

Waterborne coatings

Introduction

Waterborne paints may be considered as alternative to solvent borne products where there is a desire to reduce emissions of solvent. Protective coating systems based on waterborne products can offer similar corrosion protection as solvent borne systems. The waterborne paints will, after drying and curing, provide corrosion protection by the same principles as solvent-borne paints: by the barrier effect, the inhibitor effect and/or galvanic effect.

The drying and/or curing mechanism will depend on the generic type and it may deviate from solvent borne coatings in other ways than just being dissolved in water instead of solvent. This guideline describes important points and limitations to be aware of when using waterborne coatings.

Safety

Use adequate personal safety equipment and follow sound procedures. Apply only in well-ventilated areas. Observe safety labels on packaging and paint containers and consult Hempel's Safety Data Sheets for the products to be applied.

Scope

This Hempel Technical Guideline includes application instructions for Hempel's waterborne protective products. These products can be divided into 3 families depending on the binder type

- Hemucryl (1-component acrylics)
- Hemuthane (2-component polyurethanes)
- Hemudur (2 component epoxies)

Also relevant is HEMUCRYL BRUSH AGENT 99810. See separate PDS.

For additional advice see also Hempel's Technical Guidelines available at <https://www.hempel.com/service-and-support/technical-guidelines>:

- Substrates
- Surface preparation
- Application

General characteristics of water-based paints

General chemistry – Dispersions

Waterborne paints are based on binders dispersed in water called dispersions. Dispersions consist of tiny (colloid 0.1 - 1 µm) particles of binder components dispersed in water.

Dispersion paints dry as the water evaporates causing the tiny polymer particles to melt together gradually forming the final paint film in a process called coalescing.

To achieve this film formation a coalescing agent is often added. The coalescing agent is a solvent - normally with lower volatility than water. It softens the binder particles, enabling them to fuse into a continuous film. For this reason, water borne does not mean solvent free. Check the water borne paints VOC on the datasheet for more detail.

The drying mechanism is as follows:

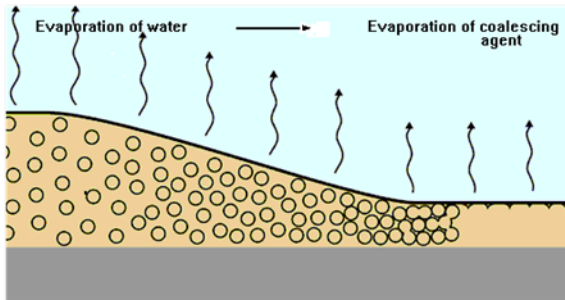
The water evaporates and the particles will pack together, the concentration of the coalescing agent increases and at a certain point the polymer particles fuses into a coherent paint film. Finally, the coalescing agent will also evaporate.

If the particles are relatively soft by themselves, they will after packing collapse to form the final paint film (without the need of the coalescing agent) – this is mainly a principle used for decorative paints.

Besides the dispersion of binder, the paints may contain pigment, fillers and additives in the same manner as solvent borne products.

Dispersions of acrylics

Dispersions of acrylic are based on large macro molecules (polymers) that during film formation entangles to create a coherent resistant and protective film. No chemical reactions takes place.



Other generic waterborne coating types will have to react further to obtain the desired properties:

Dispersions of epoxy or polyurethane

Dispersions of epoxy or polyurethane are 2-component and will cure chemically similarly to traditional solvent-borne epoxy or polyurethane coatings. Base resin and curing agent are present in separate dispersion particles in the mixed paint. After evaporation of water the 2 components will become mixed due to coalescence and the curing reactions takes place.

Flash rust:

Steel corrodes in contact with water and oxygen (air):

Steel + Water + Oxygen (air) → **Corrosion**

So, how is it possible to use waterborne coatings for corrosion protection? This is possible because the waterborne primers for corrosion protection contain inhibitors that prevent flash rusting for a limited time, while the paint is wet on the steel substrate.

