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Pipeline Coating Corrosion, Understanding Testing and UV Degradation of Fusion Bonded Epoxy Coatings

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ABSTRACT

Recently (2019) the Federal Energy Regulatory Commission (FERC) requested information on behalf of a State Department of Health regarding the efficacy and the environmental impact of a pipeline coating utilized to prevent corrosion on the exterior of a steel gas pipeline. This presentation addresses several key considerations and provides testing procedures for pipeline coatings and addresses the effect of weathering. The authors provide firsthand experience with polymer coatings and the effects of UV degradation.

Although Fusion Bonded Epoxy Linings have been utilized for exterior corrosion protection of pipe for decades, recent media reports have called into question the viability of this technology when sticks of pipe are stored outdoors and subject to weathering environments. This presentation will address questions raised by FERC and provide a summary of today's state of the art testing procedures for FBE, to determine the root cause of the "chalking" and provide some practical tips that can minimize the problem. This presentation utilizes a case study approach from actual North American Pipelines as well as qualification and testing protocols to examine the challenges of exterior pipeline corrosion prevention. This paper draws upon the Author's field and laboratory experience.

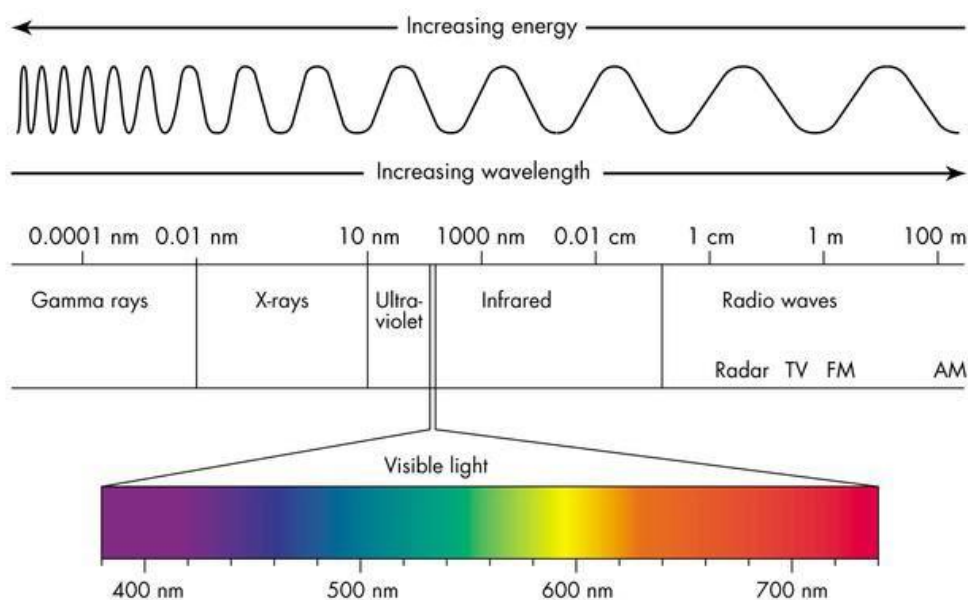
Key words: FBE, Chalking, Pipe Exposure Laboratory Testing

INTRODUCTION

This paper is an overview of FBE compositional testing protocol of qualification testing with regards to the mechanism of chalking, compositional analysis of chalk and impact of chalk on safety, coating performance and film loss. Examples of which can be seen below:



As a quick refresher, visible light is between ~350 nanometers to ~800 nanomeers. UV light as well as X and Gamma rays have sbustantially more energy than infrared and can be determental to the fusion bonded epoxy coatings.



EXPERIMENTAL PROCEDURE

This laboratory investigation consisted of exposing steel pipe sections coated with a light green colored fusion-bonded epoxy (FBE) coating to controlled accelerated weathering conditions for 1500 hours and testing for the degree of chalking of the coating after every 500 hours of exposure. These FBE-coated pipe sections were also checked for any changes in weight and coating thickness at each exposure interval. Additionally, a two-component, solvent-based polyamide epoxy coating system (white) from a major coating supplier, was spray-applied onto blasted steel test panels and tested along with the FBE-coated pipe sections for chalking, weight, and coating thickness changes after accelerated weathering exposure. The sample preparation procedures, test methods employed, and test results are provided below.

FBE-coated Pipe Samples

Several samples approximately 6 in. x 4 in. were cut from a section of 5/16 in. thick FBE-coated steel pipe obtained from the field. Of the samples cut from the pipe section, seven were chosen for this testing: one sample was retained as a control while three were exposed to 1500 hours of continuous ultraviolet light, and another three were exposed to repetitive cycles of UV and condensation for 1500 hours. The samples were evaluated for chalking, weight change, and dry-film thickness after every 500 hours of exposure.

Generic Epoxy Coating System Test Samples

Seven - 6 in. x 4 in. x ¼ in. cold-rolled steel test panels that had been previously solvent-washed and abrasively blasted to a surface profile of 3.5 mils were coated with a generic epoxy coating system fast cure (white) epoxy from a major coating supplier a solvent-based, two-component, polyamide epoxy coating system. The two components (parts A and B) were mixed, reduced with 10 percent (v/v) MEK (methyl ethyl ketone), and mixed again. The reduced coating mixture was then spray-applied to the steel panels using conventional (pressurized air) spray equipment and allowed to dry and cure in accordance with the coating manufacturers written recommendations.

After drying and curing, the samples were then exposed and tested as above: one sample was retained as a control, three were exposed to 1500 hours of continuous ultraviolet light, and another three were exposed to repetitive cycles of UV and condensation. These samples were also evaluated for chalking, weight change, and dry-film thickness after every 500 hours of exposure.

Preparation of Coated Samples Before Exposure

The coated surface of the seven FBE test samples were gently wiped with a soft, wet cotton cloth to clean off any residual dust and dirt. For both sets of panels (FBE and the generic epoxy coating), the edges and back surfaces of the panels designated for the UV/condensation exposure were protected using adhesive tape (black vinyl tape for the edges, clear packaging tape for the back surfaces). Tape was used to protect the uncoated portions of the test panel from degradation. The hanging hole in each of the generic epoxy coating (GEC) and FBE panels designated for UV/condensation exposure was also protected with black vinyl tape. Small pencil marks were made on each panel 2 in. from both the top and bottom edges to visually divide each panel into three 2 in. x 4 in. areas, designated as top, mid, and low areas.