

Purbond AG, Sempach Station

Assessment with respect to ecology and health

Polyurethane-based 1C adhesives (PURBOND®)



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1 Experts assess PUR adhesives: Ecological and health impacts

For some 20 years, Purbond has been producing polyurethane-based 1C adhesives. The globally active Swiss company is a pioneer in this industry and one of its leading providers. With its systems approach, Purbond mainly serves manufacturers of load-bearing wood components such as glued laminated timber (glulam), cross-laminated timber, and solid structural timber.

Pioneer in PUR adhesives technologies

In the past years, public awareness has more and more actively focused on environmental and health aspects. A growing number of customers and interested users have asked Purbond for relevant information on its products. Ernst Basler + Partner, an independent, internationally active Swiss engineering, planning, and consulting company, was commissioned by Purbond to compile a backgrounder on PURBOND adhesives. Its purpose is to answer ecology- and health-related questions and enlighten its readers.

Why this assessment concerning ecology and health?

2 Wood as a construction material

Wood is a highly versatile renewable raw material. The quality of wood is very disparate. As an untreated commodity, it has several disadvantages with respect to its suitability as a construction material, such as shrinkage (loss of volume as it dries), swelling (increase of volume as it absorbs moisture), warping (distortion while drying), and a tendency to crack. However, wood can be refined and converted into high-grade products: the wood is sawn or shredded and transformed into homogeneous large-format components with suitable wood adhesives. Wooden boards can be converted into glued laminated or cross-laminated timber. Veneers, chips, and wood fibers are used to fabricate panels.

Modern wood materials from a renewable commodity

Glued laminated timber and wood materials

Thanks to their high strength and rigidity, glued laminated and cross-laminated timber elements are particularly suitable for very large wood structures such as bridges or halls. Because of their excellent dimensional stability and natural appearance, they are appreciated in residential construction for walls, floors, and ceilings.

Glued laminated timber and cross-laminated timber for load-bearing applications

Interior designers and furniture makers use either solid wood or wood materials such as particleboard, oriented strand board (OSB), medium-density fiberboard (MDF), porous fiberboard or plywood. In comparison with solid wood, all processed wood materials are characterized by high dimensional stability, free formability, and affordability. Conversely, the adhesives used to manufacture such components may lead to high indoor formaldehyde and VOC concentrations.

Wood panels for interior applications

3 Wood adhesives: major differences

Manufacturers of certified wood components with load-bearing functions such as glued laminated timber and cross-laminated timber are bonded primarily with the following types of adhesives:

- Melamine resin adhesives (MF/MUF)
- Phenol resorcinol adhesives (PF/RF/PRF)
- Polyurethane adhesives (PUR)

These adhesives must meet a wide range of requirements related to functional strength, aesthetic appeal, and ecology and health concerns. Not all of them are unobjectionable.

Table 1:
Comparison of wood adhesive systems

Adhesive system	Aesthetics (joints)	Formaldehyde emissions
	☹☹ = dark ☺ = clear	☹ = weak ☹☹ = sizable ☺ = none
Melamine resin adhesives	☺	☹☹
Phenol resorcinol adhesives	☹☹	☹
Polyurethane adhesives	☺	☺

As illustrated by Table 1, PURBOND adhesives unite all positive advantages: they produce clear joints and do not release any artificially generated formaldehyde.

Noxious emissions: comparison with nature

PURBOND adhesives do not influence the release of formaldehyde

Formaldehyde occurs naturally in wood and is also released to the environment in small amounts. To quantify this difference, the Austrian IBO institute examined four wood elements bonded with PURBOND adhesives and one unbonded solid-wood specimen (natural wood) and measured their formaldehyde emissions¹⁾. No significant difference in formaldehyde release was detected between the bonded and unbonded specimens. This confirms that the PURBOND adhesive system does not introduce additional formaldehyde in the wood elements and does not influence the release of natural formaldehyde contained in wood. Thus, wood materials bonded with PURBOND release only the same minute amounts of formaldehyde as natural wood.

