Henkel

Henkel –
Your Worldwide Partner

Resources

Henkel takes pride in having the most experienced and knowledgeable Technical staff to support any friction bonding operation. For any additional questions or recommendations, contact your Technical Sales Representative.

Literature

Henkel's "Adhesives for Bonding Friction Materials Selector Guide"

Books

Petrie, Edward M., Handbook of Adhesives and Sealants, McGraw Hill, New York, 2000.

Skeist, Irving.1990. Handbook of Adhesives, 3rd Addition. Van Nostrand Reinhold, New York.

Martin, Robert W., The Chemistry of Phenolic Resins, John Wiley & Sons, New York, 1956.

Test Methods

ASTM D2196 – Viscosity
ASTM D-2369 – Total Solids
SAE J840C – Shear Test
SAE J2257 – Shear Test

USA
Henkel Corporation
32100 Stephenson Highway
Madison Heights, Michigan 48071
Tel: 866.332.7024
Fax: 248.583.2976

Canada
Henkel Canada Corporation
2225 Meadowpine Blvd.
Mississauga, Ontario, L5N 7P2 Canada
Tel: 905.814.6511
Fax: 905.814.5391

Asia
Henkel Japan Ltd.
Henkel Technology Center - Asia Pacific
27-7, Shin Isogo-cho, Isogo-ku,
Yokohama 235-0017 Japan
Tel: 81.45.758.1800
Fax: 81.45.758.1851

Europe
Henkel KGaA
Henkelstraße 67
40191 Düsseldorf, Germany
Tel: +49.211.797.0
Fax: +49.211.798.4008
www.henkel-technologies.com

Mexico
Henkel Capital S.A. de C.V.
Blvd. Magnocentro No. 8
Piso 2 Interlomas
52760, Huixquilucan
Edo. de México
Tel: +52.55.3300.3628
Fax: +52.55.5836.1393

Henkel Corporation
Madison Heights, MI
U.S.A.
866.332.7024
www.henkel.us
automotive.henkel.com

Friction Bonding Manual

Plastilock® and Aqualock® Friction Adhesives

Henkel

Table of Contents

Introduction

This manual describes step-by-step how to apply, bond and test friction products using Henkel's Plastilock® and Aqualock® adhesives. The procedures and equipment recommendations in this manual will provide you with the necessary information to develop and maintain an efficient and reliable friction bonding operation.

Plastilock® and Aqualock® friction bonding adhesives have been developed to meet the demanding requirements of automotive and industrial friction applications. These products are designed to be tough at temperatures as low as -40ºF (-40ºC) and strong at temperatures as high as 600ºF (316ºC). All of Henkel's friction adhesives are highly resistant to oils, transmission fluids, and solvents.

For over 50 years, Plastilock® 605™ has been the industry standard for OEM and after-market friction applications. Aqualock® adhesives were developed over 10 years ago to provide our customers with environmentally friendly versions of our Plastilock® products.

With Henkel's Plastilock® and Aqualock® adhesives, you have the satisfaction of knowing that you are using the safest and highest performance products available for bonding friction materials.

Chemistry and Technology

Plastilock® and Aqualock® adhesives are based on phenolic resin chemistry. Phenolic resins provide excellent adhesion as well as thermal resistance in the cured state. These resins are typically modified with nitrile rubber to add flexibility and chemical resistance to the cured part. These resins and rubbers are dissolved in solvent, dispersed in water, or calendered or coated into a film form.

Phenolic resins cure through a condensation reaction when heat is applied. The chemical reaction, or crosslinking, of phenolics results in water being given off. Because of the evolution of water during this cure, phenolic resin adhesives must be held under constant pressure during cure to force water vapor out of the adhesive film. If inadequate pressure is applied during cure, the final bond will be spongy and weak. Typically, phenolic resins require at least 375-450ºF (191-232ºC) for 20-30 minutes under at least 75 psi (517 kPa) to fully cure.

Drum Brakes

Removal of Old Linings for Rebuilt Shoes

Riveted Linings

Remove rivets with a punch, cold chisel, or automotive de-riveter. Remove lining from shoe. If the core has been dipped with a corrosion protective primer, remove the primer by heating to 725-750°F (385-399°C) for 30 minutes to 1 hour. Do not exceed 750°F (399°C). Heating above 750°F (399°C) may warp or distort the shape of the metal core. Proceed to cleaning.

