Acrylic road marking and flooring

Application data and cure data

We are Nouryon, your partner in essential chemistry for a sustainable future. 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®, Perkadox® and Trigonox®. We also have a whole range of auxiliary products, such as accelerators and promoters, to meet your specific production requirements.

This application guide introduces you to our thermoset product portfolio and helps you find a suitable curing system for your specific application.

Road marking comes in various forms:

- as tape, which are temporary road markings
- as paint and coating which is mainly acrylic paint or polyurethane
- as thermoplast (acrylic) hot melt which is heated up to approx. 170°C and spray-plasted or melt-plasted on the road
- as cold-plast polymerization of acrylic resin on the road

The last one, cold plast acrylics is discussed in this application guide as for this system the hardening is done at room temperature with the use of organic peroxides.

Applications

Acrylic road marking and flooring.

General composition

30-40 wt% Acrylic resin i.e. Methyl Methacrylate (MMA) Syrup
60-70 wt% Fillers such as ATH and color chips
5% additives such as pigments

Process equipment

Road marking: using a spray machine which may have two configutations:

Option 1:
Two resin lines, one resin part being pre-accelerated with amine and the other part being pre-catalyzed with peroxide. The pre-accelerated and pre-catalysed resin are mixed just prior to spraying. In that case two types peroxides are suitable: Perkadox CH50 (X/L), Perkadox GB-50 (X/L) and Perkadox L-40RPS.

Option 2:
The peroxide in its pure form is mixed just before the spray nozzle in the spraying machine. In that case only one type of peroxide is suitable: Perkadox L-40RPS.

Flooring: casting equipment:
The pre-accelerated resin and all necessary ingredients are mixed and peroxide is added at the end. The mixture is stirred by hand or using an electric mixer. The resin is poured over the surface, equalized and left to cure.

Cure temperatures
Normally at ambient temperature between 20 and 40°C but curing can also be tuned to ambient temperature down to 5°C or even lower.

Cure system for room temperature cure
For room temperature cure the common cure system is based on Benzoyl peroxide (BPO) and an Amine accelerator.

BPO is typically suitable for curing acrylic resins. It is furthermore a robust cure system and also cures very well in humid conditions and at low temperatures which is key for out-door application such as road marking and flooring.

BPO is available as free flowing powder, Perkadox CH-50X / Perkadox GB-50X which is the common grade for road marking and flooring.

For clear castings we recommend Perkadox CH-50L / Perkadox GB-50L which is low in water content and resulting in a clear and transparent end product.

BPO is also available as a pumpable suspension, Perkadox L-40RPS which is of particular use for high pressure (98/2) pressure machines for road marking application.

PRODUCT NAME	DESCRIPTION	PEROXIDE CONTENT (%)	ACTIVE OXYGEN (%)	TS MAX. (°C)	SADT (°C)
Perkadox CH-50X	Free flowing, readily soluble in MMA, BPO powder in DCHP	50%	3.3	25	55
Perkadox CH-50L	Free flowing, readily soluble in MMA, BPO powder in DCHP with low water content	50%	3.3	25	55
Perkadox GB-50X	Phthalate-free and free flowing, readily soluble in MMA, BPO powder in EGDB	50%	3.3	25	55
Perkadox GB-50L	Phthalate-free and free flowing, readily soluble in MMA, BPO powder in DCHP with low water content	50%	3.3	25	55
Perkadox L-40RPS	Pumpable dispersion of BPO phthalate free	40%	2.6	25	50

Perkadox GB-50 grades are phthalate-free BPO formulation which are introduced to the market as of Q2, 2018. The introduction is done because DCHP (the carrier in Perkadox CH-50) is classified CMR Carcinogenic cat. 1B.

Shelf life
The shelf-life of an acrylic resin containing Perkadox CH-50X / Perkadox GB-50X is about 20 days at 20 °C.

Amine accelerators
Benzoyl peroxide (BPO) is used in combination with an aromatic tertiary amine accelerator such as Accelerator NL-67 which is a non tox teriary amine. Resins are often pre-accelerated with amines in such case there is no need to add the amine separately.

