

TKH-Technical Information Sheet

EPI Adhesives

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Introduction

Section 1.3. of the TKH technical information sheet 3 "Dispersion Wood Glues" mentions EPI adhesive systems (Emulsion-Polymer-Isocyanate). This supplementary information sheet provides additional technical data regarding the characteristics of this type of adhesive.

1. Characterization of EPI adhesives

EPI adhesives are dispersion based adhesives manufactured using different polymers. They are mainly solvent-free. However, they may be modified with different additives to adjust processing and bond characteristics.

A specific feature of EPI adhesives is the cross-linking with relatively high amounts (normally 15%) of an isocyanate (usually MDI). This cross-linking reaction results in a high water and heat resistance of the adhesive.

What to do when D4 is too limited as the only criteria?

The classification of wood glues according to DIN EN 204 describes application areas of the highest class D4 as follows:

Interior use with frequent heavy exposure to drain-off water or condensation.

Exterior use, exposed to weather factors but with adequate surface protection.

Experience has shown, however, that in some instances the adhesives are exposed to higher stress.

2. Areas of application

Thermoplastic wood glues are classified based on their water resistance and governed by EN 204. This classification has no validity for duroplastic (e.g. condensation adhesives) or elastomeric adhesives (e.g. polyurethane adhesives). EPI adhesives can be assigned to the thermoplastic wood adhesives group based on their processing conditions. These adhesives can be tested according to EN 205. Results of such testing in many cases are better than those of a D4 adhesive. The same applies for testing of heat resistance according to EN 14257 (WATT '91), which for EPI adhesives produces considerably higher results than for classical D3 or D4 PVAc-based adhesives.

These characteristics of EPI adhesives are the reason for the specific qualification for applications where D4 criteria alone are too limited. A typical example is a front door oak panel with a dark finish. According to the application area, a D4 adhesive might be adequate, however, joint openings can not be entirely excluded with conventional PVAc-D4 glues, the reason being the combination of moisture and strong heat exposure as well as the resulting stress caused by swelling and shrinkage of the wood.

For such areas of application with extreme stress exposure, an adhesive is required which guarantees extreme bond strength even under aforementioned climatic conditions.

On the one hand, these requirements can be covered by adhesives from the group of structural timber construction adhesives (see box), but also by EPI adhesives. Please observe that for the construction of load-bearing structures as defined by DIN 1052 only approved adhesives are admissible. In addition, the construction of such elements shall only be performed by authorized and monitored companies.

For structural glued timber constructions, adhesives are used which are thoroughly tested for climatic stress for interior and exterior use. If testing according to EN 301/302 is successful, these adhesives may receive certification for use in load-bearing structures according to DIN 1052. Here, we find duroplastic condensation-resin based adhesives, polyurethane adhesives but also EPI adhesives.

Table 1: Examples of thermoplastic wood adhesives for solid wood applications				
Application	Wood types	Stress class	Typical adhesives	Notes
Furniture manufacture, interior construction	Local timber types	D1, D2, D3	PVAc-white glues	
Furniture manufacture, interior construction	Exotic timber types	D1, D2, D3	PVAc-white glues EPI adhesives	For furniture manufacture, EPI adhesives are primarily used in Asia.
Parquet manufacture	Wood materials, different solid wood types	D3	PVAc-white glues, EPI adhesives	On account of many different timber types and different heat resistance values, increasingly EPI adhesives are used.
Window corner joints	Local timber types, special window timber types	D3, D4	PVAc-white glues	Increased heat resistance (> 7 N/mm ²) required by DIN EN 14257.
Window squares	Local timber types, special window timber types	D4	PVAc-white glues, EPI adhesives	Increased heat resistance (> 7 N/mm ²) required by DIN EN 14257.
Conservatories, non-structural structures	Local timber types, special window timber types	D4 not applicable	EPI adhesives	Weather resistance, exterior joints. Generally, pre-testing is imperative.
Woods for exterior use	Moisture resistant timber types, larch	D4 not applicable	EPI adhesives	

Compared to other bonds, composite glue joints where isocyanate is used as cross-linking agent, are very resistant to weathering. Note: like with all polyurethane-based systems, direct UV exposure of the glued joint in combination with oxygen can cause oxidation reactions which will then reduce the bond strength.

This entails that the adhesive as a free film has no resistance to direct sunlight exposure. Only the composite bond where the glue joint is located on the inside, guarantees that the required resistance is maintained. Consequently, it is recommended to provide for adequate structural or chemical surface protection, as required by DIN EN 204:2001 (D) for stress class D4.

3. Processing systems and methods

Principally, the base adhesive (dispersion component) must be mixed with the cross-linking agent (isocyanate component) in the correct ratio to obtain a homogeneous compound.

