Tank Lining

Application Guide

The rubber lining industry is focused around protecting metallic structures with an elastomeric lining. Linings are suggested when metals will be exposed to harsh chemicals, abrasion and corrosive environments. Rubber lining is currently used on pipes, pumps, rail cars, storage tanks, processing tanks, plating tanks, extraction tanks, scrubbers, coal handling and mining equipment.

Metal and Metal Preparation:

Steel is the principle metal used in the rubber lining industry. When properly cleaned and protected, it provides an excellent balance of cost and service life. For severe service conditions, other metals such as stainless steel or aluminum can also be used.

Steel – The metal surface must be free of all contaminants before adhesive application. Mechanical blasting is suggested to remove any rust, scale or other tightly adhered contaminants from the steel surface. Usually sand or 25-40G steel grit is used to blast until a near-white or white metal finish is observed. A maximum blast profile of 2-4 mils is suggested for most substrates. Vacuuming or sweeping should follow the blasting step to remove dust. Degreasing before blasting is suggested whenever possible.

After blasting and degreasing, care should be taken to prevent recontamination of the clean metal surface. If possible, the prepared surface should be covered; a primer or adhesive layer should be applied within two hours after blasting. When humidity level reaches or exceeds over 70% relative humidity, the primer or adhesive should be applied as soon as possible after blasting. Moisture condensation can occur on uncoated tanks left outdoors overnight. This can result in a layer of oxidation or rust on the metal surface. Avoid blasting the metal if the dew point is within 3°C (5°F) of the current temperature to avoid condensation risk.

Stainless Steel – The same process steps noted above can also be used for the preparation of stainless steel substrates. Oxidation will rapidly begin shortly after blasting stainless steel. Sand or aluminum oxide blast media is preferred since steel grit can leave ferrous deposits on the substrate and result in rapid galvanic corrosion. The layover between blasting and coating should not exceed 2 hours after blasting during high humidity.

Aluminum – Aluminum substrates should also be prepared by blasting. Sand or aluminum oxide blast media is preferred since steel grit can leave ferrous deposits on the substrate and result in rapid galvanic corrosion. The layover between blasting and coating should not exceed 2 hours. The primer or adhesive should be applied as soon as possible after blasting.

Check blast media regularly. This inspection should include evaluating the size of the blast media and checking for contamination such as oils, grease and rust scales that have been previously removed.

During the blasting operation of various substrates, dust collection systems can help reduce the amount of fine particles that could be deposited back onto the metallic surface. Routine maintenance should be completed on compressed air filters to ensure a clean air supply.

Chemlok® Adhesives:

There are a variety of Chemlok® primers and adhesives available for use in the rubber lining industry. Technical data sheets are available for the primers and adhesives referenced below.

Primers – In the rubber lining industry, primers are used for adhesion to both the metallic substrate and the adhesive. Primers can significantly improve the environmental resistance of the bonded assembly.

Intermediate Coat Adhesives – These adhesives are typically used over primers and function by bonding to both the primer and tack cement.

One-Coat Adhesives – These products are self-priming adhesives that do not require the use of a metal primer. These adhesives can adhere to both the metallic substrate and the tack cement.

Tack Cements – These adhesives are used to hold the rubber lining to the primer and adhesive-coated substrate before the rubber is cured. Tack cements also allow for the repositioning of the rubber lining during the layup process. Typically, tack cements are similar to the rubber lining adhering via diffusion with adhesives during cure.

Preparing the Adhesive:

Temperature – Temperature affects the viscosity of Chemlok primers and adhesives. If stored cold, allow product to return to the typical working temperature before using. Drums may take as long as 48 hours to warm to temperature. Recommended storage temperature is 21- 27˚C (70-80˚F). Cold storage is not recommended.

Pails, Single Gallons and Smaller Containers – Hand stir in a "figure 8" motion with a wooden paint stick. For gallon containers, paint shakers may also be used with solvent-based adhesives. Fifteen minutes is usually sufficient. Most drum-packaged products are supplied with a built-in agitator. Chemlok 290 drums do not require agitation. See Table 1 for suggested mixing cycles based on container type. To prevent sparks from static electricity, drums should be properly grounded.

Continue mixing until all settled material is removed from the bottom and the solution has a uniform appearance. Stir frequently during use.

