



MARCH
2008

EUROPEAN
POLYURETHANE JOURNAL

POLYUREA TECHNICAL ARTICLE

Improved Polyurea Coatings with Baxxodur PC 136

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Advantages of Baxxodur™ PC 136 in comparison with conventional chain extenders

In aromatic systems, an extended potlife of about 15 secs is achieved.

In aliphatic systems, apart from longer potlife and UV stability, the final properties of the coating are attained much faster (within about 4 hours).

In the event of exposure to heat, polyurea coatings made from Baxxodur PC 136 will withstand temperatures of up to 90 °C thanks to their higher heat distortion temperature (HDT).

1. Importance of polyurea spray coating technology

Coatings based on polyurea (PUA) have become firmly established in a variety of industries. This is due, on the one hand, to the very good processability of the components of PUA systems, and on the

Physical properties of Baxxodur PC 136

Appearance	Clear colorless to slightly yellow liquid
Total amine	390 – 420 mg KOH/g
Primary amine	max. 20 mg KOH/g
Density (25°C)	0.989 g/cm ³
Viscosity (25°C)	913 mPa s
Water content	max. 0.5%
Flash point	210°C
Amine hydrogen equivalent weight (AHEW)	136 g/eq.

other, to the excellent physical properties like chemical and weathering resistance of the elastomers derived from these components. By their elasticity PUA elastomers readily bridge cracks in concrete and adhere superbly to a wide variety of surfaces.

Well-known applications include, for example, the manufacture of wear-resistant coatings for large and pickup truck cargo beds, steel and concrete coatings in bridge, tank and pipeline engineering as well as roof coatings and coatings for tanks holding bulk goods or aggressive chemicals. PUA-based spray coatings are also used in

civil and structural engineering, for example for sealing facades or foundations, coating floor slabs and parking decks, and also in hard landscaping (waterproofing of pools and ponds, amusement park and zoo applications).

The success of PUA coatings is due to the major advantages shown below:

- The two components, the isocyanate prepolymer and the amine-based curing agent, react readily to form polyurea elastomers, and this reaction is largely independent of temperature variations between –30 °C and 60 °C. PUA systems can consequently be processed even in low-temperature outdoor conditions.
- The transformation reaction is insensitive to residual humidity in the substrate because the potential competitive hydrolytic reaction with water is much slower.

Properties of polyurea coatings containing Baxxodur PC 136 as a chain extender vs. traditional aliphatic products

Properties	Baxxodur™ PC 136	Amine X	Amine Y
Flash point (°C)	210	141	104
Gel time (seconds)	5 – 15	5 – 10	5 – 10
Hard set (minutes)	2 – 3	4 – 5	4 – 5
90% property development	4 h	7 d	3 d
HDT °C (high temp)	ca. 80 – 90	ca. 60 – 70	ca. 50 – 60

PUA elastomer: mixed 1 : 1 by volume (isocyanate : resin component); aliphatic system based on 15% NCO IPDI quasi-prepolymer.

- Groutless “tanking-type” sealing of vertical and horizontal joints can be achieved in a single operation – in contrast to other coating technologies.
- Several millimeters of film build can be applied in a single continuous operation.
- Above all else, however, polyurea coatings offer benefits for service operations such as necessary repairs: since the physical properties of a PUA elastomer develop fully within less than 24 hours (compared to one or two weeks approximately in the event of polyure-

thane applications), surfaces restored with PUA coatings can be reopened to use within a minimum period of time.

- PUA systems are 100% systems – free of solvent. As a result, they are fully compliant with the strict requirements that apply to VOCs (volatile organic compounds).
- They offer high stability to various solvents, strong alkalis and acids.
- These two-component systems are applied by means of special, heatable high-pressure spraying equipment, the usual mixing ratio being 1 : 1.
- While the mixing components of PUA systems are more costly, they may clearly outperform current coating materials in many respects, depending on the requirements of the application.

