LANXESS
Energizing Chemistry

Additives solutions for Polyurethane

APAC Lanxess Virtual Day 2020

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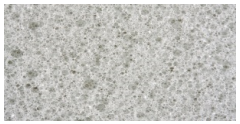
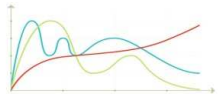
PUBLIC

Lanxess BU PLA: Polyurethane Additives Portfolio

Disflamoll®/Levagard®/PHT4-Diol™/ Reofos®	Flame Retardants	
Stabaxol®	Hydrolysis Stabilizers	
Addolink®	Crosslinkers	
Addovate®	Emulsifiers & Foam Stabilizers	
Addocat®	Catalysts	

Disflamoll® / Levagard®

Flame retardants for flexible PU foam

Flame retardants for flexible PU foam

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Disflamoll® 51092

- Butylated triphenyl phosphate
- Phosphorus content: 8,5 %
- Viscosity: 100 mPa·s (20°C/68°F)

Emerald Innovation™ NH-1

- Phosphate ester blend
- Phosphorus content: 7,9 %
- Viscosity: 82 mPa·s (23°C/73°F)

Levagard® TP LXS 51114

- Phosphorus compound
- Phosphorus content: 9,0 %
- Viscosity: 6.500 mPa·s (23°C/73°F)

Flame retardants for flexible PU foam

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Levagard® 2000

- Oligomeric alkyl phosphate ester
- Phosphorus content: 16,4 %
- Viscosity: 100 - 120 mPa·s (23°C/73°F)

Levagard® 3000

- Oligomeric alkyl phosphate ester
- Phosphorus content: 12,8 %
- Viscosity: 100 - 160 mPa·s (23°C/73°F)

Levagard® 3001

- Blend of phosphorus compounds
- Phosphorus content: 14,7 %
- Viscosity: 623 mPa·s (23°C/73°F)
-

Polyether foam
Test formulation

Components	Amount [php]
Polyether polyol (OHZ 56)	100
Water	3,0
Amine catalyst	0,08
Tin catalyst	0,16
Stabilizer	1,0
Phosphorus flame retardant	6
TDI 80	40,9
Index	107

Polyether foam

- All foams were prepared on lab scale according to a standard procedure
- Flame retardant dosage was 6 php in all foams

Polyether foam
Foam properties

Properties	Units	without FR	TDCP	D 51092	NH-1	TP 51114	L 2000	L 3000	L 3001
Density	kg/m³ (pcf)	33.2 (2.1)	33.8 (2.1)	33.5 (2.1)	33.3 (2.1)	33.1 (2.1)	33.3 (2.1)	33.2 (2.1)	33.7 (2.1)
Cream time	s	13	15	14	13	15	14	14	13
Rise time	s	150	160	155	150	152	152	155	150
Air flow	mm w.c.	180	185	170	150	200	190	170	160
CLD 40%	kPa (psi)	4.0 (0.58)	3.4 (0.49)	3.3 (0.48)	3.5 (0.51)	3.4 (0.49)	3.2 (0.46)	3.4 (0.49)	3.8 (0.55)
Compression set (22h, 50%, 70°C)	%	6.1	6.8	6.3	6.7	6.6	8.1	4.3	3.5

Polyether foam
Efficiency – FMVSS 302

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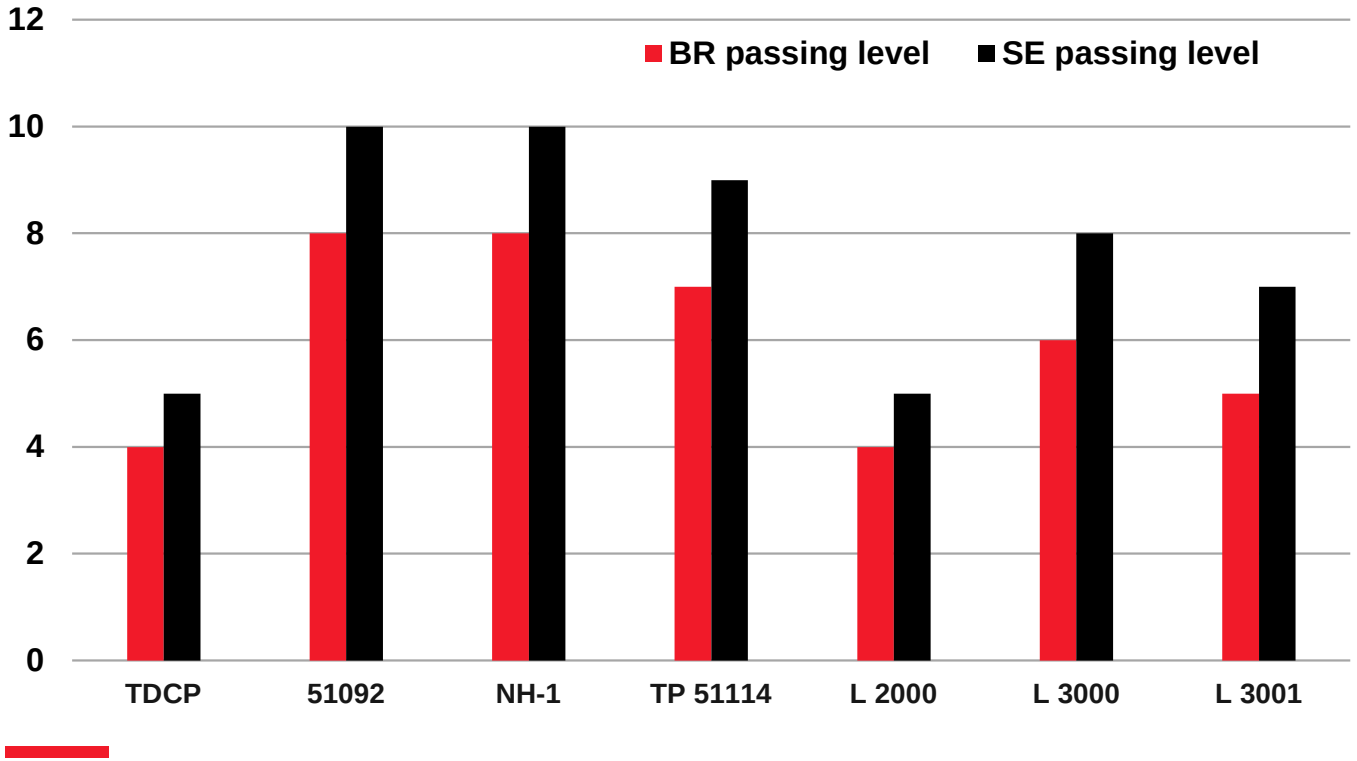
Passing level [php]