To minimize solvent loss, replace the container lid when not in use. Solvent loss reduces ingredient solubility, and increases solids content and viscosity.

Caution: If used, electric mixers should have spark-proof motors.

The primers and adhesives were developed for use without the requirement of solvent dilution, but small volume dilutions (10% or less) with compatible solvents can be conducted while mixing. Note that dilution will likely affect drying characteristics and dry film thickness of the applied coating layers.

Table 1. Mixing Cycle by Container Type

Container Type	Product Preparation	Mixing Time
Quart (1.1 L) Can	Hand stir	10-15 minutes
1-Gallon Can	Hand stir and paint shake	20-30 minutes
5-Gallon Pail	Hand stir and air-driven mixer	45-60 minutes
55-Gallon Drum*	Hand crank and air-driven mixer	8 hours

*Does not apply to Chemlok 290 adhesive.

Table 2. Minimum Recommended Dry Film Thickness and Coverage

	Suggested Minimum Dry Film Thickness	Suggested Maximum Dry Film Thickness
Adhesive System		
Chemlok 289 Primer	10.2 microns (0.4 mils)	20.4 microns (0.8 mils)
Chemlok 290 Adhesive	2.5 microns (0.1 mils)	5 microns (0.2 mils)
Chemlok 286 Tie Cement	12.7 microns (0.5 mils)	25.4 microns (1.0 mils)
Adhesive System		
Chemlok 205 Primer	10.2 microns (0.4 mils)	20.4 microns (0.8 mils)
Chemlok 6224 Adhesive	12.7 microns (0.5 mils)	25.4 microns (1.0 mils)
Chemlok 286 Tie Cement	12.7 microns (0.5 mils)	25.4 microns (1.0 mils)

Applying the Adhesive:

Various application methods are used to apply Chemlok primers and adhesives in the rubber lining industry, though brush and roll coat applications are the most popular. Both brushing and roll coating are cost effective application methods which apply an even coat of primer, adhesive or tack cement.

Nylon or natural bristle brushes are preferred when applying product by brush method. If brush strokes are visible or bare substrate or previous coats are exposed, then primer or adhesive film thickness is too low; additional product should be applied. For roll coat application, short nap rollers (5 mm) are recommended.

Primers should be applied directly to the prepared substrate as soon as possible. High humidity can cause rapid oxidation of bare metals. It is important to achieve 100% coverage of the substrate with Chemlok primers and adhesives since bare spots can result in bond failure. See Table 2 for minimum and maximum dry film thickness recommendations. Above 25.4 microns (1.0 mils), a coating layer is at risk for fracture and resulting bond failure.

Allow the primer to dry 30-60 minutes prior to applying the adhesive. The adhesive should be allowed to dry for 30-60 minutes prior to rubber layup. Inadequate drying of any layers may cause blistering during curing of the rubber.

Several days or weeks can elapse between adhesive application. It is important to control and minimize contamination of the primer or adhesive layer by protecting coated parts from the elements. Tack cement should be applied to the substrate at the time of rubber layup.