Bonded Linings

Remove the primer, adhesive, and friction material by heating to 725-750°F (385-399°C) for 30 minutes to 1 hour. Do not exceed 750°F (399°C). Heating above 750°F (399°C) may warp or distort the shape of the metal core. Proceed to cleaning.

Shoe Dips

Henkel's shoe dip products are designed as corrosion protective primers for drum brake cores. When applied following surface preparation, these products act as barriers to oxidation of the metal surface so that cleaned cores can be stored and bonded at a later time (up to 6 months). These products are available in black or clear versions to give the finished part a professional, rust-free appearance.

Products

Product Name	Base Polymers	Color	% Solids (Weight)	% Solids (Volume)	Viscosity	Solvent System
Plastilock® A-344-B™ Adhesive	Phenolic	Amber	28-31%	17%	20-40 cps.	Isopropyl Alcohol
Plastilock® A-602-B™ Adhesive	Phenolic	Amber	49-54%	40%	20-40 cps. min.	Isopropyl Alcohol, Methyl Ethyl Ketone
Plastilock® A-602-B1™ Adhesive	Phenolic	Amber	50-55%	40%	22-29 sec. (#2 Zahn cup)	Acetone
Plastilock® A-1445-B™ Adhesive	Phenolic	Black	32.5-34.5%	33%	200 cps. min.	Isopropyl Alcohol, Methyl Ethyl Ketone
Plastilock® PL1446™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	7-10%	7%	10-20 sec. (#2 Zahn cup)	Acetone, Isopropyl Alcohol
Plastilock® PL1447™ Adhesive	Phenolic Resin and Nitrile Rubber	Glossy Black	18-20%	14%	20-40 sec. (#2 Zahn cup)	Acetone, Isopropyl Alcohol
Plastilock® PL1448™ Adhesive	Phenolic Resin and Nitrile Rubber	Flat Black	9-13%	6%	12-22 sec. (#2 Zahn cup)	Acetone, Isopropyl Alcohol
Aqualock® AL6007™ Adhesive	Phenolic Resin and Nitrile Rubber	Flat Black	20-25%	18%	10-22 sec. (#2 Zahn cup)	Water

Surface Preparation

All metal surfaces must be clean of protective oils and other contamination. A solvent or aqueous cleaning system is used to remove these contaminates. Henkel is a full-service supplier of these chemistries.

Solvent-based cleaning systems use mineral spirits, methylene chloride, n-propyl bromide, or other solvents that dissolve oils. These chemicals do not require heating for use. Usually, the parts are immersed in a bath of solvent for a period of time then withdrawn from the bath and dried either at ambient temperature or with moderate heat at 120°F (49°C).

Aqueous cleaning systems are solutions of a small amount of an alkaline cleaner in water. These solutions are heated to 140-180ºF (60-82ºC). Parts are dipped into the solution for a period of time then removed from the solution and rinsed with water. The rinse water is usually heated as well so that when the parts are removed from the rinse, they dry quickly. Following the rinse, parts are dried with an oven, high velocity air, or a combination of both.

The primary advantage to a solvent cleaning system is low energy usage compared to aqueous systems which require a heated bath. The disadvantages of a solvent system include waste disposal, air quality monitoring, and the possibility of fires if a flammable solvent is used. For these reasons, Henkel recommends the use of aqueous alkaline cleaning.

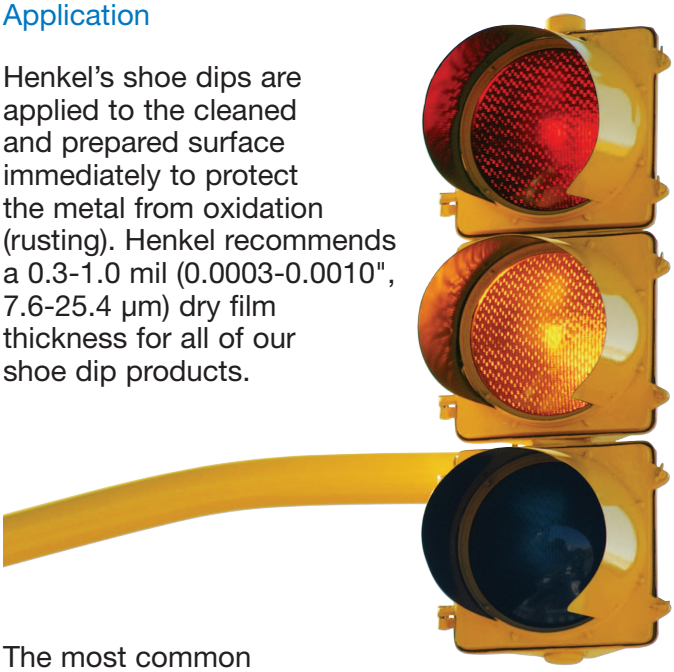
Henkel's Technical Representatives can provide cleaning chemicals and equipment recommendations along with process suggestions by request.

