]140 ([3]60)	IV**	4x7# Carton
Cadox L-30a	Lower Concentration L-50a for summer molding conditions	20	5.3	86 (30)	[3]140 ([3]60)	IV**	4x7# Carton
Trigonox 44B	Acetylacetone peroxide(AAP) for faster cure with slower gel times	25	4.0	86 (30)	140 (60)	IV	4x8# Carton, 410# Drum
Trigonox 61a	MEKP and AAP blend for fast cure with equal gel times	33	7.7	86 (30)	122 (50)	III**	4x8# Carton
Trigonox 63a	MEKP and AAP blend for fast cure with equal gel times	33	6.5	86 (30)	131 (55)	III**	4x8# Carton
Trigonox 178	MEKP and Cumene Hydroperoxide (CHP) blend for low exotherm	60	9.1	86 (30)	140 (60)		4x8# Carton
Trigonox 263	MEKP and Cumene Hydroperoxide (CHP) blend for low exotherm	48	9.2	86 (30)	140 (60)		4x8# Carton
Trigonox 524	Peroxide blend for most efficient cure with >60°C exotherms only	55	4.8	77 (25)	131 (55)		4x8# Carton

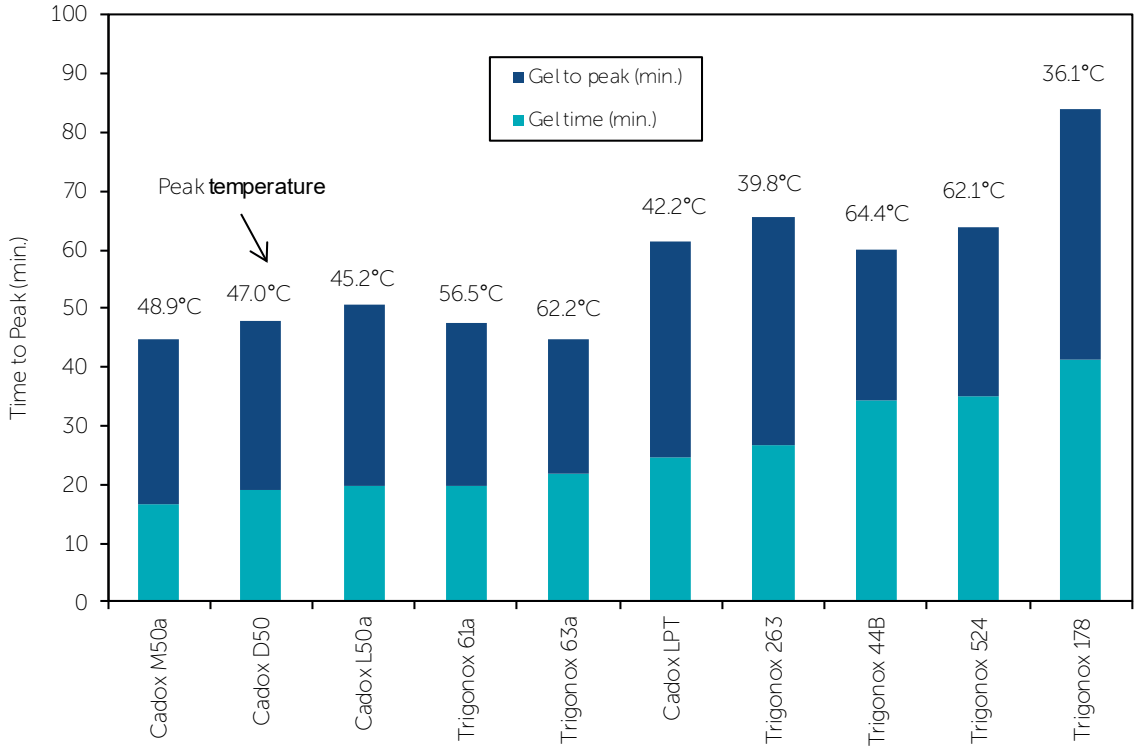
** Estimated from NFPA 432 based on similar formulations

Reactivity of these peroxides can be compared by casting ¾" panels filled with 70% CaCO3 and initiated with 1.0 phr peroxide. Results are shown in the tables of the following page. Initiators in the table are sorted in ascending order by gel-time, which is represented by the blue bar. The lavender bar stacked on top represents the time from gel to the peak exotherm. The sum of the two stacked bars is equivalent to the time to peak exotherm and is proportional to total processing time. The peak exotherm temperature noted at the top of each bar should also be monitored as it relates to the speed of cure and potential effects on shrinkage.