PRODUCT NAME	DESCRIPTION	CHEMICAL NAME	CONTENT
Accelerator NL-65-100	High reactive amine accelerator delivering short geltimes	N,N-Dimethyl p-toluidine (DMPT)	>99%
Accelerator NL-67	Medium to high reactive amine accelerator delivering moderate geltimes	Ethoxylated p-toluidine (EPT)	>99%
Accelerator NL-64-100	Low reactive amine accelerator delivering moderate geltimes	N,N-Di-ethylaniline (DEA)	>99%

From HSE point of view we strongly recommend the use of Accelerator NL-67 as this grade does not carry toxic labelling.

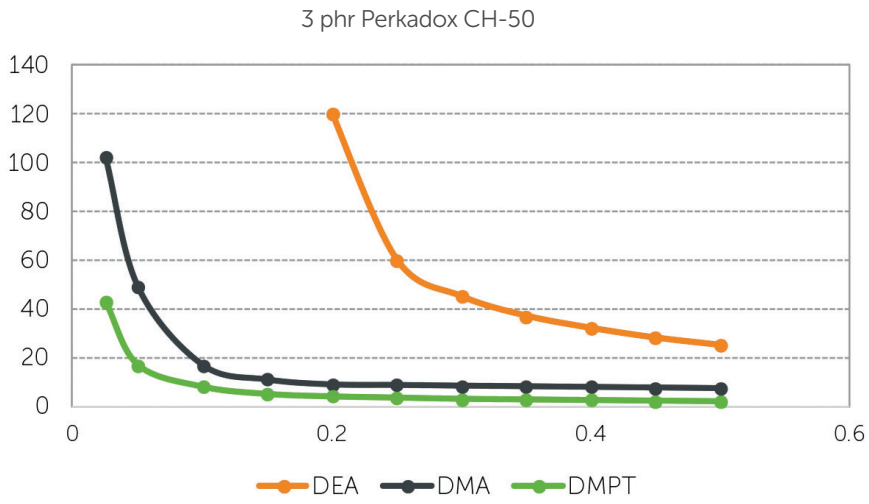
Typical ambient cure reactivity data measured at 25°C

Normally approx. 2 - 4 phr Perkadox CH-50X / Perkadox GB-50X is used, on average 3 phr.

The gel time and cure speed depends on the type and amount of accelerator mix, normally a combination of Accelerator NL-65-100 and Accelerator NL-64-100 is used. The higher the amount of Accelerator NL-64-100 the longer the geltime but the faster the hardening after the gel time. The accelerator itself is reacting away during the curing so the amount should be high enough for a complete conversion of the BPO. Normally the BPO is added in molar excess to make sure all amine reacts away.

Example of a cure system to indicate the effect of the amines on cure speed:
Intake peroxide: 3 phr Perkadox CH-50.

In the graph the effect of the intake level amine is shown:



Cure data

Accelerator NL-64-100 & Accelerator NL-65-100

The curing of unsaturated polyester resins at ambient temperatures can in general not be performed by an organic peroxide alone. The radical formation, which is necessary to start the polymerisation reaction, is at ambient temperatures with most generally applied organic peroxides too slow.

To speed up the radical formation in a controllable way, organic peroxides must therefore be used in combination with a so called accelerator. For diacyl peroxides like all Perkadox types and Perkadox 16, aromatic tertiary amines have to be used as accelerator.

For this purpose, the following amines are available:

	N,N-Dimethylaniline	(DMA)
Accelerator NL-64-100	N,N-Diethylaniline	(DEA)
Accelerator NL-65-100	N,N-Dimethylparatoluidine	(DMpT)
Accelerator NL-67	ethoxylated-para-Toluidine	(eth.DMpT)

Each amine accelerator has a different and specific influence on the decomposition of the diacyl peroxide. It is therefore possible by the proper choice of amine type and dosage level to adjust a wide variety of gel times and speed of cure. In this way a cure system can be developed for unsaturated polyester resins, which is extremely fast resulting in very short demolding times of the cured product.

The cure system dibenzoyl peroxide amine accelerator can further be characterised as being:
- not sensitive for moisture
- practically not sensitive to pigments and fillers applicable at low temperatures, even at 0°C a reasonable speed of cure can be achieved.

Possible disadvantages may be:
- a limited pot life of the amine accelerator in the UP and acrylic resin
- yellow to brown colour of the cured product
- poor UV light stability of the cured product
- a relatively high residual styrene content in the mouldings after a postcure at elevated temperatures, especially at high amine accelerator dosages.