Surface preparation (applicable to primers and DTM only)

For general advise on surface preparation see various Hempel Technical Guidelines for surface preparation <https://www.hempel.com/service-and-support/technical-guidelines>.

A surface profile corresponding to ISO comparator Fine (G) is preferred. Higher roughness Medium (G) may result in “popping” in the first layer. This can be compensated by applying a very thin coat (mist coat) of the first coating in the system.

Application

Good painting practises

The durability and performance of waterborne coatings depends, to a very high degree, on the following good painting practice. For instance, application to riveted and skip-welded constructions will require extra care when coating sharp edges, riveted joints, etc. Avoid too high thicknesses per coat. Preferably apply an extra stripe coat.

When applying and drying waterborne products it is important that the temperature of the paint and the substrate is above the Minimum Film Forming Temperature (MFFT) at which the paint can form a coherent film. Please observe the climate conditions defined in the PDS. For most acrylic paints, this minimum temperature is 10°C/50°F.

As the film formation depends on the evaporation of the water, it is very important that humidity is controlled. The temperature of the substrate must be at least 3°C/5°F above the dew point to avoid condensation, and the relative humidity should be below 80%, preferably between 40-60% . If the relative humidity is above 80% or if the temperature of the substrate is below the dew point, the coalescing agents may evaporate before the water, and the binder particles will therefore not melt together. The result will be a porous film with poor cohesion and without the expected colour and gloss.

Stirring / Mixing

Proper stirring/mixing is mandatory as well as keeping the right mixing ratio.

Waterborne products have a high tendency of foam stabilisation, therefore excessive stirring speed/time should be avoided.

Application methods:

Most of Hempel's waterborne paints can be applied by airless spraying. For regular application of water borne products it is recommended to use equipment made of stainless steel to avoid corrosion. Recommended nozzle size and pressure are mentioned in the product data sheet for each product.

The waterborne epoxy and polyurethane and some acrylics can also be applied by conventional air spray. It is recommended to use a nozzle size of around 1.6 mm.

When applying especially the acrylic paints by brush/roller, it can often be difficult to achieve the specified thickness. These paints do not have a good drag resistance or "body" so the applied wet film thickness is normally low. Addition of HEMUCRYL BRUSH AGENT 99810 will increase the "body" of the paint thereby improving the application properties by brush and roller and enabling the application of a higher wet film thickness.

"Edge" effect:

Furthermore, as waterborne paints have a high tendency to "withdraw" from sharp edges, etc., proper corrosion protection will be highly supported by careful rounding of edges and that any joints are completely closed and tight. If it is not possible to round the edges, applying additional edge protection can be a useful addition to the coating system.

DFT of waterborne coatings

- Avoid excessive film thickness
- Maximum DFT in one layer according to PDS (general rules of triple DFT according to ISO 12944 are not valid for waterborne paints)

Excessive DFTs could lead to film formation problems like cracking, wrinkling, soft films and water retention.

Exposure to low temperatures shortly after application:

In case the painted items are to be exposed to humidity/water at temperatures below 5-10°C/41-50°F shortly after finishing the paint application, it is of utmost importance, for later good performance, that the following precautions are followed:

- "Rule of thumb": The (last applied) paint layer must dry for at least 6 hours at 20°C/68°F - 40-60% RH, 12 hours at 10°C/50°F – 40-60% RH before exposure to temperatures below 5°C/41°F and/or condensation/water exposure.
Note: deviations from the indicated Film thicknesses and/or climate conditions stated in the PDS have a direct influence in the drying times.
- Avoid outdoor application in seasons with low night temperatures, frost and frost in combination with condensation or rain.
- Storage of painted constructions: avoid immersion in water conditions before fully dried.
- Check water resistance/progress of drying before outdoor exposure by rubbing the surface with water-soaked clothes and no paint residue is observed after 50 rubs

Cleaning of tools

After using waterborne paints:

1. Tools must be cleaned immediately with lukewarm soap water and/or fresh water followed by thoroughly rinsing to remove residues of detergent.

