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Application No. 58C2975

September 3, 1958

REPORT

on

PROTECTIVE COATING FOR STEEL ENCLOSURES
OF OUTDOOR AIR-CONDITIONING EQUIPMENT

Z.R.C. Products Company
Quincy, Mass.

D E S C R I P T I O N

PRODUCT COVERED BY THIS REPORT:

Protective coating for steel enclosures of outdoor air-conditioning equipment, one coat system "Z.R.C."

GENERAL CHARACTER:

This product is a mixture of zinc powder and vehicle of the synthetic resin type, the nature of which is a trade secret and on file at Underwriters' Laboratories, Inc. It is spray-applied to the clean surfaces of steel, and is dried for approximately one to two weeks at 70-75 F (21-24 C), the dry film thickness being at least 0.003 in. (3.0 mils).

The product is intended for use in protecting steel enclosures of outdoor air-conditioning equipment against ordinary atmospheric corrosion.

MARKING:

Manufacturer's name and designation on container.

THE INVESTIGATION

OBJECT:

The object of this investigation was to obtain data bearing on the comparative resistance to ordinary atmospheric corrosion afforded by this protective coating where applied to steel enclosures of outdoor air-conditioning equipment.

PLAN:

Representative specimens of the protective coating on sheet steel, both with the coating intact and with the coating scored to expose the underlying steel, were subjected to corrosion tests in the presence of salt-spray, moist sulphur dioxide-carbon dioxide-air mixture, moist hydrogen sulphide-air mixture and ultraviolet light and water.

For purposes of comparison, specimens of zinc-coated sheet steel (hot-dipped galvanized) were included in all corrosion tests conducted.

To obtain data for future use in inspections under the Laboratories' Reexamination Service, the product was subjected to composition tests.

EXAMINATION AND TEST RECORD

DESCRIPTION OF SAMPLES

Protective Coating - The manufacturer of the protective coating submitted test specimens of commercial steel which had been cleaned and coated on both sides with the protective coating as described in the previous section of this report entitled "General Character". These test specimens were of No. 18 MSG steel, 4-1/2 in. long and either 2 or 3 in. wide. Each specimen was provided with a 1/4 in. drilled hole for support during corrosion tests. The edges of each specimen, including the edges of the drilled hole, were coated with wax.

The thickness of the protective coating, as determined by means of a micrometer, before and after removal of the coating from the underlying steel with an organic solvent, showed that the coating was at least 0.003 in. (3.0 mils) thick per side.

The manufacturer also furnished, for use in composition tests, a sample of the product "Z.R.C."

Zinc-Coated Sheet Steel - A commercial grade of hot-dipped galvanized sheet steel obtained in the open market was used as the basis for comparison in the corrosion tests. These specimens were 3 in. wide, 6 in. long, and approximately 0.03 in. thick. Representative samples of this zinc-coated steel withstood four one-minute immersions in copper-sulphate solution, bright adherent deposits of copper being formed during the fifth immersion.

COMPOSITION TESTS:

METHOD

The proportions of pigment and vehicle in the product were examined and qualitative chemical tests were made for certain components.

RESULTS

The results of the composition tests corresponded to the manufacturer's statement of the composition of the product on file at the Laboratories.

CORROSION TESTS:

METHODS

Two specimens having the protective coating intact, as received from the manufacturer, and two specimens of zinc-coated sheet steel were exposed to each corrosive medium in the corrosion tests in the presence of salt-spray, moist carbon dioxide-sulphur dioxide-air mixture and moist hydrogen sulphide-air mixture. Single specimens having the protective coating or the zinc coating scored with narrow grooves so as to expose the underlying steel were also included in each corrosion test.

All corrosion tests were conducted in glass chambers at room temperature, the specimens being suspended vertically from glass rods. The specimens having the protective coating were cleaned with soap and water, and dried before being placed in the test chambers. The zinc-coated steel specimens were cleaned with soap and water, washed with ethyl alcohol and ethyl ether and dried. The cut steel edges of the galvanized steel specimens, including the edges of the hole provided for support, were covered with wax. A wax coating was also applied to the edges, and to the drilled holes of the specimens of the protective coating on steel.

The test chambers were operated throughout each day, except for the short time required for the examination of the specimens on working days and incidental maintenance. The specimens were not cleaned during the corrosion tests. All corrosion tests were continued for 2136 hours (89 days).

