BULLETIN

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Common Quality and Performance Tests for Madison Products

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Common Quality and Performance Tests for Madison Products

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Contained in this InfoTech Bulletin are the names and a brief description of the essential quality control and performance tests that Madison Chemical routinely performs on their coatings. The results of these tests are the confirmation that Madison products are of the highest quality for the selected application and use. While most are completed internally, some are also performed in the field to ensure proper application. These include Adhesion, Coating Thickness and Holiday Testing.

1. Adhesion Testing

Adhesion is the ability of the coating to stick to the substrate. The greater the adhesion value of a coating, the longer the coating's life expectancy and the greater the long term corrosion resistance.

Pull off Strength - ASTM D-4541

Adhesion can be tested using either a HATE tester or an elcometer. The HATE and elcometer tests are performed in the same manner.

- The surface to be tested and a dolly are prepared by sanding and wiping with M.E.K.
- The dolly is glued to the coating using an adhesive and allowed to cure for a minimum of 4 hours.
- Any excess glue and the coating are then cut through to the substrate using a dolly cutter.
- Using either tester the dolly is then pulled from the substrate and a value is registered in psi. This is the adhesion value.

Generally accepted adhesion values for "adequate" corrosion protection are around 2000 psi and will vary with the coating type, degree of curing and type of coating surface preparation.

Evaluating Adhesion by Knife - ASTM D-6677

- Using a sharp knife two cuts are made into the coating with a 30º to 45º angle between them down to the substrate, making an "X".
- Make each cut a minimum of 38.1 mm from the intersection.
- Using the point of the knife and beginning at the vertex of the angle, attempt to lift the coating from the substrate.
- Repeat the test in two other locations on each test panel.

The adhesion is reported on a rating system from 0 to 10 (refer to ASTM).

Evaluating Adhesion by Tape Test - ASTM D-3359

- A lattice pattern with six cuts in each direction is made in the film to the substrate.
- Pressure sensitive tape is applied over the lattice and then removed.

The adhesion is evaluated by comparison and descriptions and illustrations. (Refer to ASTM).

2. Abrasion Resistance - ASTM D-4060

Abrasion resistance is the ability of a coating to resist damage caused by abrasive materials. This is tested using a Taber Abraser which spins a coating sample against a grinding wheel for a specified number of revolutions.

- A lattice pattern with six cuts in each direction is made in the film to the substrate.
- Pressure sensitive tape is applied over the lattice and then removed.
- The Taber Abraser is first calibrated (wheels are refaced) using Abraser Re-facing Discs. The re-facing discs are placed on the tester and allowed to spin for 25 revolutions.
- The test panels are then weighed and placed on the tester which is equipped with a specified coarseness (CS-17) of grinding wheel and a specified weight (1 kg) on each wheel.
- The tester is then started and allowed to spin for a specified number of revolutions (for most products the test lasts for 1000 revolutions).
- The samples are then reweighed.

The resistance to abrasion is normally reported as the weight loss per 1000 revolutions.

3. Impact Resistance - ASTM D-2794

Impact resistance is a measure of the coatings toughness and durability. It is calculated by dropping a measured mass from a measured distance and then testing for holidays.

- The coated sample is checked to ensure that it is holiday free as per ASTM D-5162 (low voltage).
- The samples are then placed under the impact tester. A measured mass is dropped from incremental heights and the samples are checked for holidays as above.
- The height and/or mass is increased as the sample passes holiday testing until the point of failure (samples can also be tested by visual inspection ie. signs of cracking).
- The resulting height and weight combine into a pounds per inch result. The higher this result the better the impact resistance of the coating.

4. Chemical Resistance - ASTM D-543

Chemical resistance is the ability of a coating to stand up to exposure to specific concentrations of chemical solutions and common fluids (e.g. oils, gasoline, etc.). It is measured as the percent weight change of a coating sample over a predetermined amount of time of exposure.

- Free film and coupon samples are coated and allowed to cure completely.
- The free film samples are weighed and placed into the chemical solution.
- After a mutually agreed amount of time has passed at a mutually agreed temperature the samples are removed and dried before reweighing.

If the coating shows a weight change of more than 3% or if any deformity occurs the coating will fail the test. Any sample showing 3% will receive a limited recommendation only.

5. Cathodic Dispondment – CSA-Z245

Cathodic disbondment testing is a means of determining a coating's ability to resist migrating corrosion which may occur in underground service. This is done by exposing a coated steel sample, with an intentional holiday, to a direct electric current in an electrolyte. The amount of delamination is then measured from the original holiday.