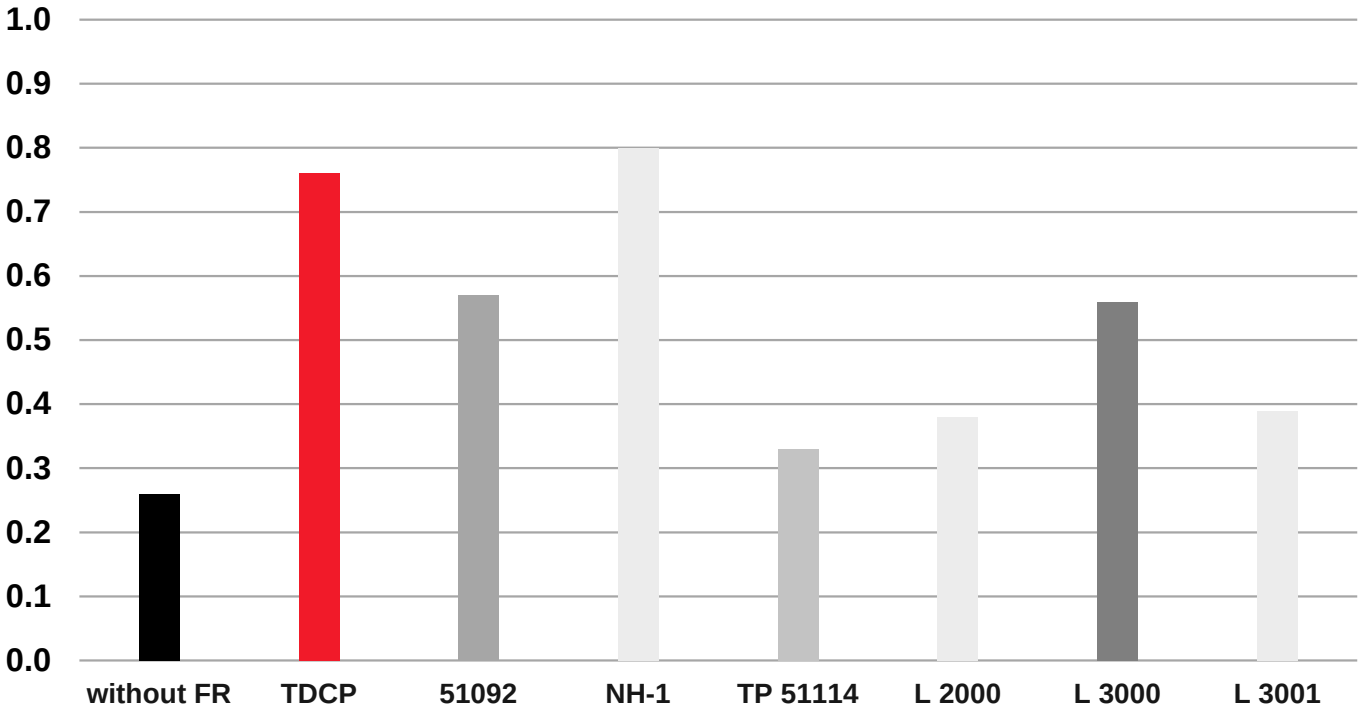


FMVSS 302

- Passing level to achieve BR and SE classification was determined

Polyether foam
Fogging B

Fogging B [mg]

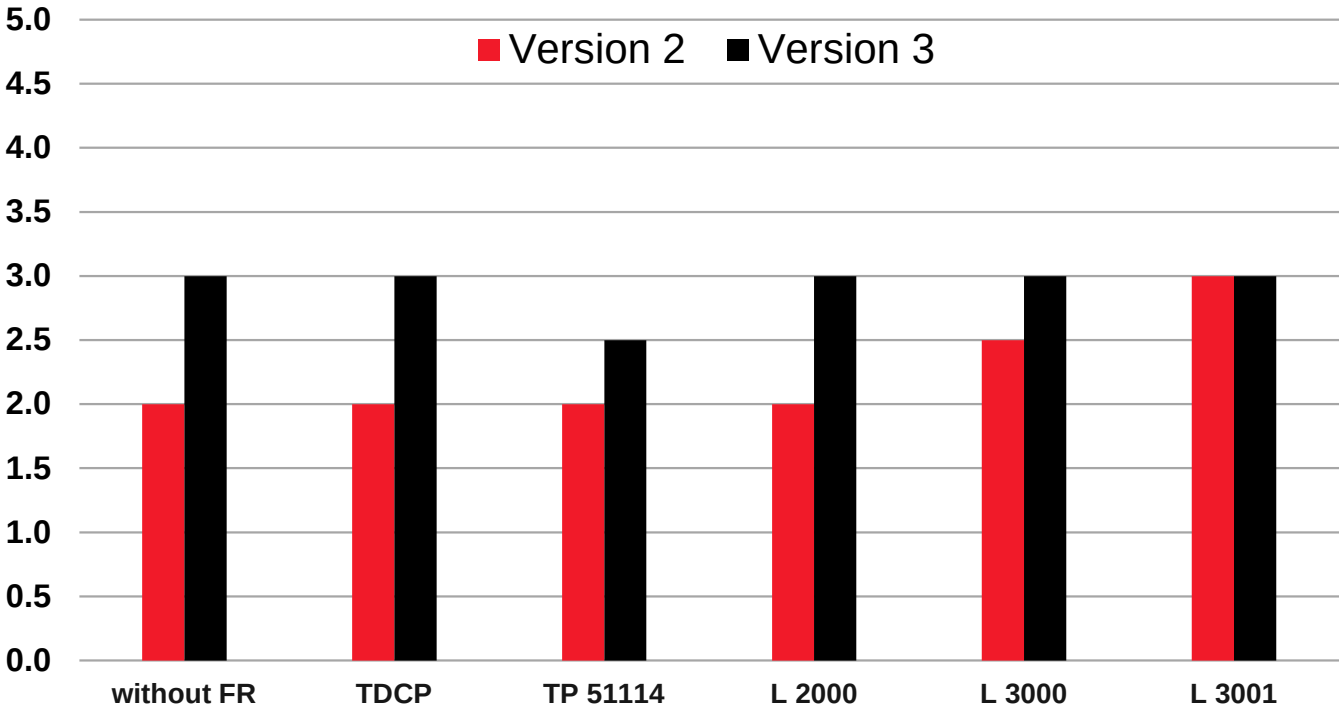


Fogging B (DIN 75201)

- Fogging of foams containing 6 php flame retardant
- Fogging B after 16 hours at 100°C/212°F was determined gravimetrically

Polyether foam
Odor – VDA 270

Odor rating



VDA 270

- Foams contain 6 php flame retardants
- VDA 270
  - Version 2:
    24 hours at 40°C
  - Version 3:
    2 hours at 80°C

➢ All foams pass the requirements of automotive industry

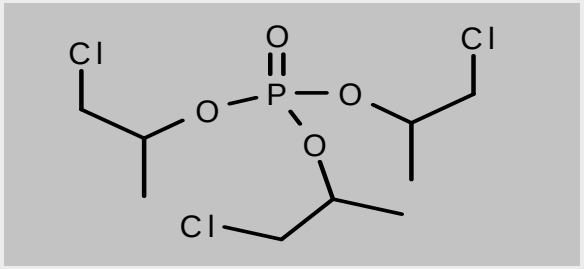
Levagard® / Disflamoll® / PHT4-Diol™

Flame retardants for rigid PU foam

Flame retardants for rigid PU foam

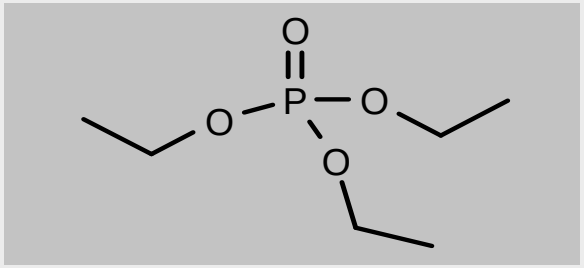
Levagard® PP

- Tris(2-chlor-isopropyl) phosphate (TCPP)
- Phosphorus content: 9,5 %
- Clorine content: 32,5 %
- Viscosity: 85 mPas (20°C/68°F)



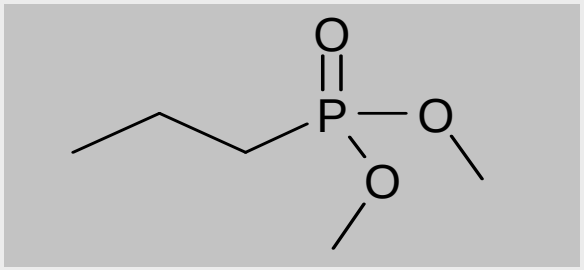
Levagard® TEP-Z

- Triethyl phosphate (TEP)
- Phosphorus content: 17,0 %
- Viscosity: 2 mPas (20°C/68°F)



Levagard® DMPP

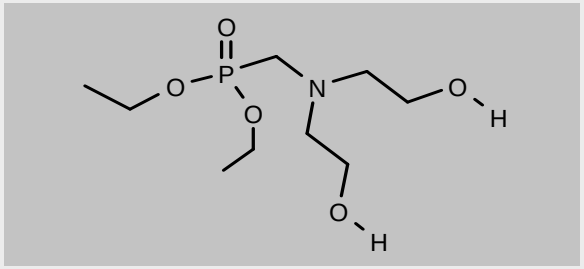
- Dimethyl propyl phosphonate
- Phosphorus content: 20,3 %
- Viscosity: 2 mPas (20°C/68°F)



Flame retardants for rigid PU foam

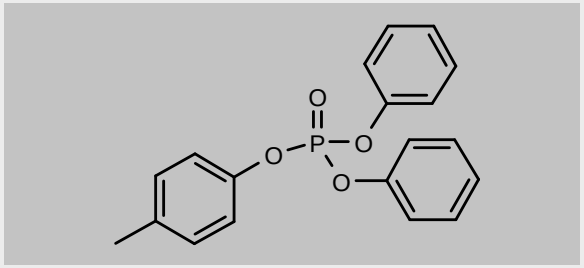
Levagard® 4090 N

- N,N-bis-(2-hydroxylethyl) aminomethane phosphonic acid diethyl ester
- Phosphorus content: 12,1 %
- OH number: 400 – 500 mg KOH/g