The chamber for salt-spray was a rectangular enclosure of glass provided with a glass cover having two openings, one for inserting a thermometer, and the other for ventilation. The chamber was supported in an inclined position to prevent condensate from the cover falling on specimens undergoing tests. The spray nozzle, or atomizer, for producing the salt-spray consisted of two glass tubes having small orifices so arranged that when humidified air was supplied at a pressure of about 10 psig to one tube, salt solution contained at the bottom of the test chamber was aspirated through the other tube and projected as a fine mist. The solution consisted of 20 per cent by weight of common salt (sodium chloride) in distilled water, the pH value of this solution being approximately 6.8. A baffle plate, made from glass, was supported above the nozzle so that spray did not impinge directly on specimens. A glass tray was provided beneath the specimens so that condensate and products of corrosion which fell from the specimens were not recirculated in the chamber.

The exposures to moist sulphur dioxide-carbon dioxide-air mixture, and to moist hydrogen sulphide-air mixture were conducted in separate glass chambers. A small quantity of water was maintained at the bottom of each chamber. An amount of sulphur dioxide equivalent to one per cent of the volume of one test chamber and an equal amount of carbon dioxide, were introduced into the chamber each working day. An amount of hydrogen sulphide equivalent to one per cent of the volume of the other test chamber was introduced into the chamber on each working day.

RESULTS

Exposure to Salt Spray

Protective Coating - The specimens of the protective coating on steel, with the coating originally intact, showed white deposits and slight attack of the coating, but no corrosion of the underlying steel on exposure to salt spray for 2136 hours, at which time the exposure was discontinued.

A specimen of the protective coating on steel with the protective coating scored to expose the underlying steel, showed thin rusting in the scored grooves on exposure to salt spray for 144 hours. At the end of 2136 hours this corrosion of the underlying steel had not progressed significantly beyond the scored grooves. Otherwise, this specimen showed essentially the same performance on exposure to salt spray as recorded for specimens with the protective coating originally intact.

Galvanized Steel - Specimens of hot-dipped galvanized steel, with the zinc coating originally intact, showed attack of the zinc coating and incipient to thin rusting of the underlying steel on about 15 per cent of the surface area on exposure to salt spray for 720 hours. On exposure for 888 hours, the specimens showed incipient to thin iron rust on approximately 25 to 40 per cent of the surface area. At the conclusion of the test after 2136 hours, there was evidence of thin to moderate rust, together with some localized pitting of the underlying steel, on approximately 60 to 90 per cent of the surfaces of the specimens.

The specimen of galvanized steel with the zinc coating scored to expose the underlying steel, showed incipient to thin rusting in the scored grooves on exposure to salt spray for 144 hours. Otherwise, this test specimen showed essentially the same performance as recorded above for specimens with the zinc coating originally intact.

Exposure to Moist Carbon Dioxide-Sulphur Dioxide-Air Mixture

Protective Coating - On exposure to moist carbon dioxide-sulphur dioxide-air mixture for a period of 120 hours, the two unscored specimens showed grayish white spotty discoloration on their surfaces. On exposure for 888 hours, the coating on each of the unscored specimens showed light reddish brown staining. At the end of the 2136 hours the specimens showed reddish brown stained areas on about 30 to 50 per cent of their surfaces.

A specimen, with the protective coating scored to expose the underlying steel, showed incipient rusting in the scored grooves on exposure to moisture carbon dioxide sulphur dioxide-air mixture for 888 hours. On exposure for 2136 hours, this corrosion of the underlying steel had not progressed significantly beyond the scored grooves. Otherwise, this specimen showed essentially the same performance as recorded above for specimens with the coating originally intact.

Galvanized Steel - Specimens of hot-dipped galvanized steel, with the zinc coating originally intact, showed attack of zinc coating and incipient rusting of the underlying steel on exposure to moist carbon dioxide-sulphur dioxide-air mixture for 888 hours. When the test was discontinued after 2136 hours, these specimens showed thin to moderate rusting of the underlying steel on about 80 to 90 per cent of the surface areas.

The specimen of galvanized steel, with the zinc coating scored to expose the underlying steel, showed incipient to thin rusting in the scored areas on exposure to moist carbon dioxide-sulphur dioxide-air mixture for 720 hours. On exposure for 2136 hours, this corrosion of the underlying steel had not progressed significantly beyond the scored areas. Otherwise, this specimen showed essentially the same performance as recorded above for specimens with the zinc coating originally intact.

Exposure to Moist Hydrogen Sulphide-Air Mixture

Protective Coating - On exposure to moist hydrogen sulphide-air mixture for 528 hours, the surface of the unscored test specimens showed a few brown-black spotted areas on their surfaces. When the test was discontinued after 2136 hours brown-black spotted discoloration was noted on approximately 3 to 20 per cent of their surface area.

