Safer paint - Water borne alternatives

SIGURNIJE BOJE - VODOTOPLJIVE ALTERNATIVE

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S a ž e t a k

Vodotopljiva pigemntirana premazna sredstva (skraćeno: boje) obuhvaćaju danas 2/3 zapadnoeuropske proizvodnje boja. Njihove prednosti u usporedbi s bojama na bazi organskih otapala jesu brzo sušenje, blag miris, mogućnost čišćenja vodom i podnošljivost vlažnih površina podloga. Nisu idealne u vlažnim i hladnim uvjetima, a slabo su i otporne prema pljuskovima neposredno nakon nanošenja, no neprestano se nastoje usavršiti. Uporaba tih sredstava povećala se zbog njihove tehničke vrijednosti i sve veće brige o zaštiti čovjekova okoliša. Sredstva na bazi organskih otapala mogu negativno djelovati na zdravlje ljudi i uvelike pridonose onečišćenju atmosfere. Hlapljivi organski spojevi mogu, uz djelovanje sunčane svjetlosti, reagirati s drugim onečišćivačima, ponajprije oksidima dušika, te stvarati ozon i druge fotokemijske oksidanse za koje se zna da su štetni za ljudsko zdravlje, ali i za drveće i drugu vegetaciju. Stručnjaci BRE-a (Building Research Establishment) istraživali su zdravstveni i sigurnosni aspekt pojedinih otapala. Smatra se da je izlaganje otapalima potencijalno opasno za zdravlje, pa je za vrijeme bojenja iznimno važno osigurati dobru ventilaciju. U Velikoj Britaniji točno su propisane granice mogućeg izlaganja otapalima na radnim mjestima za laki benzin (white spirit) i druga otapala. Granica dugotrajnog izlaganja iznosi 100 ppm, a granica kratkotrajnog izlaganja tijekom 10-minutnog razdoblja iznosi 125 ppm. U BRE-u su nastojali ustanoviti učinke izloženosti ličioca otapalu za vrijeme ličenja zidova bojama na bazi lakog benzina, pri čemu su varirali intenzitet prozračivanja, površinu koja se obrađuje i temperaturu. Ustanovljeno je da pri dobroj ventilaciji izlaganje otapalima može biti ispod granice dopuštene pri obradi manjih površina, no bojenje velikih površina zidova nosi znatan rizik za zdravlje. Zato bi za unutrašnje uređenje zidova, stropova i velikih površina kad god je moguće trebalo upotrebljavati vodotopljive boje. Ako se zbog tehničkih razloga moraju upotrijebiti sredstva na bazi organskih otapala, dobrom ventilacijom treba osigurati da koncentracija para otapala ne prelazi dopuštene granice ili je radnika potrebno zaštiti.

Smanjenje emisije organskih otapala u nadležnosti je Europske komisije. U Velikoj Britaniji i drugim europskim državama uvedena je ili se uvodi stroga kontrola zaštite okoliša radi znatnog smanjenja emisije organskih otapala u atmosferu za vrijeme proizvodnje i primjene boja i površinskih premaza. Budući da je pri uporabi boja u domaćinstvima i unutrašnjem uređenju zgrada teško kontrolirati emisiju otapala, Europska komisija razmatra plan uvođenja ekoloških oznaka za boje. Korisnicima koji biraju ekološki pogodan proizvod to bi olakšalo izbor, a i potaknulo proizvodnju ekološki primjerenih proizvoda. Temeljni element procjene ekološke vrijednosti proizvoda bila bi detaljna analiza trajnosti proizvoda, a važan bi kriterij pritom bio i sadržaj štetnih organskih spojeva.

Ipak, još je rano za predviđati nestanak boja na bazi organskih otapala. Većina vodotopljivih sredstava još sadrži manje količine hlapljivih organskih spojeva. I vodotopljive boje i boje na bazi organskih otapala neprestano se razvijaju.

Vodotopljive su boje najčešće boje za zidove, sredstva za ličenje stolarije, fasadne boje, te drvni premazi za vanjsku upotrebu.

Premazi za stolariju koji se upotrebljavaju za unutrašnja vrata, okvire, podove itd. obično su alkidni sustavi na bazi organskih otapala. Posljednjih nekoliko godina razvijeni su vodotopljivi premazi poboljšanih svojstava glede razlijevanja i sjaja, no kakvoća tih proizvoda još zaostaje za onima na bazi organskih otapala. Zahtjev za sjajnim premazom visoke kakvoće trenutno se može potpuno zadovoljiti samo proizvodima na bazi organskih otapala.