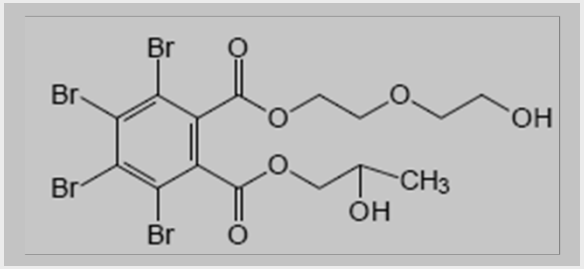
Disflamoll® DPK

- Cresyl diphenyl phosphate
- Phosphorus content: 9,1 %
- Viscosity: 46 mPas (20°C/68°F)



PHT4-Diol™

- Tetrabromophthalate diol
- Bromine content: 46 %
- Viscosity: 90.000 mPas (25°C/77°F)



Flame retardants for rigid PU foam
New developments

Levagard® 2000

- Oligomeric alkyl phosphate ester
- Phosphorus content: 16,4 %
- Viscosity: 100 - 120 mPa·s (23°C/73°F)
- Density: 1,23 g/cm^3 (23°C/73°F)
- Miscible with water

Levagard® 2100

- Organic phosphonate
- Phosphorus content: 18,4 %
- Viscosity: 25 - 40 mPa·s (23°C/73°F)
- Density: 1,18 g/cm^3 (23°C/73°F)
- OH number: 300 - 330 mg KOH/g
- Miscible with water

Rigid PIR foam
Test formulation

Components	Amount [php]	Amount [%]
Aromatic polyester polyol (OHZ 240)	100	27,8
Catalyst 1 (PMDETA)	0,25	0,1
Catalyst 2 (K-Acetate)	0,35	0,1
Catalyst 3 (K-Octoate)	1,9	0,5
Stabilizer	2,5	0,7
Water	0,5	0,1
n-Pentane	24,3	6.8
Phosphorus flame retardant	25	7,0
Isocyanate (polymeric MDI)	205	56,9
Index	300	

PIR formulation

- All foams were prepared on lab scale according to a standard procedure
- Amount of isocyanate was adjusted when a reactive flame retardant was used (index constant)
- Flame retardant dosage was 25 php in all foams

PIR foam
Foam properties (25 php FR)

Properties	Units	no FR	TCPP	TEP	L 2000	L 2100
Density	kg/cm^3 (pcf)	26.5 (1.65)	29.1 (1.82)	27.3 (1.70)	28.2 (1.76)	31.4 (1.96)
Cream time	s	15	15	13	15	12
Gel time	s	55	50	45	48	40
Open cell content	Vol-%	8.8	4.6	11.6	7.8	7.5
Thermal conductivity	mW/K m	21.8	21.9	20.8	21.4	20.9

PIR foam
Compressive strength (EN 826)

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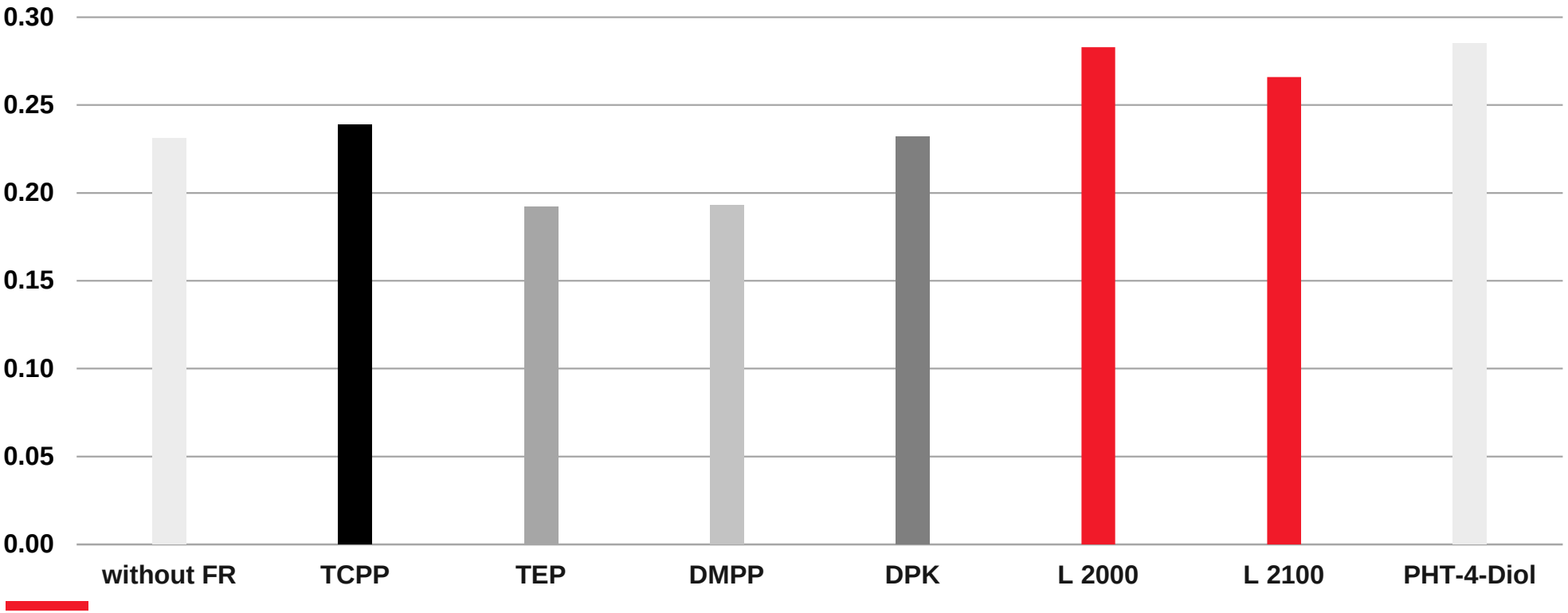
Compressive strength [MPa]



PIR foam
LOI values

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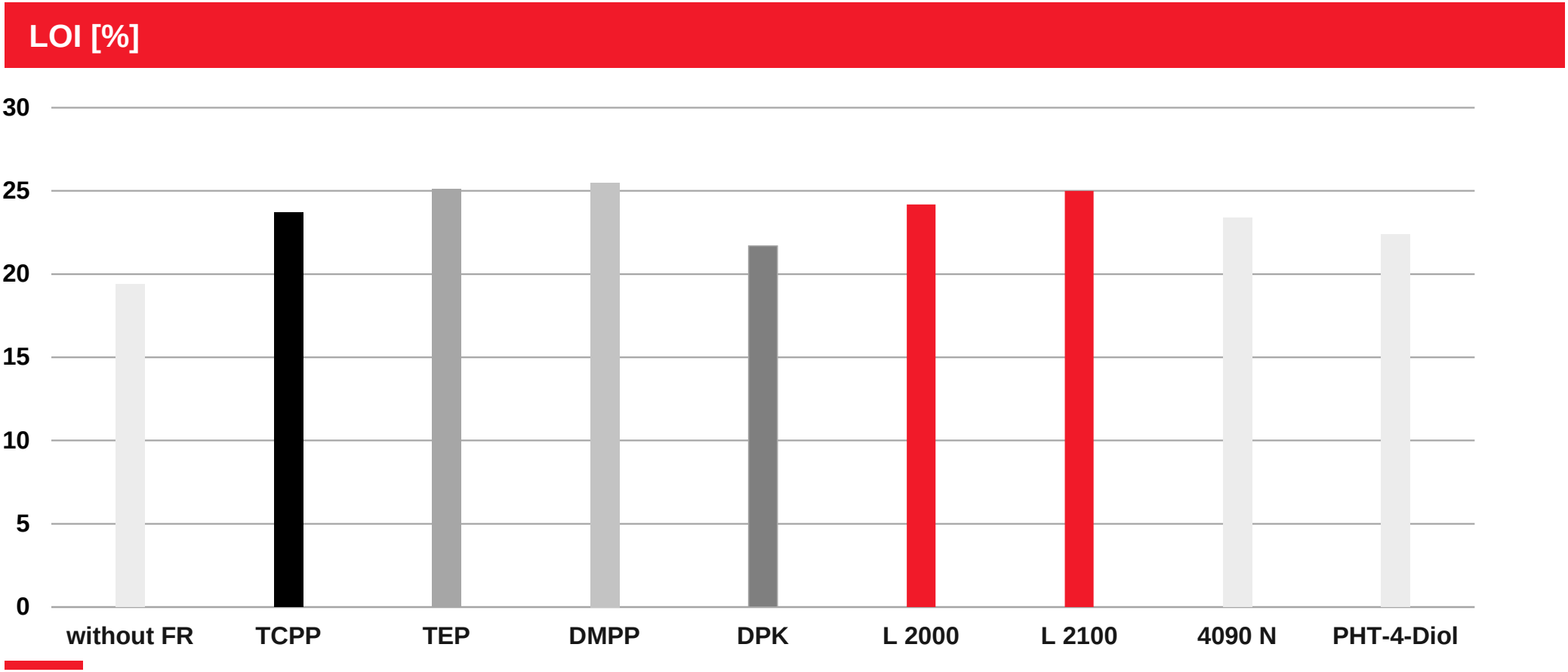

