

WATERBORNE OR HIGH SOLID?

Step-by-step to the ideal coating system

Many coating companies are now facing the task of converting to a low-solvent or solvent-free coating system. In many cases, waterborne coatings or high solids are alternatives to choose from. This report presents criteria for selecting the most suitable coating in each case.

There are various approaches for reducing solvent emissions in coating processes. One possibility is to convert to low-solvent coating systems such as waterborne coatings or high solids. But various factors need to be considered when converting a coating system. The following discussion of various criteria and a comparison of the properties of the two coating systems waterborne coatings and high solid coatings are aimed at offering help in choosing the right system.

Reducing the amount of solvent

An important point is the amount of solvent that needs to be reduced in order to meet the required limit values, as not every system is able to reduce the same amount of solvent. A conversion to waterborne coatings allows a large amount of solvent to be saved. As the coating already contains water as a solvent, it can also be thinned with water and water can be used to clean the spraying equipment.

A conversion to high solid systems does not usually save as much solvent as the use of waterborne coatings. Nevertheless, it is possible to achieve reductions that are sufficient to comply with the required limit values.

Modifications to the coating line

In most cases, the conversion from a solvent-based coating to a waterborne coating makes it necessary to modify the existing coating line. For the spraying of waterborne coatings, it is absolutely essential that all parts of the paint supply or spraying system that are in contact with the coating are made of stainless steel or a suitable plastic material.

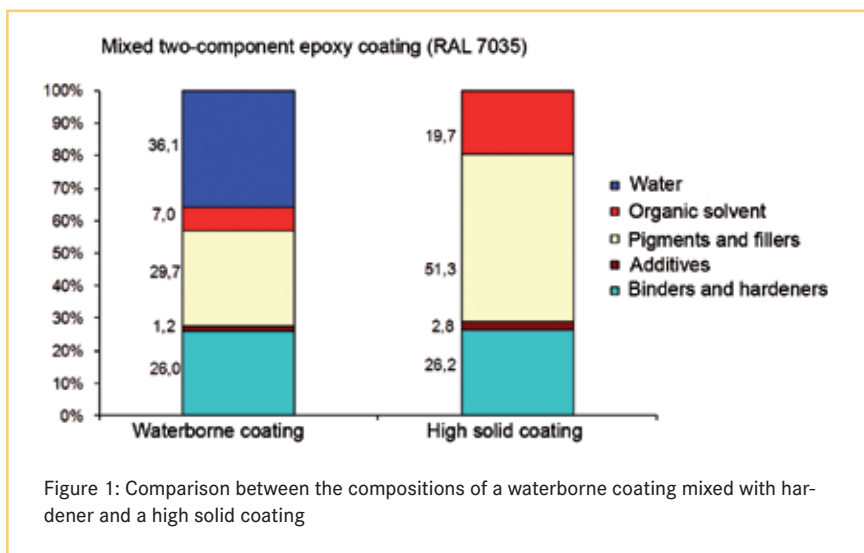
If electrostatic (ESTA) spraying is required, the paint supply system must be insulated without any contact to ground to ensure that the necessary electric voltage can be generated. Due to

the waterborne coating, this voltage is present throughout the entire paint supply system, which means that it must be installed in such a way that it is protected against any access. Some minor modifications to the application technology may also be necessary, for example the spray guns, nozzles or hoses.

In most cases, conversion to a high solid material does not require major modifications to the spraying line. Usually, the coating material can be sprayed using the existing coating line. However, some modifications to the application equipment may be required. If a paint supply system is available, the pumps should be examined to ensure that they are suitable for pumping high solid material.

Different drying properties

In waterborne coatings, water is used as a solvent. This water must be able to



escape during the drying process and reacts according to its physical properties. As the properties of water are much different from those of solvents, longer ventilation and drying times during or after the spraying of waterborne coatings need to be taken into consideration. In many cases, these longer periods result in problems in cycle-based or continuous flow systems. A possible solution is the additional use of cold dryers or IR dryers, although these involve additional costs and additional space requirements. Drying can also be promoted by a continuous flow of air ($> 0.5 \text{ m/s}$) over the wet coating film. This allows the air that is saturated with water vapour to be carried away and the coating dries more quickly.

