Chemlok® 3Stream LSR Adhesion Additive

Application Guide

Chemlok® 3Stream (3S) additive is a liquid additive that, when added to liquid silicone rubber (LSR), imparts bonding characteristics such that the rubber will bond to many substrates, including plastics and clean metals. This technology allows users to convert standard grades of LSR to self-bonding grades, saving time and money by eliminating the need to use primers, adhesives, or purchase expensive self-bonding LSRs.

Although using a premium technology is the basis of a quality bond, it's only the beginning; proper application and process is essential for maximum results. With this guide, you'll learn how to maximize efficiency and optimize results. This guide also shows how to troubleshoot common bond problems. We hope this resource will become an indispensable part of your operation and a convenient, one-source solution to many of your bonding questions.

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. These can be cleaned by either mechanical or chemical processes, or a combination of both.

Types of Surface Preparation:

There are several ways to prepare substrates for bonding with Chemlok 3S additive 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. This method includes:

- 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.

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

- Acid passivation
- Alkaline cleaning
- Solvent Washing

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 injection molding is complete. To accomplish this:

- Avoid exposure to dust, moisture, chemical fumes, mold release agents and other possible contaminants.
- When handling substrates, wear chemical resistant gloves, such as nitrile; avoid latex gloves.

- 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.

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.

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.

Stainless Steel (Chemical Preparation)

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

1. Alkaline Wash – four step process:
   - Hot water rinse (70°C)
   - Wash in sodium tripolyphosphate solution
   - Hot water rinse (70°C)
   - Hot air dry
2. Acid Passivation
   - Washing step that uses mild acid solution such as citric or oxalic acid

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

Plastics

Using Chemlok 3S additive, LSR can be bonded to many types of plastics, however a few steps must be followed to maintain good and consistent adhesion.

1. Keep parts clean - Plastic parts should be molded with no mold release, handled with gloves, and stored in a clean and dry container.
2. Keep parts dry - Immediately after molding, parts should be stored in moisture-proof packaging to avoid moisture absorption by the plastic. Desiccant packs are also helpful to absorb any extra water. This is especially important for hygroscopic plastics like polyesters and polyamides. Wet plastic can reduce the integrity of the bond.
3. Prepare plastic surfaces – It is usually not necessary to prepare plastic surfaces. If needed, the following steps can be used:
   - Solvent wipe. Hydrophobic solvents such as n-heptane and Isopar can remove waxes and mold release. Alcohol such as ethanol or isopropanol can remove polar contaminants.
   - Surface oxidation by plasma, flame, or corona treatment can help to clean the surface and improve adhesion by providing more chemical reactive groups.

Preparing Chemlok 3S Additive:

Prior to adding Chemlok 3S additive to an existing LSR feed system, confirm that all metering and injection equipment is in proper operating condition and up to date on all preventative maintenance. All components, starting with the metering injector all the way through the screw and barrel, should be clean and free of possible contaminants.

Chemlok 3S additive will bond to clean metal, including molds, if not properly seasoned. Seasoning of the mold occurs naturally over time by the deposition of low molecular weight or non-functionalized silicone already present in LSR. Upon startup of a clean mold, it is recommended to coat the mold with mold release designed for silicone (PTFE based, for example). One application of mold release is usually sufficient for startup and reapplication will not be necessary.

Chemlok 3S additive is a clear/colorless, low viscosity liquid additive. If desired, Chemlok 3S additive can be mixed with a small amount of colorant to provide a visual indicator of feeding. This can be achieved by premixing color concentrate into Chemlok 3S additive at a ratio of around 100 parts of Chemlok 3S additive to 5 parts of color. Not all color concentrates are the same, so it is important to test a small amount first and observe any obvious separation, coagulation, or other mixing issues.

Chemlok 3S additive is moisture-sensitive so containers should be tightly sealed when not in use. Short exposure to atmospheric moisture from normal handling is not a problem. Chemlok 3S additive remaining in the injector cartridge after molding is completed, not exposed to atmospheric moisture, can be left for multiple days.

Using Chemlok 3S Additive:

Chemlok 3S additive can be added to an LSR molding process using standard equipment for feeding color concentrates. Using this approach, Chemlok 3S additive is loaded into a vessel and injected into the LSR stream immediately prior to the static mixer. When selecting a feeding system, it is important to choose a system in which the air pressure used to pump Chemlok 3S additive does not come in direct contact with Chemlok 3S additive, due to its moisture sensitivity.

