Solvent-Based Chemlok® Adhesives

Application Guide

Chemlok® rubber-to-metal adhesives were first introduced in 1956. While much has changed during this time, one thing remains constant: the quality of Chemlok adhesives. The Chemlok brand is recognized globally as the industry leader in rubber-to-metal adhesives. Thus, when manufacturers have a critical application that demands a proven rubber-to-metal adhesive, they look to Chemlok products.

Although a premium adhesive is the basis of a quality bond, it's only the beginning; proper application is essential for maximum results. Whether you're dipping or spraying, you'll learn how to maximize efficiency and optimize results. This guide also shows how to troubleshoot common bond problems.

We recommend you read this entire booklet before using solvent-based Chemlok adhesives; however, we realize that many of our customers have been using our products for years, and reading this guide from cover to cover is not necessary. Regardless, we hope this resource will become an indispensable part of your operation and a convenient, one-source solution to many of your bonding questions.

Packaging:

Chemlok solvent-based adhesive systems are available in several sizes to accommodate varying production requirements. Choose from one of these convenient packages:

- 1-gallon pails (3.8 L)
- 5-gallon cans (18.9 L)
- 55-gallon (208.2 L), phenolic-lined metal drums with agitator paddles.

Substrate Surface Preparation:

One of the most important factors influencing adhesion in the bonding process is surface preparation. To ensure optimum bond performance and long-term environmental resistance, substrates must be free of organic and inorganic contaminants. Organic materials include grease, dirt and oils which can be removed by solvent or alkaline cleaning. Common inorganic contaminants are rust, scale and oxide layers. These can be cleaned by either mechanical or chemical processes, or a combination of both.

Types of Surface Preparation:

There are a number of ways to prepare substrates for adhesive application; however, the methods can be broadly divided into mechanical and chemical. Regardless of which method you choose, the essentials of all good surface preparations include:

- Removal of all surface contaminants and decomposition products.
- Prevention of recontamination.
- Careful handling through all processing steps.

Mechanical preparation involves physically removing surface contamination and increasing surface area and substrate profile. These methods include:

- Blasting – Abrasive particles (sand, grit or metal oxides) are projected against the surface with a stream of air. Blasting is especially effective for removing inorganic contamination and other corrosion compounds found on metal. The character or quality of the treatment is affected by duration of the blast; shape and size of the blasting media; particle velocity; and the hardness, porosity and other substrate properties.
- Abrading – A wire brush or abrasive paper is used to grind the surface. Care must be taken to prevent contamination of the abrasive material and to remove dust and particles after use.
- Machining – If cutting oils are completely removed, machining may provide an acceptable bonding surface. However, any oil/grease left on the metal surface will reduce adhesion. For optimum bond results, do not exceed an eight-hour layover period between machining and adhesive application.

Chemical processes, on the other hand, utilize organic and inorganic chemicals to dissolve, suspend or eliminate soils and surface contaminants. Preparation methods include:

- Vapor/solvent degreasing – The solvent vapor or alkaline cleaning solution is utilized to eliminate organic contamination or oils. Because degreasing will not remove scale or corrosion, it's best to use in conjunction with blasting for metal substrates.
- Anodizing – Aluminum oxides are electrolytically deposited on bonding surfaces.
- Passivation
- Zinc phosphating
- Alkaline cleaning
- Chromate alodizing
- Chemical etching

Special Note About Degreasers
Although chlorinated solvents like trichloroethylene and perchloroethylene are still used for degreasing, many companies have discontinued use due to environmental and health-related issues. As a result, many "environmentally preferred" alternatives have been developed, which produce surfaces clean enough for use with adhesive systems. Popular alternatives to chlorinated solvent degreasers include:

- *Water-based alkaline cleaning systems, which have been used with solvent-based and water-based adhesives.*
- *Environmentally preferred petroleum-based solvents.*

Selecting a Preparation Method:

To determine which preparation method best suits your needs, consider:

- **Economy** – In large volumes, chemical treatments are generally less expensive than mechanical methods.
- **Versatility** – Mechanical preparation methods may be applicable to numerous metals, while chemical treatments may be metal-specific.
- **Adaptability to Existing Equipment** – Existing facilities may favor either mechanical or chemical processing.
- **Adhesion Requirements** – Adhesion requirements vary from product to product, and bond quality is affected by the particular application. Therefore, surface preparation will vary accordingly.
- **Environmental Resistance** – Chemical conversion often provides enhanced environmental resistance compared to mechanical methods.
- **Government Regulations** – Waste disposal regulations may prohibit the use of chemical treatments in certain areas.

