1- Confirm manufacturer's application procedure will be followed.
2- Zinc dust content by weight in dry film should be 85% (+/- 3%).
3- Confirm SILPROTECT is lead and asbestos free.

Painting System Works(1)

for Steel Buildings

Spec. No. /Item No. : 10059-9-3PS-SS00-00001

Tech. Data No. : MTF-9-PSW1 -SH-001

REV.: 0 Date: 7/11/2009

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Supplier Document Status

CODE: 2

Code 1 = Work may proceed.
Code 2 = Revise and resubmit. Work may proceed subject to resolution of indicated comments
Code 3 = Revise and resubmit. Work may not proceed.
Code 4 = Review not required. Work may proceed.

Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods, or materials developed or selected by the Supplier and does not relieve the Supplier from full compliance with contractual obligations.

Responsible Engineer - Haitham Sami

Date Issued - 2009/11/11 , 02:04:21 PM

Supplier Requirement Category -

Equipment No. -

COLORAMA SILPROTECT®

GUIDELINES IN SELECTION OF ZINC SILICATES

There is often confusion amongst users of zinc silicate primers regarding parameters such as volume solids and spreading rates which cause few difficulties with conventional paints.

Zinc silicates are amongst the most widely used primers in the Protective Coatings Industry and it is necessary to ask “why use zinc silicate primers?”
The answer is because they offer good corrosion resistance.

For zinc silicates the anti-corrosive and mechanical properties are highly dependent upon the level of zinc dust present. Several years ago it was common to use zinc silicates containing 90% or more zinc dust in the dry film, with the only other components being the ethyl silicate and anti -sag agents. However research has driven this down to around 86% zinc dust, with other components often being reinforcing extender pigments present to give improved film properties (i.e. reduce mud cracking in thick areas). These levels potentially allow cathodic protection to take place.

Most long term current track record is based on zincs with around 85% zinc dust (higher than in most standards such as SSPC 20 or ISO 12944), in most instances the zinc being topcoated.

It is necessary to consider the composition and the typical film of a zinc silicate to fully understand what is being purchased.

Zinc silicates are unusual coatings and, along with some flat wall and masonry paints, are one of the few coatings which are designed so that all of the solid pigment particles are not coated with polymer and all of the gaps between particles are not filled with polymer, i.e. they are designed to be porous films.

It can be seen that a very considerable portion of the film is void, i.e. the film is porous (this is not a problem as with weathering it fills with salts and becomes a barrier but it does cause the well known 'pinholing' problem seen with topcoats applied over fresh zinc silicate). The fact that there is not sufficient polymer to fully wet and coat the pigment (zinc) particles present ensures electrical contact and Cathodic protection.

- **Theoretical calculations**

If a purely theoretical calculation is undertaken for a zinc silicate, assuming resin, zinc and extender all film form to give a totally void free coherent film, then typically volume solids figures of around 35-45% are achieved for commercial zinc silicates. This type of figure is clearly neither representative of the wet to dry film thickness ratio obtained in practice, nor of the spreading rates normally achieved.

The difference between the practical figures and "calculated" figures is a feature which causes many problems in the assessments of the commercial value of various zinc silicates and can lead to poor system performance and poor value for users.

- **Volume Solids Determinations**

The industry norm for volume solids quotations (necessary both to determine spreading rate and in practice to give a method of accurate commercial assessment between various suppliers' coatings) is to use methods of accurately determining the wet to dry film thickness ratio of the coating.

The actual methods normally used are those described in ISO 3233 or ASTM D2697 (generally modified to allow for ambient curing). One key aspect of both of these methods is accurate determination of film thickness by measuring the volume of the dry film, utilizing Archimedes' principle and weighing in air and water. This works well for all normal organic coatings which are formulated with the aim of achieving void free films, and values obtained correlate well with practice.

However, with zinc silicates using water, volume solids figures reflect the theoretical volume solids calculated, not that which is observed in practice.

This is due to water penetrating into the pores and voids of the coating and the volume measurement, thus not reflecting the actual position of the surface.

Therefore, to use this type of method, an alternative approach is needed, e.g. NACE Item No. 54165, which is a modification of ASTM D2697. In this instance, the water is replaced by mercury, which has a surface tension such that it does not penetrate the voids in the silicate film and in order to sink in the mercury application must be to tungsten which is of sufficiently high S.G. not to float.

Alternative methods have been described, for example in OCCA Monograph No. 4, which utilize a Profilometer to determine thickness.

Both of these methods give sensible values for volume solids, which relate well to practice.
It must be pointed out that generally it is found that some practice by the experimenter is required before consistent realistic results can be obtained by either of the methods, which we believe may be a contributing factor to some of the erroneous values which can be quoted.
In the past there have been a number of other approaches, for example, spinning down the solids using a centrifuge which generally gives unrealistically high figures. Other attempts include trying to measure wet film thickness with a wet gauge and dry with a typical d.f.t. gauge, again giving a highly inaccurate assessment.

It may be questioned as to the real relevance of this volume solids determination. Basically, it gives a measure of how much zinc the purchaser is obtaining on each square meter of surface, which is presumably why they are buying a relatively expensive primer in the first place – i.e. in the belief that the presence of the correct level of zinc is the key to obtaining long term corrosion protection.

Clearly it is beyond the scope of most purchasers of zinc silicates to check or become involved in volume solids determinations, and the considerations above are given to demonstrate the complexity of the situation and to illustrate to the prospective purchasers of this type of product that they can be misled by erroneous data sheet information, especially in the area of volume solids.