Following the removal of contaminates, brake shoe cores should be grit blasted using an aluminum oxide grit to remove surface oxidation and increase the surface roughness of the metal. This step is critical to ensuring high strength bonds. Blasting shoes with aluminum oxide grit renders the optimal surface for bonding with Henkel's adhesives.

Other surface preparation techniques include shot blasting the shoes with a wheel abrader or chemically treating the shoes with a process such as phosphating. Although shot blasting can provide an adequate bonding surface, this technique does not remove the oxidation layer on the metal surface or rough the surface to the same degree as grit blasting. Using shot instead of grit results in a much more inconsistent bond. Phosphating will remove the oxidation layer on the metal surface, but does not result in a rough surface. Henkel recommends grit blasting over shot blasting or phosphating because it results in the most consistent bonding surface.

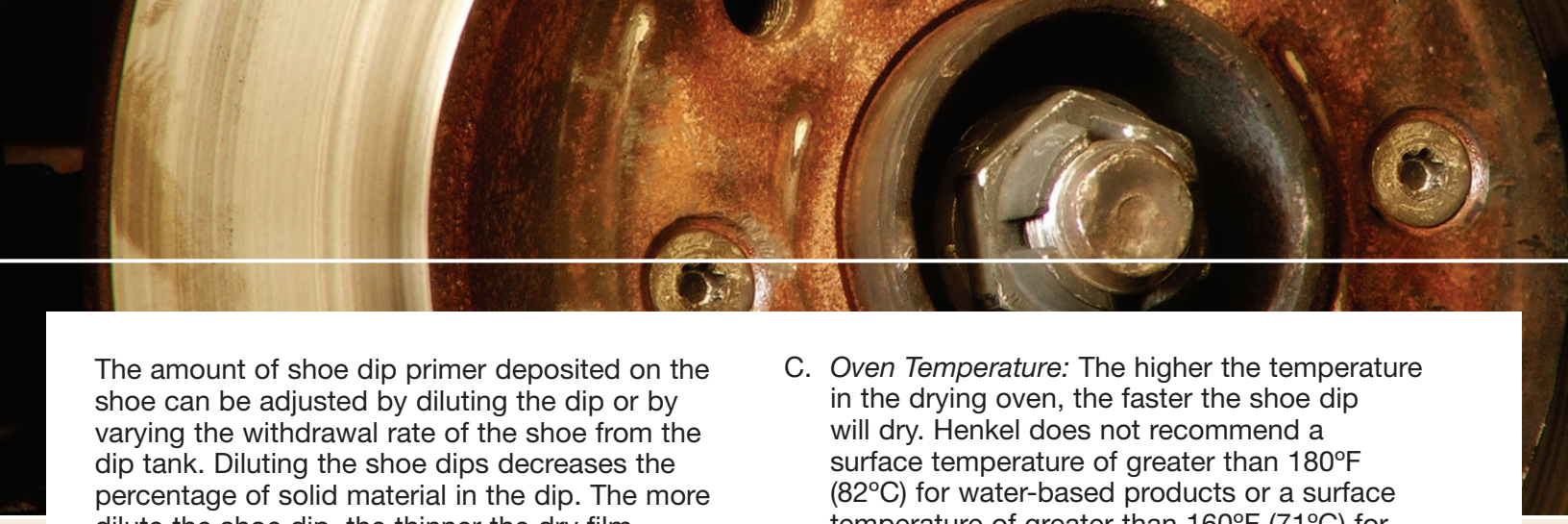
Application

Henkel's shoe dips are applied to the cleaned and prepared surface immediately to protect the metal from oxidation (rusting). Henkel recommends a 0.3-1.0 mil (0.0003-0.0010", 7.6-25.4 µm) dry film thickness for all of our shoe dip products.



The most common application method is to dip the brake cores into the shoe dip. Low percent solids products, such as Plastilock® PL1446™ Adhesive, Plastilock® PL1447™ Adhesive, Plastilock® PL1448™ Adhesive and Aqualock® AL6007™ Adhesive, are typically used as supplied and do not require dilution. High percent solids products, such as Plastilock® A-602-B™ Adhesive and Plastilock® A-1445-B™ Adhesive, require dilution for most drum brake applications. Refer to individual product information sheets for dilution instructions.