Dosing

Depending on application area and working conditions the following accelerator dosage level is recommended:

Accelerator NL-64-100

0.20 - 0.50 phr *

Accelerator NL-65-100

0.20 - 0.50 phr

*(parts per hundred resin)

Cure characteristics

In a high reactive standard orthophthalic resin the following application characteristics were determined. The diacyl peroxide used for the experiments was Perkadox CH 50X, a fast dissolving powder formulation of dibenzoyl peroxide.

Cure characteristics

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Gel times at 20°C

3 phr Perkadox CH-50X + 0.10 phr Accelerator NL-64-100	160 min.
3 phr Perkadox CH-50X + 0.25 phr Accelerator NL-64-100	54 min.
3 phr Perkadox CH-50X + 0.50 phr Accelerator NL-64-100	20 min.
3 phr Perkadox CH-50X + 0.05 phr Accelerator NL-65-100	20 min.
3 phr Perkadox CH-50X + 0.10 phr Accelerator NL-65-100	5 min.
3 phr Perkadox CH-50X + 0.50 phr Accelerator NL-65-100	0.8 min.

Cure of 4 mm laminates at 20°C

4 mm laminates have been made with 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 24h at 20°C and a subsequent postcure of 8h at 80°C.

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
3 phr Perkadox CH-50X + 0.5 phr Accelerator NL-64-100	21	26	140
3 phr Perkadox CH-50X + 0.05 phr Accelerator NL-65-100	28	35	64
3 phr Perkadox CH-50X + 0.1 phr Accelerator NL-65-100	8	13	131

	BARCOL		RESIDUAL STYRENE	
	0-5 (h)	25-30 (h)	24 h 20°C (%)	+8 h 80% (%)
3 phr Perkadox CH-50X + 0.5 phr Accelerator NL-64-100		<<1	2.9	2.1
3 phr Perkadox CH-50X + 0.05 phr Accelerator NL-65-100	1	8.5	6.6	0.8
3 phr Perkadox CH-50X + 0.1 phr Accelerator NL-65-100		<<1	3.0	1.3

Pot life at 20°C

Pot lives were determined in an UP resin at 20°C.

120 days 0.5 phr Accelerator NL-64-100

70 days 1.0 phr Accelerator NL-64-100

16 days 0.1 phr Accelerator NL-65-100

12 days 0.2 phr Accelerator NL-65-100

Accelerator NL-67

The curing of unsaturated polyester resins at ambient temperatures can in general not be performed by an organic peroxide alone. The radical formation, which is necessary to start the polymerisation reaction, is at ambient temperatures too slow.

To speed up the radical formation in a controllable way, organic peroxides must be used in combination with an accelerator. For dibenzoyl peroxides aromatic tertiary amines have to be used, it does not work with a Cobalt accelerator.

For this purpose, the following amines are available:

Accelerator NL-64-100	N,N-Dimethylaniline	(DEA)
Accelerator NL-65-100	N,N-Dimethyl-para-toluidine	(DMpT)
Accelerator NL-67	ethoxylated-para-Toluidine	(eth.DMpT)

Each amine accelerator has a different and specific influence on the decomposition of the dibenzoyl peroxide. It is therefore possible by the proper choice of amine type and dosage level to adjust a wide variety of gel times and speed of cure. In this way a cure system can be developed for unsaturated polyester resins or acrylate syrups, which is extremely fast resulting in very short demolding times of the cured product.

The cure system dibenzoyl peroxide/amine accelerator can further be characterised as being:
- not sensitive for moisture
- practically not sensitive to pigments and fillers
- applicable at low temperatures; even at 0°C a reasonable speed of cure can be achieved.

Possible disadvantages may be:
- a limited pot life of the amine accelerator in the UP resin
- yellow to brown colour of the cured product
- poor UV light stability of the cured product

A special application of the amine accelerators is their use as promoter in a ketone peroxide/cobalt accelerator cure system. The use of Accelerator NL-67 as accelerator alternative for dimethylaniline in combination with dibenzoylperoxide in orthophtalic resins is shown in the table below.