PIR foam
EN ISO 11925 – flame height

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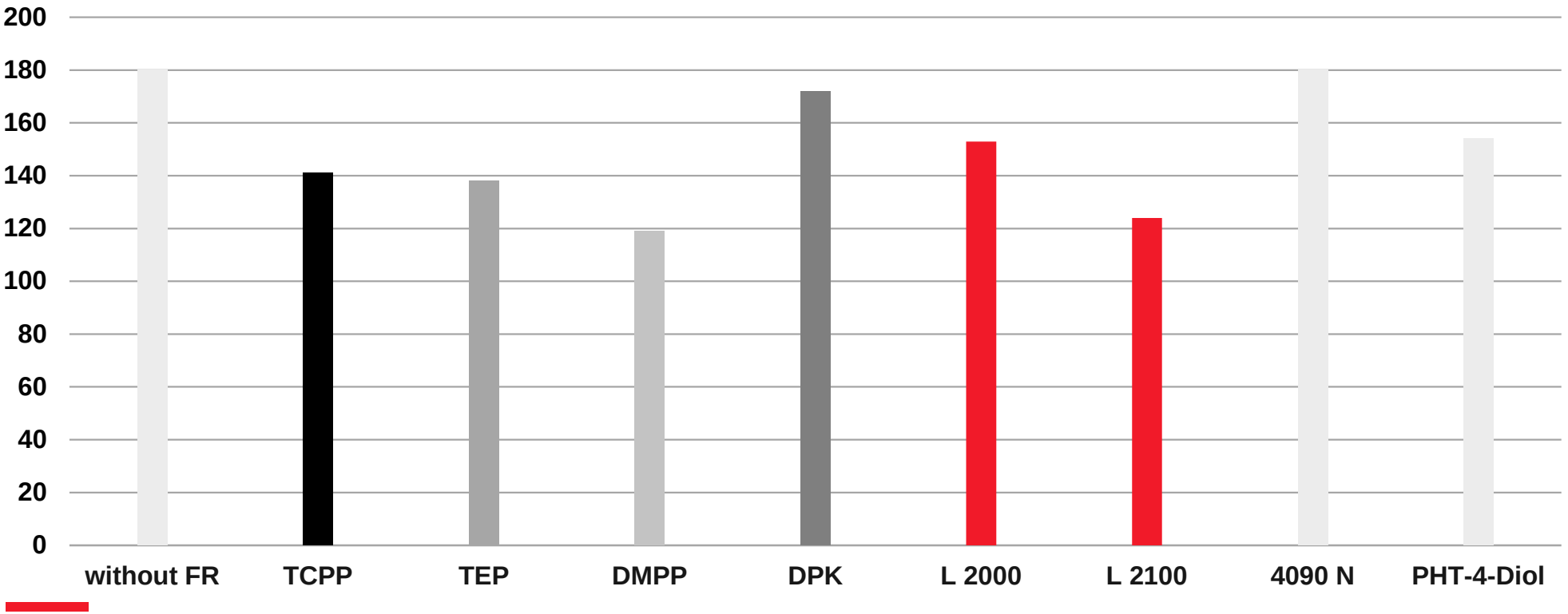
Flame height [mm]



Disflamoll® / Reofos®

Flame retardants for TPU

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Flame retardants for thermoplastic polyurethane

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Disflamoll® 51092

- Butylated triphenyl phosphate
- Phosphorus content: 8,5 %
- Viscosity: 100 mPa·s (20°C/68°F)

Disflamoll® DPK

- Cresyl diphenyl phosphate
- Phosphorus content: 9,1 %
- Viscosity: 46 mPas (20°C/68°F)

Reofos® 50, 65, 95

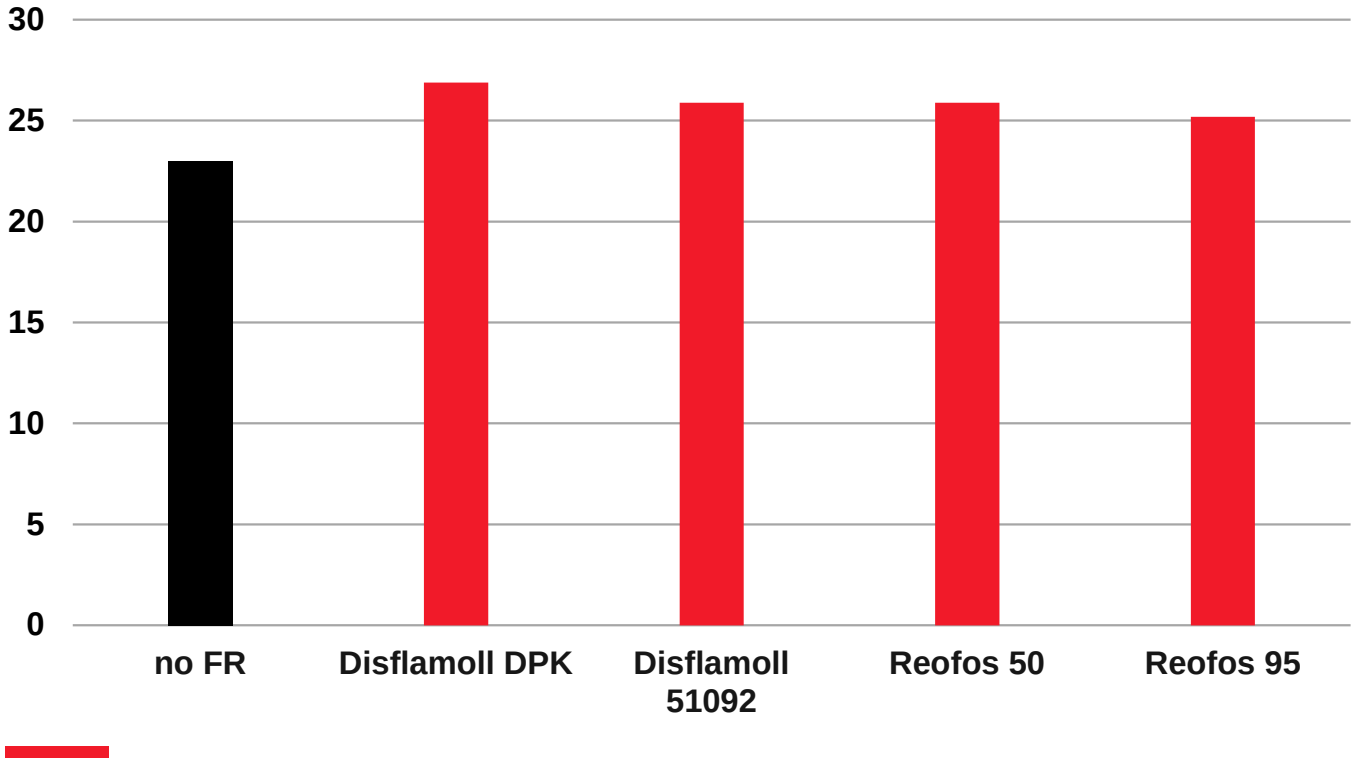
- Isopropylated triphenyl phosphates
- Phosphorus content: 8,4 / 8,1 / 7,6 %
- Viscosity: 49 / 57 / 93 mPas (25°C)