- The samples are coated to the required thickness, allowed to fully cure and tested to ensure that they are holiday free.
- An intentional holiday is drilled to specified dimensions (1/8" inch wide) in the center of the sample.
- The cell to contain the electrolyte is attached to the sample and filled with a 3% salt solution.
- The samples are then placed into the oven set to 65ºC/150°F.
- The electrodes are connected to the sample and the power is turned on. The power supply should be calibrated to read 1.5V before each test.
- The samples are tested for a length of 48 hours. Panels can also be tested at room temperature for a length of 28 days.

When the test is finished the sample is removed and inspected. The amount of disbondment is measured using ASTM D-6677, starting at the original holiday towards the edge of the sample. The shorter this distance is, the better the resistance to cathodic disbondment. (Madison results are typically 10 mm or less).

6. Hardness Testing

Hardness testing is done to determine a coating's ability to resist penetration or puncture.

Durometer Hardness - ASTM D-2240 (thick films)

Depending on the rigidity of coating being tested, either a Shore A or a Shore D Durometer is used. More rigid coatings are measured using a Shore D and softer with a Shore A.

- The Durometer is pressed into the coating and the gauge indicates a hardness reading. Several readings should be taken in order to get an average.

The higher the reading on the gauge, the harder the coating is. For example the ASTM D-2240 Shore D Hardness value for CorroCote II Classic is 70.

Film Hardness by Pencil Test – ASTM D 3363 (thin films)

Checking the hardness of a film using the pencil test is generally used for films that are too thin for the Durometer hardness gauge. This test is done by holding a pencil firmly against the film and pushing at a 45º angle away from the operator.

- Starting with the hardest lead, hold the pencil at a 45º angle (pointing away from the operator) and push away from the operator.
- Repeat the process down the hardness scale until a pencil is found that will not cut through or scratch the film.

The pencil hardness is the hardest pencil that will leave the film uncut for a stroke length of at least 1/8 in.

Pencil hardness is a good indicator of a coating's resistance to staining, scuffing and marring.

7. Coating Thickness

Wet Film Thickness - ASTM D-4414

This is the measurement of a coating's thickness while it is still wet. It is measured using a comb gauge that is simply placed onto the flat coated surface and the last comb to touch the coating is the wet mil thickness.

- A sample is coated to the approximate wet thickness
- The wet gauge is placed into the wet coating and thickness is read off the gauge.

This method is effective for most coatings but the percentage solids must be considered when measuring less than 100% solid coatings.

Dry Film Thickness - ASTM D-1186

This is a nondestructive method to measure the thickness of a non-magnetic coating applied over a ferrous substrate. The thickness is measured by using an electronic thickness gauge.

- Samples are coated to the required thickness and allowed to cure fully.
- As there are several types of dry film gauges it is advisable to follow the manufacturer's instructions for operation.
- The instrument should first be calibrated by using the calibration gauges supplied.
- Press the thickness gauge onto the coating to be measure and wait for the thickness reading to be displayed.

8. Holiday Testing

This is a method to check for discontinuities in a nonconductive coating applied to conductive substrate.

Low Voltage - ASTM D-5162

This is done using a low voltage (wet sponge) tester equipped with a sponge electrode, a ground wire and an audible or visual indicator.

- Samples are coated and allowed to cure fully.
- Connect the ground wire to the sample ensuring contact with bare metal.
- Wet the sponge on the electrode with water.
- Pass the electrode over the coated surface.

If there are any voids in the coating film, the electrical circuit will be connected and allow power to pass through the detector sounding the alarm. If there are no voids or holidays the alarm will not sound indicating a holiday free surface.

High Voltage – NACE RP-0188

This test is designed for film thicknesses of 20 mils and above using a High Voltage Tester. The electrode must be capable of maintaining continuous contact with the substrate and requires no water. The recommended voltage is approximately 100 V/mil.

9. Hiding Power - ASTM D-344

Hiding power is the ability of a coating to cover (hide) the substrate. This is a visual test in which black and white hiding power charts are coated. The amount of contrast that can still be detected through the coating will determine the hiding power.

10. Weathering Characteristics

QUV – ASTM G-52

The QUV is a cabinet in which samples are placed to determine the coatings ability to resist deterioration due to humidity and ultraviolet rays caused by the sun. The samples are removed and examined after a mutually agreeable number of 'laboratory' hours. This testing is intended to simulate accelerated environmental conditions but it is not advisable to try to correlate 'laboratory' hours with a natural equivalent.

- Samples are coated and allowed to cure fully.
- The samples are then placed into the QUV. The machine is turned on and allowed to run continuously or cyclically for a pre-determined length of time.
- The samples are removed and evaluated for gloss and colour retention.