Black shoe dips, like Plastilock® PL1446™ Adhesive, Plastilock® PL1447™ Adhesive, Plastilock® PL1448™ Adhesive, Plastilock® A-1445-B™ Adhesive and Aqualock® AL6007™ Adhesive, require constant agitation before and during use. These products have black pigments that will settle over time. These pigments are essential to maintaining a consistent appearance on the finished part. A circulating pump or a slow speed mixer with a propeller style blade work best for mixing these products.



The amount of shoe dip primer deposited on the shoe can be adjusted by diluting the dip or by varying the withdrawal rate of the shoe from the dip tank. Diluting the shoe dips decreases the percentage of solid material in the dip. The more dilute the shoe dip, the thinner the dry film thickness. The rate that the shoe is withdrawn from the tank can also be used to adjust film thickness. The faster the shoe is withdrawn from the tank, the heavier the deposit of shoe dip. The maximum deposit occurs when shoes drip excess dip after immersion.

Because of the variety of sizes and configurations of drum brake shoes and the varied environmental conditions of plants, experimentation is required to determine optimal process parameters.

Drying

Following application of the shoe dip, the dip must be completely dried. Although all of Henkel's shoe dips will dry at ambient temperature, most processes require accelerated drying by means of an oven or fans for maximum efficiency.

Drying rate is influenced by many factors including wet film thickness of the shoe dip, ambient temperature and humidity, temperature and air flow in the drying oven, and solvent system of the shoe dip. Keep the following points in mind when developing a drying process:

A. *Wet Film Thickness:* Thicker films of shoe dip will require more time to dry at a given temperature, humidity, and air flow.

B. *Ambient Conditions:* If drying is done in open air without an oven or fans, shoe dips will dry more quickly when the work area is kept warm with low humidity. Cool spring days when ambient temperatures are low and humidity is high may require significantly longer time to fully dry parts. Seasonal process adjustments may be necessary.

C. *Oven Temperature:* The higher the temperature in the drying oven, the faster the shoe dip will dry. Henkel does not recommend a surface temperature of greater than 180ºF (82ºC) for water-based products or a surface temperature of greater than 160ºF (71ºC) for solvent-based products.

D. *Air Flow:* Air flow can help to significantly reduce drying time, especially for water-based products such as Aqualock® AL6007™ Adhesive. Whether the parts are being dried at ambient or elevated temperatures, good air flow will help to keep the area around the surface of the dip free of vapor, allowing the coating to dry faster.

E. *Solvent System:* Products which contain fast evaporating solvents such as methyl ethyl ketone or acetone will dry the fastest. Products with solvents such as isopropyl alcohol or water-based products will take somewhat longer to dry.

Because of the vast variety of part configurations and geographical locations of plants, it is difficult to provide exact specifications for drying times and conditions. Henkel's Technical Representatives can assist you in developing the optimum drying process.

After parts coated with shoe dip have been fully dried, they can be stored in a clean, dry area for up to 12 months before the bonding operation. Keep in mind that parts stored in wet or humid conditions are more prone to rusting and should be cleaned and recoated if rusting occurs.

Lining Adhesives

Products

Product Name	Base Polymers	Color	% Solids (Weight)	% Solids (Volume)	Viscosity	Application	Solvent System
Plastilock® PL605-4™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	29% min.	30%	4000-6000 cps.	Brush, Spray	Methyl Ethyl Ketone, Isopropyl Alcohol
Plastilock® PL605-15™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	32% min.	31%	14000-22000 cps.	Brush, Extrusion	Methyl Ethyl Ketone, Isopropyl Alcohol
Plastilock® PL605-51™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	40% min.	35%	43000 cps. min.	Extrusion	Methyl Ethyl Ketone, Isopropyl Alcohol
Plastilock® PL607™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	46-50%	38%	35000-45000 cps.	Extrusion	Methyl Ethyl Ketone, Isopropyl Alcohol
Plastilock® PL601™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	100%	100%	Film	Film	Solvent-Free
Plastilock® PL655-1™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	100%	100%	Film	Film	Solvent-Free

Application

Plastilock® lining adhesives are typically applied to the drum brake lining material by extrusion. Other application methods include brushing and spraying. Drum brake lining adhesives should be applied in a bead or ribbon pattern (***Figure 1***). This pattern helps channel vapors that are formed during the cure of the adhesive away from the bond line.