Maintaining Surface Conditions:

Maintaining optimum surface cleanliness is essential until adhesive application is complete. To accomplish this:

- Apply the primer or adhesive immediately after the surface is prepared.
- Avoid exposure to dust, moisture, chemical fumes, mold release agents and other possible contaminants.
- Keep solvents and cleaning solutions free from contamination, and replace when necessary.
- Ensure grits and abrasives remain clean and free of contaminants.
- Check the purity of rinse water and "drying" air frequently, ensuring minimal contamination.

The water break test can be used to check for oil and grease removal. If a surface can support an unbroken film of deionized water for 60 seconds or more, it is considered essentially free from grease or oil.

General Surface Preparation:

The following three-step process is the preferred mechanical surface preparation technique.

1. Degreasing;
2. Grit-blasting; and
3. Degreasing.

The above methods produce excellent surfaces for bonding most substrates. Sometimes, more elaborate chemical methods may be needed for certain substrates or for improved environmental resistance. For more information, please contact your Parker LORD Representative. Details on each specific method mentioned above are described under the heading for the specific substrate.

Regardless of the system, selected parts must remain clean when being removed from the cleaning tank. Water break tests (ASTM International F22) should be performed regularly to check cleaning effectiveness.

Surface Preparation for Various Substrates:

Although the general principles are the same for preparing all substrates, some materials require special attention. Outlined below are guidelines for surface preparation of specific substrates:

Steel (Mechanical Preparation)

Grit blasting (with steel or aluminum oxide) is widely used for preparing steel surfaces. It is especially effective for metals covered with rust, scale, oxide layers and similar corrosion compounds.

Steel preparation usually involves:

1. Degrease – The initial alkaline cleaning is used to remove soils such as greases and oils. This is done to prevent grit contamination during the subsequent blasting step. Scale or corrosion will not be removed.
2. Grit Blast – Blasting consists of impinging abrasive particles against the metal surface with an air stream that is free of oil and water. Grit size most commonly used is G-40. Use of grit is preferred over the use of shot since grit produces a rough, open surface, while shot peens the surface and sometimes causes occlusion with loose particles.
3. Alkaline Cleaning – The second alkaline cleaning step will ensure that abrasive dust and any contaminants that may be present in the blasting media are removed.

Consult the manufacturers of blasting equipment, abrasive media and alkaline cleaning units for specific information concerning equipment for this process. The names of representative qualified suppliers will be furnished on request.

Steel (Chemical Preparation)

Chemical treatments for steel typically include iron phosphate or zinc phosphate conversion coatings.

For rubber-to-metal bonding applications, calcium-modified, microcrystalline zinc phosphate (film weight of 125-450 mg/ft^2) is recommended.

Zinc phosphate treatment consists of:

1. Hot caustic clean
2. Water rinse
3. Phosphoric acid pickle
4. Water rinse
5. Zinc phosphate
6. Cold water rinse
7. Hot water rinse
8. Hot air dry

This type of surface treatment provides on-the-shelf corrosion protection of the uncoated part as well as improved under-bond corrosion protection.

For detailed information and names of representative suppliers, consult manufacturers of phosphating treatments and other chemical treatments.

Stainless Steel (Mechanical Preparation)

Preparing stainless steel with mechanical methods includes:

1. Blasting with sand or aluminum oxide. Steel grit should not be used because it leaves ferrous deposits that can cause galvanic corrosion.
2. One-hour layover maximum between blasting and adhesive application.

Stainless Steel (Chemical Preparation)

Chemical treatment for the passivation of stainless steel involves the following:

1. Vapor degrease and/or alkaline clean
2. Immersion for 15 to 20 minutes at 49- 57°C (120-135°F) in a solution of nitric acid (20-25% by weight), sodium dichromate (2-4% by weight) and deionized water (71-78% by weight).
3. Cold water rinse
4. Dry and apply adhesive within 30 days.

Immersion times, solution concentrations and operating temperatures may be adjusted to suit conditions and alloys.

Aluminum

The preferred mechanical method for preparing aluminum is blasting. This includes:

1. Blasting with sand or aluminum oxide. Steel grit should not be used because it leaves ferrous deposits that can cause galvanic corrosion.
2. Two-hour layover maximum between blasting and adhesive application.