After mixing, the adhesive must be processed during specified pot life.

Manual application method	Automatic application method
Weighing of dispersion and cross-linking agent according to manufacturer's instructions. Manual mixing of cross-linking agent, e.g. using blade agitator.	Automatic feed or mixing units with dynamic or static mixing elements.
Manual application of adhesive using brush, trowel, gluing roller. When using pressure or glue pumps with bead or roller coating, always pay special attention to pot life.	The mixed adhesive batch may be applied with roller coating or rakel systems. When using feeder head, reduce circulating adhesive quantity to a minimum on account of short pot life. With Start-Stop systems where compound does not circulate, only fill in small amounts of mixed adhesive.

4. Failure analysis

In addition to failure analysis described in TKH technical information sheet 3 "Dispersion wood glues", please observe the specific features of 2-component dispersion adhesives.

According to manufacturer's instruction, EPI adhesives are mixed with the cross-linking agent immediately before processing. Because of the high reactivity of the adhesive systems, EPI adhesives normally have a very short pot life. It is important to process the mixed adhesive within the pot life – otherwise the bond may fail.

Typically, mixed EPI adhesives tend to foam at the end of their pot life. Consequently, never store mixed adhesives in tightly closed containers (risk of bursting).

Pot life and processibility can also be affected by user and ambient conditions:

- High temperatures reduce pot life.
- If adhesive is stirred too long, pot life is reduced.
- If mixing is insufficient, this results in an inhomogeneous distribution of cross-linking agent and thus in an inhomogeneous distribution of the bond strength.

5. Environmental and safety aspects

5.1. Main component dispersion-based

Polymer dispersions, like almost all polymers, are non-biodegradable. In hardened state, they remain in the environment or rather the abiotic or biological degradation is very slow. However, they are not classified as toxic to the environment nor do they result in bio-accumulation. Consequently, polymer dispersions are of lesser importance from an environmental protection viewpoint. Due to their composition, modern polymer dispersion component systems are very low in emissions.

5.2. Hardener component isocyanate-based

The assessment of health issues depends on the hardener system. Normally, HDI- or MDI-based hardeners are used.

Due to their volatility and the related exposure scenario, monomer diisocyanates are not used in their original form but rather exclusively in the form of high-molecular, low volatile polyisocyanates. These polyisocyanates only contain low quantities of the original isocyanate as residual monomer. MDI however is an exception, which can be used without modifications on account of its low volatility.

Isocyanates are reactive compounds. As for their toxicological characteristics, irritation potential for skin, eyes and respiratory system as well as a certain sensitizing potential must be considered, always based on the type of isocyanate and application method. As a consequence, allergic skin reactions may occur after repeated contact with the substance. Overexposure to diisocyanates by inhalation may lead to sensitization of the respiratory tract with asthma-like symptoms. While sensitization is a consequence of a single or repeated overexposure, however in persons already sensitized, subsequent allergic reactions can already occur at considerably lower concentrations. People suffering from allergies, asthma and other diseases of the respiratory system shall not perform tasks involving products which contain isocyanates.

Typically, prescriptive limits for diisocyanates in the workplace are not exceeded when using aerosol-producing application methods (e.g. with the exception of spray application and heat hardening), provided adequate airing of the rooms is ensured. Under such circumstances, low-volatile polyisocyanates do not contribute to respiratory tract exposition. Skin exposition is prevented by wearing protective gloves.

For application methods with an aerosol-producing potential, effective extraction systems must be installed. In case of short-term, temporary exposure, personal protective equipment is

sufficient: respirator mask (fine mask or filter A2–P2), protective clothing, goggles and gloves (made from butyl or fluoro-rubber). More information can be found in manufacturers' safety data sheets. As regards industrial safety and monitoring, the regulations of TRGS 430 Isocyanates- Exposition and Monitoring – apply.

Properly hardened dispersion wood glues are inert (fully polymerized synthetic resins) and are physiologically safe.

Always observe the valid safety data sheets issued by the manufacturer.

Literature:

- 1) Information data sheet TKH-3 "Dispersion wood glues"
- 2) EN 204 "Classification of thermoplastic wood adhesives for non-structural applications"
- 3) EN 205 „Adhesives - Wood adhesives for non-structural applications - Determination of tensile shear strength of lap joints"
- 4) EN 301 "Adhesives, phenolic and aminoplastic, for load-bearing timber structures - Classification and performance requirements"
- 5) EN 302 "Adhesives for load-bearing timber structures - Test methods “
- 6) EN 923 "Adhesives - Terms and definitions"
- 7) EN 14257 "Adhesives - Wood adhesives - Determination of tensile strength of lap joints at elevated temperature (WATT'91)"
- 8) DIN 1052 "Structural use of timber; design and construction - General rules and rules for buildings"