

SSPC: The Society for Protective Coatings

TECHNOLOGY UPDATE NO. 6

Chemical Stripping of Organic Coatings From Steel Structures

1. Scope

This document defines chemical strippers and discusses their use for removing existing conventional organic coatings from steel structures. Chemical stripping is recognized as one of a number of technologies available for the removal of existing coatings prior to repainting.

2. Description and Use

Chemical stripping involves application of a chemical to existing paint, allowing it to dwell for a period of time to attack the organic binder, removing bulk paint/stripper residues, and properly cleaning the steel substrate prior to repainting. Section 3 below describes methods used to identify which type of stripper will work most effectively, and typical application and removal options. Section 3 also presents containment and disposal options for stripper wastes.

3. Discussion

3.1 GENERIC STRIPPER TYPES AND USES: The chemical composition of strippers falls into two distinct generic categories. The first group is generally a blend of low molecular weight solvents known as "bond breakers." The stripper solvents break existing paint bonds and "wrinkle" the paint so that it can be removed from the surface. Where old paint exists in multiple coats, bond breakers may require multiple applications for complete removal. Bond breakers may contain toluene, methylene chloride, or methyl ethyl ketone, which can remove paint faster, but may result in worker exposure to potentially hazardous chemicals and therefore require special worker protection to maintain exposure below permissible exposure limits (PELs). Bond breaking strippers may also be comprised of compounds such as N-methyl-pyrrolidone (NMP) or dibasic ester (DBE). These strippers work more slowly but are generally less toxic and may require less stringent worker protection. The bond breakers are generally selected for use in removing all coatings except oil-based, inorganic, or metallic coatings. The second category of chemical strippers is the caustics. These strippers contain one or more common caustic chemicals, such as sodium, calcium, and magnesium hydroxide. Rather than attacking bonds between coating layers or between coating and substrate, caustics soften the entire paint system. Their use is generally restricted to oil based paint systems, typical of those found on structures such as bridges and tank exteriors. These older structures more commonly contain lead-based primers, on which caustics have proven to be quite effective. An exception to the use of caustics on oil based paint exists where aluminum flake pigment is present. Caustics cause aluminum

to produce bubbles of hydrogen at the interface between the stripper and the substrate, rendering the stripper ineffective. For these applications, the aluminum-containing coatings must first be removed using one of the bond breakers, typically an NMP based product.

3.2 STRIPPER SELECTION: Chemical stripper selection is based upon a number of variables, all of which can be assessed by performing patch tests on the existing paint system. Typical variables include thickness of the existing coating, ambient temperature and humidity, presence of aluminum paint, and time restrictions on the potential job site such as traffic control restrictions. Since these variables do exist, it is highly recommended that a representative from the stripper manufacturer, or his agent, be present to assist in conducting patch tests. Changes to application parameters (such as amount applied and dwell time) can affect the results of a patch test. A trained manufacturer's representative can assist in proper assessment of patch test results. To account for existing paint thickness variations on a candidate structure, patch tests should be conducted in more than one location and each should cover at least one square foot of surface.

The stripper types described in Section 3.1 generally work best at ambient temperatures above 10 °C (50 °F) and at high relative humidity. When using the bond breaker strippers, application thicknesses and dwell times will vary. However, products with solvents of low molecular weight and thus greater volatility have far shorter dwell times than the less volatile NMP/DBE products. Also, the latter products are generally lower in volatile organic compound (VOC) solvent content. As mentioned in Section 3.1, the bond breakers frequently require multiple applications to remove existing paint systems completely.

The caustics will typically remove up to 500 micrometers (20 mils) of existing oil (e.g., alkyd) paint systems using a stripper wet film thickness of 1600 micrometers (63 mils). Coverage rates at 1575 micrometers (62 mils) application thickness average between 0.5-0.6 m²/L (20-25 sq. ft/gal) for caustic strippers. Coverage rates will decrease in direct proportion as application thickness increases. Dwell time for alkyd coatings will vary between 4 and 24 hours, depending on their oil length. Variations of the existing paint thickness as well as weather conditions can greatly impact dwell times. Properly supervised patch testing can accomplish assessment of all the variables and will provide definitive information regarding performance of stripper type and cost for each application. It is recommended that service environment conditions during patch test and stripper application be fully documented.