Dobra otpornost prema vremenskim utjecajima i visoka elastičnost termoplastičnih vodotopljivih polimera poput akrilata daju vodotopljivim premazima posebne prednosti za primjenu na drvu u vanjskim uvjetima. Nedostaci s obzirom na razlijevanje i izgled imaju manju važnost. Sjaj je zadovoljavajući, a trajnost sjaja i boje mogu biti i bolji nego u alkidnih premaza. Nedostatak im je nemogućnost uporabe u kombinaciji sa staklarskim kitom na bazi lanenog ulja.

Prvi vodotopljivi premazi koji su se počeli primjenjivati za drvo u vanjskim uvjetima temeljni su drvni

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Članak je objavljen u časopisu "Architects Journal" (br 7/1992), a donosimo ga zbog sve češće primjene i zanimanja potrošača za površinsku obradu ugrađenog drva vodotopljivim premazima.

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premazi. Početni nedostaci tih premaza, poput slabe adhezije u vlažnim uvjetima i velike propusnosti vlage, uglavnom su uspješno riješeni. Ako ti proizvodi zadovoljavaju propisane specifikacije, osiguravaju djelotvornu zaštitu drva za vrijeme gradnje i dobra su podloga za bilo koji sustav površinske obrade. Vodotopljivi završni premazi rjede se upotrebljavaju iako su iskustva u radu s njima vrlo dobra. U istraživanjima otpornosti prema vremenskim utjecajima ti su premazi pokazali dobra svojstva koja su, u usporedbi s alkidnim premazima, predočena u tablici 1. Usporedna istraživanja postupka održavanja i obnavljanja površina obrađenih vodotopljivim premazima i premazima na bazi organskih otapala potvrdila su da vodotopljivi premazi imaju bolja svojstva.

Malo veća propusnost vodotopljivih premaza glede vlage u određenim okolnostima može uzrokovati specifične probleme koji se trenutno istražuju.

Continuing developments in water-borne paints have widened their market share against the potentially more hazardous solvent-based paints. Roy Miller explains why.

Water-borne paints now account for two-thirds of western- European paint production. Compared with solvent-borne paints, they have many advantages - notably rapid drying, low odour, clean-up using water, and tolerance to damp surfaces. They are, however, not ideal in wet and cold conditions and have poor early shower resistance. But they offer a good balance of performance characteristics which are subject to continuous improvement.

Health and environmental aspects

The use of water-borne paints has increased with the growing recognition of their technical merits, and has recently received fresh stimulus from increasing concern over the potential environmental hazards of solvent-borne paints, which may adversely affect the health of painters and occupants of buildings, and which contribute in a major way to the burden of volatile organic compounds (VOCs) in the atmosphere.

VOCs are materials capable of reacting in sunlight with other pollutants, principally oxides of nitrogen, to produce ozone and other photochemical oxidants, which are recognised as presenting health hazards and are damaging to trees and other vegetation.

The Building Research Establishment (BRE) recently investigated the health and safety aspects of solvents on behalf of the Property Services Agency (PSA). It has long been appreciated that solvent exposure is a potential health hazard, and the importance of ensuring good ventilation during painting operations is well recognised. Occupational exposure limits (OELs) for white spirit and other solvents are laid down by the Health and Safety Executive. [1] The long-term exposure limit (LTEL) for time-weighted average exposure (TWA) is 100 ppm (parts per million), and the short-term exposure limit (STEL) for any given 10-minute period is 126 ppm. However, information has been lacking on the actual levels of solvent vapour which are likely to be generated during typical wall-painting operations. BRE wanted to establish the levels of solvent vapour produced by white spirit-based paints during indoor painting. The exposure of a painter to solvent was measured using personal sampling and a portable infra-red analyser, in different combinations of the following:

. ventilation
. area painted
. temperature.

The trials showed that although solvent exposure levels may be below the limit when small areas of surface are being painted in well-ventilated conditions, painting large wall areas constitutes a significant health hazard. When the walls of a test office of 31 m^2 were painted under unventilated conditions, the STEL was exceeded after about 10 minutes and concentrations approaching six times the limit were reached before the painting was finished. Smaller areas generated lower peak values; but in unventilated conditions the STEL was still exceeded after painting an area of about 15 m^2, and even an aera of 2 m^2 might present a hazard.

Natural or forced ventilation reduced the potential hazard, but as many as seven to 11 air changes per hour were not sufficient to produce safe working conditions.

