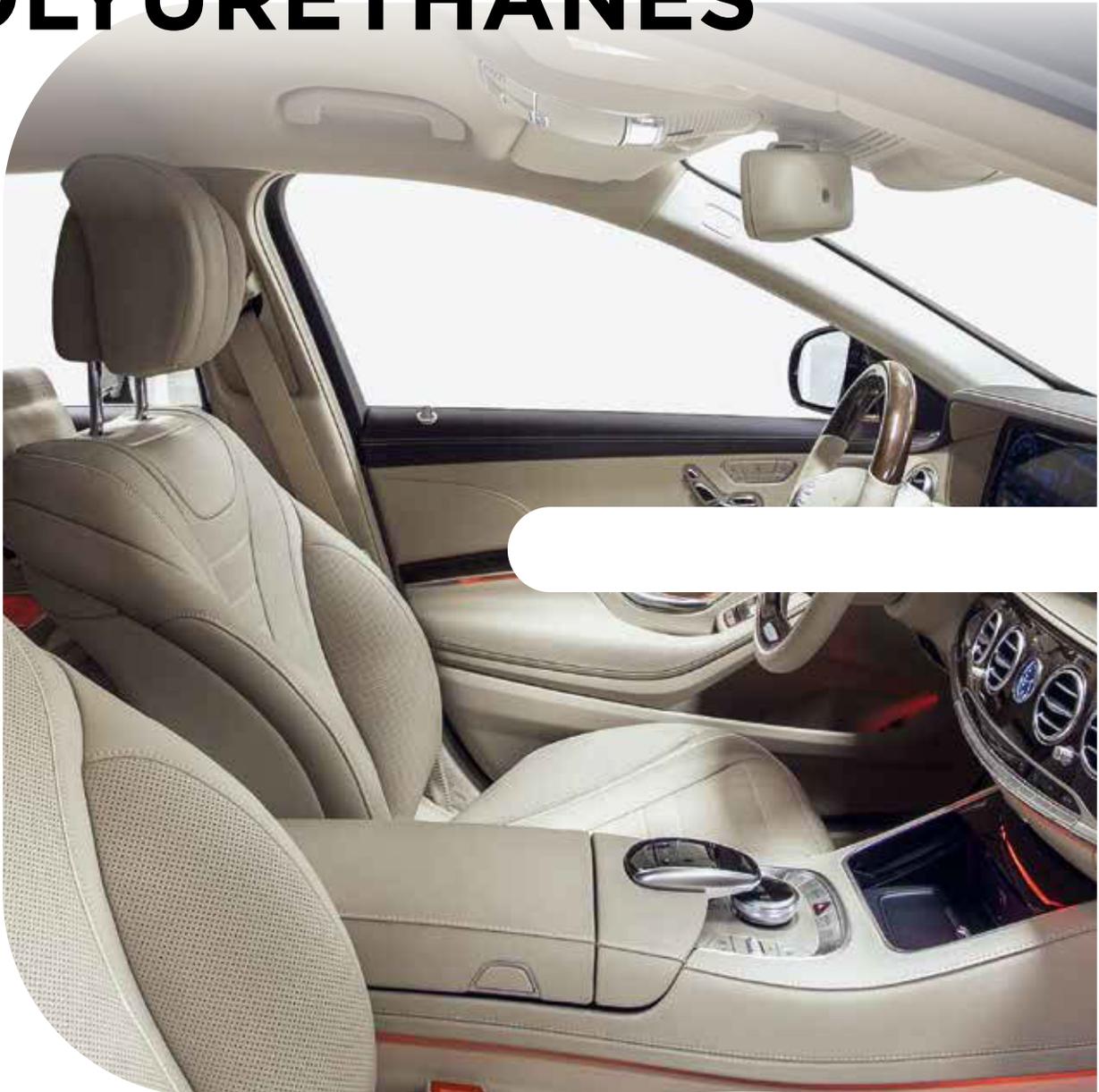


# Exolit® for **POLYURETHANES**



what is precious to you?