Zinc content generally is not so difficult, as is often stated, or the fact that the product complies with a certain standard with regard to zinc content is mentioned (but there have been instances of zinc dust simply being removed from the powder component of zinc silicates simply to reduce costs).

How best can a specifier/purchaser then select which zinc silicate to use. Much information can actually be obtained from the data, or requested from the suppliers, as figures which tend to be correct can easily be checked.

1. **Quoted Volume Solids:**

(In some instances this is not quoted and instead a spreading rate is given – this is in effect the same data), e.g., theoretical spreading rate to give 75 microns d.f.t. is 8.0 m2/l and corresponds to an assumed volume solids of 60%

2. **S.G.:**

The higher the S.G., the more zinc present, and the volume solids will also be higher.

3. **Packing Weights of Binder and Zinc Powder:**

When the weight of zinc powder is available a calculation can easily be made to give the weight of zinc per square meter and thus an evaluation of potential effectiveness. For units between 10-15 liters it is suggested 1 kg is allowed for packing weights.

COLORAMA SILPROTECT®

ZINC SILICATE APPLICATION ASPECTS

Zinc Silicates are the primers of choice for the petrochemical and offshore applications. As tank linings, they are used without topcoats, however topcoats are usually specified for atmospheric exposures.

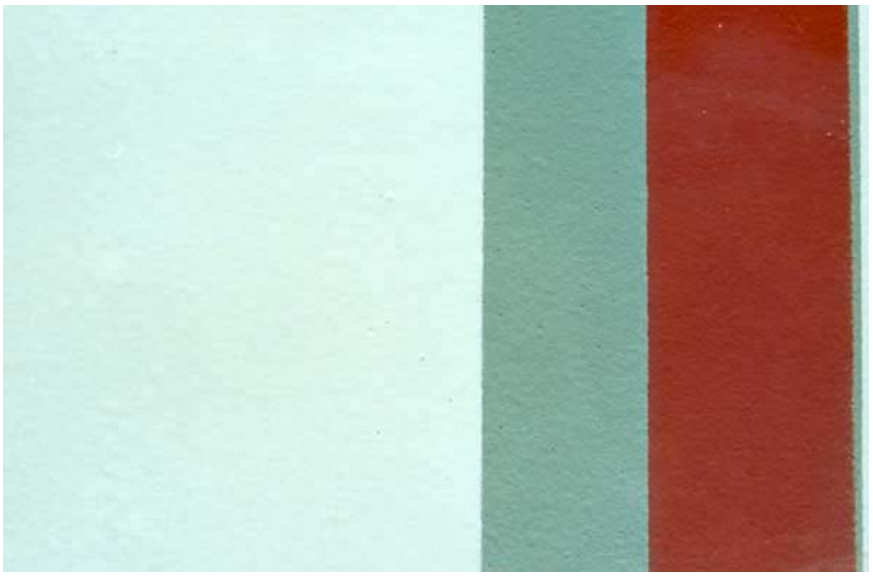
The correct application of zinc silicate primers is of utmost importance for the correct protection of the substrates. There are two major issues which should be taken into consideration, when applying zinc silicate primers. These are:

1. Porosity
2. Excessive thickness

POROSITY & POPPING PROBLEMS

- **Causes of the problem**

Topcoating inorganic zinc rich coatings may be more difficult than with any other coating because of the inherent porosity of zinc primers. The binder partially wets and adheres to the zinc dust particles together and to the substrate, but it does not fully encapsulate or seal the surface. Therefore, topcoats applied over the porous surface may displace entrapped air causing pinholes, bubbles, or voids within the topcoat cross-section. Topcoat bubbling is often called **POPPING** or **BLISTERING**.



The higher the ambient temperature, the greater is the problem. Also if the temperature of the substrate rises steadily, the problem of popping will increase. Very small pinholes are usually acceptable however pinholes which are visible with the naked eye are not acceptable and should be repaired.

- **How to avoid the problem**

In order to avoid the problem of popping, an experienced applicator is of major importance, since the quality of application is of vital importance. In order to maximize productivity, inexperienced applicators, may apply zinc primers using a powerful airless machine at high pressure and with a large or worn tip.

Therefore an experienced applicator should safeguard the following:

1. Ensure that steel is blasted to Sa 2½, blasting profile 40-70 μm
2. Do not allow a heavily pitted steel profile
3. Substrate temperature should not be excessive, and if it exceeds 40ºC, thinner should be added
4. Substrate temperature should be at least 3ºC above dew point
5. Relative humidity should be above 40ºC
6. Nozzle pressure should be 90-100 bar and nozzle orifice should be approximately 0.48 to 0.64 mm
7. Constant agitation of the zinc silicate coating is of utmost importance

EXCESSIVE THICKNESS

Excessive dry film thickness (DFT) can lead to two main problems:

1. Mud Cracking
2. Low adhesion or cohesive strength

- **Mud Cracking**

Mud cracking occurs due to shrinkage during drying and is usually caused by too high DFT. It can also occur due to application over substrates of too low blast profile. High relative humidity combined with poor ventilation can also play a vital role in this problem.

In order to avoid mud cracking the applicator should ensure the following:

1. DFT should not exceed 150 µm
2. Blast profile should be 40-70µm
3. Relative humidity should be above 40ºC and good ventilation should be ensured

- **Low Adhesion**

All zinc silicate primers will remain weak if not properly cured. In very dry conditions zinc silicates may take longer time to reach full curing. Also at higher film thickness curing and thorough hardening may take very long times.

Therefore to avoid these problems the applicator should ensure:

1. Apply in not too dry conditions
2. Relative humidity should be above 40ºC and good ventilation should be ensured
3. Topcoat should not be applied over non-cured silicate primers