Chromate alodizing of aluminum also produces excellent bonds. This involves:

1. Solvent degrease or aqueous clean
2. Water rinse
3. Deoxidizer
4. Water rinse
5. Chromate conversion treatment
6. Water rinse
7. Warm air dry

Consult the manufacturers of the proprietary materials used in these processes for more information.

Aluminum surfaces may also be prepared by anodizing (electrolytic deposition of aluminum oxide).

Magnesium

Depending upon the required environmental resistance, preparation of magnesium surfaces varies. Blasting with sand or aluminum oxide provides a good bonding surface, but the bond will not provide outstanding environmental resistance. For best results, use chemical methods such as chromic pickling or anodizing. The chrome-pickle process consists of:

1. Vapor degrease and/or alkaline clean
2. Cold water rinse
3. Chrome-pickle
4. Cold water rinse
5. Hot water rinse

Brass and Copper

In addition to blasting with sand or aluminum oxide, brass and copper surfaces may be treated with chemical methods including ammonium persulfate etching. This method involves:

1. Solvent degrease and/or alkaline clean
2. Immersion for 1 to 3 minutes at room temperature in a solution of ammonium persulfate (25% by weight) and water (75% by weight).
3. Water rinse at room temperature
4. Dry and apply adhesive as soon as possible.

In addition to ammonium persulfate etching, there are a number of commercially available etchants. Consult the manufacturers of these specific products for product selection and processing information.

Lead

Mechanical methods are used almost exclusively with lead and are usually satisfactory. If the lead surface is freshly abraded and an oxide film has not had time to form, surface preparation may not be required.

Zinc

Zinc surfaces are almost always prepared mechanically. However, be careful when bonding directly to zinc-plated, galvanized or electrogalvanized surfaces. Typically, hot dip-galvanized substrates can not be adhered to, whereas some electrogalvanized surfaces may be bondable.

Plated Metals

Two unique problems are often encountered when preparing and bonding plated metals:

- Vigorous mechanical treatment may penetrate and destroy the plating.
- Adhesion of the plating to the base metal may be inadequate.

Since the plating process produces a clean, bondable surface, freshly plated surfaces often do not require additional preparation. Keep in mind, however, that plating changes surface properties such as adhesion, porosity and surface stress of the metal deposit. Current density, composition of the plating bath (including brightener content) and temperature of the bath also affect the bondability of the plated surface.

When mechanical pretreatment is used, abrade the surface lightly. Fine grades of sand or abrasive paper will minimize penetration. The correct chemical treatment depends upon the type of metal which is deposited during the plating process.

If the plating does not adhere tightly to the base metal, the plating process itself should be investigated. Application of Chemlok 205 or 207 primer, 5.1-10.2 micron (0.2-0.4 mil) dry film thickness, often improves adhesion to plated metals.

Plastics

Rubber can be adhesive bonded to many rigid plastics. To prepare plastic surfaces:

1. Clean with aqueous alkaline or a non-aggressive solvent.
2. Lightly sand or abrade the surface. Avoid sanding vigorously; this creates excessive heat which will melt the plastic, impede bonding and warp the substrate. Check dimensional tolerances after surface roughening.

A rough surface can be molded into the plastic by using a mold that has been textured. Use only internal plastic mold releases. Further details concerning the proper treatments of many engineered plastics are available on request.

Miscellaneous Substrates

The principles outlined in this document can be adapted to the surface preparation of almost any rigid material for bonding. Again, the essentials of proper surface preparations include:

- Removal of all surface contaminants and decomposition products.
- Prevention of recontamination.
- Careful handling through all processing steps.

Also remember that high surface profiles [as high as 50.8-76.2 micron (2-3 mil)] from mechanical blasting generally bond better than those with low surface profiles [less than 12.7 micron (0.5 mil)].

Preparing the Adhesive:

Temperature – Temperature affects the viscosity of Chemlok primers and covercoats. If stored cold, allow them to return to the usual working temperature before using. For drums, this may take as long as 48 hours. Recommended storage temperature is 21-27°C (70-80°F). Cold storage is not recommended.

Dilution – Regardless of dilution amounts, it is important in all cases that the appropriate diluent be added to the primer or adhesive while stirring. Depending upon the application, dilution of both the primer and covercoat may be required. Mixing guidelines are listed in data sheets that come with each Chemlok product.