In a high solid coating, there is still an evaporation of solvent during the drying process. As there has only been a change in quantity compared to conventional coating systems, no modifications or only minor modifications to the coating line or the drying process are usually necessary. However, one must make sure that the drying or the hardness of the coating are sufficient after the process, as different binders are often used in high solid coatings.

Pretreatment of the workpieces

Adhesion to the substrate is a fundamental prerequisite for the durability of coatings. The surfaces of the workpieces to be coated must be clean, free of grease and wettable. If a waterborne coating is used, one must make sure that the substrate is wetted by water. All dirt and especially grease and oil from previous processes must be removed from the surface of the workpiece. In order to guarantee this, the installation of cleaning equipment (cycle or continuous flow

	Waterborne coating		High solid coating	
Substrate	Steel sheet		Steel sheet	
Pretreatment	Blasted	Iron phosphated	Blasted	Iron phosphated
Primer	Two-component epoxy primer		Two-component epoxy primer	
Topcoat	Two-component PU topcoat		Two-component PU topcoat	
Overall dry film thickness in μm	120 - 140	125 - 140	120 - 135	115 - 125
Degree of blistering – surface	0 (S0)	0 (S0)	0 (S0)	0 (S0)
Degree of blistering – edge	0 (S0)	0 (S0)	0 (S0)	0 (S0)
Degree of corrosion – surface	Ri 0	Ri 0	Ri 0	Ri 0
Degree of corrosion – edge	Ri 1	Ri 0	Ri 1	Ri 0
Corrosion creep at the cut line	d 2,5	d 2,5	d 2	d 2

Table 1: Results of an open-air weathering test with a salt spray for a waterborne and a high solid epoxy PUR coating system on a blasted and iron phosphated substrate

line) for the intensive cleaning and/or pretreatment is often necessary.

For high solids too, the substrate must be clean, grease-free and wettable – but in this case it must be wettable by solvent. As the previously used conventional coating material already contained solvent, the previously used cleaning processes are usually sufficient to ensure good adhesion of the high solid coating to the substrate.

Training process during application

The usual personal protective equipment is required for the application and processing of waterborne coatings. Waterborne coatings can be sprayed using all common spraying processes, such as high-pressure, HVLP, airless and ESTA systems. A necessary requirement, and one that should not be underestimated, is the consideration of the training period for the coating personnel, as these have to become accustomed to the new coating system. During this initial period, for example when spraying PUR systems, a certain amount of self-monitoring by the coating personnel with regard to the applied film thickness is absolutely essential in order to avoid blistering due to excessively high film thicknesses.

The use of personal protective equipment is also necessary when spraying high solid coatings. The material can also be applied using all common coating systems and a training period for the coating personnel should be planned. Due to the higher solid content, excessively high film thicknesses are often applied, which is reflected in a higher material consumption. Therefore, in this case too, self-monitoring by the coating personnel is necessary.

Temperature-sensitive waterborne coatings

Less stringent safety requirements need to be complied with for the transport and storage of waterborne coatings than for solvent-based systems, for example with regard to flammability. However, one property of waterborne coatings that must be taken into consideration is their temperature sensitivity, which often requires the use of temperature-controlled transport, especially in winter. In summer too, excessively high temperatures can result in a destabilisation of the binder dispersion. Therefore, a storage and transport temperature of between $+5^\circ\text{C}$ and $+30^\circ\text{C}$ should be maintained.

