

A
solvent-based

B
waterborne
Bayhydur® quix

THE INVISIBLE DIFFERENCE

Bridging the gap between performance,
sustainability and productivity



ABSTRACT

Stricter regulatory requirements on chemicals, emissions and workplace hygiene; the competitive pressure to minimize production costs while remaining innovative; ecological demands fueled by increasing environmental awareness among end-users, particularly in Europe and the U.S.: these key trends in the global wood coatings market are presenting wood coating and furniture manufacturers with new challenges.

As a result, OEMs and furniture part manufacturers are looking for more sustainable coating solutions that still keep productivity high. UV curing technologies are a possible alternative if the high investment is justified. On the other hand, water-borne systems can be easily implemented in existing lines. 1K water-borne (1K WB) coating systems come with good drying times but are inferior in performance compared to solvent-borne systems. As for 2K water-borne (2K WB) systems, wood coating manufacturers see them as a low-VOC* solution with a similar performance to solvent-borne systems but are unhappy about their slow drying performance.

A newly developed fast-curing hydrophilic polyisocyanate hardener from Covestro, Bayhydur® quix 306-70, uniquely solves this slow-drying problem while maintaining the required high performance properties and, in particular, lowering VOC emission levels to less than 100g per liter. This White Paper demonstrates why this new product makes ecological and economic sense in the current market situation.

GOOD TO KNOW

Wood coatings that dry slowly lower productivity. Yet time is money and high productivity an increasingly important survival factor in business, especially in high-wage economies. Such considerations are an important factor for the global industrial wood coatings market.

In today's keenly competitive climate with globalized procurement possibilities, furniture part manufacturers are being forced to minimize their production costs in order to offer competitively priced coated wood components to their customers. At the same time, they have to stay innovative to survive.

Driven by stricter regulatory requirements on chemicals, indoor emissions and workplace hygiene, OEMs and furniture part manufacturers are looking for more sustainable solutions while keeping productivity and performance high. A newly developed hybrid hydrophilic polyisocyanate hardener from Covestro promises to bridge this gap between sustainability and productivity without a trade-off in performance.

1K WB

✓ Low VOC
✓ Short drying time
X Lower performance

2K WB

✓ Low VOC
X Slower drying time
✓ High performance

MARKET BACKGROUND AND KEY TRENDS

In 2017, global consumption of industrial wood coatings totaled 2.5 million metric tons and the market was worth €8 bn worldwide.

In the three segments of the global market the main driver is furniture applications, which accounted for 81% of the total volume of 2.5 million metric tons in 2017. This was followed by joinery applications with 17% of the market and parquet flooring with 2%. In that same year, the APAC region had a 53% share of the global market, EMEA 29%, NAFTA 15%, and LATAM 3%.¹

Around 32% of the global industrial wood coatings market is dominated by traditional 2K solvent-borne polyurethane technology. Up to now, the strong presence of solvent-borne technology has been based on the high mechanical and chemical resistance properties of such coatings, their unique balance of flexibility and hardness, and their very fast drying capability. The latter is of course critical for high productivity, especially in the furniture segment.

Though originally developed to protect and enhance the beauty of wood surfaces, wood coatings are increasingly being required to show haptic qualities and even display smart functions. In furniture applications, the surface of an item has become its main image carrier and there is clear evidence of a natural look & feel trend in interior design³. This trend is linked to increasing consumer interest in comfort, well-being and more environmentally friendly solutions. A survey of wood coating manufacturers conducted by Covestro in 2018 revealed a wide range of desired wood coating properties: a scratch-resistant, non-gleaming, deep-matt look; label-free systems offering easy and safe handling; 1K systems with higher chemical resistance (1K with 2K performance); sustainable binders with standard quality, higher hardness as well as scratch and fingerprint resistance; more durable natural looks; low VOCs; and faster curing, to name just the most important requirements.

From a legal, ecological and health perspective the most significant trend is for lower levels of VOC emissions. Stricter regulatory requirements on chemicals (e.g. REACH in the European Union), indoor emissions and workplace hygiene, China's tax on VOC emissions, and the growing demand for more sustainable wood coating solutions are driving the need for alternatives to reduce VOCs in coating applications. Water-borne solutions have long been available on the market. Yet up to now, users have had to choose between fast-drying systems with low performance (1K polyacrylate systems) or high-performing polyurethane-based systems with slower drying properties.