Flame retardants for TPU
Comparison in TPU (15% in polyether TPU)

Properties	Units	Without FR	Disflamoll DPK	Disflamoll 51092	Reofos 50	Reofos 95
Shore A	-	83	80	77	79	77
Shore D	-	35	29	28	28	28
Tensile strength	MPa	47,4	37,8	44,1	41,1	46,6
Elongation	%	572	659	630	680	641
Tg (DSC)	°C	-39,6	-45,1	-42,4	-43,1	-42,4
LOI	%	23,0	26,9	25,9	25,9	25,2
Fire rating (2 mm)	UL 94 V	-	V 2	V 2	V 2	V 2

Flame retardants for TPU
LOI – Polyether-TPU

[%]



LOI testing

- Sample thickness: 4 mm
- Dosage: 15 %

Flame retardants for thermoplastic polyurethane
Product overview – Conclusions

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Disflamoll® 51092

- Suitable for polyester and polyether based TPU
- Good flame retardant efficiency

Disflamoll® DPK

- Suitable for polyester and polyether based TPU
- Good flame retardant efficiency
- Good plasticizing efficiency

- Suitable for polyester and polyether based TPU
- Good flame retardant efficiency

Reofos® 50

- Suitable for polyester and polyether based TPU
- Good flame retardant efficiency
- Low volatility

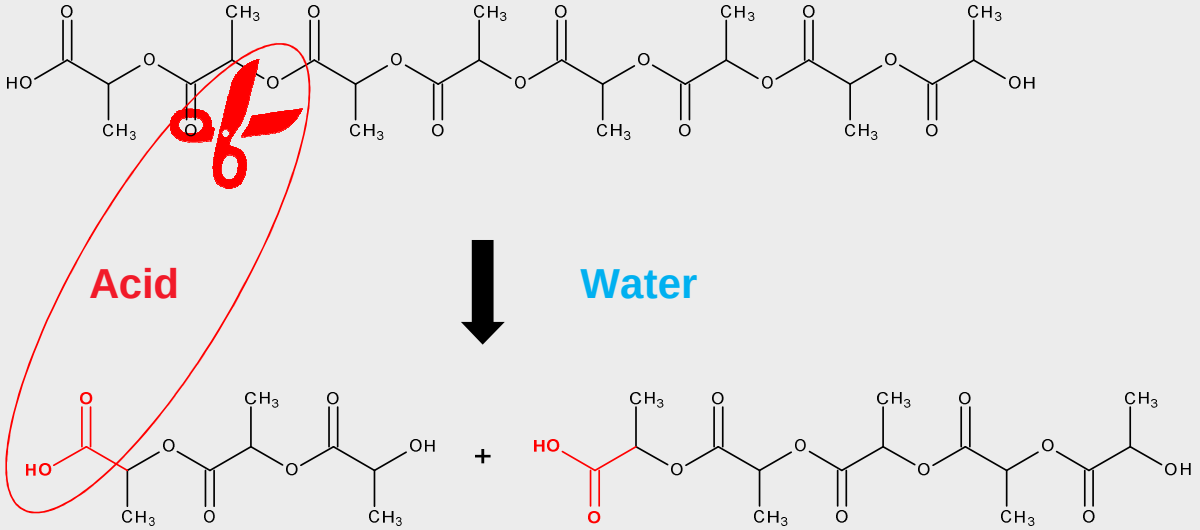
Reofos® 95

Stabaxol®

Highly effective anti-hydrolysis stabilization for polyester PU and TPU

Stabaxol®

What is hydrolysis?

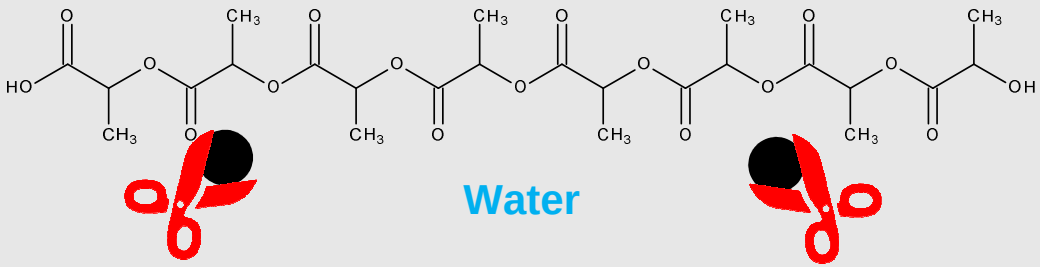


Polymer degradation

No stable processing
(Low melt stability)

No stability in application
(Limited hydrolysis resistance)

Stabaxol®
Mode of function

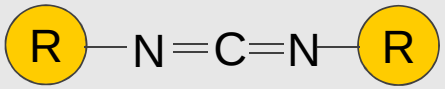


Carbodiimides react with carboxylic acids (e. g. COOH end groups in polyesters)

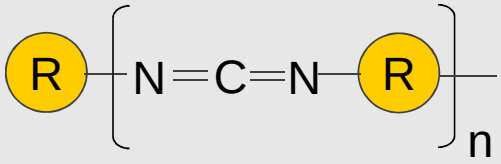
- Hydrolysis is an autocatalytic process accelerated by acids
- LANXESS carbodiimides react **selectively** as carboxylic acid scavengers
- **Carbodiimides significantly slow down the degradation process**
- Selectivity: - COOH > - NH_2 > - OH >> H_2O

Carbodiimides:

- Monomeric Type



- Polymeric Type



Sterical hindrance results in

- Thermal stability
- Long term hydrolysis protection
- Storage stability

Stabaxol®

Product range and recommended use

Product	Applications								
Active ingredients	**PET**	**PBT**	**PLA**	**PU**	**PA**	**PU rubber**	**TPU**	**TPE-E**	**EVA**
Stabaxol® I	☐	☐	☐	■		■	■		☐
Stabaxol® I LF	☐	☐	☐	☐		☐	■		■
Stabaxol® L	☐	☐	☐	■		■	■		☐
Stabaxol® P	■	■	■	■	■	■	■	■	■
Stabaxol® P 100	■	■	■		■	■	■	■	■
Stabaxol® P 110	■	■	■		■			■	■
Stabaxol® P 200				■			■		■
Masterbatches (standard grades)									
Stabaxol® KE 7646	■								
Stabaxol® MB PET 3040	■								
Stabaxol® MB TPE 6030								■	
Stabaxol® MB TPE 6040								■	

☐ possible use ■ recommended use

Tailor-made solutions for custom-made masterbatches based on different polymer types are also available.

Stabaxol®

Product Portfolio Overview

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Energizing Chemistry

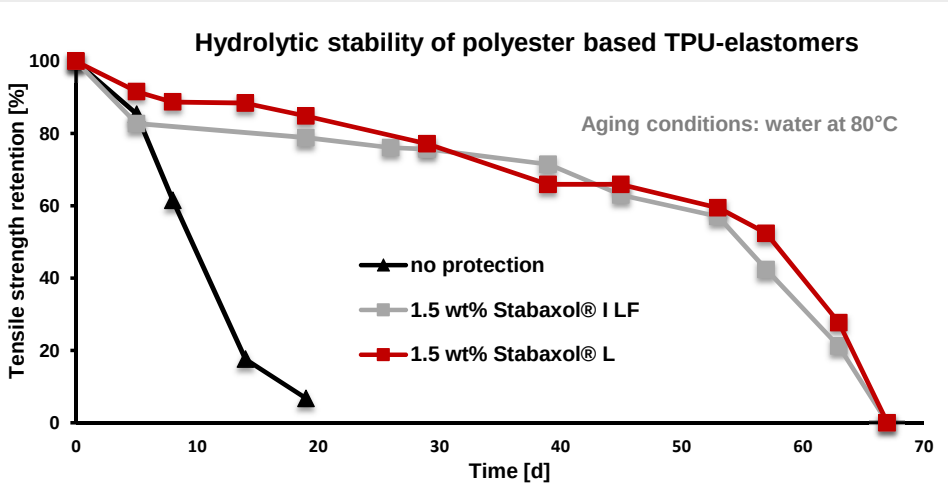
Description and Performance of Stabaxol®