Pails and Single Gallons – 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.

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

Adhesive Handling

Solvent-Based	Water-Based
Store at 1-38˚C (30-100˚F)	Do not freeze
Agitate at 40 to 60 rpm initially	Do not shake
Decrease agitation to 20 to 30 rpm	Agitate at 20 to 30 rpm
Ground drum with grounding straps	No grounding straps required

Adhesive Preparation

Container		Solvent-Based	Water-Based	Mixing Time
1 gallon	(3.8 L)	Hand stir and paint shake	Hand stir and air-driven mixer	20-30 minutes
5 gallon	(18.9 L)	Hand stir and air-driven mixer	Hand stir and air-driven mixer	45-60 minutes
55 gallon	(208.2 L)	Hand crank and air-driven mixer	Hand crank and air-driven mixer	8 hours

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.

Drums – Chemlok products are available in standard 55-gallon drums as well as 55-gallon units with built-in agitators. The standard drum has two openings [3/4-inch and 2-inch (1.91 cm and 5.08 cm)] in the drum head, while the agitator drum has a 2-inch (5.08 cm) side opening near the drum head outer edge. Regardless of type, all steel drums have protective interior coatings that have been tested for safe storage.

Most Chemlok products are available in agitator units, which have a double-blade agitator accessible through a bung in the center of the drum head. (See Figure 1.) Initially, a steel hand crank should be used to loosen settled material. The adhesive should be agitated at least three to four hours at 40 to 60 rpm prior to use; eight hours is recommended length of time. For continuous agitation, a variable speed, air-driven motor is typically used.

Caution: Electric motors should not be used because of spark and fire hazard. To prevent sparks from static electricity, drums should be properly grounded.

Applying the Adhesive:

Chemlok solvent-based adhesives may be applied by brushing, dipping, spraying or roll coating. General recommendations are:

- Primer dry film thickness – 5.1 to 12.7 micron (0.2 to 0.5 mil).
- Covercoat dry film thickness – 12.7 to 25.4 micron (0.5 to 1.0 mil).
- Post-vulcanization bonding – 20.3 to 33.0 micron (0.8 to 1.3 mil).

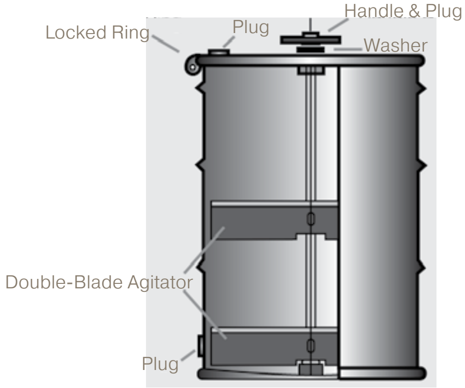

Figure 1. Typical 55-gallon drum with agitator

Hand Brushing – Chemlok solvent-based adhesives are suitable for hand brushing straight from the can. When using this method, wear cloth gloves and work in a clean environment. Also make sure there are no dirty or greasy objects within reach.

When working from small, open containers, solvent evaporation may increase adhesive solids. This is particularly true with large brushes, which carry a substantial volume of adhesive in the brush body. This adhesive dries and, in some cases, becomes pasty.

If brush strokes become visible on painted parts, dilute the adhesive to the original viscosity. Brushing is easiest when the viscosity is correct.

Primers and covercoats usually dry in 30 to 60 minutes at 21˚C (70˚F). Higher temperatures and/or increased air circulation will accelerate drying time.

Dip Application – Hand-dipping Chemlok adhesives is recommended when only a small number of parts need to be coated or when factory conditions prohibit mechanical units. To avoid excess coating, sags and drips, withdraw parts from the adhesive slowly. Also be sure to control the viscosity and agitate the adhesive frequently.

Mechanical Dipping – There are two primary mechanical dipping applications: conveyor equipment and dip tanks.

Conventional conveyor equipment is classified as either monorail or bar conveyor systems. The monorail system is a single-chain unit; the bar conveyor is a double-chain assembly with bars running horizontally between the chains. Selection of a conveyor unit depends on the size and number of parts to be dipped.

For best results, arrange the conveyor's dipping section so parts are withdrawn at an angle rather than straight up and down. By removing the parts at an angle, the conveyor's forward motion provides a gradual vertical lift, which allows excess fluid to drain evenly from parts.