High reative ortho resin	100	100	100			
Medium reactive ortho resin				100	100	100
Perkadox CH-50X	2	2	2	2	2	2
Dimethylaniline	0.1			0.1		
Accelerator NL-67		0.1			0.1	
Accelerator NL-64-100			0.5			0.5
4 mm. laminate at 20 °C						
Gel time in min.	56	30	54	66	34	64
Time to peak in min.	71	40	62	91	55	76
Peak exotherm	68	84	111	49	53	89
Barcol hardness:						
after 2 hrs	50	54	57	38	44	53
after 24 hrs	54	55	58	48	49	57
Residual styrene after 24 hrs (%)	4.3	4.0	2.0	3.7	3.9	1.5
Residual styrene 8 hrs at 80°C (%)	0.7	0.8	0.7	0.3	0.3	0.3

Perkadox CH-50

Perkadox CH-50 is a free flowing, fine, granular powder containing 50% dibenzoylperoxide for the curing of unsaturated polyester and acrylic resins at ambient and elevated temperatures.At temperatures up to 80°C, Perkadox CH-50 should be used in combination with an aromatic tertiary amine accelerator, above 80°C the use of an accelerator is not required.

Perkadox CH-50 is easy to handle, easy to disperse and dissolves very quickly in unsaturated polyester resins and acrylic resins. When in acrylic resins a very high degree of transparency of the cured part is required the special grade Perkadox CH-50L is advised. The curing system Perkadox CH-50/amine accelerator shows a very fast cure that is hardly influenced by humidity and fillers.Even at low temperatures a relatively good cure will be obtained. A disadvantage may be the yellow color and poor light resistance of the moulded product.

For ambient temperature curing the following amine accelerators are available to adjust the gel time and speed of cure of the cure system based on Perkadox CH-50:

- Accelerator NL-65-100 (N,N-Dimethyl p toluidine) for short gel times
- N,N-Dimethylaniline for medium gel times
- Accelerator NL-64-100 (N,N-Diethylaniline) for long gel times

Dosing

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

Perkadox CH-50

2 - 5 phr *

Amine accelerator

0.05 - 0.5 phr

*(parts per hundred resin)

Cure characteristics

In a high reactive standard orthophthalic polyester resin the following application characteristics were determined.

GEL TIMES AT 20°C

UP resin	100	100	100	100	100	100	100
Perkadox CH-50	3.0	3.0	3.0	3.0	3.0	3.0	3.0
N,N-Dimethylaniline	0.1	0.4					
Accelerator NL-64-100	0.1	0.5					
Accelerator NL-65-100	0.05	0.1	0.4				
Gel time (minutes)	22	6	160	20	20	5	1

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
3 phr Perkadox CH-50 + 0.1 phr N,N-Dimethylaniline	0.5	0.8	2	h
3 phr Perkadox CH-50 + 0.4 phr N,N-Dimethylaniline			<0.5	h
3 phr Perkadox CH-50 + 0.5 phr Accelerator NL-64-100		0.5	1	h
3 phr Perkadox CH-50 + 0.05 phr Accelerator NL-65-100	1	2.5	14	h
3 phr Perkadox CH-50 + 0.1 phr Accelerator NL-65-100			0.5	h

Perkadox CH-50X

Perkadox CH-50X is a non-caking, fine, granular powder with excellent free flowing properties containing 50% dibenzoylperoxide.

Perkadox CH-50X is used for the curing of unsaturated polyester resins and (meth)acrylic resins at ambient and elevated temperatures. At temperatures up to 80°C, Perkadox CH 50X should be used in combination with an aromatic tertiary amine accelerator, above 80°C the use of an accelerator is not required.

Perkadox CH-50X is easy to handle, easy to disperse and dissolves very quickly in unsaturated polyester resins and (meth)acrylic resins.

The curing system Perkadox CH-50X/amine accelerator shows a very fast cure that is hardly influenced by humidity and fillers. Even at low temperatures a relatively good cure will be obtained. A disadvantage may be the yellow color and poor light resistance of the moulded product.

For ambient temperature curing the following amine accelerators are available to adjust the gel time and speed of cure of the cure system based on Perkadox CH-50X:

- Accelerator NL-65-100 (N,N-Dimethyl p toluidine) for short gel times
- N,N-Dimethylaniline for medium gel times
- Accelerator NL-64-100 (N,N-Diethylaniline) for long gel times

Dosing

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

Perkadox CH-50

2 - 5 phr *

Amine accelerator

0.05 - 0.5 phr

* (parts per hundred resin)

Cure characteristics

In a high reactive standard orthophthalic polyester resin the following application characteristics were determined.