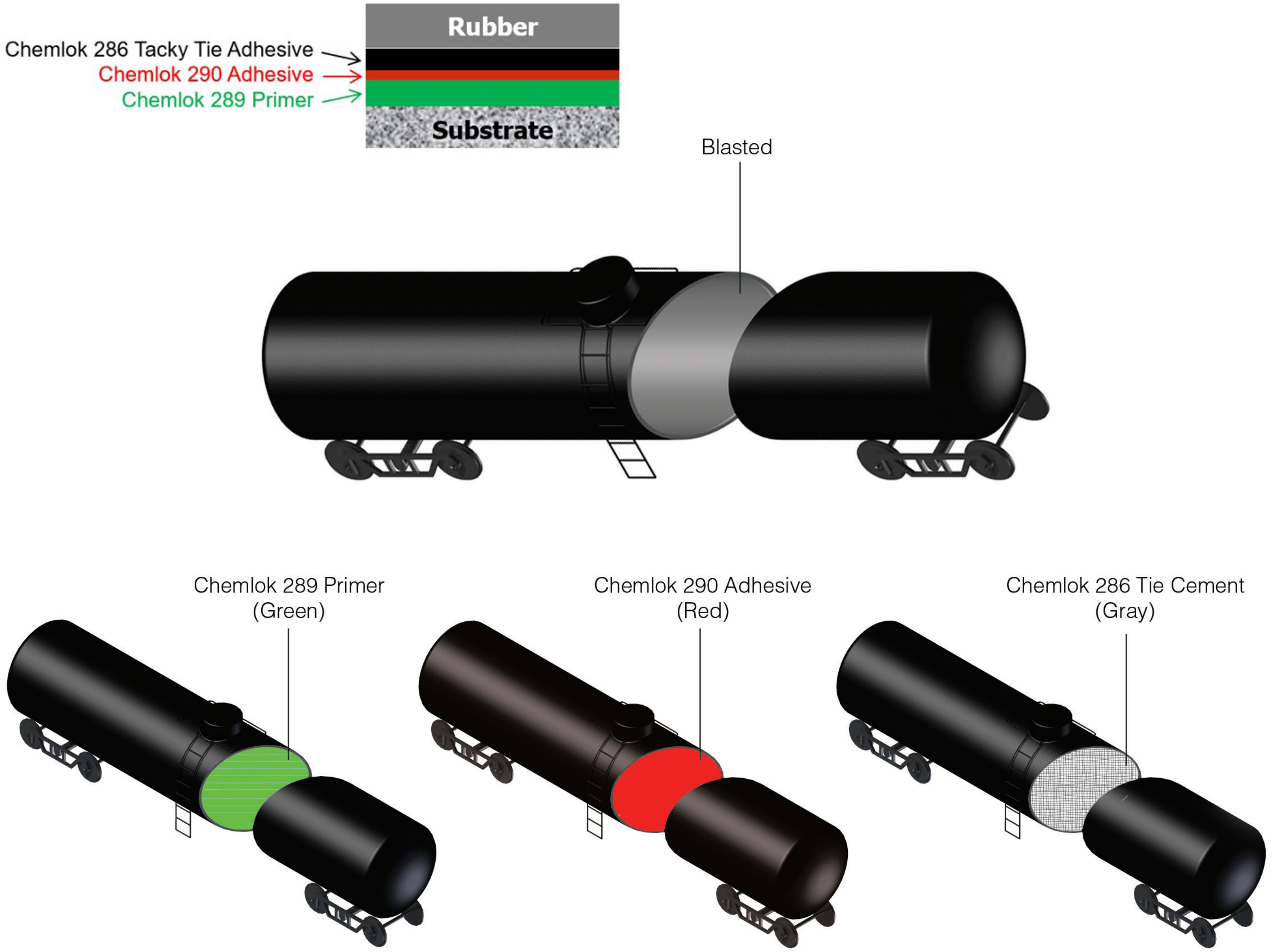

Figure 1. Cross Section Chemlok 289/290/286 Bondline

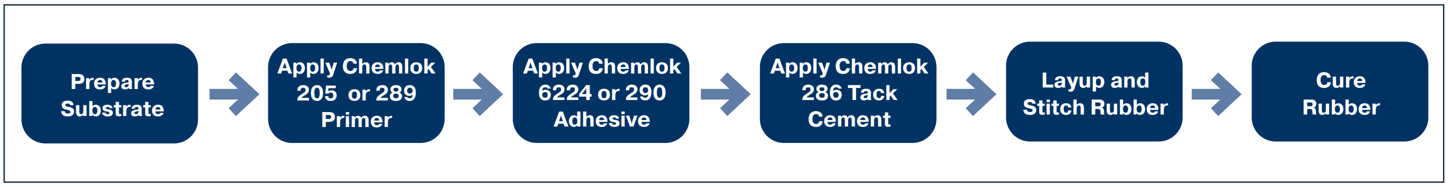

Figure 2. Rubber Lining Process

Table 3. Evaluating Rubber Performance

1	**Excellent**
2	**Good**
3	**Fair**
4	**Poor**

	Natural Rubber	Synthetic Polyisoprene	SBR	Chloroprene	NBR	Butyl	Polybutadiene	EPDM	Polysulfide	Polyurethane	Polyacrylate	Silicone	Fluorocarbon	Chlorosulfonated PE
Physical Properties														
Tensile Strength	1	2	2	2	2	2	2	2	4	1	3	4	3	3
Elongation	2	1	2	1	2	1	2	2	2	1	3	1	3	3
Compression Set	2	3	2	2	2	3	3	3	4	1	2	1	1	2
Resilience	1	1	2	1	2	3	1	2	3	1	2	2	3	2
Electrical Resistance	1	1	1	3	4	1	1	1	3	2	3	1	2	2
Mechanical Resistance														
Tear	1	2	3	2	2	2	2	4	3	1	3	3	3	2
Abrasion	1	1	1	1	1	2	1	2	3	1	2	3	2	2
Cut Growth	1	1	2	2	2	1	3	2	4	2	2	3	3	2
Temperature Resistance														
Heat	2	3	2	2	2	1	3	1	2	2	1	1	1+	1
Low Temperature	2	2	3	3	3	3	2	2	2	3	4	1	4	2
Environmental Resis-tance														
Water	1	1	1	2	1	1	1	1	2	2	3	2	2	2
Acid	2	2	2	2	2	1	2	1	3	3	3	3	1	1
Alkali	2	2	2	2	2	1	2	1	2	3	4	3	3	1
Aliphatic Hydrocarbons	4	4	4	2	1	4	4	4	1	1	1	2	2	2
Aromatic Hydrocarbons	4	4	4	4	2	2	4	3	1	3	4	3	1	1
Chlorinated Solvents	4	4	4	4	4	4	4	4	2	2	4	3	3	1
Ketones	2	2	2	3	4	2	4	1	2	4	4	3	4	3
Alcohol	2	2	3	3	1	1	2	4	2	2	4	2	1	2
Lubricating Oils	4	4	4	2	1	4	4	4	1	2	1	4	2	4
Synthetic Oils	3	3	4	4	2	3	3	3	2	4	2	3	2	4
Hydraulic Oils	4	4	3	2	3	3	4	2	3	4	2	4	2	2
Fuels	4	4	4	2	1	4	4	4	1	1	1	3	1	3
Weather	3	3	3	1	2	1	3	1	1	1	1	1	1	1
Oxidation	2	2	2	2	2	1	1	2	1	1	1	1	1	1
Ozone	4	4	4	1	4	1	4	1	1	1	1	1	1	1

Rubber Application:

Prior to application, the calendared rubber sheet must be clean of contaminants. Freshly calendared sheets may not need special preparation. Highly talc-coated sheets or those with excessive dirt may need to be solvent wiped prior to application.

Typically the rubber sheet will have a plastic film covering the side to be bonded. This plastic film must be removed prior to the rubber application.