Simultaneous testing is also done placing panels on the outdoor exposure rack in order to compare to the QUV testing.

Salt Fog Chamber - ASTM B-117

The Salt Fog Chamber is used to expose coated samples to a consistent warm salt fog for the evaluation of a coatings ability to resist corrosion of the substrate. The samples are removed after a mutually agreeable number of laboratory hours and inspected. This testing is intended to simulate accelerated environmental conditions but it is not advisable to try to correlate laboratory hours with a natural equivalent.

- Samples are coated and allowed to cure fully. Any exposed edges are to be covered.
- An 'X' is cut through the coating to the substrate in the exposed section of the test sample.
- The Salt Fog Chamber is turned on and allowed to reach operating temperature before the samples are introduced.
- The chamber is left to run continuously for a pre-determined amount of time.

At the completion of the test, the samples are removed and visually evaluated for general appearance, blistering and undercutting of the coating.

Salt Water Immersion – ASTM D-870

Salt water immersion testing is done to expose coated samples to a consistent flow of warm salt water and oxygen. The samples are hung in the chamber 50% immersed for a mutually agreeable number of hours then removed and examined. This testing is intended to simulate accelerated environmental conditions but it is not advisable to try to correlate laboratory hours with a natural equivalent.

- Samples are coated and allowed to cure fully. The edges are cleaned to remove any coating.
- The testing equipment is turned on and allowed to reach operating temperature before the samples are introduced.
- The samples are put into the 'tub' and the water level is adjusted to submerge the samples approximately half way.
- The equipment is allowed to run continuously for a pre-determined length of time.
- The samples are inspected visually and mechanically for undercutting.

11. Recoat Window - Madison

Recoat window testing is performed to calculate the amount of time that may lapse between the consecutive applications of coating and still maintain required adhesion values.

- Several samples are coated a first time and then recoated at various time intervals.
- These samples are allowed to completely cure.
- The adhesion is the tested on each sample. Using a chisel and hammer the coating is chipped off the substrate.

If the two layers of coating appear as one there is good adhesion between them and this would indicate that the second layer was applied within the recoat window. If a line can be seen between the layers the adhesion is not as good and this would indicate the end of the recoat window. If the second layer completely delaminates from the first than the recoat window has been passed.

12. Sag Resistance

Sag resistance is the ability of the coating to build or hang on a vertical surface.

Multi-notch Applicator – ASTM D 4400

This test method covers the laboratory determination of the sag resistance of liquid coating. Samples are drawn down onto a test chart and observed for vertical hang.

- The material to be tested should first be adjusted to 25°C/75°F before testing.
- An anti-sag meter is used to draw the liquid down onto a test chart from 3 to 12 mils (WFT).
- Immediately hang the chart with the drawdown stripes in a horizontal position, with the thinnest stripe at the top.
- Allow the sample to dry in this position.

The sag resistance is measured as the thickest stripe that has not merged with the stripe below it.

Sag Panel – Madison

This test method covers the sag resistance of a coating when sprayed in a wedge pattern onto a sag panel. Sag Panels are sprayed at increasing thickness on a vertical surface and measured for film build before sagging.

- The sag panel should first be cleaned with M.E.K.
- Hang the panel on a vertical surface, and spray the material in a wedge pattern. (Start with thin coat on top and gradually increase the thickness as you work done the panel).
- The panel should be left hanging vertically until fully cured.

The sag resistance (hang) is measured at the point were the coating sags no more then 1/4 inch. At this point take a measurement of the dry film thickness (ASTM D1186).

13. Flexibility – ASTM D 522

This test method determines the ability to resist cracking (flexibility) of coatings on substrates of sheet metal. The samples are applied at a uniform thickness then bent over a mandrel and the resistance to cracking is determined.

- A test panel is placed over a mandrel and using a steady pressure, bent approximately 180º around the mandrel.
- The sample is the removed and examined for any visible cracking to the unaided eye.
- This procedure is repeated using successively smaller diameter mandrels until failure occurs.

14. Edge Retention

Edge retention is performed in order to determine the ability of the coating to be able to hang on the edge (or weld) of the substrate. The edge retention specimen should use an Aluminum Alloy 6061, 1 inch structural angle (90º) section approximately 6 inches long.

- The 90º edge of the specimen is ground to a radius of 1mm by lengthwise passes, and then grit blasted.
- A topcoat is then applied to both sides (first) and the edge (last) within one minute.
- The cured samples are sectioned at three locations.

Measurements are taken from the flat edge and compared to the thickness at the apex in order to determine the edge retention. The average of all the readings should be no less then 70%. The dry film thickness is measured by a photomicrograph from an optical microscope, or directly from a magnified image on the computer.