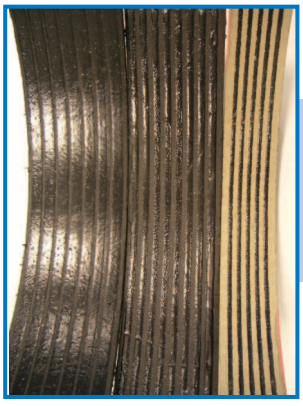


Figure 1

Examples of Bead and Ribbon Style Coating Patterns

A. *Bead Pattern:* Extrude beads 3/16-1/4" (4.8-6.4 mm) wide to form flat, narrow strips. Depending on the width of the lining, 6-8 beads are used. The dry bead height should be 12-15 mil (0.012-0.015", 305-356 µm).

B. *Narrow Ribbon Pattern:* Extrude ribbons 3/8-1/2" (9.5-12.7 mm) wide to form flat, narrow strips. Depending on the width of the lining, 4-6 ribbons are used. The dry bead height should be 8-12 mil (0.008-0.012", 203-305 µm).

C. *Wide Ribbon Pattern:* Extrude ribbons 5/8-3/4" (15.9-19.1 mm) wide to form wide, flat strips. Depending on the width of the lining, 2-3 ribbons are used. The dry bead height should be 8-10 mil (0.008-0.010", 203-254 µm).

D. *Full-Width Solid Pattern:* Adhesive is applied to the entire bonding surface of the lining material. This pattern is not widely used, but can be effective on very narrow drum brakes.

Drying

Lining adhesive must be fully dried before it is mated with the core and bonded. Coated linings can be left in ambient air for 24 hours or drying can be accelerated with drying ovens. If linings are to be dried using an oven, Henkel recommends letting the adhesive dry in open air for 5-10 minutes. This additional open air time will help to minimize blistering. After the part has set in open air for 5-10 minutes, it can be dried using an oven set at 180-250°F (82-121°C) for 20-30 minutes. A multi-stage oven that adjusts from low temperature to high temperature will dry Plastilock® lining adhesives most efficiently and will yield the best looking coating pattern with very little blistering. Good air flow in the oven will also aid in drying. Typically 500-3000 cubic feet per minute (14-85 m^3/min.) of air is used.

A maximum of 3-5% residual solvent is allowed in dried lining adhesive. To test for the amount of residual solvent in the lining adhesive, remove the ribbons or strips of adhesive from the lining after the drying cycle. Weigh these strips. Place the strips in an aluminum tray or other open container

and dry them for an additional 2-4 hours at 180-250°F (82-121°C). Allow the strips to cool. Reweigh the strips. Subtract the final weight of the strips from the initial weight. Divide this number by the initial weigh to determine the percent weight loss. This percent is the amount of residual solvent in the lining. If this amount is greater than 5%, adjust the drying conditions until the residual solvent is less than 5%.

Curing

Plastilock® and Aqualock® friction adhesives are cured with heat and must be kept under constant pressure during cure. The brake core and lining are positioned in a jig (***Figure 2***). A band is placed around the perimeter of the fixture (***Figure 3***). Pressure of 75-150 psi (517-1034 kPa) is applied to the jig using a special expansion machine and a nut is tightened to maintain pressure on the parts (***Figure 4***).

After assembly, the jig is placed in an oven and cured. Plastilock® and Aqualock® adhesives must be cured at bond line temperatures above 375°F (191°C). The phenolic resins in these products will not begin to cure unless the adhesive reaches this minimum temperature. The curing oven will need to be set significantly higher to reach this minimum bond line temperature. Because the size of the part will greatly effect the time it takes for the bond line to reach temperature, refer to the following procedure to determine the optimal cure parameters.

1. Hollow out the back of the friction material large enough to insert a thermocouple at the bond line. Attach the thermocouple to a pyrometer calibrated to indicate temperatures directly. Put brake assembly in the pressure jig. Position the pyrometer so it can be read easily during the test.
2. Set temperature controls and conveyor speeds to desired settings. Do not change settings during test.
3. Place jig into oven and monitor temperature. If temperature changes quickly, use the Short Cure Chart. This chart will be useful for small parts with little thermal mass. If the temperature changes relatively slowly, use the Long Cure Chart. This chart is typically used on large parts or when oven temperatures are set low.
4. Take temperature readings every 2 minutes.
5. Mark temperature readings on the chart with an X. If the 2-minute reading is 180°F mark an X at the intersection of the lines running up from 2 minutes and over from 180°F.
6. After 24 minutes (Short Cure) or 75 minutes (Long Cure), the test is complete.
7. Draw a curve connecting the Xs.
8. At the point your curve joins Line ABC, read the time on the scale at the bottom of the chart.
9. This is the minimum time you can use to get a good quality bond at the oven temperature settings you have chosen. Additional time beyond this minimum is necessary to fully cure the adhesive.
10. If necessary, make adjustments to the speed of the oven conveyor or to the set temperature of the oven.