The amount of Chemlok 3S additive injected to achieve optimum adhesion is usually around 1% by weight. However, part design, substrate type, LSR grade, and other factors can influence bonding performance, so it is recommended to test loading levels from 0.5% up to 1.5% by weight.

Review metering equipment tolerances to confirm that the feed system can control Chemlok 3S additive at desired loading levels.

Upon start-up or during troubleshooting, to confirm the proper loading of Chemlok 3S additive, purge some LSR material and then apply that material to the substrate. Then place the substrate in an oven at 150°C for five minutes minimum. (This temperature/time may need adjusted for the individual substrate type and mass.) Once the part is removed from the oven, allow it to cool and try to hand peel the LSR material from the substrate to determine if the bonding is acceptable.

Refer to Figure 1 for an example of a feeding setup using Graco equipment.

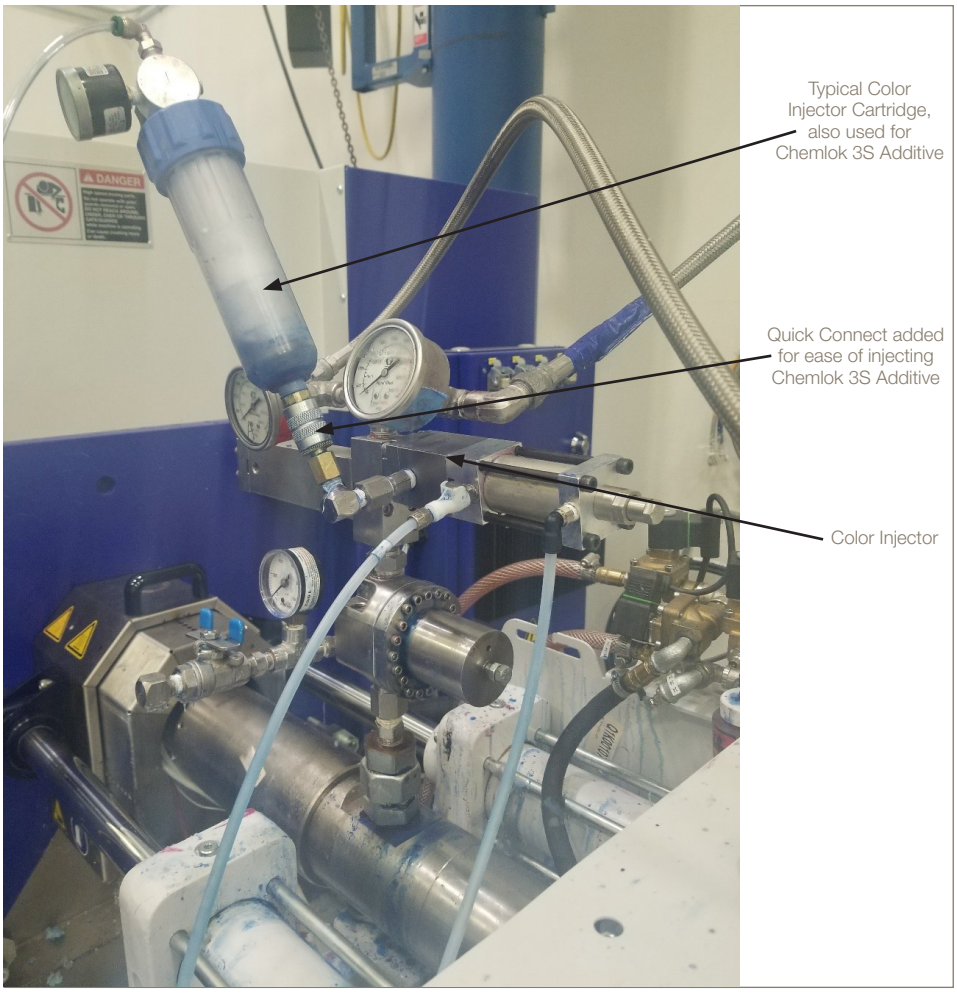

Figure 1. Example of LSR Feeding System

Molding Considerations:

Injection molding process DOEs have shown that the main processing parameters that affect bonding performance of Chemlok 3S additive are cure temperature, cure time, and postbaking. Better bonding is achieved at higher temperatures and longer cure cycles. Maximize these parameters, as the process and substrate allow, for maximum adhesion. Chemlok 3S additive generally requires a curing temperature of greater than 150ºC to achieve reasonable adhesion. Minimum cure time will be determined by the cure temperature, LSR grade, and part design.