After using solvent-borne paints or after a long period without using the equipment:

1. Remove all filters from filter-houses (pumps/filter stations).
2. Flush by recirculating the system for 5min with a suitable solvent (HEMPEL'S Thinner 08450/08080)
3. Flush the system with Hempel's Cleaner 98701 for 5 min.
4. Flush the system with water / Hempel's Cleaner 98701 mixture (4:1) for 5min.
5. Final flush of the system with water for 5min.
6. Check all filter-houses, clean manually and insert new filters.

After using waterborne and before using solvent-borne paints:

1. Remove all filters from filter-houses (pumps/filter stations)
2. Flush by recirculating the system for 5min with water.
3. Flush the system with water / Hempel's Cleaner 98701 mixture (4:1) for 5min.
4. Flush the system with Hempel's Cleaner 98701 for 5min.
5. Final flush of the system for 5min with a suitable solvent (HEMPEL'S Thinner 08450/ 08080).
6. Check all filter-houses, clean manually and insert new filters.

After using one waterborne and before using another type of waterborne paint:

1. Flush by recirculating the system for 5min with water.
2. Flush the system with water / Hempel's Cleaner 98701 mixture (4:1) for 5min.
3. Final flush of the system with water for 5min.
4. Check all filter-houses, clean manually and insert new filters if needed.

Adhesion and wetting properties

Water has a high surface tension compared to solvents. Normally this makes the waterborne paints more critical in wetting of the substrate.

Therefore, waterborne coatings should normally neither be used as primers on marginally prepared surfaces (St 2, St 3 or WJ 1-4), nor used on top of aged alkyds or cured epoxy or polyurethane without roughening.

When waterborne coatings are used on porous substrates such as concrete or wood, special sealers, preferably based on a micro-dispersed binder, should be used as primer/sealer.

Colour

It is important to know that there may be a considerable colour difference between the wet and dry paint. The reason for this is again the binder. The binder as dispersion is whitish and makes the colour of the wet paint appear lighter, but when the water evaporates the binder becomes transparent and the coating will obtain the intended colour.

The applied and cured film of waterborne acrylic paints will usually have a gloss and colour retention superior to their solvent-borne cousins, mainly due to the binders of higher molecular weight.

Pot life of two-component products

It is very important to note that some waterborne two-component epoxy products may behave completely differently to solvent-borne coatings at the end of the pot life.

Where the viscosity of solvent-borne products normally increases to a level, where the paint cannot be used, the viscosity of waterborne coatings may remain unaffected.

The problem with no visible or otherwise clear end of pot life for 2 component waterborne coatings introduces a risk of paint failures and lower product performance. To reduce this risk the following is recommended:

1. Write down the time of mixing
2. Measure the temperature of the paint.
3. Use Product Data Sheet to assess the pot life at the measured temperature
4. Set an alarm clock to warn when pot life is exceeded
5. Discard the remaining paint at the end of the pot life.

The advice about pot life provided by the Product Data Sheet must be followed, as the pot life for some products becomes longer when temperature decreases, but for other products may become shorter – in contrast to solvent-borne two-component products. Consult the Product Data Sheet.

Shelf-life and storage

Store at temperatures between 5°C and 35°C. The shelf life is reduced at temperatures above 35°C. Do not expose to frost during storage, transportation and drying. Temperatures below 0°C can lead to irreversible damage to the product even after a later temperature increase.

The general recommendation regarding storage is to keep the paint sheltered from sunlight and rain and preferably at a temperature between 15°C/59°F and 30°C/86°F.

This document is intended for professional use and provides generic advice in respect of the subject matter only. It is not intended to be used as a comprehensive guide. The buyer/applicator should always read the relevant Product Data Sheet ("PDS") and Safety Data Sheet ("SDS") relating to the Products ordered which are available for download on www.hempel.com. If in doubt, please contact your local Hempel representative for further advice. To the extent relevant, the disclaimer set out in the relevant PDS(s) applies to this document.