When using dip tanks, the adhesive should be agitated continuously, ensuring a good top-to-bottom turnover. The constant motion prevents skinning and sweeps air bubbles to the side. Circulating pumps or submerged impeller agitators are very effective. Because of the filler content, diaphragm pumps, if used, should be dual-diaphragm models.

Tank depth should only accommodate the largest part to be dipped. Additional depth only increases the volume of the tank and lessens the likelihood of adhesive turnover. Also, the tank bottom should be slanted so that immersion depth of the parts and the tank depth both decrease as parts move up and out at an angle.

To facilitate adhesive changing and minimize down-time, tanks should be mobile. If parts are to be partially dipped or if the conveyor's low point is not adjustable, provisions will be needed for raising or lowering the tank.

A drip pan behind the dip tank is also recommended. If excess droplets from the parts have not hardened, they may be returned to the tank. However, if the material has solidified, it should be discarded. Other suggestions include:

- Equipment made of carbon steel.
- Large piping to ensure low-pressure operation.

- Solvent-resistant packing or a mechanical seal in all pumps.
- Method for agitating contents of the tank.

Chemlok adhesives may be agitated or pumped continuously over indefinite periods without damage. However, over-mixing can cause solvent loss.

Depth of Immersion – As a general rule, avoid immersing parts deeper than absolutely necessary. This minimizes adhesive build-up. For parts that require only partial coating, adjust the conveyor line height or immersion tank level to suit your needs.

It's also important to clean part-hanging hooks prior to use. And when a variety of parts will be processed by the same dipping equipment, various hook sizes may be needed.

Design of Metal Parts – To ensure successful dipping, a metal contour or hole should be designed in the part's upper body for securing it to a conveyor hook. The part should hang so drainage is toward a point where the adhesive tear will not interfere with the molding process. Air entrapment can be avoided by changing positions on the conveyor hook.

Protruding stud heads that have been welded or swaged into flat plates frequently trap air where the weld is not completely filled. If the stud is at a high stress point, the small void can be the first spot of bond failure. Hand touch-up of critical points may be needed to prevent solvent entrapment.

Perforated Metals – When parts with small perforations are dipped, adhesive is frequently trapped in the holes, causing webbing or sagging. You may need to "touch up" these areas with a paint brush. Withdrawing parts slowly from the dip tank helps prevent these problems.

Precautions with Threaded Parts – Soft, rubber caps or thimbles for externally threaded studs, or a cork for tapped holes, are often used to protect threads from adhesive coating. Unfortunately, these protective devices are not always effective. **Do not dip if it is important to the function of the part that threads be clean.**

Withdrawing Parts From the Adhesive – Removing metal parts slowly from the adhesive is critical to dipping success. If removed too quickly, an excessive amount of adhesive may cling to the part. This excess adhesive drains slowly and unevenly, forming tears, sags and lips on the edges. Collectively, these imperfections reduce aesthetics, prolong drying time and, ultimately, affect the overall molding operation.

For optimum results, remove parts slowly and evenly. This allows uniform adhesive drainage, helping eliminate bond defects. A vertical withdrawal rate of 3 feet (91 cm) per minute is usually satisfactory.

Dip/Spin Coating – Dip/spin coating may be used on small parts, but appearances are not as uniform as dipping. Despite reduced aesthetics, this method is satisfactory for many applications, including rubber-encapsulated inserts.

When dip/spin coating, place parts in a dip/spin barrel, dip in the appropriate primer, then spin in the drum at a high rpm until excess primer is removed. Coated parts can then be dumped onto a screen or open conveyor to dry at room temperature or in warm, dry, circulating air. The same procedures can be used when applying the adhesive covercoat.

Spray Application – Spray application of adhesives is particularly applicable when coating one side or certain areas of a part. When spraying, however, it is important that the adhesive reach the substrate wet. If drying occurs before reaching the metal, adhesion will be poor.

Hand-held guns may be used for small runs, while conveyorized or automated units are effective for large production operations. To reduce overspray, electrostatic units can be employed. And for small, intricate parts, an air brush may be used. Regardless of size, properly adjusted equipment ensures delivery of uniform films – without sags and tears.

During hand-spray operations, parts are often assembled on racks that incorporate masks wherever needed. If the application requires overall coating, parts can be rotated in front of the spray gun. Chain-on-edge conveyors can be programmed to automatically rotate metals as they pass the guns.