2. Synthesis

PUA elastomers are obtained by mixing two reactive components: a (poly)isocyanate component and an amine or amine-mix component that acts as a curing agent. The isocyanate components are based on either aromatic (MDI prepolymer) or aliphatic (HDI or IPDI prepolymer) systems. The curing agents used are mostly polyetheramines and, in lesser volumes, chain extenders. Moreover, sterically hindered diamines, additives (defoamers, flame retardants) and pigments may be added to achieve certain properties. The selection of the chain extenders is of vital importance: these are secondary diamines that are less reactive than primary amines and therefore extend the gel time. At the same time they raise the polymerization level and cross-link density. This improves hydrolytic stability and produces water-tight films that show excellent mechanical and chemical stability.

3. Problems and solutions in application

Being highly reactive systems, PUA systems require special application techniques. Prolonging the potlife while achieving the final coating hardness faster than in the past is a desirable development goal.

As one of the world's leading suppliers of amines, BASF has a broad range of polyetheramines and cycloaliphatic amines that are used as curing-agent components. Baxxodur PC 136, an innovative chain extender, is now available as a product that offers major advantages in processing polyurea systems. The cycloaliphatic secondary diamine Baxxodur PC 136 has been developed in successful cooperation with The Hanson Group LLC, USA, to suit the specific requirements of spray coating applications. Table 1 summarizes the physical properties of Baxxodur PC 136.

This product allows the reactivity of the appropriate PUA system to be modified to suit the particular application. In the less cost-intensive aromatic systems with comparatively shorter curing times, Baxxodur PC 136 permits an extended potlife of up to 15 secs approximately. This makes handling more reliable, which means that coatings with consistent properties can be achieved. In aliphatic systems, the benefit of a longer potlife is complemented by the fact that the final film properties are reached much faster than with traditional chain extenders. In contrast to the commercial products

available to date, Baxxodur PC 136 produces 90% of the final coating properties after just about 4 hours (table 2, properties) – a curing time that is comparable to that of aromatic PUA systems.

Repairs can be carried out fast and without any problem, and the fact that optimum vertical crosslinking makes the repair highly effective is particularly noteworthy. The short hard set time (2-3 minutes) ensures that the coating can be walked on after just a few minutes. This is essential for subsequent operations: they can start immediately after the spray coating has been applied. The major advantage of aliphatic systems as compared to aromatic ones is their UV stability, while they have to date had the decisive disadvantage of curing more slowly. Baxxodur PC 136 clearly speeds up these systems, partially eliminating that disadvantage.

With respect to heat exposure, the fact that the stability of the PUA coating is lost at a temperature of 60-70 °C has to date been a disadvantage. However, coatings based on Baxxodur PC 136 will withstand temperatures of up to 90 °C because they feature a higher heat distortion temperature (HDT).

This novel type of chain extender is also found to offer advantages from the cost/benefit point of view, thanks to its reduced amine hydrogen equivalent weight and excellent crosslinking efficiency, the amount of product to be applied can be reduced by up to 20% in comparison with conventional products. Baxxodur PC 136 has been approved for use in PUA systems in Europe, the USA and China (EINECS-, TSCA-, IECSC-registered).

4. Prospects and trends

PUA technology, which – other than in the USA – is yet very recent in Europe, is beginning to develop steadily. In order to promote market awareness and acceptance, the Polyurea Development Association Europe (PDA Europe) has been formed to provide a platform for all players in the European PUA market. Among other tasks, PDA Europe supports the development of special education programs and the establishment of product, safety and environmental standards and use recommendations.

In Baxxodur PC 136, BASF offers a newly developed product that helps users to open up and develop successfully a very broad range of polyurea coating applications. Customers can rely on the global presence, comprehensive chemical expertise and dependable services offered by BASF [1]. In addition to the advantages reported above, i.e. extended potlife and faster development of final film properties, future development activities will focus on improving the finish quality with regard to appearance, on reducing the film build of the coating while maintaining its mechanical properties, and on developing polyurea coatings that provide superior flame-retardant properties.

[1] Information on all aspects of this versatile technology and the raw materials needed for it can be found in the new brochure released by the Intermediates division of BASF, "Your Competent Partner for Polyurea Coatings."

The brochure is available for download on the Internet at <http://www.basf.de/intermediates>.

Baxxodur™ PC 136 is a trademark of BASF SE.