3.3 CONTAINMENT: Containment guidelines for chemical stripping involve the following considerations:

during stripper application; during stripper removal; during surface preparation for painting; and during painting. Each of these considerations will vary based on geometry of the structure (tanks, bridges, pipelines) as well as on which methods are used for application and removal of the stripper. In general, the containment structure should be in accordance with SSPC-Guide 6 (Class 1C, 2C or 3C), and it should be constructed so as to prevent stripper residues from impacting the immediate environment. Typically, plastic sheeting, at least 150 micrometers (6 mils) thick, is resistant to the chemical strippers described above, and works adequately for most applications, if it can withstand any anticipated wind load. For some structures such as around the circumference of ground storage tanks, additional materials such as plywood may be employed to serve as a base for retaining solid stripper residues so they can be more easily transferred into waste containers. In addition, it is advisable to provide some means of containing any rinse liquids generated during stripper removal. Containment structures may or may not require forced air ventilation based on which type of stripper is used, the method of removing the stripper, potential exposures during pre-painting and painting operations, and project locale.

3.4 WORKER HEALTH AND SAFETY: Specific requirements for worker health and safety can be found by referring to the product specification sheets and material safety data sheets supplied by the chemical stripper manufacturer. Typically, caustic strippers are water based and therefore do not release significant airborne contaminants. However, since they are corrosives, they can cause skin burns. Materials that are chemically impervious must be used to protect eyes and skin. Solvent based strippers also require chemically resistant skin protection, and protection against airborne solvent vapors may be required. Depending upon the method of removal (see Section 3.6), airborne concentrations of toxic metals may be encountered when removing coatings containing lead or other toxic metals.

Specific respiratory and personal protective equipment requirements should be in accordance with all applicable OSHA standards.

3.5 STRIPPER APPLICATION: Procedures for applying chemical strippers vary based on geometry of the structure to be stripped, type of stripper used, and productivity desired. In general, strippers are spray applied using conventional paint pumps. Caustic strippers require pumps which are chemically resistant and can accommodate thicker materials. The caustics should be air sprayed but the bond breakers can be applied with airless pumps. Chemical strippers may also be applied using trowels or brushes although these tools will generally not allow for the thickness control which can be achieved by spraying.

Some caustic applications may require using a splatter coat prior to full application of the stripper. The splatter coat is a light, non-continuous application of the stripper which is allowed to dry prior to spraying the full stripper coating. The splatter coating is typically required on older alkyd paint systems,

where the caustic causes accumulation of oil at the steel/coating interface, resulting in loss of stripper adhesion on vertical surfaces. The dried splatter coating will prevent this premature release and allow the stripper to complete its stripping cycle. The need for a splatter coating is typically discovered during the patch test cycle.

Production rates for strippers can vary greatly and should be determined based on patch tests and other variables listed above, but typically should be directly related to how much area can be cleaned following the dwell cycle. For example, if the dwell cycle is overnight, application will generally take place in the previous afternoon. The area sprayed should be restricted to that which can be properly cleaned prior to the next spray cycle. For tanks, using a three man crew, production rates are typically between 300 to 400 m² per day (3,000 to 4,000 sq. ft. per day) for a complete application/removal cycle, whereas for bridges and other structural steel of complex geometry, these rates will drop to between 100 to 200 m² per day (1,000 to 2,000 sq. ft. per day).

3.6 STRIPPER REMOVAL: Chemical stripper residues can be removed using a number of methods which include both hand and mechanical tools and rinsing or wiping. Choice of removal methods should be based on structure geometry, production rate desired, and collection of waste residues. When removing residues where bond breaker strippers have been used, rinsing is usually not required, but the surface may require a wipe prior to a second stripper application or subsequent surface preparation for painting. This step, if required, will be identified during patch testing.

Most older structures with lead paint will be chemically stripped using a caustic product. This process requires hand scraping the bulk residues using broad knives, followed by rinsing to remove any remaining lead primer residues. The rinsing step can be accomplished with wet sponges for smaller areas but for larger jobs, rinsing should be done with a system which produces a minimal amount of water. Typically, any airless paint pump using a 0.5 mm (0.02 in) tip, will generate a rinse stream of less than 1.25 L/min (0.33 gal/min) at 3.4 MPa (500 psi). This will suffice to remove any excess stripper residues with minimal water waste. Pressure washers are not recommended as they generate more pressure and water and their waste streams are more difficult to contain. Other mechanized removal processes which can enhance productivity while minimizing waste include ice blasting, carbon dioxide (CO₂) blasting, and vacuum rinsing.

During stripper removal, care must be taken to direct all wastes, including rinse liquids, to the containment area. Certain structures may lend themselves to separation of liquids and solids. Where applications produce excessive liquids during the removal cycle, stripper residues can be filtered to facilitate easier disposal (see Section 3.7 below).

Following removal of caustic chemical stripper residues, steel surfaces will typically exhibit some degree of alkalinity. This alkalinity may require reduction prior to painting, based on the chemistry of the coating to be applied. Surface pH can