	Stabaxol I		Stabaxol P200	Stabaxol P	Stabaxol P100
Delivery form	Crystallized melt	Powder	Liquid	Powder, Pastilles	Powder
Chemical description	Monomeric	Monomeric	Oliogomeric	Polymeric	Polymeric
Melting-temperature	ca. 40°C	ca. 53°C	5°C	60 – 90°C	100 – 120°C
Molecular-weight	360 g/mol	360 g/mol	2.000 g/mol	3.000 g/mol	15.000 g/mol
Application polymers	(PET), (PBT), TPU, PU, EVA, Adhesives		TPU, PU, Adhesives	PET, PBT, TPU, EVA, (Adhesives)	PET, PBT, PA, TPU, TPEE, (EVA)
Benefits	- Fast reaction - High efficiency - Cost effective		- Easy handling - Good solubility in Polyester Polyol - No off-gassing	- Long-term stability - Low off-gassing	- Very good long-term stability - Low off-gassing - Good thermal stability

New development products

Stabaxol® L

Description	▪ Monomeric carbodiimide ▪ Liquid or solidified melt ▪ NCN-content: > 8 wt%
Application	▪ TPU- and cellular PU-elastomers, PET ▪ Injection molding, sealing, shoe systems ▪ PU hot/cold casting systems ▪ Rollers, automotive auxiliary springs
Properties	▪ **Excellent hydrolysis protection in TPU-elastomers**, PET ▪ **Very reactive acid scavenger** even at low temperatures ▪ Reduced off-gassing and higher thermal stability in comparison to Stabaxol® I ▪ **No labeling** (based on the required tox-data for 100 tons REACh registration)



Stabaxol®
Application

PET

Fibers, films, screens, filters

PBT

Sheathing for optical fibers, injection-molded articles for electrical/electronic applications

PLA

Automotive, electronics, appliances, construction, bath and office equipment

PA

Monofilaments, industrial injection moldings, tubes, containers

TPE-E

Cable sheathing, industrial injection moldings

TPU

Cable sheathing (automotive), shoe systems, injection molding (electrical/electronic), sealings

PU

PU hot/cold casting systems (automotive auxiliary springs, Vulkollan® applications), ester flexible foam, rollers

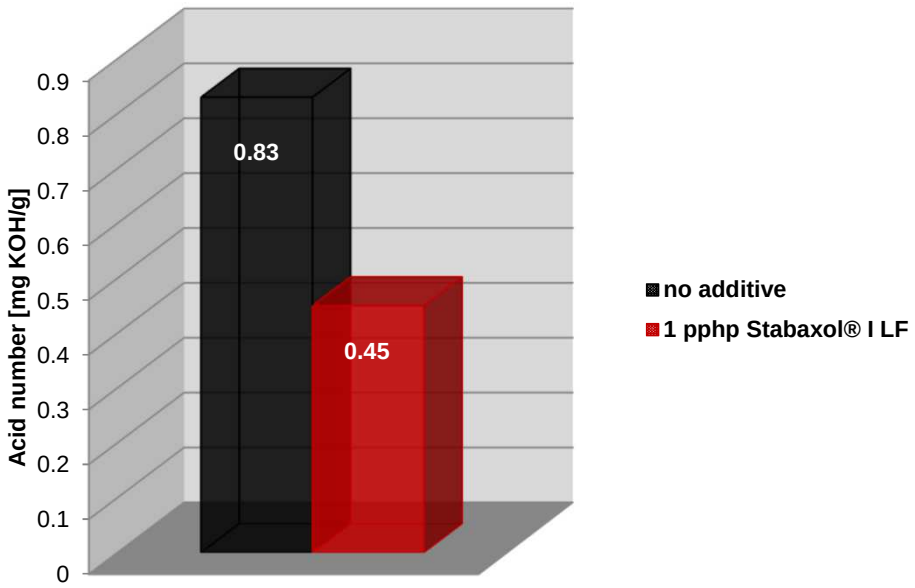
PU Rubber

Rollers, drive belts, membranes, seals

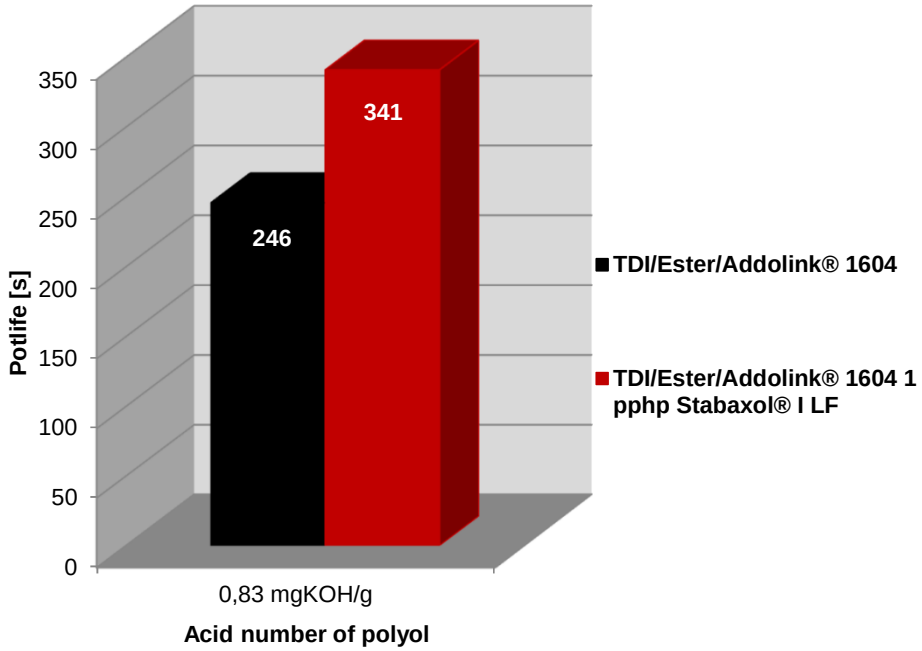
Application as acid scavenger

Stabaxol® I – Potlife extension

Acid value reduction in a polyester polyol
0.1 pphp NCN – reaction time: 0.5h @ 80°C