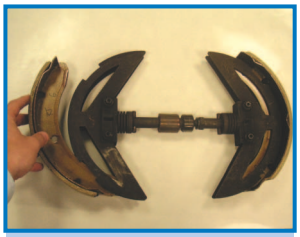


Figure 2

Figure 3

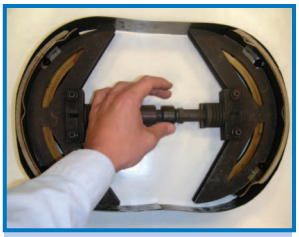
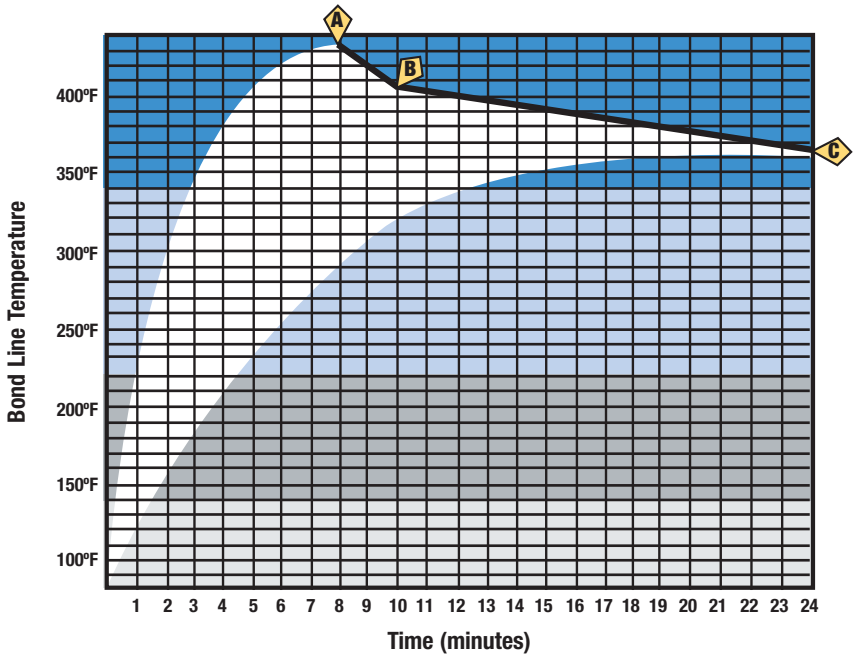


Figure 4

Short Cure Chart (oven curing)

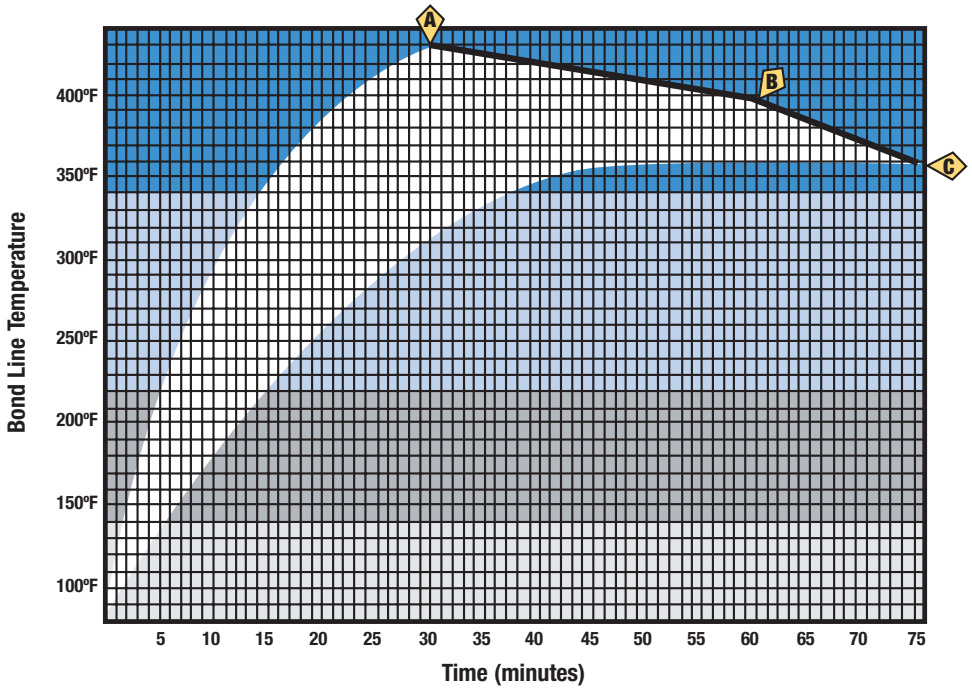


Bonding Area — Temperature area in which a heat-resistant bond is obtained.

