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INFORMATIONAL REPORT AND TECHNOLOGY UPDATE

Thermal Pre-Cleaning

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Foreword

Although thermal precleaning has long been a standard procedure in the oil and gas industry as a method of surface preparation for the application of high-bake coatings to the interior surfaces of oilfield tubular goods,⁽¹⁾ it is now commonly used in the process industry as well. The surfaces of tanks, rail tank cars, tubular goods, and process equipment that have been exposed to a corrosive environment are usually pitted and scaled and contain chemical contaminants both on the surface and within the grain boundaries of the substrate. Failure to remove deleterious amounts of these contaminants ultimately results in blistering and premature failure of the coating.⁽²⁾ Years of industry experience have shown that abrasive blasting alone will not adequately remove all contaminants, especially in the bottom of pits.

Thermal precleaning is not used exclusively; rather, it is a surface preparation method that, when used in conjunction with other cleaning methods, can achieve the degree of cleanliness required for a successful coating application.

⁽¹⁾ Thermal precleaning procedures for the oilfield tubular goods are a special case requiring higher temperature ranges for adequate degradation. For specific information on these procedures, refer to NACE Standard RP0191(latest revision), "The Application of Internal Plastic Coatings for Oilfield Tubular Goods and Accessories."¹

⁽²⁾ Trimber cites the most commonly used contemporary methods for detecting contaminants and then lists the most recent and generally industry-accepted levels of residual contaminants that will not adversely affect coating performance.² The list includes the following information:

1. Weldon, et. al., whose laboratory work indicates that chloride levels need to be less than 5 $\mu\text{g}/\text{cm}^2$ and sulfate levels less than 10 $\mu\text{g}/\text{cm}^2$.
2. Swedish Corrosion Institute, studies indicate levels less than 2 $\mu\text{g}/\text{cm}^2$ and 10 $\mu\text{g}/\text{cm}^2$ respectively.
3. British Maritime studies indicate levels less than 7 $\mu\text{g}/\text{cm}^2$ and 16 $\mu\text{g}/\text{cm}^2$ respectively.
4. When coating thickness exceeds 250 μm (10 mils), the tolerance level appears to be good at concentrations up to 50 $\mu\text{g}/\text{cm}^2$ for both types of contaminants.
5. The conclusion is that the data indicates levels of chloride contamination on the order of 2 to 10 $\mu\text{g}/\text{cm}^2$ and sulfate contamination on the order of 10 to 20 $\mu\text{g}/\text{cm}^2$ can adversely affect the performance of most coatings.

The bibliography lists other articles that address this subject.

Thermal precleaning is typically used in conjunction with abrasive blasting, high-pressure water cleaning, steaming, chemical treatment (e.g., phosphoric acid), or several repetitive applications of thermal precleaning and abrasive blasting in order to facilitate the removal of deleterious levels of salts and carbonaceous materials produced as a result of thermal precleaning.

Within industry there is sufficient experience with thermal precleaning, particularly by coating application shops, to warrant the issuance of this state-of-the-art report by means of which industry can refer to a consensus document for thermal precleaning in coating specifications.

This state-of-the-art report was prepared by NACE/SSPC Task Group B on Surface Preparation by Thermal Cleaning,⁽³⁾ which is a component of NACE Unit Committee T-6G on Surface Preparation for Protective Coatings and the SSPC Surface Preparation Committee. This report is issued by NACE International under the auspices of Group Committee T-6 on Protective Coatings and Linings and by SSPC: The Society for Protective Coatings.

General

This state-of-the-art report addresses the use of thermal precleaning for tanks, vessels, rail tank cars and hopper cars, and process equipment when preparing surfaces for the application of high-performance or high-bake coating and lining systems.

Definitions

Thermal Precleaning: Thermal precleaning is the application of high temperatures to aid in the partial or complete degradation, embrittlement, and/or dilution and subsequent removal of contaminants and failed or old coatings from the surface of a substrate prior to abrasive blast cleaning and coating application. Dry heat and wet heat are two common types of thermal precleaning.

Dry Heat: The structure to be thermally precleaned is subjected to elevated temperatures by appropriate means, such as an oven, in order to: (1) thermally degrade wax, grease, oil, tar, drawing compounds (if the proper temperatures are achieved), and some hydrocarbon-based volatiles; and (2) embrittle existing coatings to facilitate their removal from ferrous and nonferrous substrates. Thermal precleaning removes all volatile contaminants from the substrate that might otherwise come out during the curing process and result in blistering of the coating.

Wet Heat: The structure to be thermally precleaned is heated to elevated temperatures by steam (pressurized or unpressurized) for the purpose of diluting and removing salts of oxidizing acids such as nitric and sulfuric acid, mineral

acids such as hydrochloric acid, alkalies, and other chemical contaminants such as sulfates and chlorides that either reside on or have permeated the grain boundaries of ferrous and non-ferrous surfaces.

Preparation for Thermal Precleaning

All heavy deposits of wax, grease, oil, etc., some of which may autoignite when heated, are typically removed in accordance with SSPC-SP 1, "Solvent Cleaning."³ Heavy rust scale, nodules, tubercles, and other encrusted contaminants can be removed prior to thermal precleaning in order to facilitate removal of embedded contaminants. The methods of removal include abrasive blasting (such as NACE No. 4/SSPC-SP 7⁴), water blasting or water jetting (in accordance with NACE Standard RP0172⁵), or mechanical means such as hand or power tool cleaning (in accordance with SSPC-SP 2,⁶ or SSPC-SP 3⁷).

Application of Thermal Precleaning

Thermal precleaning is time and temperature related. Previous experience is generally the governing factor in the length of time required to effectively remove deleterious amounts of contaminants from the substrate. The specific temperature and duration of the heat application vary with the heat method, type of contaminant, substrate material, and complexity of substrate configuration.

CAUTION: Some exterior paints or other components (such as alloys, wooden bolsters, elastomeric materials in valves, gasket materials, etc.) of the item being heated may be altered or adversely affected by the applied temperature. Some compounds/chemicals that are in contact with the substrate may cause stress corrosion cracking in welds and base metals, and more elaborate testing/inspection is typically performed in these cases. The item to be thermally precleaned is typically inspected for stress corrosion cracking before precleaning, if possible, or before lining application if base metal is obscured by existing linings or corrosion deposits. Thermal precleaning is not intended for use in the removal of hydrogen in steel.

Dry Heat

Thermal precleaning using dry heat may degrade or char existing coatings and/or remove some contaminants from the surfaces of tanks, vessels, piping, and other hydrocarbon-contaminated surfaces. Oven temperatures are typically 232 to 426 °C (450 to 800 °F). Under certain conditions lower temperatures are sometimes used; general practice is that the thermal precleaning temperature be a minimum of 28 °C (50 °F) above the curing temperature of the coating to be applied or the operating temperature of the equipment. When high-bake coatings are to be applied to a contaminated structure, the structure is thermally precleaned at a temperature in excess of the final bake temperature of the coating being applied. This procedure

⁽³⁾ Chaired by the late Carroll Steely, formerly with Vickers Industrial Coatings, Lyons, Texas.