Chemlok solvent adhesive or tack cement can be applied to the side of the rubber sheet that will be in contact with the adhesive-coated surface. This adhesive or tack cement should be dried for 30-60 minutes, allowing for diffusion into the rubber sheet. This also helps to avoid solvent entrapment which can lead to blisters and bond failures.

Concurrently, Chemlok tack cement is applied to the adhesive-coated metal tank.

The rubber sheet must be applied to the Chemlok adhesive-coated surface without stretching. The stock must be rolled down without trapping air between the rubber and adhesive-coated tank. A clean cloth liner is often used when handling the rubber stock. The rubber needs to be properly stitched or pressed onto the substrate after application.

Seams are usually prepared in either lap or butt joints. Lap joints consists of a 45-degree skive cut that is overlapped 1-1.5 inches (25.4-38.1 mm). Butt joining typically uses a strip of rubber to cover the seam created by the two 45 degree skive cuts. This thin strip of rubber can be solvent wiped or coated with tack cement. Reference the owner specification for detailed instructions on how to properly prepare a seam for the given application.

Figure 3. Rubber Stitching after Application

Vulcanization Techniques:

There are three main techniques used throughout the rubber lining industry to cure the rubber. Selecting the proper vulcanizing technique is based on the rubber, substrate and size of the bonded assembly.

- Autoclave Curing – high heat, high pressure
- Exhaust Steam or Hot Water Curing – medium heat, low pressure
- Chemical Curing – low temperature, no pressure

Autoclave Curing

Autoclave curing provides a fast cure and high quality adhesion between the substrate, adhesives and rubber. The autoclave curing process is limited by the size of the tank and/or autoclave vessel. Autoclave cure temperatures usually range from 120-170°C (248-338°F). Times vary from 30 minutes up to 24 hours depending on temperature, substrate size, rubber thickness, and cure package. The rubber supplier should be contacted for proper cure conditions of the rubber for each rubber lining application.