Cadox M-50a has the fastest gel time and is the most common product used in cast polymer. AAP containing products (Trigonox 61a, Trigonox 63a, Trigonox 44B, and Trigonox 524) may be utilized for faster cure cycles. These products have a faster gel to peak (cure time) than MEKP, but typically a slower gel time. MEKP/CHP blended products (Trigonox 178 and Trigonox 263) are mostly used in thicker parts where higher exotherms need to be avoided. They can also be used in warmer environments to avoid high exotherms and have the added benefit of better ambient post cure behavior.

Cure behavior in ¾" panels

(30% Orthopthalic UPE Resin, 70% CaCO3 filler, 1.0 phr peroxide)



Residual styrene in the ¾" panels is representative of the degree of cure and provides some insight into the varying efficiencies. A table for comparison is included on the following page. Products with higher exotherm produced lower residual monomer. Trigonox 524 is a blend of a ketone peroxide and a perester that is very effective in reducing residual styrene, however an exotherm of 60°C or higher must be achieved to be most effective. Parts can also be post cured to reduce residual monomer content.

Residual styrene of ¾" panels

INITIATOR	AMBIENT CURE 24 HRS	POST CURED 3 HRS AT 54.4°C	POST CURED 3 HRS AT 82.2°C
1.0 phr Cadox M50a	2.32	0.86	0.02
1.0 phr Cadox D50	2.10	0.89	0.02
1.0 phr Cadox L50a	2.32	0.82	0.01
1.0 phr Trigonox 61	1.78	0.76	0.00
1.0 phr Trigonox 63	1.68	0.77	0.04
1.0 phr Cadox LPT	2.41	0.80	0.00
1.0 phr Trigonox 263	2.16	0.58	0.00
1.0 phr Trigonox 44B	1.74	0.84	0.04
1.0 phr Trigonox 524	1.31	0.54	0.00
1.0 phr Trigonox 178	2.16	0.52	0.00

Cure data

Trigonox 44B

Trigonox 44B is an acetyl acetone peroxide formulation for the curing of unsaturated polyester resins in the presence of a cobalt accelerator at room and elevated temperatures.

With the curing system Trigonox 44B/cobalt accelerator a much faster speed of cure may be achieved than with curing systems based on a MEKP plus cobalt accelerator, at room and elevated temperatures. Normally the gel times with Trigonox 44B are comparable to those with Butanox M-50.

Trigonox 44B is particularly suitable in those applications where a fast mold-turnover is required, e.g. for the cold press molding or resin injection molding techniques.

The system Trigonox 44B/cobalt accelerator will give a higher peak exotherm than a standard MEKP/cobalt accelerator system. Due to this fact, is it recommendable to avoid the production of too thick laminates in one operation. At low temperatures a reasonable speed of cure is still obtained when Trigonox 44B is used in combination with large amounts of cobalt accelerator possibly in combination with N,N Dimethylaniline as promotor.

Dosing

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

Trigonox 44B	Accelerator NL-49PN
1 - 2 phr *	0.5 - 3 phr

* (parts per hundred resin)

In a high reactive standard orthophthalic resin in combination with Accelerator NL-49PN (= 1% cobalt) the following application characteristics were determined:

Gel times at 20°C

2 phr Trigonox 44B + 0.5 phr Acc. NL-49PN	15 minutes
2 phr Butanox M-50 + 0.5 phr Acc. NL-49PN	12 minutes
2 phr Trigonox 44B + 1.0 phr Acc. NL-49PN	8 minutes
2 phr Butanox M-50 + 1.0 phr Acc. NL-49PN	7 minutes

Cure of 1 mm pure resin layer at 20°C

The speed of cure is expressed as the time to reach a Persoz hardness of respectively 30, 60 and 120 s.