GEL TIMES AT 20°C

UP resin	100	100	100	100	100	100	100
Perkadox CH-50	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	0.1	0.4					
Accelerator NL-64-100	0.1	0.5					
Accelerator NL-65-100	0.05	0.1	0.4				
Gel time (minutes)	22	6	160	20	20	5	1

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
3 phr Perkadox CH-50 + 0.1 phr N,N-Dimethylaniline	0.5	0.8	2	h
3 phr Perkadox CH-50 + 0.4 phr N,N-Dimethylaniline			<0.5	h
3 phr Perkadox CH-50 + 0.5 phr Accelerator NL-64-100		0.5	1	h
3 phr Perkadox CH-50 + 0.05 phr Accelerator NL-65-100	1	2.5	14	h
3 phr Perkadox CH-50 + 0.1 phr Accelerator NL-65-100			0.5	h

Cure of 4 mm laminates at 20°C

4 mm laminates have been made with 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 24h at 20°C and a subsequent postcure of 8h at 80°C.

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
3 phr Perkadox CH-50X + 0.1 phr N,N-Dimethylaniline	24	31	99
3 phr Perkadox CH-50X + 0.5 phr Accelerator NL-64-100	21	26	140
3 phr Perkadox CH-50X + 0.05 phr Accelerator NL-65-100	28	35	64

	BARCOL		RESIDUAL STYRENE	
	0-5 (h)	25-30 (h)	24 h 20°C (%)	+8 h 80% (%)
3 phr Perkadox CH-50X + 0.1 phr N,N-Dimethylaniline		<1	3.2	1.0
3 phr Perkadox CH-50X + 0.5 phr Accelerator NL-64-100		<<1	2.9	2.1
3 phr Perkadox CH-50X + 0.05 phr Accelerator NL-65-100	1	8.5	6.6	0.8

Pot life at 20°C

Pot lives were determined of a mixture of Perkadox CH-50X and a non-preaccelerated resin at 20°C.

21 days 3 phr Perkadox CH-50X

11 days 6 phr Perkadox CH-50X

Perkadox L-40 RPS

Perkadox L-40 RPS is a pumpable, sprayable easy dispersing form of dibenzoyl peroxide for the curing of unsaturated polyester resins at ambient and elevated temperatures. At cure-temperatures up to 80°C, Perkadox L-40 RPS should be used in combination with an aromatic tertiary amine accelerator, above 80°C the use of an accelerator is not required.

Perkadox L-40 RPS can be pumped through internal and external mix FRP spray equipment and poured or metered by volume, Perkadox L-40 RPS is easier to use and handle than conventional dibenzoyl peroxide pastes or dispersions. The low water content of Perkadox L-40 RPS allows for use in all FRP applications.

The curing system Perkadox L-40 RPS/amine accelerator shows a very fast cure, which is hardly influenced by humidity and fillers. Even at low temperatures a relatively good cure will be obtained. A disadvantage may be the yellow color and poor light resistance of the molded product.For ambient temperature curing the following amine accelerators are available to adjust the gel time and speed of cure of the cure system based on Perkadox L-40 RPS:

- Accelerator NL-65 100 (N,N-Dimethyl p toluidine) for short gel times
- N,N-Dimethylaniline for medium gel times
- Accelerator NL-64 100 (N,N-Diethylaniline) for long gel times

Dosing

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

Perkadox L-40 RPS

2.5 - 6 phr *

Amine accelerator

0.05 - 0.5 phr

* (parts per hundred resin)

Cure characteristics

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

GEL TIMES AT 20°C

UP resin	100	100	100	100	100	100	100
Perkadox L-40 RPS	3.8	3.8	3.8	3.8	3.8	3.8	3.8
N,N-Dimethylaniline	0.1	0.4					
Accelerator NL-64-100			0.1	0.5			
Accelerator NL-65-100					0.05	0.1	0.4
Gel time (minutes)	22	6	160	20	20	5	1

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
3.8 phr Perkadox L-40 RPS + 0.1 phr N,N-Dimethylaniline	0.5	0.8	2	h
3.8 phr Perkadox L-40 RPS + 0.4 phr N,N-Dimethylaniline			<0.5	h
3.8 phr Perkadox L-40 RPS + 0.5 phr Accelerator NL-64-100		0.5	1	h
3.8 phr Perkadox L-40 RPS + 0.05 phr Accelerator NL-65-100	1	2.5	14	h
3.8 phr Perkadox L-40 RPS + 0.1 phr Accelerator NL-65-100			0.5	h

Cure of 4 mm laminates at 20°C

4 mm laminates have been made with 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 24h at 20°C and a subsequent postcure of 8h at 80°C.