The findings of this work have been incorporated into a PSA technical memorandum. This requires that whenever possible, water-borne (emulsion) paints be specified for interior decoration of walls, ceilings, and other large areas. Where sound technical reasons exist for the use of a solvent-borne paint, natural or forced ventilation capable of reducing the solvent vapour concentration below the OEL must be ensured, or personal protective equipment provided.

A subsequent study conducted by the Paint Research Association (PRA) compared solvent-borne and water-borne interior building paints in terms of safety during application, performance and cost. This showed that when applied in unventilated conditions, water-borne paints were consistently below the OELs, whereas solvent-borne paints generally produced solvent levels in excess of the OEL. However, one solvent-borne paint containing isoparaffinic solvent, which was free from aromatic constituents, generated solvent levels below the OEL.

Since this study the Paintmakers Association, the National Federation of Painting and Decorating Contractors, and the Union of construction and Allied Trades and Technicians have published a tripartite statement of intent which lays particular emphasis on the substitution, wherever possible, of solvent-borne products by water-borne alternatives. [3]

Legislation and the EC dimension

Health and safety issues relating to solvents are covered by the COSHH Regulations 1988, which re-

quire employers to protect the long-term health of operatives by ensuring that exposure limits are not exceeded. This may necessitate checking or monitoring of solvent vapour levels to ensure that ventilation arrangements are adequate, and possibly the provision of personal protective equipment for the operator.

The task of reducing VOC emissions is being addressed within the European Commission. Strict environmental controls have been or are being introduced into the UK and other European countries aimed at drastically reducing the emission into the atmosphere of VOCs during both the production and use of paints and surface coatings, which account for over 40 per cent of the contribution to VOC emissions from solvent sources. The Environmental Protection Act has set the framework for controlling industrial emissions by setting emission limits and control standards. Where processes exceed the designated limits it will be necessary to install methods of arrestment, for example, adsorption or incineration, or change to an alternative coating, for example, water-borne, solvent-free or powder coating.

Performance of solvent-and water-borne paints on exterior wood **Table I:**

Property	solvent-borne	water-borne
adhesion	good over well-prepared surfaces	good over well-prepared surfaces.
long-term extensibility	moderate	good
flow	good	moderate
gloss levels[1]	high	moderate
colour stability	moderate	good
moisture permeability	low to moderate	moderate to high
maintenance interval	4-6 years	5-8 years
redecoration procedure	moderate good	easy moderate
tolerance to adverse weather during application	good	moderate
blocking resistance[2]	good	moderate

[1]low-gloss level finishes are available in all paint types
[2]self-adhesion between contacting surfaces

Emissions from household and building paints are more difficult to control, but consideration within the EC is being given to an eco-labelling scheme for paints. This would provide authoritative guidance to users who wish to choose products for environmental reasons and encourage the proliferation of more environmentally-benign products. A key element of the assessment of a product's environmental impact will be a full life-cycle analysis or "cradle-to-grave" approach. An important criterion in any eco-labelling scheme will be a limit on VOC content.

However, it is too early as yet to assume the demise of solvent-borne coatings. Most water-borne paints still contain small amounts of VOCs as co-solvents. A recent study reported that, when all aspects of the product life-cycle are considered, the environmental impact of solvent-borne and water-borne trim (see below) paints are not significantly different. Developments in both types of product continue. Coalescent-free formulations have been introduced for some types of emulsion paint, and efforts are being made to improve solvent-borne paints by formulating them with lower VOC content and more environment-friendly solvents, for example, the isoparaffinics examined in the PRA trial.

Performance must be considered carefully. Although the principal objective of any eco-labelling scheme will be to limit environment-damaging substances, products gaining the award will have to meet acceptable performance standards, since poor appearance or performance would be counter- productive by causing consumption of additional material. In addition, water-borne paints are still in some ways inferior to their solvent-borne counterparts, notably in their flow, appearance and tolerance of adverse climatic conditions.

Water-borne applications

The principal applications for which water-borne paints can be considered are wall paints, trim paints, masonry paints and exterior coatings for wood.

Wall paints

Water-borne emulsion paints have long been the normal choice for interior walls, and the evident risks from using solvent- borne eggshell paints in this application mean that such products can in future only be used where there is a requirement for high resistance to wear and cleaning. The indications already are that some of the relatively new acrylic eggshell paints are equivalent in application properties and wear resistance to the solvent-borne products.

The selection of emulsion paints should soon be made easier for the specifier by the introduction of a new British Standard (BS) specification which is in the final stages of completion. It brings together requirements for three different qualities of emulsion paint and includes a high wear and moisture resistant classification.