Persoz	30	60	120	s
2 phr Trigonox 44B + 0.5 phr Acc. NL-49PN	<1	1.5	5	h
2 phr Butanox M-50 + 0.5 phr Acc. NL-49PN	2.4	4.1	13	h
2 phr Trigonox 44B + 1.0 phr Acc. NL-49PN	<<1	1	4	h
2 phr Butanox M-50 + 1.0 phr Acc. NL-49PN	1.7	3	10	h

Cure of 4 mm laminates at 20°C

4 mm laminates have been made with a 450 g/m2 glass 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 25-30.
- Residual styrene content after 24 h at 20°C and a subsequent postcure of 8 h at 80°C.

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
2 phr Trigonox 44B + 0.5 phr Acc. NL-49PN	15	28	67
2 phr Butanox M-50 + 0.5 phr Acc. NL-49PN	13	36	44
2 phr Trigonox 44B + 1.0 phr Acc. NL-49PN	8	18	97
2 phr Butanox M-50 + 1.0 phr Acc. NL-49PN	8	26	64

	BARCOL	RESIDUAL STYRENE	
	25-30 (h)	24 h 20°C (%)	+8 h 80% (%)
2 phr Trigonox 44B + 0.5 phr Acc. NL-49PN	<1	4.4	0.1
2 phr Butanox M-50 + 0.5 phr Acc. NL-49PN	15	6	0.3
2 phr Trigonox 44B + 1.0 phr Acc. NL-49PN	<<1	0.9	0.2
2 phr Butanox M-50 + 1.0 phr Acc. NL-49PN	1	5	0.1

Pot life at 20°C

Pot lives were determined of a mixture of Trigonox 44B and a non-preaccelerated UP resin at 20°C.

2 phr Trigonox 44B	20 h
4 phr Trigonox 44B	11 h

Trigonox 524

Trigonox 524 is a peroxide formulation based on acetylacetone peroxide and tert butyl peroxybenzoate.

Trigonox 524 has been developed for the cure of unsaturated polyester resins at ambient and elevated temperatures in combination with a cobalt accelerator (e.g. Accelerator NL-49 PN= 1% cobalt).

Application area for the cure system Trigonox 524 plus a cobalt accelerator can be e.g. continuous laminating, resin transfer moulding and filament winding.

Dosing

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

Trigonox 524	Accelerator NL-49PN
1 - 2 phr *	0.1 - 1.0 phr

* (parts per hundred resin)

Cure characteristics in pure UP resin

In a high reactive standard orthophthalic UP resin, the following application characteristics were determined:

Gel time at 20°C

2 phr Trigonox 524 + 0.5 phr Acc. NL-49PN	19 minutes
2 phr Trigonox 44B + 0.5 phr Acc. NL-49PN	15 minutes
2 phr Butanox M-50 + 0.5 phr Acc. NL-49PN	12 minutes
1 phr Trigonox 524 + 0.5 phr Acc. NL-49PN	24 minutes
1 phr Trigonox 44B + 0.5 phr Acc. NL-49PN	19 minutes
1 phr Butanox M-50 + 0.5 phr Acc. NL-49PN	17 minutes

Cure of 4 mm laminates at 20°C

4 mm laminates have been made with a 450 g/m2 glass 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 a subsequent postcure of 8 h at 80°C

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
2 phr Trigonox 524 + 0.5 phr Acc. NL-49PN	18	30	71
2 phr Trigonox 44B + 0.5 phr Acc. NL-49PN	15	28	67
2 phr Butanox M-50 + 0.5 phr Acc. NL-49PN	13	36	44

	BARCOL		RESIDUAL STYRENE	
	0-5 (h)	25-30 (h)	24 h 20°C (%)	+8 h 80% (%)
2 phr Trigonox 524 + 0.5 phr Acc. NL-49PN		<1	4.9	<0.01
2 phr Trigonox 44B + 0.5 phr Acc. NL-49PN		<1	4.4	0.10
2 phr Butanox M-50 + 0.5 phr Acc. NL-49PN	3	15	6.0	030

Cure characteristics at elevated temperature

Cure of 4 mm laminates at 50°C

To demonstrate the performance of Trigonox 524 in resin transfer moulding applications, 4 mm laminates have been made with a 450 g/m2 glass chopped strand mat. The glass content in the laminates is 50% (w/w). The UP resin used was a one component low profile resin formulation.