Spray Equipment – Many manufacturers make paint guns that are also suitable for applying Chemlok adhesives. The preferred system includes:

- Gun tips and air caps suited for job-specific volume and spray pattern.
- Adjustable air pressure on the liquid supply tank.
- Controllable atomizing air pressure on the gun or air source.
- Screen (usually 50 mesh) in the liquid line.
- Filters and moisture traps in air lines.

Removal of oil and water is critical to preventing contamination. Therefore, the entire spray system should be easy to dismantle and clean. In instances of low-flow equipment, should settling of diluted adhesive in a flow-restricted area become a problem, it may be necessary to install plumbing which switches to a clean-out solvent every eight hours.

When spraying Chemlok adhesives, it is also important to continuously agitate the supply tank. If liquid lines have too small a diameter, for instance where the diameter is smaller than 3/8 inch (9.5 mm), the lines should be short to provide rapid flow rate and prevent dead spots where settling can occur.

Electrostatic Spray Equipment – A number of devices may be used for electrostatic spray applications, including electrostatic and conventional electrostatic air hand guns, and spinning disc and mini-bell electrostatic applicators. (The controls and adjustments on electrostatic and conventional electrostatic guns are similar except for the necessity of a remote power-pack.)

When using these applicators, a small amount of Methyl Ethyl Ketone (MEK), or other polar solvent such as diacetone alcohol or cyclohexanone, may be needed to increase covercoat polarity. Slow-evaporating aromatic solvents may also be added to primers to improve the spray's wrap quality.

Do not, however, exceed 15% ketone by volume when diluting a topcoat that will be sprayed over an uncured primer. This eliminates the chance of re-solvating the primer.

Because of the high dilution typically used with primers and adhesives, both must be continuously agitated. Also, hose and piping lengths should be minimized, and precautions should be taken against adhesive settling in the lines during extended shut-downs.

Coverage – Estimating coverage of sprayed adhesives is difficult, as the quantity used depends largely upon the amount of overspray. In many cases, it may be as much as 50%. With electrostatic spraying, however, transfer efficiency may be as high as 75%; thus, a much higher coverage rate can be expected.

Controlling Atomizing Air Pressure – Maintaining atomizing air pressure is important to successful spray application. If the pressure is too high, adhesive droplets may disperse and dry before reaching the metal, leaving a dry, dusty appearance. Threads of material will also be seen floating in the spray booth, otherwise known as "cobwebbing." You can control the problem by reducing atomization pressure, further dilution or by using a higher boiling solvent.

Controlling Premature Drying – Spray-coated parts dry much more quickly than dipped parts, as partial drying occurs during atomization. To properly wet the metal, the adhesive must be fluid when it reaches the substrate. If multiple guns are used, ensure each is applying a wet coat. Do not apply a dry coat with the first gun then cover it with a wet coat.

Roll Coating – Roll coating may be used to coat cylindrical or flat objects. Shafts and pipes can be coated by holding them momentarily between two rotating felt rolls that have been dipped in adhesive. A mohair fabric paint roller can be used to coat large, flat surfaces. However, short nap rollers are preferred.

Reverse Roll Coating – Reverse roll coating is used to apply Chemlok solvent-based products to coil steel, coil aluminum or coil stainless. If you do not have two coating units that can run in tandem, the primer must be covercoated at a later time.

When reverse roll coating, pump the primer (or adhesive) from a drum into a coating pan. A pick-up roll then transfers the adhesive to an applicator roll that the coil metal passes over at a line speed of 100 to 150 feet (30 to 46 m) per minute. Adjust the primer or adhesive flow rate so it overflows the coating pan into a slanted trough, which then returns the material to the drum. This system ensures constant agitation.

Drying Processes:

All Chemlok solvent-based adhesives can be dried at room temperature – 30 to 60 minutes at 21°C (70°F) is sufficient. If faster drying is necessary, use a circulating air dryer at 66-93°C (150-200°F). Be sure there is adequate air circulation, though, because the fastest drying occurs when the solvent is removed and begins diffusing through the surface. Air may be recirculated, provided there is enough exhaust to prevent excessive solvent build-up.

With closed systems, care must be taken to prevent explosive solvent build-ups. For this reason, conveyorized dryers with open ends and crosswise air circulation are most often used. Gas-fired ovens may also be used if they are designed properly. It's also important to purge solvent vapors and unburned gas before restarting gas ovens. Do not operate ovens over 110°C (230°F).