# Exolit for **POLYURETHANES**

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## **CONTENTS**

Introduction	4
Exolit overview	5
Flexible foam	6
Rigid PUR and PIR for insulation	12
Other applications/systems	14



# Under the tradename Exolit Clariant offers a distinctive range of non-halogenated flame retardant solutions providing environmentally more compatible fire protection for transportation, construction and consumer applications.

## GENERAL INFORMATION

Polyurethanes are used in a variety of different industries, including transportation, construction and consumer applications. They are combustible due to their chemical nature, so flame retardants are needed to fulfil regulatory requirements.

Widely used standard flame retardants like additive halogenated phosphate esters (e. g. TCPP = Tris(1-chloro-2-propyl)phosphate) suffer significant disadvantages:

- Migration and emission, leading to additional exposure to chemicals for end-users
- Increasing concerns of possible risks for environment, health and safety (EHS)
- Regulatory scrutiny: Several phosphate esters might be banned from usage in various products in the near future<sup>1</sup>
- PUR producers are facing demanding regulations regarding the emission of volatile organic compounds (VOC)<sup>2</sup>

## EXOLIT FOR POLYURETHANES

Our flame retardants allow meeting stringent emission and migration requirements, because they are either reactive, or inorganic solids with low vapor pressure and solubility.

## KEY PRODUCT FEATURES

- Non-halogenated, phosphorus-based flame retardants
- Reactive polyols or additive solids with low vapor pressure
- Reduced smoke density and smoke gas corrosivity

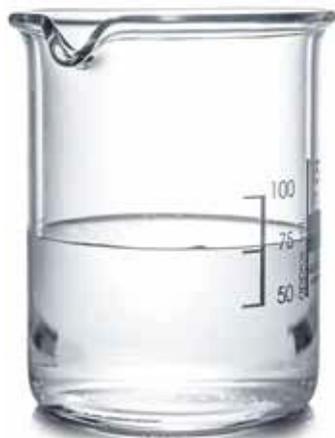
## BENEFITS

- Reduction of damage and extended escape times
- Reduced emissions (e. g. fogging and VOC values)
- High effectiveness
- High polymer compatibility
- Preferable environmental and health profile

<sup>1</sup> See e. g. GADS list, <http://www.gadsl.org/>, or CORAP list, <https://echa.europa.eu/information-on-chemicals/evaluation/community-rolling-action-plan/>

<sup>2</sup> See e. g. in China (GB/T 27630-201X)

# EXOLIT OVERVIEW



PRODUCT NAME	TYPE	DESCRIPTION	CHEMISTRY	FLEXIBLE FOAM	RIGID FOAM	OTHERS (E. G. CASE, INTEGRAL SKIN FOAM, CAST RESINS)
EXOLIT AP 422 	Solid, additive	Fine-grained white APP powder with low water solubility; D <sub>50</sub> approx. 17 μm <sup>4</sup>	Ammonium polyphosphate	■ ■ <sup>3</sup>	■ ■	■
EXOLIT AP 423 	Solid, additive	Micronized AP 422, especially fine powder; D <sub>50</sub> approx. 8 μm <sup>4</sup>	Ammonium polyphosphate	■ ■ <sup>3</sup>	■ ■	■
EXOLIT AP 462	Solid, additive	Microencapsulated APP with extreme low water solubility; D <sub>50</sub> approx. 20 μm <sup>4</sup>	Ammonium polyphosphate	■ ■ <sup>3</sup>	■ ■	■
EXOLIT AP 750	Solid, additive	Intumescent system based on APP	Ammonium polyphosphate synergistic blend	■	■ ■	■
EXOLIT OP 550	Liquid, reactive	Reactive, non-halogenated phosphorus polyol, functionality approx. 2	Proprietary phosphorus polyol	■ ■	-	■
EXOLIT OP 560	Liquid, reactive	Reactive, non-halogenated phosphorus polyol, functionality approx. 2	Proprietary phosphorus polyol	■ ■	-	■
EXOLIT RP 6520	Liquid paste, additive	Thixotropic dispersion of red phosphorus (carrier: castor oil)	Red phosphorus dispersion in castor oil	-	■ ■	■

■ ■ Established application, guide formulations available

■ Proof of concept

<sup>3</sup> Recommended for polyester PUR foams

<sup>4</sup> Technical data



Products that offer outstanding sustainability advantages are excelled with our EcoTain® label. These products have undergone a systematic, in-depth screening process using 36 criteria in all three sustainability dimensions: social, environmental and economic.