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
3.8 phr Perkadox L-40 RPS + 0.1 phr N,N-Dimethylaniline	24	31	99
3.8 phr Perkadox L-40 RPS + 0.5 phr Accelerator NL-64-100	21	26	140
3.8 phr Perkadox L-40 RPS + 0.05 phr Accelerator NL-65-100	28	35	64

	BARCOL		RESIDUAL STYRENE	
	0-5 (h)	25-30 (h)	24 h 20°C (%)	+8 h 80% (%)
3.8 phr Perkadox L-40 RPS + 0.1 phr N,N-Dimethylaniline		<1	3.2	1.0
3.8 phr Perkadox L-40 RPS + 0.5 phr Accelerator NL-64-100		<<1	2.9	2.1
3.8 phr Perkadox L-40 RPS + 0.05 phr Accelerator NL-65-100	1	8.5	6.6	0.8

Pot life at 20°C

Pot lives were determined of a mixture of Perkadox L-40 RPS and a non-preaccelerated UP resin at 20°C.

38 days 2.0 phr Perkadox CH-50X

20 days 3.8 phr Perkadox CH-50X

Perkadox GB-50

(also applicable for Perkadox GB-50L and Perkadox GB-50X)

Perkadox GB-50 is a free flowing, fine, granular powder containing 50% dibenzoyl peroxide for the curing of unsaturated polyester and acrylic resins at ambient and elevated temperatures. At temperatures up to 80°C, Perkadox GB-50 should be used in combination with an aromatic tertiary amine accelerator. Above 80°C the use of an accelerator is not required.

Perkadox GB-50 is easy to handle, easy to disperse and dissolves very quickly in unsaturated polyester resins and acrylic resins. When in acrylic resins a very high degree of transparency of the cured part is required the special grade Perkadox GB-50L is advised. The curing system Perkadox GB-50/amine accelerator shows a very fast cure that is hardly influenced by humidity and fillers. Even at low temperatures a relatively good cure will be obtained. A disadvantage may be the yellow colour and poor light resistance of the moulded product.

For curing at ambient temperature the following amine accelerators are available to adjust the gel time and speed of cure of the cure system based on Perkadox GB-50:

- Accelerator NL-65-100 (N,N-Dimethyl p toluidine) for short gel times
- Accelerator NL-67 (Ethoxylated-p-toluidine) for medium gel times
- Accelerator NL-64-100 (N,N-Diethyl aniline) for long gel times

Dosing

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

Perkadox GB-50	Amine accelerator
2 - 5 phr *	0.05 - 0.5 phr

* (parts per hundred resin)

Cure characteristics

In a high reactive standard orthophthalic polyester resin the following application characteristics were determined.

GELTIME CLEAR RESIN AT 20°C (GELNORM)

UP resin	100	100	100	100	100
Perkadox GB-50	3.0	3.0	3.0	3.0	3.0
Accelerator NL-64-100	0.1	0.5			
Accelerator NL-65-100			0.0	0.1	0.4
Gel time (minutes)	160	20	20	5	1

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
3 phr Perkadox GB-50 + 0.1 phr Accelerator NL-64-100		0.5	1	h
3 phr Perkadox GB-50 + 0.05 phr Accelerator NL-65-100	1	2.5	14	h
3 phr Perkadox GB-50 + 0.1 phr Accelerator NL-65-100			0.5	h

Cure of 4 mm laminates at 20°C

4 mm laminates have been made with 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 24h at 20°C and a subsequent postcure of 8h at 80°C.

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
3 phr Perkadox GB-50 + 0.5 phr Accelerator NL-64-100	21	26	140
3 phr Perkadox GB-50 + 0.05 phr Accelerator NL-65-100	28	35	64

	BARCOL		RESIDUAL STYRENE	
	0-5 (h)	25-30 (h)	24 h 20°C (%)	+8 h 80% (%)
3 phr Perkadox GB-50 + 0.5 phr Accelerator NL-64-100		<1	2.9	2.1
3 phr Perkadox GB-50 + 0.05 phr Accelerator NL-65-100	1	8.5	6.6	0.8

In a medium reactive standard orthophthalic polyester resin the following application characteristics were determined.