Handling Coated Parts:

After drying, unload coated metal parts directly from the conveyor into tote baskets. They may be handled while warm without danger of scuffing; however, be aware of any sharp points and corners.

Coated areas that will receive high levels of stress should be protected or retouched if damaged. Removing adhesive from these areas may cause premature bond failure.

Both clean metal parts and coated materials should be kept free of contamination. Because fingerprints can adversely affect adhesion, gloves are highly recommended. Thin, white, cotton gloves are satisfactory, as they show soil easily, are economical enough to be discarded when necessary, and are thin and porous enough to be comfortable.

Coated Parts Layover Stability:

Mold as soon as possible, but store all coated parts properly to ensure maximum layover. Typically, this entails sealing adhesive-treated metals in a clean plastic container and storing the package in a cardboard box. These precautions ensure parts are not exposed to UV light, and are protected from airborne contaminates.

Storage:

Temperature variations encountered during shipping and storage typically do not affect the performance of Chemlok solvent-based primers and adhesives. However, freezing temperatures may increase viscosity, and some products may gel. All products should be warmed to room temperature before using. Refer to product literature for additional information.

Summer storage and shipping temperatures, on the other hand, may exceed safe limits for Chemlok products. Shipping and storage temperatures of 21-27°C (70-80°F) are recommended, and temperatures greater than 38°C (100°F) should be avoided. Also, avoid storing Chemlok products near heating units and in upper racks of non-air conditioned warehouses. Cool and well-ventilated storage areas are ideal and should be used whenever possible. Special handling and storage precautions, when necessary, will be clearly marked on drums.

Molding Considerations:

One of the most important steps in the manufacturing process is molding. During this phase, the adhesive-coated metals and elastomer are placed in the mold cavity, and under proper conditions of time, temperature and pressure the bonded assembly is formed.

Controlling each step in the molding process is critical to bond success. Major variations in any step will cause bond failures. Minor alterations, though not detrimental individually, can collectively result in poor or marginal adhesion and above-average scrap rates.

For ideal bonding, maintain maximum mold pressure with minimum elastomer viscosity. This pressure/viscosity ratio, typically obtained with the specified time and temperature conditions, ensures peak wetting at the adhesive-elastomer interface. It also optimizes physical properties of the elastomer being cured.

Other considerations include:

- **Adhesive Dry Film Thickness (DFT)** – One of the most important factors in environmental performance. Low and high DFT films can result in poor performance. Refer to the applicable technical data sheet for recommended DFT.
- **Molding Pressure** – Optimum adhesion requires adequate pressure and intimate contact of elastomer and adhesive during vulcanization and cure. Molds that are either too tight or are too loose will hinder bond quality.
- **Temperature** – Dramatic temperature variations from cavity to cavity may cause bond failure, lack of cure, or overcure conditions. Mold temperature should be checked periodically, particularly within the individual cavities. Tempilsticks®, or selective melting-point wax pencils, are excellent for spot-checking mold cavities. Thermocouples can also be used, but they must be calibrated regularly.
- **Mold Design** – When designing the mold, provisions should be made to facilitate substrate loading as well as removal of the vulcanized part. Avoid mold parting lines in critical bond areas and avoid placing sprue holes near adhesive-coated metals. Close proximity during mold filling can cause sweeping or wiping of the adhesive from the metal surface.

Post Treatment:

Following part bonding, additional treatments are usually required. However, exercise caution throughout the process, especially during the following situations:

- When deflashing parts with dry ice or nitrogen. If temperatures in the tumbler remain too low for an extended period, there may be a failure between the adhesive and elastomer.
- When cleaning with a wire brush, grinding or machining. These procedures may cause bond problems by generating too much heat.
- When electroplating. If current densities are too high, the bond will be highly stressed during plating. Also, the adhesive must resist the plating bath.
- When painting parts. Bonds may fail if the adhesive does not resist solvents in the paint.

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.

When adhesive solvents evaporate too quickly, ultra-fast drying of the adhesive as it leaves the spray nozzle (cobwebbing) may occur. This dry spray prevents the primer or adhesive from wetting and adhering to the metal surface. Another problem is sweeping, when flow of the elastomer stock during bonding causes displacement of the adhesive from the metal.

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:

Proper handling of Chemlok adhesives is essential for safe and effective application. Although many of the safety concerns can be avoided by using water-based Chemlok systems, we recommend these procedures be followed 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 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.

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