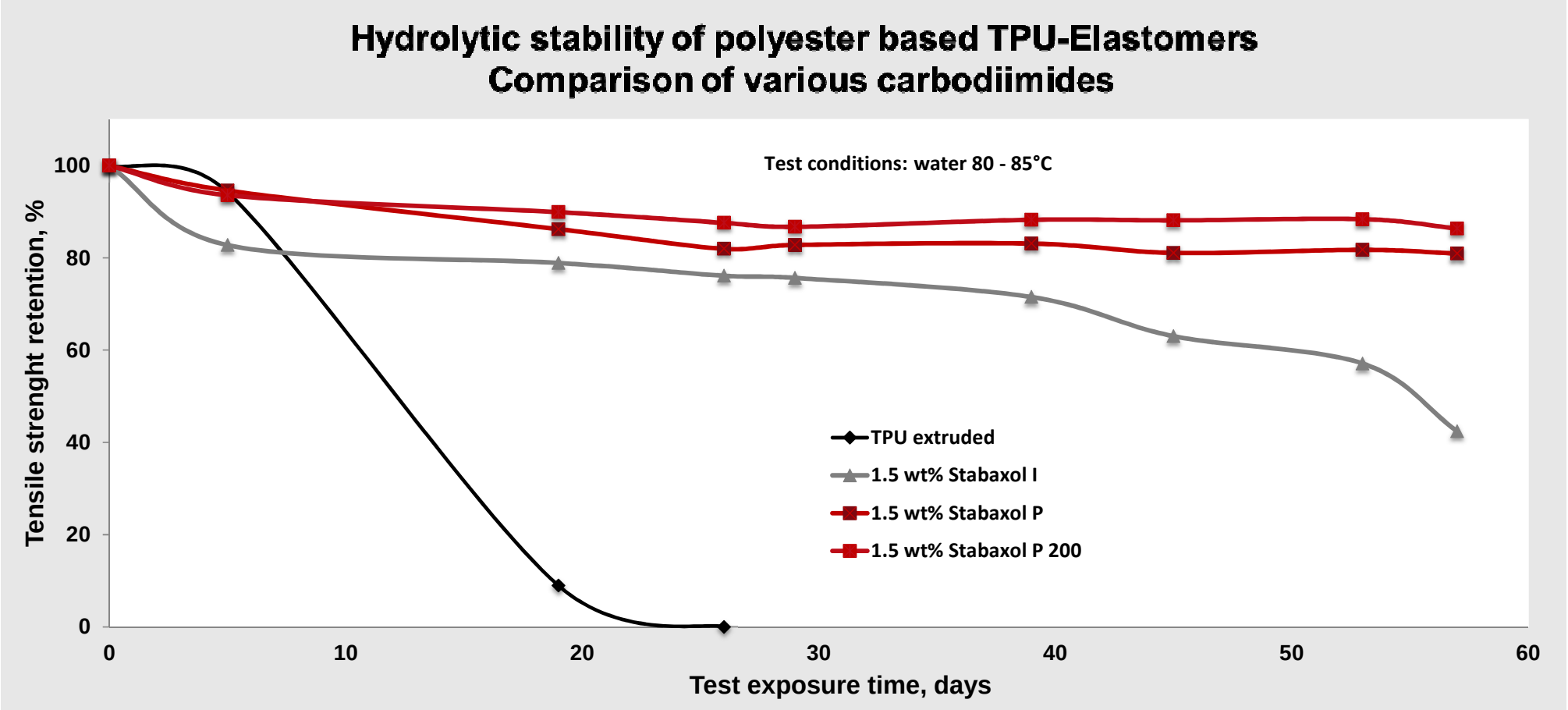


Potlife extension:
Hot Cast PU with amine crosslinker



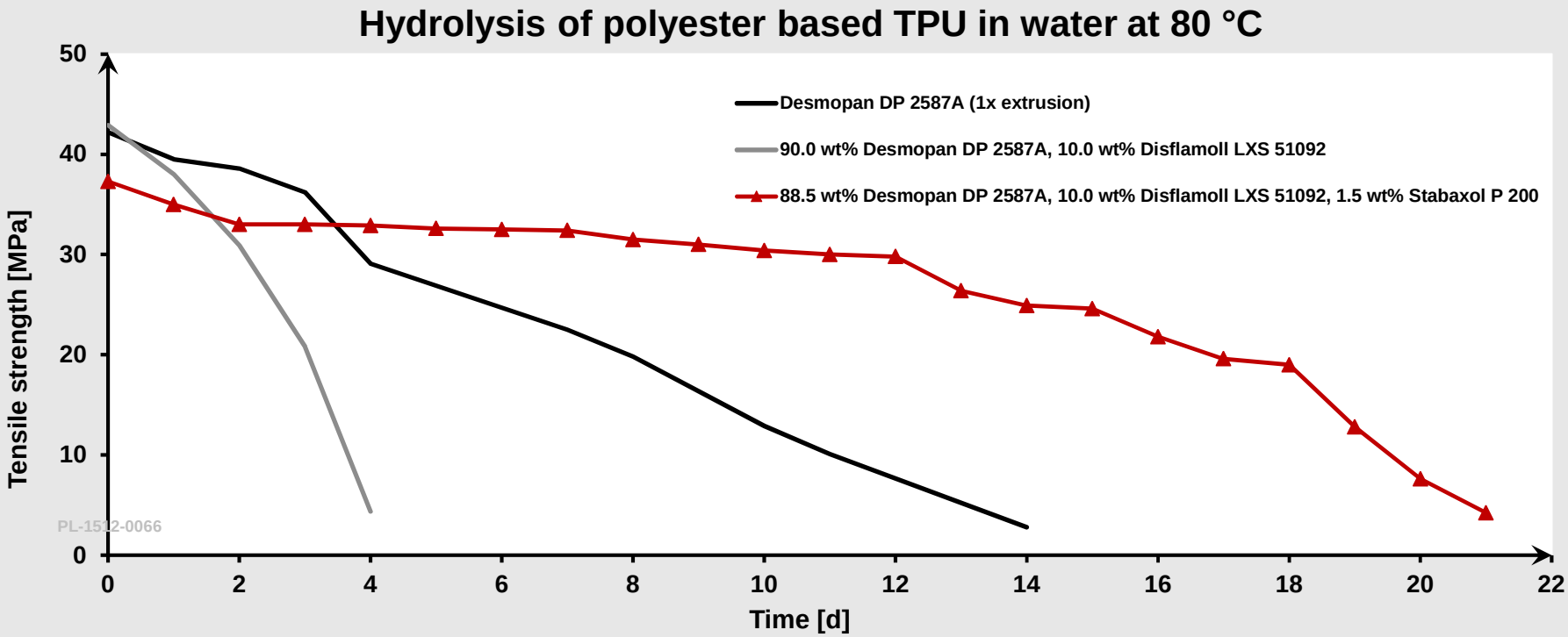
Hydrolytic stability of TPU elastomers

Stabaxol® I /P / P200: Excellent performance (Compound)



Hydrolytic stability of TPU

Stabaxol® P 200 in combination with Disflamoll®



Disflamoll ® LXS 51092 + Stabaxol P ® 200

Addolink®

Crosslinkers for Polyurethane Applications

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Addolink® : Typical Applications

Wheels & Rollers

Footwear

Mining Equipment

Dampening Elements

Printing Equipment

Pipeline Inspection

Addolink® crosslinkers are predominantly used in cast elastomers & TPU

HQEE*

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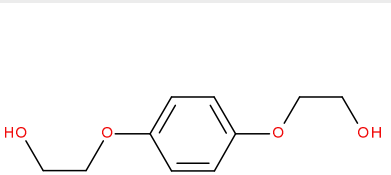
Description

- Hydroquinone bis(2-hydroxyethyl)ether (HQEE)
- Melting point: min. 104 °C
- Water content: max. 0.1 %



Application

- Glycolic chain extender
- High performance hot cast elastomers with MDI-based prepolymers
- Especially useful for thermoplastic urethane elastomers (TPU)

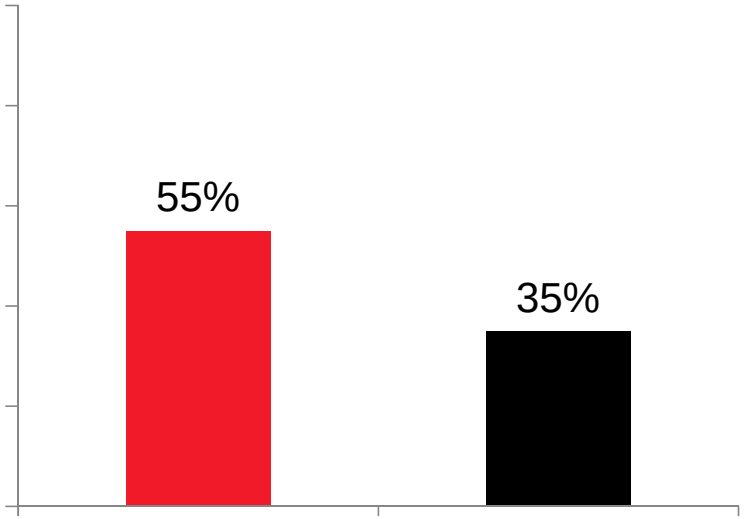
Properties

- High purity product (≥ 99.2 %) with reduced amount of side products
- Very good mechanical & dynamical properties
- Good MbOCA** alternative with suitable MDI-based prepolymers

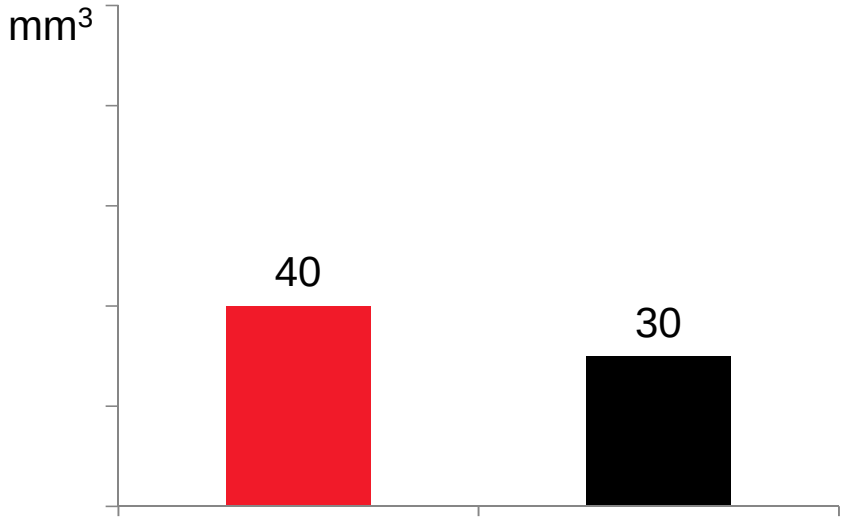
* Available under different trade names
** Sunset 22.11.2017. Extension of use in EU for a 4-year review period recommended by ECHA (as of 30.11.2017)

HQEE vs. 1,4-Butandiol (BDO)*

Compression Set



Abrasion



Chain extension with HQEE provides elastomers with better dynamic properties & lower abrasion

* Used as chain extender in MDI / Ester TPU, Shore D 60: lower values are better

HQEE: Typical End-Applications

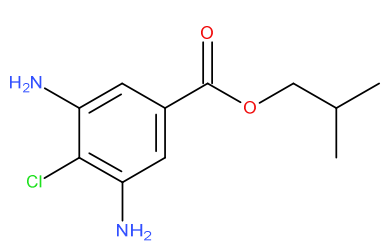
Rollers & Wheels	For high dynamic load capacity or high speed applications, e. g.: roller coaster, fork lift trucks etc.	
Sealings	O-rings for high temperature and / or high pressure applications	
Sporting Goods	Ski boots, wheels for roller-skates	
Shoe Soles	Wear insert for high heels etc.	