2.5M

metric tons consumption
of industrial wood coatings
in 2017¹

32%

of the global industrial wood
coatings market is dominated
by traditional 2K technology²

53%

of global industrial wood
coatings are consumed by the
APAC region, followed by EMEA
(29%) and NAFTA (15%)¹

*VOC (Volatile Organic Compounds)

¹ Irfab GICM Industrial Wood Coatings 2017

² Polyurethane: Coatings, Adhesives & Sealants, European Coatings Library, Vincentz Network 2019, p. 142

³ The top 15 Interior Design trends for 2019 <https://www.decoraid.com/blog/top-interior-design-trends-2019>

THE SLOW-DRYING ISSUE

Unlike in other applications, solvent-borne polyurethane wood coatings often rely mainly on aromatic polyisocyanate crosslinkers to speed up drying. The yellowing tendency caused by aromatic polyisocyanates is not a problem for clear wood coatings, as the wood itself tends to yellow to a greater extent than the yellowing caused by the aromatic polyisocyanates in the coating. For white pigmented systems aliphatic polyisocyanates or blends with aromatic polyisocyanates are used in combination with polyols to achieve low yellowing levels.

Not surprisingly, wood coating manufacturers using 2K solvent-borne polyurethane technology have been skeptical about switching to high-performance 2K water-borne systems because of the slow-drying issue. Wood coating manufacturers who are already using 2K water-borne polyurethane technology are now looking for ways to increase productivity. For both these groups of customers Covestro has come up with a solution to the slow-drying problem that bridges the gap between sustainability and productivity. Bayhydur® quix is a novel hydrophilic hardener that allows 2K water-borne polyurethane to dry as fast as solvent-borne aromatic wood coatings, but with one decisive difference: 80% reduction of VOC emissions, from >500 g per liter for a standard solvent-borne system to <100 g per liter for a water-borne system.

80%

reduction of
VOC emissions⁴

< 2 h

is the time needed for
Bayhydur® quix water-borne
wood coatings to achieve
total dry⁴

“Water-borne wood coatings based on Bayhydur® quix can achieve total dry (T4) in less than 2 hours. The coatings can be sandable even faster than when using a standard solvent-borne system”

Dr. Eva Tejada
Business Unit Coatings, Adhesives & Specialties
Covestro Deutschland AG

NOVEL CHEMISTRY BREAKS NEW GROUND

As the hardener determines the curing speed of a wood coating system, efforts have focused on overcoming the hurdle of developing fast crosslinkers that work in water-borne coatings. **There have been various attempts to reduce the drying times of water-borne 2K polyurethane-based coatings by hydrophilizing highly reactive polyisocyanates with aromatic isocyanate groups like toluene diisocyanate (TDI).** However, the water-borne systems formulated using these pure aromatic polyisocyanates do not produce coatings with a sufficiently high aesthetic appeal. Combining hexamethylene diisocyanate (HDI) and TDI did not solve the problem either. Additionally, the pure aromatic and mixed aliphatic-aromatic non-ionic hydrophilized crosslinkers contain considerable amounts of hydrophilic polyether alcohols. These are required for adequate emulsification, but this results in a permanently high coating hydrophilicity and reduced hardness.

Consequently, Covestro had to invest a great deal of research into selecting the right monomers and optimizing the amount and type of hydrophilization. Different internal hydrophilization systems were tested to develop the new crosslinker. **The best results were achieved using anionic hydrophilization in the polymers. This achieved rapid drying combined with good gloss, film transparency, and outstanding chemical resistance of comparable standard to the best currently available solution.** Different percentages of TDI were also tested in the polymer before the optimal ratio of TDI/HDI was found. The outcome has been the development of the first-ever mixed aliphatic-aromatic polyisocyanate based on HDI and TDI which is suitable as a crosslinker component for 2K water-borne polyurethane coating systems.

This new aromatic-aliphatic crosslinker makes it possible to formulate high-performance 2K water-borne coatings that dry as fast as solvent-borne systems but come with a significant reduction in VOC emissions. The new hardener, which features a patented technology and is marketed as Bayhydur® quix 306-70, allows the formulation of fast-curing 2K water-borne wood coatings of polyurethane quality, with high mechanical and chemical resistance, good film appearance and a long pot life of up to seven hours. Once Covestro's chemists had reached this stage in the product development, the novel hardener was put to the test.

PROOF OF PERFORMANCE

The new product was tested in different systems to determine what benefits it brought in wood coating applications. The results revealed up to 60% shorter drying times than standard 2K water-borne systems, which thus matched the drying times of aromatic solvent-borne systems. With 7-hour workability, a figure that meets the industry's requirements, the water-borne coatings based on this novel hardener can be formulated to have a similar pot life to solvent-borne coatings. Last but not least, in both clear and pigmented systems Bayhydur® quix 306-70 was shown to be highly resistant to aggressive substances such as coffee, wine, mustard, and ethanol. An additional benefit is that despite the specific aromatic character of the hydrophilic hardener, its yellowing behavior is closer to that of an aliphatic product and is thus suitable for white pigmented formulations as well.