For the transport and storage of high solids, the same safety requirements as

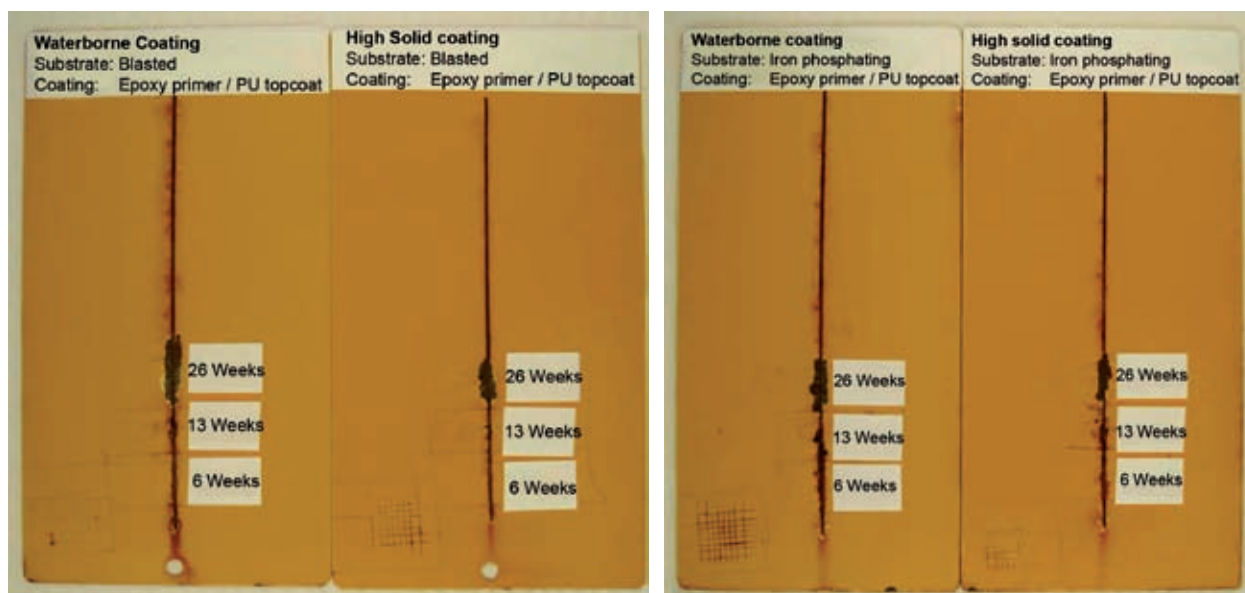


Figure 2: Comparable results between waterborne and high solid coatings on both the iron phosphated (left) and the blasted (right) steel substrate

for conventional coating systems usually apply. Although these coatings are not sensitive to frost at 0 °C, they should nevertheless not be stored at temperatures significantly below 0 °C.

Recycling coatings makes sense

Although waterborne coatings emit much less VOC (volatile organic compounds), they are not always environmentally unproblematic. Due to the additives used in waterborne coatings and their hydrophilic nature, they can damage organisms if released into open water.

Cleaning water can be removed from the coating material by using suitable coagulating agents. The coating sludge produced from two-component waterborne coatings must be disposed of as special waste as it cannot be thermally recycled due to its high water content. A clear advantage of water-soluble one-component systems is that the coating sludge can in some cases be recycled after ultrafiltration and added to fresh coating material. Recycling makes sense when there is no colour change and a high coating throughput rate. In this case, the additional costs of purchasing

and operating the filtration system must be taken into account.

Contaminated solvent that was used for cleaning purposes in the processing of high solid systems can be regenerated by distillation and be reused. VOC-free solvent (dibasic ester) can also be used for cleaning the coating line. Coating sludge, for example from distillation, can be thermally recycled.

Not completely solvent-free

In order to optimise various properties, such as substrate wetting, surface drying or flow characteristics, even modern waterborne coatings contain a certain amount of organic solvents, although only a small amount. Depending on the system, this amount can be between <1 % and approximately 10 %. High solid coatings still have a solvent content of up to 35 % in sprayable form. At FreiLacke, coating systems with a solvent content of <15 % are called ultra high solid coatings. In order to positively influence the VOC balance of a high solid coating, it contains a much higher proportion of pigments and fillers. To ensure a sprayable viscosity in spite of the low solvent

content of approximately 20 %, the use of low viscosity and high solid binders is necessary, Figure 1.

Resistant to corrosion

Corrosion resistance also plays an important role in the selection of a coating system. In tests, waterborne coatings and high solid coatings exhibited comparable results. For example, the coating systems were subjected to the SCAB test, an open-air weathering test used for example at Volvo. The test objects were sprayed three times a week with a 5 % salt solution in order to achieve accelerated corrosion of the steel substrate.

With the same dry film thickness, no blisters were observed on the surface or the edges in an evaluation after 26 weeks, Table 1. The waterborne coating and the high solid coating showed no differences in corrosion creep at the cut line, Figure 2.

The authors:

Edgar Romey, Andreas Morlock, Development and Application Technology, Liquid Coatings, Emil Frei GmbH & Co.KG, Döggingen, Germany, Tel. +49 7707 151-314, e.romey@freilacke.de, www.freilacke.de