1) Test chamber analysis of material specimens for the presence of formaldehyde, volatile organic compounds, and isocyanates; Analysis report. Innenraum Mess- & Beratungsservice, Österreichisches Institut für Baubiologie und -ökologie GmbH (IBO), Vienna (2009)

Apart from formaldehyde, volatile organic compounds (VOCs) are further noxious airborne substances that can occur indoors because they are used as solvents in some wood adhesives. In the form of terpenes, VOCs also occur naturally in the essential oils of plants, including wood. The above-mentioned analysis¹⁾ was therefore performed to detect the presence of VOCs as well. The results showed no significant differences between wood elements bonded with PURBOND adhesives and unbonded wood specimens. All specimens exhibited only very low VOC concentrations of natural origin. Contrary to other PUR adhesives on the market, PURBOND adhesives are VOC-free.

PURBOND adhesives are solvent-free

During the manufacturing process and in applications involving polyurethane adhesives, isocyanates are of significance as highly reactive chemicals. With adequate ventilation and occupational hygiene measures in the production environment, this is an absolutely problem-free issue. As confirmed by measurements²⁾ at various production sites, the isocyanate concentrations were consistently at least 120 times lower than the MAC threshold (maximum allowable concentration at the workplace) which is defined as 50 µg/m³. The polyurethanes form via intermediates in reactions with the moisture of the wood and as carbon dioxide (CO₂) decomposes. They constitute a crosslinked structure and become totally inert so that they no longer release any isocyanates. In a comparison with unbonded wood samples, the experiments¹⁾ with different bonded wood elements showed that isocyanate degassing did not occur in any of the examined specimens. Thus, PURBOND adhesives in bonded wood materials are absolutely unobjectionable from a physiological standpoint.

Cured, PUR-bonded wood elements contain no isocyanates

4 Quality labels and standards

In high concentrations, formaldehyde can cause irritations of mucous membranes and sensory disorders. In 2004, the gas was classified as carcinogenic. In Switzerland, the *Lignum 6.5* quality label has become the norm for informing consumers as regards the formaldehyde content of a wood product. Emission class E1 is the equivalent in the European Union. Both of these norms specify a limitation to less than 6.5 mg formaldehyde/100 g of wood material, which corresponds to 0.1 ppm formaldehyde.

Conventional standards do not guarantee safety

Today, many wood materials honor these thresholds. Nonetheless, despite compliance with the guidelines, problems do occur. One reason is that in many cases, emissions are compounded by several emitting objects (ceilings, floors, furniture). Even if these objects comply with the relevant standards individually, they may exceed the permissible concentration as an object group. The decisive factor for assessing the indoor formaldehyde concentration is the ratio between the emitting surfaces and the volume of air in the room. Additionally, high temperatures (for example near radiators), processing irregularities, or increased air

High formaldehyde concentration despite compliance with standards

2) Assessment of isocyanate exposure in the application of polyurethane adhesives; Thesis by Rafaela Studer. ETH Zürich / EMPA Dübendorf (2003)

moisture loads (for instance in kitchens and bathrooms) are known to significantly increase formaldehyde emissions of wood materials.

Safety through compliance with strictest standards

The world's strictest standards for the release of formaldehyde come from Japan (JAJA F****) and California (CARB). PURBOND products comply not only with the European emission class E1 but are also certified pursuant to the latest Japanese F**** standards. Thus, users of PURBOND products can rest assured that even combinations of different wood materials will not result in a problematic airborne burden.

Suitable for Minergie-Eco

In Switzerland, the Minergie label has established itself as a benchmark for sustainable building techniques. More recently, the Minergie-Eco label has appeared and is being specified in more and more public-sector tenders and by private builders. In addition to energy-efficiency criteria, Minergie-Eco-certified structures also address requirements related to health and ecological building methods. This new label guarantees a high-quality working and living environment. One of the restrictions imposed on adhesive systems is the large-area deployment of uncoated wood materials that emit formaldehyde. Wood materials bonded with PURBOND easily comply with the Minergie-Eco label requirements.

5 Ecological recycling of wood materials

Commodity or energy source

At the end of their useful lives, buildings today are often demolished in such a way that the materials of which they are composed can be systematically reused. This process is also called "unbuilding". The quality of waste wood intended for the production of wood materials or for combustion must be analyzed. Among other factors, the presence of wood preservatives determines the eligibility of waste wood for downstream processes. Shredders turn waste wood into chips and shavings. Depending on the quality, these fragments are used to generate energy or as a raw material for the production of particleboard panels. The forward-looking cascaded utilization of wood – from logs and beams as well as glued laminated timber to chips and particleboard or to combustion for energy generation – is not restricted in any way for products bonded with PURBOND.



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