EcoTain® products significantly exceed sustainability market standards, have best-in-class performance and contribute overall to sustainability efforts of the company and our customers. We are determined to keep expanding the number of EcoTain® products and continue to screen our product portfolio.

Discover EcoTain®: [CLARIANT.COM/ECOTAIN](http://CLARIANT.COM/ECOTAIN)

# FLEXIBLE FOAM

In numerous flexible PUR foam applications, e. g. in automotive and transportation, flame retardants are required to meet various flammability standards. At the same time, there is an increasing trend towards non-halogenated low-emission solutions.

## EXOLIT OP 550 AND EXOLIT OP 560

- Exolit OP 550 and Exolit OP 560 are excellent choices for upholstering anything from car seats to padded doors, headliners and panels
- Exolit OP 560 has been confirmed as »an alternative anticipated to be safer for use in upholstered polyurethane foam« by the United States Environmental Protection Agency (U. S. EPA)<sup>5</sup>

## CHARACTERISTICS AND BENEFITS

- Reactive flame retardants which are chemically reacted into the polymeric matrix, effectively preventing unwanted migration from the foam
- Medium-viscosity liquids, non-halogenated phosphorus polyols, functionality of approximately 2
- Lower fogging and VOC values can be achieved which meet stringent emission standards for PU flexible foams in the automotive industry

## ADDED VALUE

- Exolit OP 550 and Exolit OP 560 have been shown to be very effective, with only one third of the dosage required compared to TCPP for passing FMVSS<sup>6</sup> 302 (SE) – See chart on page 8

<sup>5</sup> EPA's Design for the Environment Program, »Flame Retardants Used in Flexible Polyurethane Foam: An Alternatives Assessment Update« (August 2015, EPA 744-R-15-002)

<sup>6</sup> FMVSS = Federal Motor Vehicle Safety Standards for the occupant compartments of a motor vehicle





### **EXOLIT AP 422 AND EXOLIT AP 462**

Clariant's Exolit AP products are based on high molecular weight ammonium polyphosphate (phase II). They are effective flame retardants, particularly suitable for polyester-based PUR flexible foams. Their characteristics and benefits are:

- High phosphorus content for high FR performance
- Inorganic solids: no contribution to VOC or fogging, no migration
- Lower solubility in water: minimum catalyst interaction
- Exolit AP 422 was awarded the Clariant EcoTain Label for outstanding sustainability and best-in-class performance