Trim paints

Trim paints for use on interior doors, frames, skritings and so on, have traditionally been finished in a conventional solvent-borne alkyd paint system.

A BS specification for undercoat and gloss paint is due to circulate for public comment. It is intended to

cover the conventional system having a high-gloss appearance and suitability for both interior and exterior applications. However, advances in technology may produce water-borne systems which can conform with the specification.

Advances in the technologies of water-borne paints during the last few years have led to products with improved flow and gloss properties but the quality of finish still generally falls short of that achievable with the traditional finish. The requirement for a high-quality gloss finish can only at present be fulfilled by solvent-borne products.

Masonry paints

The exterior masonry paint market is predominantly served by emulsion paints which are available in a range of surface appearances and compositions. A life of three to seven years is expected, though 10 years may be achieved by the better systems. Masonry paints of the solvent-borne type, mostly based on Pliolite resin, remain available; their particular attraction is their ability to dry more quickly in cold and damp conditions, and thereby provide resistance against early showers. They are accordingly invaluable in year-round painting. No standards for masonry paints currently exist but work is in progress within a working group of the European Standards Committee CEN TC139.

Paints for exterior wood

On wood substrates the good weather-resistance and especially high extensibility of the water-borne thermoplastic polymers such as acrylics used in water-borne paints are especially advantageous, and shortcomings in flow and appearance are generally of less consequence. Gloss levels are adequate, and gloss and colour retention can be better than those of alkyds. However, the incompatibility of water-borne paints with fresh linseed oil putty is inconvenient.

Wood primers were one of the first applications of water-borne coatings on wood and are now well established. Technical solutions have been found to early problems of poor adhesion under wet conditions and high moisture permeability, though BRE evaluations of industrial wood primers reported in IP 17/87 revealed some unsatisfactory primers having too high a level of moisture permeability which permitted wood splitting. Experience shows that products conforming to the performance specification for water-borne wood primers, BS 5082, provide effective protection for components during construction and a sound foundation for any paint system.

Water-borne finishing paints have been used to a lesser extent, though experience has generally been good. One factory-applied, semi-gloss system for joinery has been found to maintain its integrity for over 10 years, and in BRE trials has performed outstandingly well. In one trial on windows, in a BRE test building, this system is only now beginning to show minor signs of breakdown after 20 years.

A similar order of performance is difficult to obtain from water-borne paints designed for site application. Nevertheless, such paints possess an attractive combination of properties (Table I) and in BRE outdoor weathering trials performance has been consistently good when contrasted with solvent-borne alkyd paints of both conventional and newer exterior quality.

On new works, acrylic and alkyd-acrylic hybrid paints can be expected to maintain their integrity for more than five years. Water-borne paints have also been shown to have the tolerance required for maintenance work. Comparative BRE maintenance trials on solvent- and water-borne paints showed that the performance of both was poorer on previously painted work but that overall the water-borne paints performed better.[5]

The performance of some products has been exceptional. This is considered to have been due principally to the better flexibility of the water-borne systems. Little importance is attached to the "microporosity" or higher moisture permeability claimed for some products, and indeed recent debate over reports from Scandinavia of problems of premature decay in cladding painted with water-borne paints suggests that higher permeability could, under some circumstances, have specific disadvantages. Similar problems have not been encountered in practice in the UK, possibly due to the requirements for a high standard of preservative treatment for wood cladding, but the problem is currently being investigated.

REFERENCES

[1] HSE Guidance Note EH 40/92
[2] Safe use of solvent-borne paints, PSA Technical Memorandum No 2/90
[3] An information pack on this is available from The Paintmakers Association
[4] Study Laboratory of the Government Chemist
[5] BRE Information Paper 16/87

Other useful sources of information

BRE digests
Digest 354 Painting exterior wood
Digest 197 Painting walls - Part 1
Choice of paint
Digest 198 Painting walls - Part 2
Failures and remedies

BRE information papers
IP3/92 - Solvent vapour hazards during painting
IP 2/92 - Factory-applied stain basecoats for exterior joinery
IP 10/90 - The use of fungicidal paints to control mould growth
IP20/87 - External joinery end grain sealers and moisture control
IP17/87 - Factory-applied priming paints exterior joinery
IP12/85 - Water-borne paints for exterior wood
IP22/79 - Difficulties in painting Fletton Bricks

British Standards
BS 5082: 1986 Water-borne priming paints for woodwork. BSI, London, 1986
BS 5358 1986 Solvent-borne priming paints for woodwork. BSI, London, 1986.