Partial Bond Area — Weak bond will result if cure is stopped in these temperatures.

Flow Area — Adhesive softens, wets metal and flows over bonding area — pressure important.

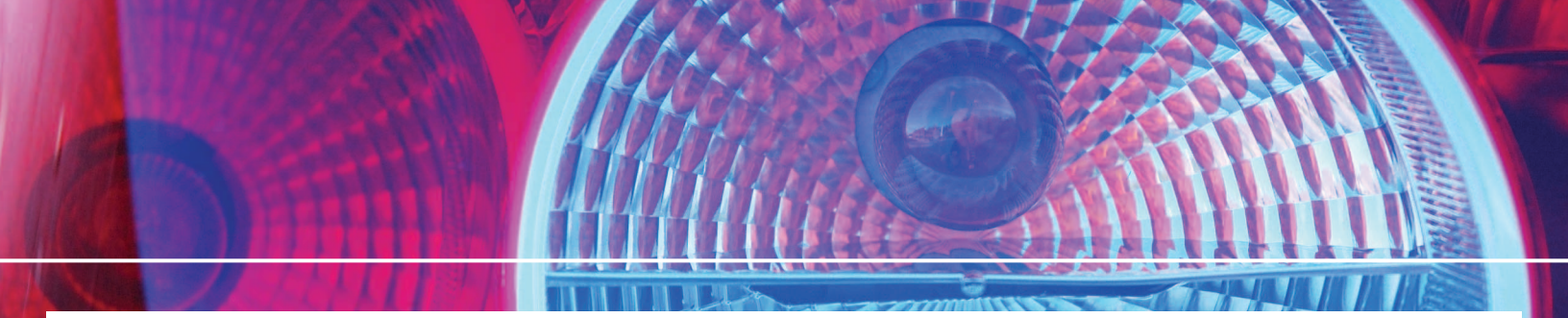
Long Cure Chart (oven curing)



Bonding Area — Temperature area in which a heat-resistant bond is obtained.

Partial Bond Area — Weak bond will result if cure is stopped in these temperatures.

Flow Area — Adhesive softens, wets metal and flows over bonding area — pressure important.



Testing and Troubleshooting

Bonded drum brakes are tested by shearing the lining material off of the core of the shoe. This test is performed using a fixture designed to fit the shape of the shoe core. The shoe is placed in the fixture and a force is applied to the lining material in a perpendicular direction to the bond line. Once the lining has been sheared from the core, observe the failure pattern of the lining material. An ideal bond is one in which the friction material fails in at least 90% of the area across the table of the core. This means that no spots of bare metal are showing and a significant layer of friction material is left on the core.

Inadequate bond strength could be caused by many factors. Among the most common causes of poor bonds is uneven or too little pressure during cure. The primary indication of too little pressure or uneven pressure is that the ribbon or bead pattern of the adhesive will still be evident on the sheared surface (***Figure 5***). Also, the adhesive will appear porous or spongy. The pressure applied to the shoe during cure is necessary to force all of the vapors formed during cure out of the adhesive layer. If inadequate pressure is applied, these vapors will remain trapped in the adhesive causing a weak or "blown" bond (***Figure 6***).

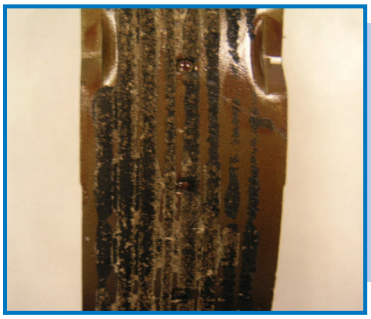


Figure 5

Ribbon pattern remains on sheared shoe as a result of inadequate pressure.