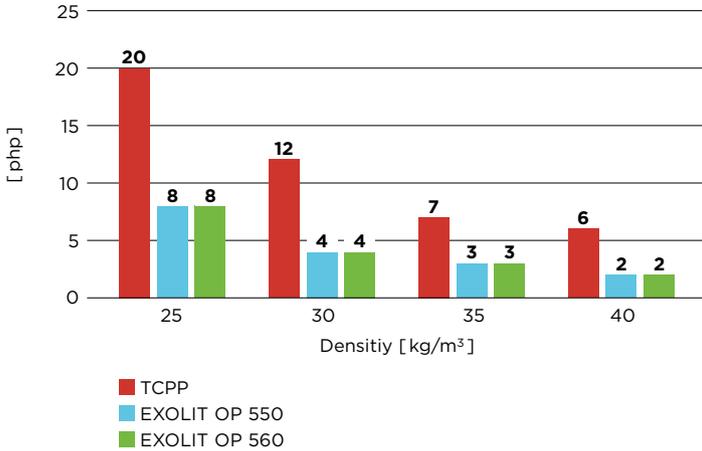


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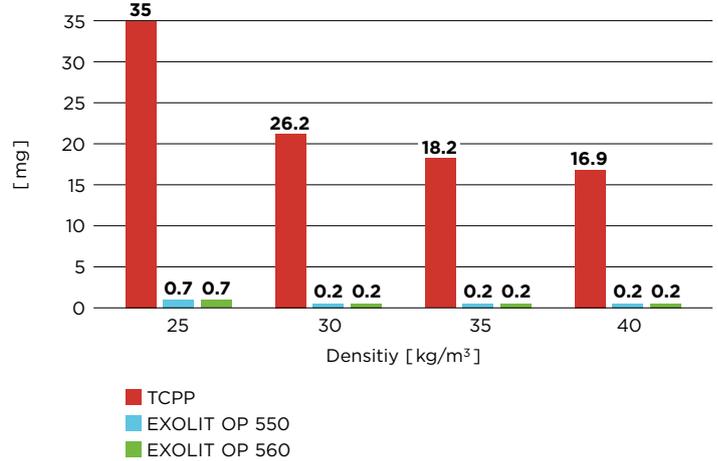
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# FLEXIBLE FOAM

## EXOLIT OP 550 AND EXOLIT OP 560 ARE UP TO 3 TIMES MORE EFFECTIVE THAN TCP P<sup>7</sup>



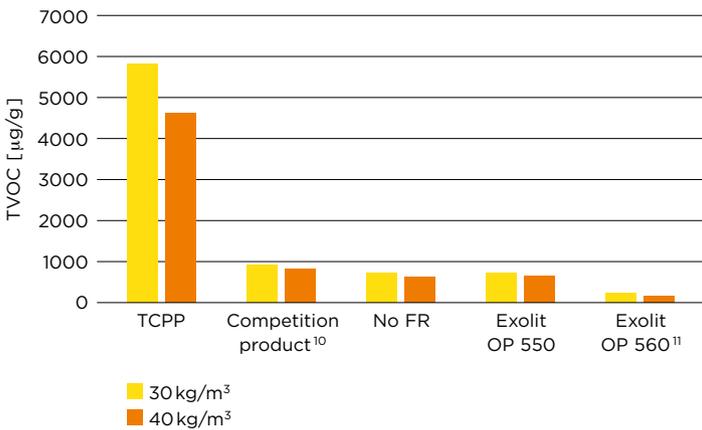
## CLARIANT'S REACTIVE FLAME RETARDANTS ALLOW REDUCED FOG VALUES<sup>8</sup>



<sup>7</sup> Flexible polyether PU foam;  
Minimum FR dosage required for FMVSS 302 (SE)  
(Federal Motor Vehicle Safety Standard for the occupant compartments of a motor vehicle)

<sup>8</sup> DIN 75201: Fogging Condensates  
Flexible polyether PU foam, FMVSS 302 (SE)

## EXOLIT FLAME RETARDANTS ALLOW MEETING STRINGENT FIRE SAFETY STANDARDS AND VOC REGULATIONS, WITHOUT INCREASING EXPOSURE TO CHEMICALS<sup>9</sup>



<sup>9</sup> VOC Emissions / VDA-278  
(Thermal desorption analysis of organic emissions according to German Association of the Automotive Industry (VDA));  
Flexible polyether foams with minimum FR dosage needed to pass FMVSS 302 (SE)

<sup>10</sup> Non-reactive triaryl phosphate

<sup>11</sup> Emission-optimized additive package



## GUIDE FORMULATION FOR VARIOUS APPLICATIONS AND STANDARDS

TYPE OF FOAM	APPLICATION	STANDARD	PRODUCTS	DOSAGE	FORMULATION DETAILS (ACID NUMBER, DENSITY)
Standard polyether	Automotive slabstock, molded	FMVSS 302 (SE)	<b>EXOLIT OP 550</b> <b>EXOLIT OP 560</b>	2-8 php	Polyether polyol (48 mg KOH/g), 25-40 kg/m <sup>3</sup>
Standard polyester	Automotive slabstock	FMVSS 302 (SE)	<b>EXOLIT OP 560</b> <b>EXOLIT AP 422</b> <b>EXOLIT AP 462</b>	2-8 php	Polyester polyol (60 mg KOH/g), 25-30 kg/m <sup>3</sup>
CMHR <sup>12</sup>	Upholstered furniture (UK)	BS 5852 (Crib 5)	<b>EXOLIT OP 550</b> <b>EXOLIT OP 560</b>	2-4 php	Polyether polyol (25-30 mg KOH/g), 37 kg/m <sup>3</sup> , melamine (20-24 php)

<sup>12</sup> Combustion Modified High Resilience Foams, especially for seating applications



# Reactive, non-halogenated FR System for **HIGHLY FLAME-RETARDANT FLEXIBLE PUR FOAMS**

A joint development project including Clariant and Florida Institute of Technology (FIT) has yielded formulations for highly flame-retardant MDI-based flexible PUR foams.

