Testing after painting

Introduction

Once a coating application has been completed then on occasion the Coating specification will require testing of the coating system beyond standard dry film thickness measurement and visual assessment, to check the integrity of the coating system.
Care should be used when specifying and performing these tests, following the specification and good painting practise should result in achieving the desired result, and, since some tests are destructive then the integrity of the system can be compromised if repairs to the tested areas are not carried out according to the specification. Note that these tests are not a substitute for proper execution of the specification, and deficiencies during surface preparation and application are not mitigated by achieving an acceptable test result.
These tests may include, but are not limited to,

- High voltage holiday detection
- Pull off adhesion testing
- Solvent rub

For these tests testing of the system may only be performed once the coating system is fully cured. The tests to be performed contained in the specification should include the test method, or standard to follow for the testing, the acceptance criteria and, as these tests are destructive, a repair method for any areas damaged or found not to conform to the specification during the testing. This information should be included in the specification and outlined at the project setup meeting.

Scope

This article provides a description of some of the tests that may be carried out on a paint system after application has been completed.

High Voltage Holiday Detection

High voltage holiday detection is a test of the insulation property of the coating, this is related to thickness and continuity of the film. A discontinuity is described in ISO 29601 as a flaw, void, pinhole, holiday, crack, thin spot, foreign inclusion or some kind of contamination that results in a significant lowering of the dielectric strength of the protective coating film. The test is performed using high voltage (thousands of volts) on for example high thickness coatings used for aggressive chemicals or buried pipelines. Due to the nature of these objects, where any kind of porosity is not acceptable, the entire surface (100%) must be tested, and all pores repaired.

The specified thickness of the systems to be tested is typically in excess of 500µm (20 mils), and the voltage to be used dependents on the coating thickness and the standard used. Testing of systems with a dry film thickness of under 500µm is generally not recommended and should be agreed by all parties. It is recommended to use a voltage from the applicable standard that is relevant for the minimum acceptable thickness of the system to avoid any unnecessary damages by the test causing subsequent repairs. Testing with excessive voltage increases the risk of damaging the coating system.

Safety
This procedure involves the use of very high voltages, and whilst there are several safety features built into modern test equipment, care must be taken to ensure that the operator does not come into contact with any of the live parts of the equipment. Please refer to the equipment manufacturers documentation for more details. Appropriate PPE should be used.

Standards
There are several standards available that describe the testing procedure and recommend voltages for various coating system film thicknesses (ISO 29601, NACE SP0188, ASTM D 5162, AS3894.1). The recommended voltages can vary from one standard to the next hence the need for the standard to be used to be named in the specification. The criteria for the test are also slightly different with some standards recommending using the mean measured thickness of the area for the voltage setting and others the thickness in the specification. Hempel would recommend using the specified thickness to determine the voltage to be used and when a minimum thickness is specified that is lower than the specified thickness then this is the value that should be used. Adopting this will prevent areas within specification being damaged by the equipment when an average thickness has been applied that is above the specified thickness but still within the acceptable thickness range for the system and its uses.

Procedure
Once the coating is sufficiently cured to allow testing (this normally means fully cured, contact Hempel for details) the voltage to be used for the test should be selected from the standard specified, based on the coating thickness. The procedure in the applicable standard

should be followed carefully and any areas where low thickness is found marked carefully. At regular intervals, the earth connection should be checked to ensure that there is a solid connection that enables the apparatus to work.
Once the testing is complete then all areas found to be deficient should be repaired using the original specification to ensure the protection of the object.
Note that there are some types of coatings where high voltage holiday detection is not be used. These are coatings which are electrically conductive, due to the inclusion of conductive pigments such as metallic zinc or aluminium, graphite, and MIO.

Pull off adhesion testing

Pull off testing is a destructive test and gives information about a localised area in or on the object that is being tested and so may not be representative of the entire object, the result achieved is dependent upon the application conditions. Repair of the area with the full system is necessary in every case. It can be advantageous, if agreed by all parties, to prepare test plates at the exact same location and under the same conditions and the same way as the object to be coated and perform tests on these objects to avoid damaging the coating system on the main object. Note that these panels must remain in the same environment as the main object for the entire period of the application and curing.