Exhaust Steam or Hot Water Curing

Exhaust steam or hot water is also used in the rubber lining industry. These methods would include the introduction of live steam or hot water under minimal pressure into the tank or vessel to complete the vulcanization process. Size of the substrate is not as critical compared to the autoclave curing process; however large vessels can be difficult to keep at an elevated temperature. Cure temperature is limited to 75-95°C (167-203°F) due to the inability to develop pressure. Due to the lower temperatures of exhaust steam or hot water, moderately longer cures of 24-72 hours are required.

Chemical Curing

Chemical curing can be used when higher temperature curing is not applicable due to substrate size or on-site relining applications where heat may not be readily available.

Troubleshooting:

ASTM International provides a set of detailed symptom descriptions for bond failures. These descriptions allow complete and accurate problem assessment as well as quick solutions. (In this document, the terms “elastomer” and “adhesive” should be interpreted as “rubber” and “cement”, respectively.)

The four basic ASTM International designations are:

- **RC** – failure at the rubber-cement interface.
- **CM** – failure at the cover cement-metal interface; or at the primer-metal interface.
- **CP** – failure at the cover cement-primer interface.
- **R** – failure in the rubber.

Rubber-Cement (RC) Failures

Separation between rubber and cement is usually characterized by a hard, glossy surface on the metal with little or no visible rubber.

Common causes of RC failure include: precuring of the adhesive or rubber before the rubber comes in contact with the adhesive; inadequate cement film thickness; low molding pressure or temperature; inadequate cure; and migration of plasticizers, oils and other incompatible compounding ingredients.

Cement-Metal and Primer-Metal (CM) Failures

A clean separation between metal and primer or adhesive indicates that no adhesion has occurred. Often, oil, dirt, dust or other contaminants inhibit bonding. In some cases, environmental factors cause under-bond separation.

Cement-Primer (CP) Failure

Separation at the cover cement-primer interface is easily detected if the primer cement and cover cement are different colors. These failures are invariably due to contamination of the primer, plasticizer migration from the elastomer, or inadequate primer/adhesive mixing or drying.

Rubber (R) Failures

Rubber failures are separated into the following categories:

SR (Spotty Rubber) – Often caused by pre-bond surface contaminants, this failure appears like splattered rubber on the metal surface. SR breaks are also caused by ultra-fast adhesive drying as it leaves the spray nozzle (cobwebbing).

TR (Thin Rubber) – Thin rubber failures are marked by even, but very light rubber residue on the metal surface. These imperfections usually occur with butyl or rubber stocks that are highly oil-extended. When oils migrate to the RC interface, they create a bond layer that is part adhesive, part oil and part rubber. This weak layer easily fails when the part is stressed.

HR (Heavy Rubber) – A thick or heavy layer of rubber remaining on the metal surface indicates an excellent bond. The stock fails because it is stressed beyond its cohesive strength.

SB (Stock Break) – With stock breaks, the elastomer appears as if it was folded back on itself, then broken off. The break is jagged and at a sharp angle to the metal surface.

Although there are four primary bond failures, keep in mind that rubber-cement, cement-metal and rubber failures are often found in combination.

Safe Handling:

The solvents used in most primers and adhesives are flammable. Improper use of these safety precautions could result in fire or explosions.

No open flame, welding or smoking should be permitted during the rubber lining operation. **Avoid the use of electrical switches, tools or fans that could generate a spark within close proximity to the lining operation. Brass or non-sparking tools should always be used on metallic surfaces to prevent sparking from occurring.** Plastic containers and tools should be avoided due to risk of spark generation with friction.

All equipment used in the lining application should be electrically grounded to prevent sparking. See Figure 4 for an example of a safe drum setup.

Proper ventilation or proper personal protective equipment should always be used when handling primers and adhesives.

Proper handling of Chemlok adhesives is essential for safe and effective application. Follow recommended safety procedures when using any Chemlok product:

- Ventilate application and storage areas.
- Avoid use around ignition sources.
- Utilize clean, dry sources of compressed air to avoid contamination.
- Wear proper personal protective clothing.
- Clean application and processing equipment regularly.
- Dispose of waste according to federal, state and local regulations.
- Read labels, SDS and data sheets before use.
- Consult the safe handling guide for more detailed safety information.