Addolink® 1604

LANXESS
Energizing Chemistry

Description

- Isobutyl 3,5-diamino-4-chlorobenzoate (CDABE)
- Melting point: approx. 88 °C
- Water content: max. 0.15 %



Application

- Amine chain extender
- High performance hot cast elastomers with TDI-based prepolymers
- Especially useful for large & intricately shaped parts, e. g. pipeline pigs

Properties

- Very good mechanical & dynamical properties
- Long pot life, favorable classification
- Good MbOCA* substitute

* Sunset 22.11.2017. Extension of use in EU for a 4-year review period recommended by ECHA (as of 30.11.2017)

Addocat®

Catalysts for Polyurethane Applications

PUBLIC

Addocat®: Complete Product & Application Overview

LANXESS Energizing Chemistry

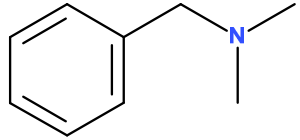
Addocat®	Rigid Foam				Flexible Foam			Elastomers			Coatings	Adhesives & Sealants	Special Characteristics
	Slab	Panels	Spray Foam	Appliance & Pipe Insulation	Ester	Ether	Molded-Integral	Cast	Cellular	TPU			
DB (BDMA)	■	■		■	■						■	■	Gelling co-catalyst, good emulsifier, improves flow and adhesion to facings, reduces friability in high-water formulations
PP (Blend of tert. amines)		■		■	■				■		■	■	Balanced catalyst, improves flow
SO (Tin(II) octoate)			■		■	■	■						Strong gelling catalyst for flexible foam
10/9 (Tertiary amine)											■	■	Mild gelling catalyst for wood coatings
105 (TEDA/DPG)	■	■	■	■		■	■		■		■	■	Strong multi-purpose gelling catalyst
108 (BDMAEE/DPG)	■	■	■	■		■	■						Strong blowing catalyst, improves flow
117 (DMP)	■	■		■	■								Gelling co-catalyst, good solubilizer
118 (DMDEE)			■	■	■	■	■		■		■	■	Catalyst for 1K & spray foam, improves shelf-life
1221VN (Blend of tert. amines)	■	■											Balanced rigid foam catalyst
1656N (Blend of DBTL & TEA)	■												Used mainly in rigid slabstock
1926 (Blend of DMCHA & polyol)	■	■		■									Improved metering compared to DMCHA

Addocat® DB

LANXESS
Energizing Chemistry

Description

- Benzyldimethylamine (BDMA)
- Viscosity: 3 mPa·s
- Water content: max. 0.15 %



Application

- Rigid foam: panels, slab, *in-situ* foam, esp. high-water formulations
- Flexible foam: sole catalyst in ester-based formulations
- Also used in cold-cast elastomers, EP and UPE resins etc.

Properties

- Cost-effective, moderate back-end biased universal co-catalyst
- Reduces friability, provides tough & elastic surface
- Very good emulsifier, improves flow & adhesion to facings

Addocat® PP

LANXESS
Energizing Chemistry

Description

- Blend of tertiary amines
- Viscosity: 3 mPa·s
- Water content: max. 0.5 %

Application

- CASE: coatings based on aliphatic isocyanates, cellular elastomers*
- Flexible foam: ester-based formulations
- Rigid foam: panels, appliance & pipe insulation

Properties

- Moderate activity balanced amine catalyst
- Improves flow
- Water soluble

* Addocat® PP is used together with Addovate® SM, Addovate® DD 1092 and suitable Stabaxol® grades in the production of NDI-based high performance microcellular elastomers

Addovate®

Silicon-free Emulsifiers & Foam Stabilizers for Polyurethane Applications

PUBLIC

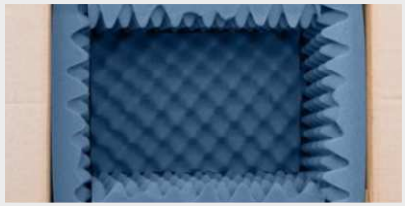
Addovate® : Typical Applications

Automotive upholstery

Textile lamination

Filters & sponges

Dampening elements



Packaging

Carpet underlay

Addovate® surfactants are predominantly used in ester flexible foam & cellular elastomers

Addovate®: Product and Application Overview*

	Function			Main Application				
Non-Ionic	**Emulsifier**	**Stabilizer**	**Crosslinker**	**Technical**		**Textile**	**Low Odor / Fogging**	**Cellular Elastomers**
				Standard	**Semi-rigid**			
Addovate® EM	+++	+		■		■	■	
Addovate® WM	+++			■	■			
Addovate® 3240	+++			■			■	■
Ionic								
Addovate® DD 1092*	++							■
Addovate® SM*	++	++	+	■	■			■
Addovate® SV	++	++	+					■
Addovate® TX	+	+++	+	■		■		

* Used together with Addocat® PP and suitable Stabaxol® grades in the production of NDI-based high performance microcellular elastomers

Addovate® EM / TX

LANXESS
Energizing Chemistry

Description	▪ Addovate® EM: non-ionic emulsifier ▪ Addovate® TX: ionic emulsifier & foam stabilizer ▪ Often used together, but can be combined with other Addovate® grades
Application	▪ Textile grade ester foam, e. g. for textile lamination, paint rollers etc. ▪ Standard technical grade foam, e. g. sponges, packaging etc. ▪ Especially suitable for clickable foam
Properties	▪ Silicon-free, organic surfactants ▪ Very even cell size, no pin holes, excellent cell size control ▪ Less cutting loss due to a smaller edge zone

Addovate® WM / SM

LANXESS
Energizing Chemistry

Description

- Addovate® WM: non-ionic emulsifier
- Addovate® SM: ionic emulsifier & foam stabilizer
- Typically used together, but can be combined with other Addovates®

Application

- Standard & semi-rigid technical foam, e. g. filters, sealants, packaging
- Water-blown & crosslinked cellular elastomers* (machine casting)
- Addovate® SM can be substituted with SV for hand casting

Properties

- Silicon-free, organic surfactants
- Small, even cell size

* Addovate® SM is used together with Addocat® PP, Addovate® DD 1092 and suitable Stabaxol® grades in the production of NDI-based high performance microcellular elastomers

Thank you for your attention

Disclaimer

This information and our technical advice – whether verbal, in writing or by way of trials – is subject to change without notice and given in good faith but without warranty or guarantee, express or implied, and this also applies where proprietary rights of third parties are involved. Our advice does not release you from the obligation to verify the information currently provided - especially that contained in our safety data and technical information sheets - and to test our products as to their suitability for the intended processes and uses. The application, use and processing of our products and the products manufactured by you on the basis of our technical advice are beyond our control and, therefore, entirely your own responsibility. Our products are sold in accordance with the current version of our General Conditions of Sale and Delivery.

Unless specified to the contrary, the values given have been established on standardized test specimens at room temperature. The figures should be regarded as guide values only and not as binding minimum values. Kindly note that the results refer exclusively to the specimens tested. Under certain conditions, the test results established can be affected to a considerable extent by the processing conditions and manufacturing process.

LANXESS Deutschland GmbH, D-50569 Köln

BU PLA (Polymer Additives)