Gelcoats

Application data and cure data

Nouryon is the world's leading producer of organic peroxides for the curing of thermoset resins and coatings. 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.

Sharing our thermoset experience is one of the biggest resources we offer. This application guide introduces you to our thermoset product portfolio and helps you find a suitable curing system for your specific situation.

Main products and process equipment

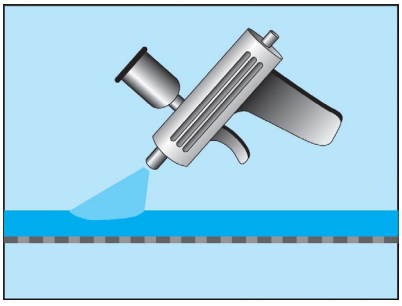
Spray up or brush application.

Nouryon curing agents

The curing system for the gelcoats application is mainly based on Butanox M-50 and Butanox M-60. Both are very suitable for gelcoats in marine applications by their guaranteed low water content and the absence of polar solvents. Water and polar solvent should not be present because they can cause osmosis in the gelcoats.

Special peroxides: Butanox P-50

Butanox P-50 for example is specifically developed for fast curing of gelcoats and for improved appearance and reduction of styrene emission. Butanox P-50 is of course of the same high quality as Butanox M-50 and Butanox M-60 and the product of choice for several international boat builders.



Reason for our products

- A guarantee of quality and reliability
- Outstanding technical and customer service
- Intensive safety research
- A global distribution network and security of supply
- Customized application research: special formulated products for an optimal performance in your application

Common problems and solutions

Too long gel time

To achieve a shorter gel time you can add more peroxide or increase the amount of (Cobalt) accelerator. We recommend a maximum intake of peroxide of 2% to avoid formation of too many radicals and loss of mechanical properties. In case this is still not sufficient we recommend adding Promotor C or Promotor D in a dosage level of 0.1-0.5%.

Too short gel time

A longer gel time can be achieved by reducing the amount of peroxide or by switching to another peroxide like Butanox LA-IN or Butanox LPT-IN. These curing agents have a lower hydrogen peroxide level and lead to longer gel times.

In case this would not be slow enough we recommend our Inhibitor NLC-10 which is a radical catcher. An intake level of 0.1-0.5% is usually enough. One should be aware that overdosing the inhibitor can lead to undercure as the inhibitor eats the peroxide radicals.

Too high peak exotherm (white fibers and delamination)

A high peak exotherm can lead to excess of expansion and shrinkage and cause delamination (i.e. cracks in the laminate). Because of the delamination sometimes the glass reinforcement becomes visible (white fibers). Clearly such laminate will not meet the mechanical properties you aimed for. The peak exotherm ideally remains below 100°C.

To avoid a too high peak we recommend a low reactive peroxide like Butanox LPT-IN or Butanox LA-IN. Should this not be sufficient, because perhaps the part is very thick, we recommend a peroxide with a peak reducing effect such as Trigonox 75 or Trigonox 82. These products effectively reduce the peak exotherm. Depending on the shape of the part and thickness the most suitable peroxide can be selected.

Too long cycle time or demolding time

To reduce the cycle time (to achieve faster demolding) we recommend a peroxide with a higher reactivity like for example Trigonox 44B. The gel time will be long enough for the hand lay-up step. Once the curing starts there will be a sharp peak exotherm and a fast curing resulting in a low residual styrene content.

Should Butanox M-50 be too slow and Trigonox 44B be too fast, you can consider Trigonox 61, Trigonox 63 or Trigonox 65 which have a reactivity in-between.

Mixing problem in the spraying machine / Monitoring the cure

Our Vanishing Red (VR) peroxides provide all of the benefits of normal dyed peroxides, such as for insurance peroxide addition and verification of consistent mixing, but without the lasting red color that normal dyed peroxides leave in the cured end products. There is a full range of Vanishing Red peroxides available including are Butanox M-50VR, Butanox LPT-IN.