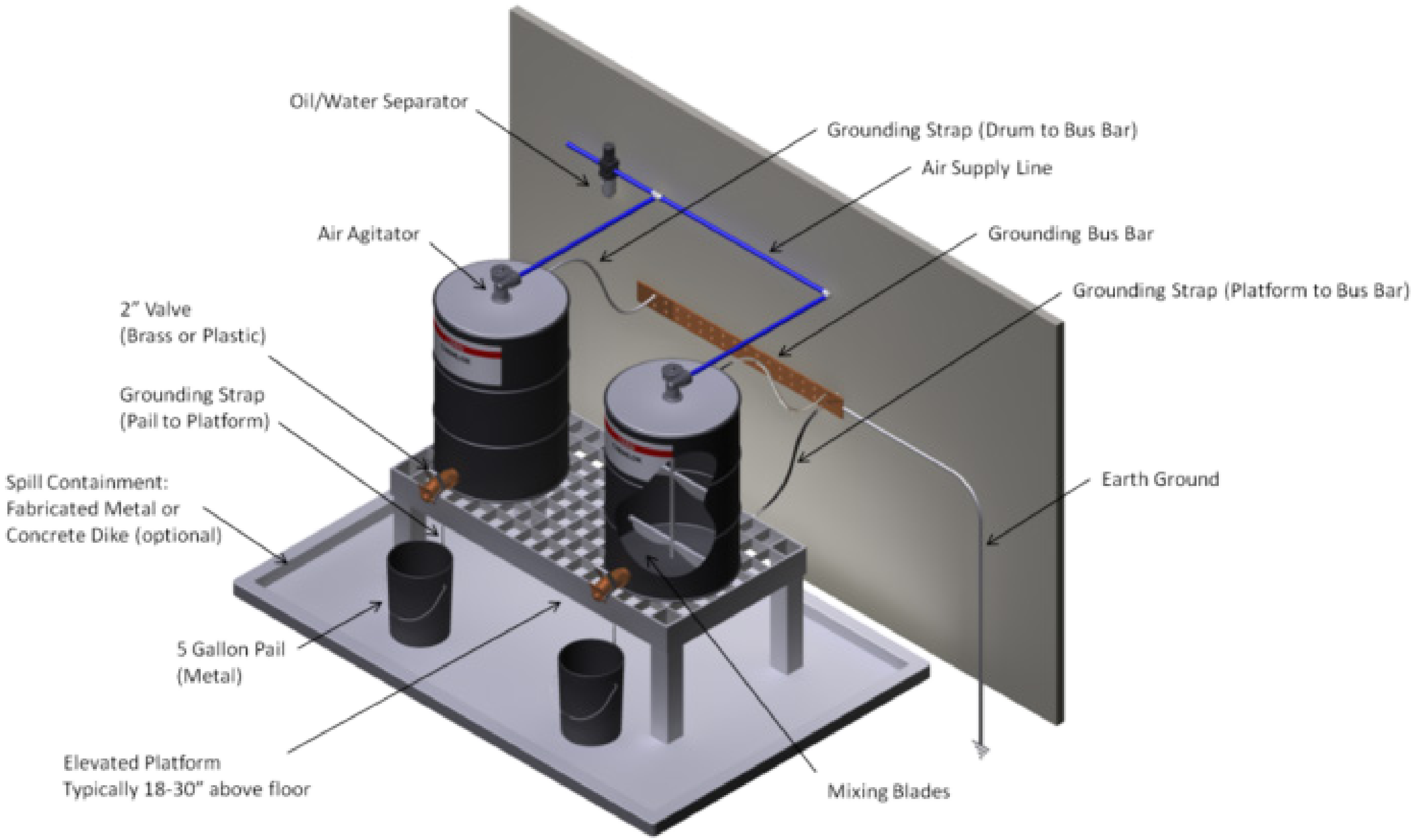

Figure 4. Drum Setup with Safety Features

OD AG1012 04/24 Rev.3

Parker Lord
Engineered Materials Group

111 LORD Drive
Cary, NC 27511-7923
USA

phone +1 877 275 5673

www.Parker.com/EPM