- The new non-halogenated FR technology is based on Clariant's reactive and low-emission Exolit OP 560 and special synergists
- Formulations for seating, mattress and packaging applications have been developed and subjected to extensive FR testing
- Foams can meet stringent FR requirements for applications such as upholstery & furniture, aviation and marine
- Disclosure of proprietary formulations and joint development projects are in principle possible under respective agreements (e.g. NDA, JDA)



**MECHANICAL PROPERTIES OF NEWLY DEVELOPED FOAMS**

		<b>FURNITURE</b>	<b>MATTRESS</b>	<b>PACKAGING</b>
<b>DENSITY</b>	kg/m <sup>3</sup>	32.0	44.9	46.5
<b>TENSILE STRENGTH</b>	kPa	96.5	110.3	96.5
<b>TEAR STRENGTH</b>	N/mm	0.2	0.2	0.2
<b>ILD<sup>13</sup> 25 %</b>	kPa	3.7	3.9	5.0
<b>ILD<sup>13</sup> 65 %</b>	kPa	10.3	13.5	22.9
<b>SUPPORT FACTOR</b>	R 65 %/25 %	2.8	3.5	4.7
<b>RESILIENCE</b>	%	48.0	45.0	37.0

<sup>13</sup> ILD = Indentation Load Deflection



**REQUIREMENTS OF VARIOUS FLAMMABILITY TESTS AND PERFORMANCE OF NEWLY DEVELOPED REPRESENTATIVE FORMULATIONS**

STANDARD	REQUIREMENTS	PERFORMANCE
<b>BS 5852 (CRIB 5)</b> Upholstered furniture (UK)	Char < 100 mm	✓
	No escalating combustion	✓
	No flame after 10 min	✓
<b>CAL-TB 133</b> Seating in public buildings	Peak HRR < 80 kW	26–48 kW
	THR < 25 MJ in 10 min	1.9–4.0 MJ
<b>16 CFR 1633</b> Mattress Test	Peak HRR < 200 kW	25–30 kW
	THR < 15 MJ in 10 min	1.6–2.9 MJ
<b>CAL-TB 129</b> Mattresses in public buildings	Peak HRR < 100 kW	27–32 kW
	THR < 25 MJ	5–8 MJ
	Mass loss < 3 lbs (10 min)	< 0.7 lb
<b>NFPA 267 (NAVY MODIFICATION)</b> Sand Burner 50 kW / 5 min, 100 kW / 10 min	Peak HRR < 150 kW	22–33 kW
	Average smoke < 300	96–251
	Burn length < 432 mm	✓
<b>FAR 25.853 APPENDIX F, PART 11</b> Oil burner 120 kW/m <sup>2</sup> / 2 min Aviation: passenger aircraft	Burn length < 432 mm	✓
	Mass loss < 10 %	✓

# RIGID PUR AND PIR FOR INSULATION

Energy-saving is a global megatrend. PUR and PIR rigid foams offer superior insulation performance, but they are combustible and require effective flame retardants to be safely used in construction applications.

## EXOLIT FLAME RETARDANTS FOR INSULATION

### EXOLIT AP 422 AND EXOLIT AP 462

Exolit AP 422, Exolit AP 462 are safer and more sustainable alternatives to volatile and scrutinized flame retardants such as halogenated and non-halogenated phosphate esters (e.g. TCPP).