7 h

potlife can be achieved
with Bayhydur® quix⁴

Clear glossy coating based on	Bayhydrol® A 2846 - Bayhydur® quix	Bayhydrol® U 2755/1- Bayhydur® quix	Standard 2K Solvent-borne system
Approx. VOC **	123 g/l	66 g/l	612 g/l
Drying time - T1	35 min	55 min	18 min
Drying time - T4	1h 45 min	2h	1h 50 min
Sandable after x h at RT	2.5 h	2h	4 h
viscosity	>7 h	>7h	>7 h
dE after 1d 50°C	0.06	0	0.17
dE after UV (5320mJ/cm2)	1.68	1.86	3.56

60%

faster drying time in
comparison to standard
2K water-borne
polyurethane systems⁴

**Calculated according to the definition in Directive 2004/42/EC

2K solvent-borne coating based on RR 6627 (Desmophen® 1300 BA / Desmophen® 881 X / Desmodur® IL 1351 BA / L 75)

CONVINCING ECONOMICS

The economic argument for Bayhydur® quix 306-70 will prove particularly interesting to wood coating manufacturers who are currently using 2K solvent-borne polyurethane technology. Although the newly developed hardener is more expensive per kilogram, the overall cost of this solution tells a different story: first, solvent-borne systems generally need more hardener – 20-30% in solvent-borne systems compared to 10-15% in water-borne ones; second, as solvent-borne systems tend to generate more overspray than the water-borne ones, water-borne systems contribute to a higher transfer efficiency. By maximizing transfer efficiency and spraying less paint, manufacturers not only save money in material costs, but also reduce waste and decrease VOC emissions. In other words, solvent-borne systems are actually more expensive than a superficial straight comparison of the two raw materials in supply form would suggest. Moreover, the traditional argument that a slow-drying system costs time and money at the application stage is no longer valid when using Bayhydur® quix as a hardener. And that will please OEMs and furniture part manufacturers on the one hand and end-users on the other.

⁴ European Coating Journal, issue 09/2019, p20

SUSTAINABILITY IN PRACTICE

Nowadays, sustainability is an overused buzzword that often hides a multitude of 'greenwashing' sins. However, the high-performance 2K water-borne coating technology based on Bayhydur® quix 30-70 does indeed lead to a genuine improvement in the sustainability of wood coatings compared to traditional 2K solvent-borne polyurethane systems. One important 'anti-greenwashing' argument is the positive contribution this novel hardener makes to the following

UN Sustainable Development Goals:

 <p>3 GOOD HEALTH AND WELL-BEING</p>	Substantial reduction in air pollution during the application phase through much lower VOC emissions (Target 3.9)
 <p>8 DECENT WORK AND ECONOMIC GROWTH</p>	Improvement in the safety and wellbeing of coating manufacturers' personnel and end-product applicators in their working environment through the use of chemicals that are labeled more favorably and reduce their exposure to solvents (Target 8.8)
 <p>12 RESPONSIBLE CONSUMPTION AND PRODUCTION</p>	Better chemical management through a significant reduction of waste-to-air formation (i.e. VOCs) along the life cycle (Targets 12.4 and 12.5)

If you want to know more about the UN Sustainable Development Goals, visit the United Nations Website:
<https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

THE BOTTOM LINE

No other competitor can currently offer a high-performance 2K hydrophilic hardener that dries as fast as solvent-borne alternatives. This gives Bayhydur® quix 306-70 a unique advantage that paves the way for a technology shift in wood coatings. This shift means moving away from coatings with high VOCs to those with very low VOC emission levels combined with fast drying and high performance.

CONCLUSIONS

This new development from Covestro will both facilitate and speed up the shift from the well-established 2K solvent-borne technology towards more environmentally friendly, high-performing 2K water-borne wood coating systems. The difference Bayhydur® quix 306-70 makes may be invisible in terms of look and feel but is of decisive benefit to both wood coating manufacturers and end-users. Wood coating manufacturers can now offer products that combine high all-round coating qualities with a reassuringly high ecological and economic performance. End-users in furniture, joinery and parquet applications can look forward to a fast-drying, high-performing product that is safe and easy to handle. Moreover, you will not feel the difference, but the environment does!

61%

of consumers are worried about climate change⁵

**Starting Formulations based on Bayhydur® quix
and samples are available on request.**

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Sources

¹ Irfab GICM Industrial Wood Coatings 2017

² Polyurethane: Coatings, Adhesives & Sealants, European Coatings
Library, Vincentz Network 2019, p. 142

³ The top 15 Interior Design trends for 2019 [https://www.decoraid.com/
blog/top-interior-design-trends-2019](https://www.decoraid.com/blog/top-interior-design-trends-2019)

⁴ European Coating Journal, issue 09/2019, p20

⁵ How to become a sustainable brand, Whitepaper Euromonitor
International 2019