The following parameters were determined:

- Gel time in pure resin.
- Time-temperature curve.
- Residual styrene content after a cure time of time to peak plus 5 minutes.

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)	RES. STYRENE TTP+5 MIN. %
1 phr Trigonox 524 + 0.5 phr Acc. NL-51P	1.1	2.9	106	0.95
1 phr Trigonox 44B + 0.5 phr Acc. NL-51P	0.8	2.0	90	2.00

Pot life at 20°C

Pot lives were determined of a mixture of Trigonox 524 and a non-preacelerated UP resin at 20°C

1 phr Trigonox 524	4 days
2 phr Trigonox 524	2 days

Trigonox 263

Trigonox 263 is a convenient pre-blended initiator suitable for curing unsaturated polyester, vinyl ester and acrylic thermosetting resins at ambient conditions in conjunction with a metal salt. Trigonox 263 produces lower exotherms than standard MEKPs and is useful in warm and hot weather climates. Applications include cast polymer and laminates. Additional end-use information is available in Nouryon's application brochures.

Applications

Trigonox 279 is a peroxide formulation based on acetylacetone peroxide and tertbutyl peroxybenzoate.

Trigonox 279 has specially been developed for the cure of unsaturated polyester resins at elevated temperatures in combination with a cobalt accelerator (e.g. Accelerator NL-49 = 1% cobalt).

Application area for the cure system Trigonox 279 plus a cobalt accelerator can be e.g. continuous laminating, resin transfer moulding, filament winding and centrifugal casting.

Dosing

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

Trigonox	Accelerator NL-49PN
1 - 3 phr *	0.5 - 2.0 phr

* (parts per hundred resin)

Cure characteristics

In a high reactive standard orthophthalic UP resin, the following application characteristics were determined:

Gel time at 20°C

1 phr Trigonox 279 + 1.0 phr Acc. NL-49PN	15 minutes
1 phr Trigonox 44B + 1.0 phr Acc. NL-49PN	13 minutes

Cure of 4 mm laminates at 20°C

4 mm laminates have been made with a 450 g/m2 glass 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 25-30 respectively.
- Residual styrene content after 24 h at 20°C and a subsequent postcure of 8 h at 80°C

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
1 phr Trigonox 279 + 1.0 phr Acc. NL-49PN	17	31	68
2 phr Trigonox 44B + 0.5 phr Acc. NL-49PN	15	28	67

	BARCOL		RESIDUAL STYRENE	
	0-5 (h)	25-30 (h)	24 h 20°C (%)	+8 h 80% (%)
1 phr Trigonox 279 + 1.0 phr Acc. NL-49PN		<1	5.4	<0.01
2 phr Trigonox 44B + 0.5 phr Acc. NL-49PN		<1	4.4	0.10

Cure characteristics at elevated temperature

Cure of 8 mm laminates at 80°C

To demonstrate the performance of Trigonox 279 in filament winding applications, 8 mm laminates have been made with a 450 g/m2 glass chopped strand mat. The glass content in the laminates is 33%.
The UP resin used was a medium reactive standard orthophthalic one.

The following parameters were determined:

- Time-temperature curve.
- Residual styrene content after a cure time of time to peak plus 5 minutes.

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)	RES. STYRENE TTP+5 MIN. %
1.0 phr Trigonox 279 + 1.0 phr Acc. NL-49PN	0.6	5.0	132	0.03
1.0 phr Trigonox 44B + 1.0 phr Acc. NL-49PN	0.6	4.8	126	2.5

Pot life at 20°C

Pot lives were determined of a mixture of Trigonox 279 and a non-preaccelerated UP resin at 20°C.

1 phr Trigonox 279	43 hrs
2 phr Trigonox 279	27 hrs

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

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Additional information

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

Nouryon

We are a global specialty chemicals leader. Industries worldwide rely on our essential chemistry in the manufacture of everyday products such as paper, plastics, building materials, food, pharmaceuticals, and personal care items. Building on our nearly 400-year history, the dedication of our 10,000 employees, and our shared commitment to business growth, strong financial performance, safety, sustainability, and innovation, we have established a world-class business and built strong partnerships with our customers. We operate in over 80 countries around the world and our portfolio of industry-leading brands includes Eka, Dissolvine, Trigonox, and Berol.

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