Gas formation while using vinylester resins

The gas formation is caused by the reaction between hydrogen peroxide in the MEKP and some ingredients in the resin forming gas bubbles (oxygen). This can be reduced by using a peroxide with low hydrogen peroxide content such as Butanox LPT-IN. The ideal (non- gassing) solution is the use of a cumyl hydroperoxide which contains no hydrogen peroxide at all. Cumyl hydroperoxide is marketed as Trigonox K-90 and Trigonox 239, the latter containing a promotor for fast reactivity.

A summary containing the standard reactivity data of the most used products in this application can be found on the next pages.

Cure data

Butanox M-50

Butanox M-50 is a general purpose methyl ethyl ketone peroxide (MEKP) for the curing of unsaturated polyester resins in the presence of a cobalt accelerator at room and elevated temperatures.

The curing system Butanox M-50/cobalt accelerator is particularly suitable for the curing of gelcoat resins, laminating resins, lacquers and castings; moreover, the manufacture of light resistant parts may be possible contrary to the curing system benzoyl peroxide/amine accelerator.

Practical experience throughout many years has proven that by the guaranteed low water content and the absence of polar compounds in Butanox M-50, this peroxide is very suitable in GRP products for e.g. marine applications.

For room temperature application it is necessary to use Butanox M-50 together with a cobalt accelerator (e.g. Accelerator NL-49PN)

Dosing

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

Butanox M-50	Accelerator NL-49PN
1 - 4 phr *	0.5 - 3 phr

* (parts per hundred resin)

Cure characteristics

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 Butanox M-50 + 0.5 phr Accelerator NL-49PN	12 minutes
2 phr Butanox M-50 + 1.0 phr Accelerator 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 Butanox M-50 + 0.5 phr Accelerator NL-49PN	2.4	4.1	13	h
2 phr Butanox M-50 + 1.0 phr Accelerator NL-49PN	1.7	3.0	9.5	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 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 Butanox M-50 + 0.5 phr Accelerator NL-49PN	13	36	44
2 phr Butanox M-50 + 1.0 phr Accelerator NL-49PN	8	26	64

	BARCOL		RESIDUAL STYRENE	
	0-5 (h)	25-30 (h)	24 h 20°C (%)	+8 h 80% (%)
2 phr Butanox M-50 + 0.5 phr Accelerator NL-49PN	3	15	6	0.3
2 phr Butanox M-50 + 1.0 phr Accelerator NL-49PN		1	5	0.1

Pot life at 20°C

Pot lives were determined of a mixture of Butanox M-50 and a non-preaccelerated UP resin at 20°C.

2 phr Butanox M-50	12 h
4 phr Butanox M-50	7 h

Solubility

Butanox M-50 is miscible with phthalates and slightly miscible with water.

Colors

Butanox M-50 is available in the colors blue, yellow-A, red-YM and red-YM 1/6.

Butanox M-60

Butanox M-60 is a general purpose methyl ethyl ketone peroxide (MEKP) for the curing of unsaturated polyester resins in the presence of a cobalt accelerator at room and elevated temperatures. Butanox M-60 is a 10% higher concentrated version of Butanox M-50.

The curing system Butanox M-60/cobalt accelerator is particularly suitable for the curing of gelcoat resins, laminating resins, lacquers and castings; moreover, the manufacture of light resistant parts may be possible contrary to the curing system benzoyl peroxide/amine accelerator.

Practical experience throughout many years has proven that by the guaranteed low water content and the absence of polar compounds in Butanox M-60, this peroxide is very suitable in GRP products for e.g. marine applications.

For room temperature application it is necessary to use Butanox M-60 together with a cobalt accelerator (e.g. Accelerator NL-49PN).