### CHARACTERISTICS AND BENEFITS:

- Exolit AP 422 and Exolit AP462 are based on high molecular weight ammonium polyphosphate (phase II)
- Because of lower solubility in water, catalyst interaction is reduced
- Thanks to microencapsulation, Exolit AP 462 is even less susceptible to reaction with amine catalysts, and easily dispersible in typical polyester polyols
- Being non-toxic, inorganic substances, Exolit AP 422 and Exolit AP 462 pose no additional risk to health and environment, and do not contribute to harmful VOC emissions
- Exolit AP 422 has shown to be less abrasive to PUR dosing and metering equipment than many other common solid fillers in trials with renowned equipment manufacturers

## ADDED VALUE

- Favorable environmental and health profile compared to TCPP
- Negligible plasticizing effect, reduced influence on mechanical properties
- Higher system-stability compared to other APP grades
- Exolit AP 422 was awarded the Clariant EcoTain Label for outstanding sustainability and best-in-class performance



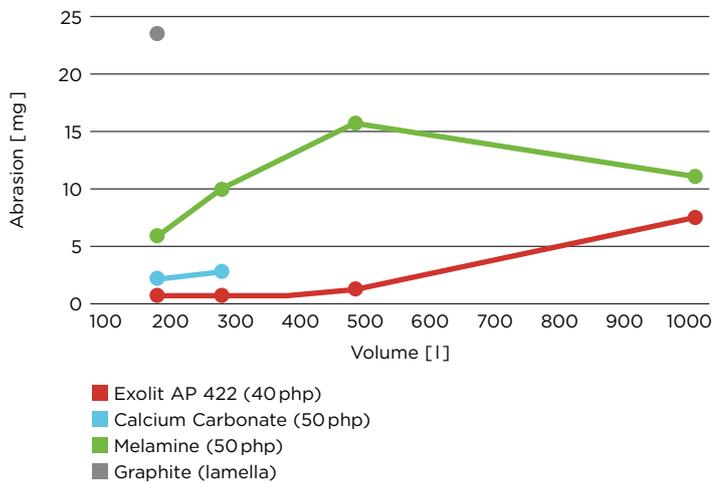
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## GUIDE FORMULATION FOR RIGID PUR AND PIR

TYPE OF FOAM	APPLICATION	STANDARD	PRODUCTS	DOSAGE	FORMULATION DETAILS (ACID NUMBER, DENSITY)
Rigid PIR	Construction Insulation	DIN 4102 (B2) EN 13501-1 (E)	<b>EXOLIT AP 422</b> <b>EXOLIT AP 462</b> <b>EXOLIT RP 6520</b>	8–15 php	Index 315, polyester polyol (acid number: 240 mg KOH/g), 20 php pentane, Density: 30–37 kg/m <sup>3</sup> , Compressive strength > 120 kPa
Rigid PUR	Construction Insulation	DIN 4102 (B2)	<b>EXOLIT AP 422</b>	35–45 php	Index 110, polyether polyol (sucrose/amine), Acid number: 530 mg KOH/g, pentane, Density: 30–43 kg/m <sup>3</sup> , 18–22 php TEP

### EXOLIT AP 422 IS LESS ABRASIVE TO PUR DOSING AND METERING EQUIPMENT THAN MANY OTHER COMMON SOLID FILLERS<sup>14</sup>



