Figure 1 shows the kinetics of the process. The stage of the pH value was regularly measured. Graph a in low speed in the dissolver. In order to monitor the dispersion stage, the addition of an inhibitor at the dispersion stage.

Trials have shown, however, that the desired effect cannot be achieved through stabilisation with polymer additives: the flake surface may be well stabilised, but the zinc flake then loses its most important metal property, its activity as a sacrificial anode and thus its corrosion protection properties in the coating.

The use of an inhibitor to prevent emission of hydrogen during the dispersion stage, achieves both results at the same time: storage stability is improved and corrosion protection properties of the coating are maintained.

The best inhibitor for this purpose has been found to be 1-nitropropane, a volatile organic nitro compound which inhibits the formation of hydrogen. During curing, it flashes off with other volatile components from the film without affecting the cathodic protection. Experiments which confirm the value of this additive are described below.

A medium oil alkyd resin emulsion supplied as a 40% by weight solution of the polymer in water (acid number: 20 mg KOH/g, viscosity: ca 930 mPa s, pH value: 7.2) was used as binder. Two zinc pigments with different particle shapes were used: "Super Fein" zinc dust and "TV" zinc flake. Their characteristics are summarised in Table 1.

The idea of using two different zinc pigments in combination is based on previous observations with inorganic zinc flake/zinc dust in ethyl silicate coatings, which have shown that the combination leads to good cathodic protection and a barrier effect [4, 5]. The "TV" zinc flake produced by Eckart is a product with coarser particles, a smaller specific surface area and less reactivity than other types of zinc flake. All components were added to the millbase (as shown in Table 2) according to the guide formulation and dispersed at elevated temperatures of 30-40°C; a soft, stirrable sediment; a constant pH value; good appearance of the coatings: smooth and faultless surface; the original properties of the coatings, including corrosion protection, are maintained.

Good storage stability for a paint of this type means:
- No formation of hydrogen or other chemical reactions during storage of the paint at room temperature, or at elevated temperatures of 30-40°C;
- A constant pH value;
- A soft, stirrable sediment;
- Good appearance of the coatings: smooth and faultless surface;
- The original properties of the coatings, including corrosion protection, are maintained.

Two methods were used to investigate the storage stability of the paint. Quantitative measurement of the hydrogen formed at 25°C, as described above, showed that some 10 to 12 hours after preparation the primer without inhibitor had already emitted more than 30 ml of hydrogen from 120 g of paint. In contrast, the guide formulation paint displayed good stability: during storage, and over a period of more than 125 days, no emission of hydrogen was observed at all.

Visual observation of the formation of hydrogen was also obtained by noting the degree of delamination (%) of "Scotch" adhesive tape sealing a hole in the lid of the paint.
container, and of the behaviour of the material in a closed container at room temperature, 30°C and 40°C.

The practical significance of this method is the fact that this determines the storage stability of the paint in its sealed container - an important requirement for single-pack formulations. A closed glass container and the typical filling (70%) for zinc-containing materials allowed the behaviour of the paint in the can to be studied.

The tape delamination test readily showed the differences in storage stability. Without inhibitor the system is not stable: after one day the tape delamination had risen to 100%.

In the container a vigorous reaction with the formation of bubbles between the zinc and polymer was observed.

The paint with the guide formulation remained stable for a period of 75 days at room temperature. No changes to the zinc surface or the polymer were detectable. After 75 days this primer was stirred and applied. Due to the large particle size, the sedimentation of the zinc flakes was of a soft consistency and could be easily stirred in.

This paint also provided no indications of the formation of hydrogen during storage over a period of 95 days at 30°C. After this period, the paint was once again smoothly stirred and used for coating.

Storage of the guide formulation paint at 40°C, however, showed that this system is not sufficiently stable: after five days several bubbles were produced on the zinc surface.

The formation of a white polymer layer on the surface of the zinc gradually followed. Although it was not possible to measure the formation of any hydrogen, the trial was cancelled due to the changes in the container after 20 days and the paint was not used.

Figure 2 shows the kinetics of the formation of rust on the scratch (in %) relative to the duration of the salt spray test on the coatings. The test compares the coatings: four hours after preparation of the paint after storage of the paint at room temperature over a period of 75 days or at 30°C over a period of 95 days respectively.

The scratch was evaluated daily under the microscope and subsequently the kinetics of the formation of rust monitored. As can be seen from Figure 2, the original coatings (stored for only four hours) also showed no formation of rust on the scratch after approximately 600 hours of the salt spray test. With the coatings which were prepared after storage of the primer over a period of 75 days at room temperature, 5% rust was found on the scratch after 400 hours' salt spray test. This is also a positive result. Deterioration in corrosion protection, namely 15% rust after 240 hours of the salt spray test, was observed for the coatings after storage over a period of 95 days at 30°C.

These results demonstrate that it is possible to maintain the corrosion protection of paint coats after the storage of the paint at room temperature and at 30°C. Investigations are continuing on these aspects.

Figure 3 shows cross-sections of the paint coats (applied 4 hours after preparation) without (a) and after the salt spray test over 600 hours (b).

As can be seen from Figure 3a, the coating was densely packed and the zinc particles had good contact with each other and with the metal substrate before stressing. All the important conditions for the build-up of the corrosion protection effect are therefore met.

After a period of stress of 600 hours in the salt spray test (Figure 3b) it was observed that the coating displayed a very porous structure and a thick layer of white rust. However, a solid zinc flake/zinc dust layer remained on the metal substrate (approximately 15-20 µm thick), in which the corrosion protection continued to act.

The primer stored for 95 days at 30°C presented a less dense structure and fewer regular zinc particle contact points than the paint coat prepared from the unaged sample. After 240 hours in the salt spray, the paint coat presented a good appearance. A layer thickness of 20-25 µm retained good contact of the zinc particles with each other and with the metallic substrate. This layer is sufficiently thick, that is to say, the coating offers potential for cathodic protection.

The layer of white rust in the coating has a dense structure and a clear limitation, indicating that the surface of the paint coats was denser and less porous than the original coating.

Current results on the development and technology for the preparation of anti-corrosion paints relating to the storage stability of the paint and the corrosion protection of the corresponding coatings are summarised in Table 3. The disadvantages of these coatings are the porous structure of the surface, which leads to the formation of white rust and insufficient cathodic protection of the coatings after storage of the paint. Research is continuing on improvements to these aspects.

- It has been found that 1-nitropropane blocks the formation of hydrogen which is possible. The common solution of protecting the pigment surface with a polymeric coat interferes with its anticorrosive effects.
- Paints containing zinc pigments (especially zinc flake/dust mixtures) in waterborne alkyd resins are capable of giving good corrosion protection, but their storage stability is very poor due to the formation of hydrogen from zinc oxidation.
- The general solution of protecting the pigment surface with a polymeric coat interferes with its anticorrosive effects.
- It has been found that 1-nitropropane blocks the formation of hydrogen in these primers but is less effective with the other volatile components during curing without adversely affecting the corrosion protection.

- Tests on a paint containing this inhibitor are presented. It is shown that this retains good anticorrosive performance even after extended storage at temperatures up to 30°C and no evolution of hydrogen could be detected.

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