Dosing

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

Butanox M-60	Accelerator NL-49PN
1 - 4 phr *	0.5 - 3 phr

*(parts per hundred resin)

Cure characteristics

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 Butanox M-60 + 0.5 phr Accelerator NL-49PN	10 minutes
2 phr Butanox M-50 + 0.5 phr Accelerator NL-49PN	12 minutes
2 phr Butanox M-60 + 1.0 phr Accelerator NL-49PN	6 minutes
2 phr Butanox M-50 + 1.0 phr Accelerator 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 Butanox M-60 + 0.5 phr Accelerator NL-49PN	2.2	3.8	12	h
2 phr Butanox M-50 + 0.5 phr Accelerator NL-49PN	2.4	4.1	13	h
2 phr Butanox M-60 + 1.0 phr Accelerator NL-49PN	1.3	2.5	9	h
2 phr Butanox M-50 + 1.0 phr Accelerator NL-49PN	1.7	3.0	9.5	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 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 Butanox M-60 + 0.5 phr Accelerator NL-49PN	13	33	50
2 phr Butanox M-50 + 0.5 phr Accelerator NL-49PN	13	36	44
2 phr Butanox M-60 + 1.0 phr Accelerator NL-49PN	7	23	71
2 phr Butanox M-50 + 1.0 phr Accelerator NL-49PN	8	26	64

	BARCOL		RESIDUAL STYRENE	
	0-5 (h)	25-30 (h)	24 h 20°C (%)	+8 h 80% (%)
2 phr Butanox M-60 + 0.5 phr Accelerator NL-49PN	2	13	5.7	0.3
2 phr Butanox M-50 + 0.5 phr Accelerator NL-49PN	3	15	6	0.3
2 phr Butanox M-60 + 1.0 phr Accelerator NL-49PN		<1	4.7	0.1
2 phr Butanox M-50 + 1.0 phr Accelerator NL-49PN		1	5	0.1

Pot life at 20°C

Pot lives were determined of a mixture of Butanox M-60 and a non-preaccelerated UP resin at 20°C.

2 phr Butanox M-60	10 h
4 phr Butanox M-60	6 h

Butanox P-50

Butanox P-50 is a high reactive methyl isopropyl ketone peroxide (MIPKP) for the optimal curing of unsaturated polyester resins in the presence of a cobalt accelerator at room and elevated temperatures.

The curing system Butanox P-50/cobalt accelerator is particularly suitable for the curing of gelcoat resins and laminating resins used for the production of boat hulls, deck parts, truck panels, car panels or sanitary ware products. Practical experience has proven that by the guaranteed low water content and the absence of polar compounds in Butanox P-50, this peroxide is very suitable in GRP products for high demanding end-markets like marine applications (boat building).

For room temperature application it is necessary to use Butanox P-50 together with a cobalt accelerator (e.g. Accelerator NL-49PN).

Dosing

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

Butanox P-50

1 - 4 phr *

Accelerator NL-49PN

0.5 - 3 phr

* (parts per hundred resin)

Cure characteristics

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 Butanox P-50 + 1.0 phr Accelerator NL-49PN	6 minutes
2 phr Butanox M-50 + 1.0 phr Accelerator NL-49PN	7 minutes

Cure of 0.5 mm ISO/NPG gelcoat

(800 µm wet = 500 µm dry)

ISO/NPG (not preacc.) Butanox M-50 Butanox P-50 Accelerator NL-49PN	100 2 1.5	100 2	100 2
Cobalt content (mg/kg)	150	67	67
Geltime 800 µm layer/wet (min.) Drying time (min.) Persoz hardness after 3 hours after 4 hours after 6 hours after 24 hours	12 73 - 19 34 122	15 58 - 25 47 132	12 49 24 37 55 146

Cure of 2 mm laminates at 20°C

2 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

	TIME TO PEAK (min.)	PEAK EXOTHERM (°C)
2 phr Butanox P-50 + 0.25 phr Accelerator NL-51PN	28	39
2 phr Butanox M-50 + 0.25 phr Accelerator NL-51PN	41	29

	BARCOL	
	0-5 (h)	25-30 (h)
2 phr Butanox P-50 + 0.25 phr Accelerator NL-51PN	0.5	1.5
2 phr Butanox M-50 + 0.25 phr Accelerator NL-51PN	1	3.5

Pot life at 20°C

Pot lives were determined of a mixture of Butanox P-50 and a non-preaccelerated UP resin at 20°C.

2 phr Butanox P-50	15 h
4 phr Butanox P-50	6 h

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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

Nouryon is 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 more than 9,700 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. Visit our **website** and follow us **@Nouryon** and on **LinkedIn**.

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