Other process parameters such as fill speed, injection pressure, and hold pressure will be determined by part design, quality, etc., and should not affect bond integrity.

Chemlok 3S additive, in many cases, provides sufficient adhesion immediately after molding. However, adhesion can be further increased by postbaking the molded parts. Generally, 30 minutes or less at 150ºC can provide rubber-tearing bond strength. Hotter cycles can also be used for faster adhesion development.

The optimal postbake cycle will be dependent on substrate as well as desired rubber physical properties.

Maximum adhesion is something that develops over time after the part is manufactured – thus, minimizing stress during demolding is important. The part should be designed such that it can be removed from the mold with minimal stress on the bondline.

Equipment Preventative Maintenance:

Contact your equipment provider(s) for detailed preventative maintenance plans. This section is intended to provide preventative maintenance guidance when using Chemlok 3S additive. This section is not intended to supersede the recommendations of each equipment provider.

Proper care should be taken to keep metering and injection equipment in proper operating condition. Prior to start-up, confirm that all components starting with the metering injector all the way through the screw and barrel are clean and clear of contaminants. When the injection molding machine is in stand-by mode for an extended period, it is recommended to flush the system clean, clearing out the injector all the way through the screw and barrel of any LSR and Chemlok 3S additive. Addition of Chemlok 3S additive to LSR does not affect the pot life of the mixed LSR.

Adhesion Troubleshooting:

A good way to test adhesion is to simply attempt to remove the rubber from the substrate. This can be done in a variety of ways, including hand-peeling or instrumented peeling on a tensile tester. Generally, two characteristics are evaluated: peel strength and failure mode.

Peel Strength: To measure peel strength, a defined width of silicone is peeled and force is measured. The peel value is expressed in terms of force per unit length, such as pounds of force per inch or Newtons per millimeter. Measuring peel strength on an actual part can be very difficult, so this measurement is usually done on test coupons.

Failure Mode: Because peeling is a destructive test, the failure mode defines the way in which the failure occurred. There are three main ways in which failure can occur: cohesive, boundary layer, and adhesive. Cohesive failure is the most desired failure mode and means that the rubber failed cohesively in itself, thus the bond strength exceeds the strength of the rubber. Boundary layer failure occurs when a very thin layer of rubber or bonding agent residue remains on the substrate, but the rubber is able to be removed mostly intact. Adhesive failure means that the rubber cleanly peels off the substrate and does not leave behind any rubber or residue.

Recommendations: If bond strength or failure mode is insufficient, the following steps are recommended to increase adhesion:

- Bake parts after molding – Instituting a postbake step almost always increases adhesion. Typical post-bake processes range from 150ºC for 15 minutes up to 220ºC for 1 hour.
- Increase cure temperature – Chemlok 3S additive works best at cure temperatures of 150ºC and above. Adding more heat to the process will improve adhesion.
- Increase cure time – Chemlok 3S additive builds adhesion over time, so increasing cure time can improve adhesion.
- Increase loading level of additive – typical loading levels of Chemlok 3S additive range from 0.5% up to 1.5% by weight. Higher levels typically give stronger adhesion.
- Treat plastic substrate – surface treatments for plastics, such as plasma, flame, or corona, will improve adhesion.
- Verify cleanliness of substrate – the substrate must be clean to ensure good bonding.

Safe Handling:

Proper handling of Chemlok 3S additive is essential for safe and effective application. We recommend these procedures be followed when using any Chemlok product:

- Read labels, SDS and data sheets before use.
- Wear proper personal protective equipment.
- Clean processing equipment regularly.
- Dispose of waste according to federal, state and local regulations.

Parker LORD Applications Laboratory:

As an extension of our product development efforts, Parker LORD has injection molding machines in Erie, PA. By simulating customers' applications, we can provide detailed technical support and more thoroughly evaluate optimum application characteristics of new products.

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