Geltime clear resin at 20°C (Gelnorm)

3 phr Perkadox GB-50 + 0.15 phr Accelerator NL-67 15 minutes

Cure of 4 mm laminates at 20°C in Bisphenol A eopxy VE resin

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

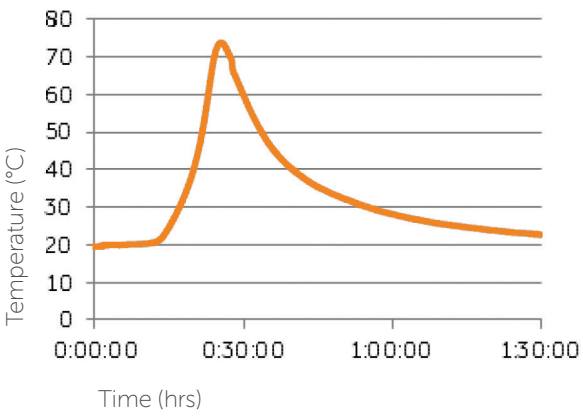
The following parameters were determined:

- Time temperature curve (SPI method)
- Speed of cure expressed as the time to achieve a Barcol hardness (934-1) of 25.
- Residual styrene content after 24h at 20°C

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
3 phr Perkadox GB-50 + 0.15 phr Accelerator NL-67	16	26	74

	BARCOL	RESIDUAL STYRENE
	25 (h)	24 h, 20°C (%)
3 phr Perkadox GB-50 + 0.15 phr Accelerator NL-67	1	1

Graph 1. Time temperature curve



In a high reactive Bisphenol-A epoxy vinyl ester resin the following application characteristics were determined.

Gel time clear resin at 20°C (Gelnorm)

3 phr Perkadox GB-50 + 0.15 phr Accelerator NL-67 11 minutes

Clear SPI reactivity data with different types of accelerators

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
3 phr Perkadox GB-50 + 0.2 phr Accelerator NL-64-100	29	39	150
3 phr Perkadox GB-50 + 0.2 phr Accelerator NL-65-100	4	9	150
3 phr Perkadox GB-50 + 0.2 phr Accelerator NL-67	8	15	164

Cure of 4 mm laminates at 20°C in MMA resin

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

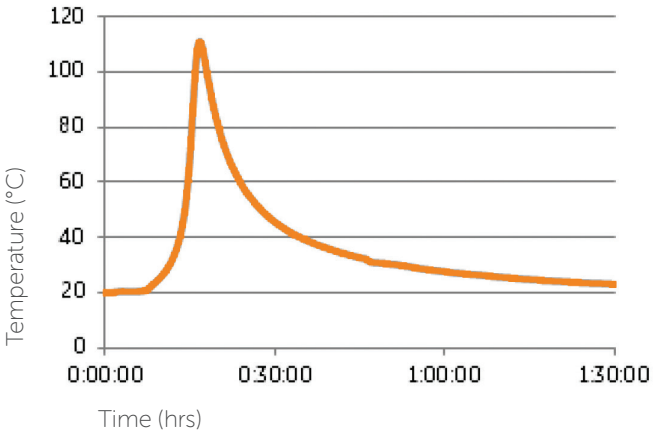
The following parameters were determined:

- Time temperature curve (SPI method)
- Speed of cure expressed as the time to achieve a Barcol hardness (934-1) of 25.
- Residual styrene content after 24h at 20°C

	GEL TIME (min.)	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
3 phr Perkadox GB-50 + 0.15 phr Accelerator NL-67	10	17	111

	BARCOL	RESIDUAL STYRENE
	25 (h)	24 h, 20°C (%)
3 phr Perkadox GB-50 + 0.15 phr Accelerator NL-67	1	17

Graph 2. Time temperature curve



In a standard methacrylate syrup the following application characteristics were determined.

Cure time clear resin at 20°C (Gelnorm)

3 phr Perkadox GB-50 + 0.15 phr Accelerator NL-67 29 minutes

Time-temperature curve of a thin layer at 20°C (SPI-method)

	CURE TIME (MIN.)	PEAK EXOTHERM (°C)
3 phr Perkadox GB-50 + 0.15 phr Accelerator NL-67	30	59

Pot life at 20°C

The pot life is determined of a mixture of Perkadox GB-50 and a non-pre-accelerated UP resin at 20°C.

21 days 3 phr Perkadox GB-50

11 days 6 phr Perkadox GB-50

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

Nouryon

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