A specimen with the protective coating scored to expose the underlying steel, showed a slight black deposit of iron sulphide in scored grooves when subjected for 24 hours to moist hydrogen sulphide-air mixture. At the end of the 2136 hours, heavy deposits of tubercular black iron sulphide were noted in the scored grooves, but there was no significant corrosion elsewhere on the surfaces of the specimens. In unscored areas, the specimen showed essentially the same performance as recorded above for specimens with the coating originally intact.

Galvanized Steel - On exposure to moist hydrogen sulphide-air mixture for a period of 2136 hours, the two unscored specimens showed no evidence of iron sulphide.

A specimen scored to expose the underlying steel showed a slight black deposit of iron sulphide in scored grooves when subjected to moist hydrogen sulphide-air mixture for 24 hours. When exposure was discontinued after 2136 hours heavy deposits of black iron sulphide were noted in the scored grooves. Otherwise, this specimen showed essentially the same performance as recorded for specimens with the zinc coating originally intact.

TESTS IN THE PRESENCE OF ULTRAVIOLET LIGHT AND WATER:

METHOD

Specimens having the protective coating on steel, and comparison specimens of zinc-coated steel (as described under "Description of Samples") were exposed to ultraviolet light from a single carbon arc formed between two vertical electrodes, 1/2 in. in diameter, located at the center of a revolving vertical metal cylinder 31 in. in diameter and 17 in. high. The arc was operated with approximately 13 amp direct-current, the potential across the arc being approximately 140 v. The arc was enclosed by a clear globe of No. 9200PX Pyrex glass.

The specimens were mounted vertically (facing the arc) on the inside of the metal cylinder, which was rotated about the arc at the rate of three revolutions per hour. A system of nozzles was provided so that each specimen was sprayed in turn with water as the cylinder revolved. During each revolution of the cylinder (20 minutes) each specimen was exposed to light from the arc for 11-2/3 minutes, to water spray without light for 3-1/3 minutes, and was shielded from light and water spray for 5 minutes. The temperature within the cylinder, while the apparatus was in operation, was of the order of 48 C (120 F). A very small amount of ozone was produced by the arc and was present in the atmosphere within the cylinder.

Duplicate specimens with the protective coatings and zinc coating on steel intact, and also single specimens scored to expose the underlying steel, were included in the tests. Each specimen was exposed to ultraviolet light for 360 hours and to water spray for a total of 102-1/2 hours. The specimens were examined each working day for evidence of deterioration of the coating and corrosion of the underlying steel.

RESULTS

Protective Coating - On exposure to ultraviolet light for a period of 360 hours and to water spray for 102-1/2 hours, the specimens having the protective coating intact showed no evidence of rusting.

The specimen with the protective coating scored to expose the underlying steel showed thin rust in the scored grooves when subjected to ultraviolet light for 360 hours and to water spray for 102-1/2 hours. Otherwise, the specimen showed essentially the same performance as recorded above for specimens with the coating originally intact.

Galvanized Steel - On exposure to ultraviolet light for a period of 360 hours and to water spray for 102-1/2 hours, the two unscored specimens of hot-dipped galvanized steel showed no evidence of rust, but their surfaces were discolored, being a dull gray.

The specimen with the zinc coating scored to expose the underlying steel showed essentially the same behavior as the specimens with the coating not scored.

C O N C L U S I O N S

The protective coating covered by this report ((thickness of coating at least 0.003 in. (3.0 mils)) is judged acceptable for use on steel enclosures of outdoor air-conditioning equipment when the suitability of the combination has been determined by Underwriters' Laboratories, Inc.

This conclusion is based on the results of comparative corrosion tests of representative samples of this coating on sheet steel in the presence of salt spray, sulphur dioxide-carbon dioxide-air mixture, hydrogen sulphide-air mixture, and ultra-violet light and water as recorded in this report.

With respect to protection of the underlying steel against ordinary atmospheric corrosion likely to be encountered in the practical use of steel enclosures of outdoor air-conditioning equipment, it appears that this protective coating, when intact, is equivalent to hot-dipped galvanized coating (zinc coating withstanding four one-minute immersions in copper sulphate solution). When this protective coating is mechanically damaged so as to expose the underlying steel, corrosion of the exposed steel is to be anticipated, but such corrosion is not likely to spread materially beyond the exposed areas of steel or beneath the protective coating.

This product will be placed under our Reexamination Service.

Tests and Report by:

C. G. Yarrow

C. G. YARROW
Project Engineer
Chemical Department

Reviewed by:

C. C. Clogston

C. C. CLOGSTON
Assoc. Managing Engr.
Chemical Department

SUBMITTED:

R. E. Dufour

R. E. DUFOUR
Senior Assoc. Managing Engr.
Chemical Department

CGY:BRM