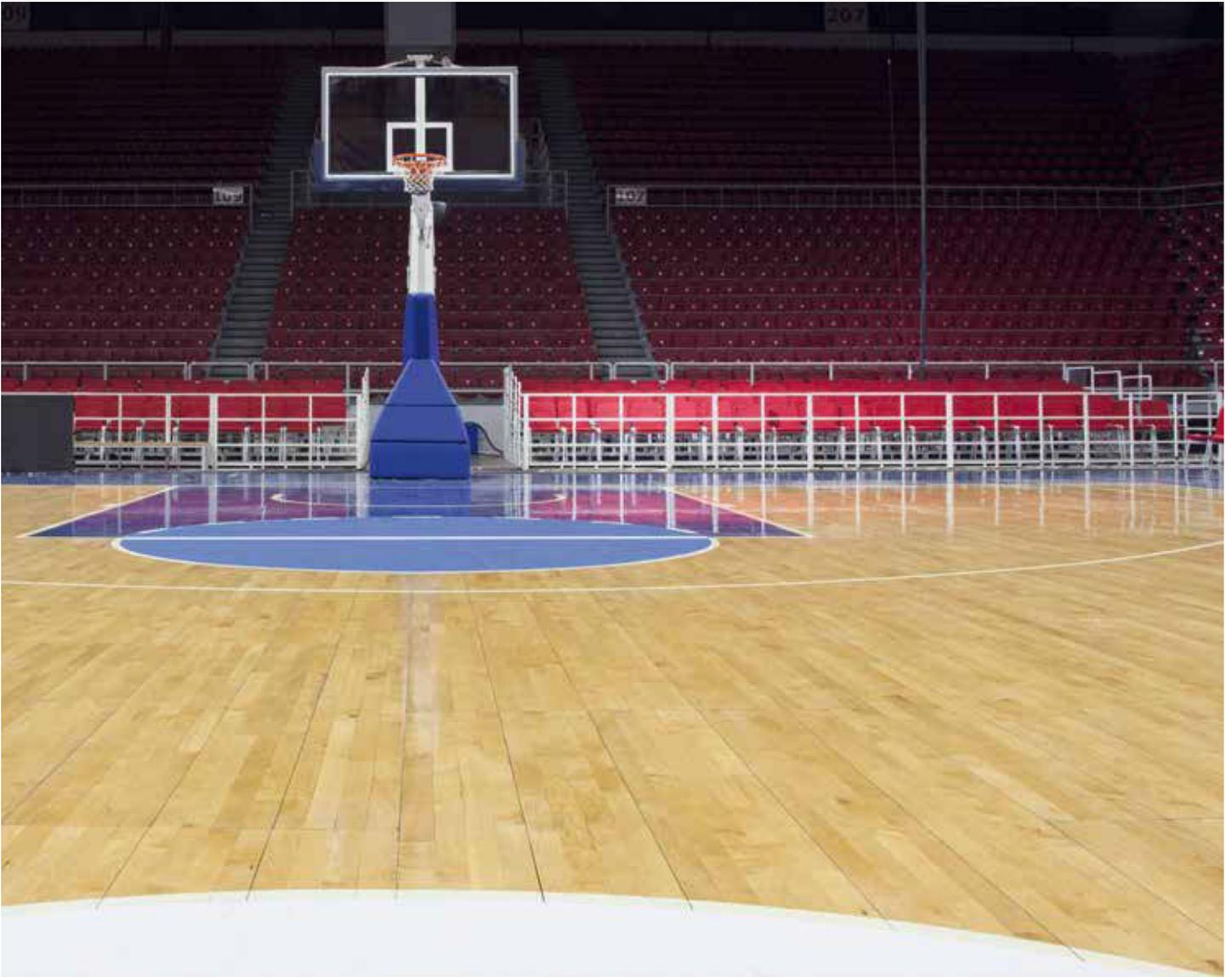
<sup>14</sup> Abrasion test with high pressure PUR dosing machine with various polyol dispersions

Test Specimen:

Steel C 15; throughput 50 kg/min; Spray pressure: 200 bar;  
Nozzle aperture: 3.5 mm; Distance nozzle-specimen: 5.6 mm

# OTHER APPLICATIONS/ SYSTEMS

PUR CASE<sup>15</sup> systems cover a very broad spectrum of material properties. They can therefore be tailored to fit the requirements of many industries and applications.





Diversity of PUR CASE materials and applications leads to an increasing demand for non-halogenated and low-emission flame retardant solutions, e.g. in automotive applications.

Exolit Flame Retardants are compatible with a wide range of CASE materials, cast resins and integral skin foams.

#### **EXAMPLES**

- Exolit AP 422 and Exolit AP 462 in PUR textile coatings
- Exolit OP 930<sup>16</sup> in PUR artificial leather and adhesives
- Exolit OP 560 and Exolit RP 6520 in cast resins and coatings (e.g. E&E or construction applications)
- Exolit AP 750 in semi-rigid integral skin foams (e.g. transportation applications)
- Exolit AP 422 in rigid integral skin foams (e.g. E&E applications)



<sup>15</sup> CASE: Coatings, adhesives, sealants and elastomers

<sup>16</sup> Organic phosphinate

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