Safety
This procedure involves the use of glue, all local regulations regarding their use should be observed and appropriate PPE should be used.

Standards and assessment
Once the coating system has fully cured then pull of adhesion tests may be carried out according to ISO 4624 and ISO 16276-1. These standards describe the procedure for carrying out the test but do not provide acceptable values for the results. These may be obtained for standard systems from Hempel, however the values stated in such documents as our Laboratory Test Statements (LTS) are from applications and tests performed under laboratory conditions and results for applications on site will not normally be at the same level as these. In these standards the glue used for attaching the dolly to the surface may be epoxy or cyanoacrylate (super or 10 second glue) The curing time for the epoxy glue, and thus the time before performance of the pull off test is much longer than that for cyanoacrylate glue, however despite the common name for cyanoacrylate glue, ’10 second glue’, it is recommended that the glue be left for at least 1 hour to dry before a pull off test is attempted. Before gluing test surfaces should be cleaned and abraded to a smooth even surface. ‘

There are several types of equipment available and the pneumatic and hydraulic types are preferred over the hand wheel types such as the Elcometer 106. The pneumatic and hydraulic types deliver a smooth increase in force and a more accurate result whereas the hand driven types deliver uneven staccato increases in the force applied and can result in inaccurate results.
The number of dollies used should allow for an assessment of the adhesion across the entire object, so they should be placed in areas representative of the construction. However it is important to note that pull off testing can only be performed on smooth surfaces. A curved surface (whether concave or convex) will result a in significantly lower false value. Note if there are requirements for cutting or not cutting the paint system around the dolly before testing.
A test report should include the full system, product names, dry film thickness, pre-treatment and application conditions, the equipment type and glue used and the diameter of the dolly and how the coating and glue around the dolly was cut. Furthermore, state the results including the value for the fracture, and the nature of the fracture with an estimation of the percentage of each type of fracture i.e. where in the coating system the fracture was and the percentage, to the nearest 10% of that fracture, as outlined in the standard.

Solvent rub

Chemically curing coatings change during the curing process and become more resistant to solvents as they cure. It can be desirable to check the level of solvent resistance before, for example applying a topcoat or exposing to system to certain service conditions.

Safety
This procedure involves the use of solvents, all local regulations regarding their use should be observed and appropriate PPE should be used.

Standards
ASTM D-4752 describes measuring methyl ethyl ketone (MEK) resistance of Inorganic Zinc -Rich primers by solvent rub. The method involves performing 50 double rubs (forward and back) of a coated surface size 150mm x 25mm using a lint free cheesecloth soaked in methyl ethyl ketone and then examining and rating the surface of the coating afterwards. The rating ranges from 0 to 5, where a 0 rating refers to bare steel exposed after all or some of the double rubs. In this case the number of double rubs required to expose the steel should be reported. The maximum rating 5 indicates that there is no effect on the surface and that the Zinc silicate is cured and ready for overcoating. Whilst a rating of 5 is acceptable, in some circumstances a rating of 4 may be also – contact Hempel for requirements for specific products and exposures (Rating 4 is categorised as a burnished appearance on the rubbed area and a slight amount of zinc on the surface after 50 double rubs). Normally ratings below 4 are not acceptable.
ASTM D 5402 describes a procedure for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs. The method is very similar to ASTM D 4752, whilst only using 25 double rubs. Interpretation of the results is not as straightforward as with ASTM D 4752 since the standard can

be sued for a wide range of products, and as noted in the standard the level of solvent resistance does not necessarily indicate the level of curing as some coatings will exhibit resistance to some solvents before they are sufficiently cured to be exposed to the environment intended, so great care must be taken when interpreting results.
Whether the coating is cured or not can only accurately be determined by knowing the temperature and time after application or sampling and chemical analysis by an appropriate laboratory.

Conclusion

As a note for the above tests, there is no substitute for following the specification and ensuring that all coatings are applied on the correctly prepared surface under the correct conditions. The pull off and solvent rub tests show the properties of the coatings in a localised area, and it cannot be assumed that the results obtained are valid for all areas unless of course all areas are treated in the same way

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