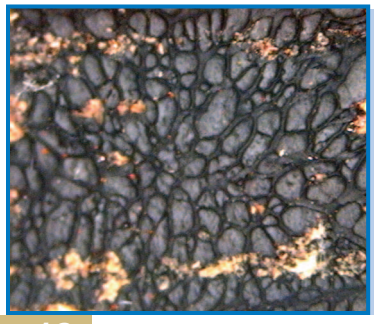


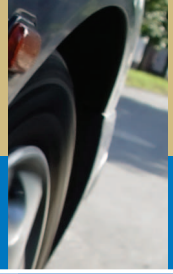
Figure 6

Magnified view of "blown" bond. Adhesive appears porous due to trapped water vapor in the bond line.

Refer to the following chart to help troubleshoot a poor bond:

Adhesive is visible on both core table and on lining. Failure mode is cohesive (within the adhesive layer).		
Look For....	Causes	Remedies
Bead or ribbon pattern of lining adhesive is still visible.	Uneven or low pressure during cure.	• Increase pressure. • Check that shoes are positioned correctly in jig.
	Not enough adhesive applied.	• Check film thickness of dried adhesive. • Adjust bead pattern. Add more beads or narrow the gap between beads.
Adhesive is spongy or "blown."	Incomplete cure.	• Increase cure time and/or temperature.
	Too much residual solvent in lining adhesive.	• Test percent solids of a few beads off of a lining. Residual solvent should be less than 5%. Contact Henkel for procedure. • Increase air flow, time, or temperature in drying oven.
	Low pressure during cure.	• Increase pressure. • Check that shoes are positioned correctly in jig.
Portions of the shoe are bonded fully, while other parts are not bonded or are "blown."	Uneven pressure during cure.	• Check that shoes are positioned correctly in jig. • Check shoe for warping. • Adjust or replace band or fixture.
Adhesive can be softened or wiped off with methyl ethyl ketone.	Adhesive is not fully cured.	• Increase cure time and/or temperature.

Spots of bare metal are showing.		
Look For....	Causes	Remedies
Bare metal failure.	Contaminated shoe dip.	• Clean tank and fill with dip.
	Shoe not fully cleaned before shoe dip was applied.	• Examine cleaning bath and replace cleaning solution if necessary. • Lengthen time in cleaning bath or increase temperature of bath. • Check grit or shot for oil contamination. Replace grit or shot if necessary.
Shoe dip can be wiped off or becomes tacky when wiped with methyl ethyl ketone.	Incomplete cure.	• Increase cure time and/or temperature.
	Shoe dip has expired.	• Clean tank and fill with fresh dip.



Disc Brakes

Products

Product Name	Base Polymers	Color	% Solids (Weight)	% Solids (Volume)	Viscosity	Application	Solvent System
Aqualock® AL6000™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	28-32%	27%	5000-7000 cps.	Brush, Spray, Curtain Coat, Roll Coat	Water
Aqualock® AL6002™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	28-32%	26%	15000-18000 cps.	Brush, Spray, Curtain Coat, Roll Coat	Water
Aqualock® AL6004™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	26-30%	25%	3500-7000 cps.	Brush, Spray, Curtain Coat, Roll Coat	Water
Aqualock® AL6700™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	32-36%	29%	300-800 cps.	Brush, Spray, Curtain Coat, Dip	Water
Plastilock® PL601™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	100%	100%	Film	Film	Solvent-Free
Plastilock® PL655-1™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	100%	100%	Film	Film	Solvent-Free
Plastilock® PL605-F™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	100%	100%	Film	Film	Solvent-Free
Plastilock® A-344-B™ Adhesive	Phenolic Resin	Amber	28-31%	17%	20-40 cps.	Brush, Spray, Dip	Isopropyl Alcohol
Plastilock® A-602-B™ Adhesive	Phenolic Resin	Amber	49-54%	40%	100 cps. min.	Brush, Spray, Dip	Methyl Ethyl Ketone, Isopropyl Alcohol
Plastilock® A-602-B1™ Adhesive	Phenolic Resin	Amber	50-55%	40%	22-29 sec. (#2 Zahn cup)	Brush, Spray, Dip	Acetone

Surface Preparation

All metal surfaces must be clean of protective oils and other contamination. A solvent or aqueous cleaning system is used to remove these contaminates. Henkel is a full-service supplier of these chemistries.

Solvent-based cleaning systems use mineral spirits, methylene chloride, n-propyl bromide or other solvents that dissolve oils. These chemicals do not require heating for use. Usually, the parts are immersed in a bath of solvent for a period of time then withdrawn from the bath and dried either at ambient temperature or with moderate heat of 120°F (49°C).

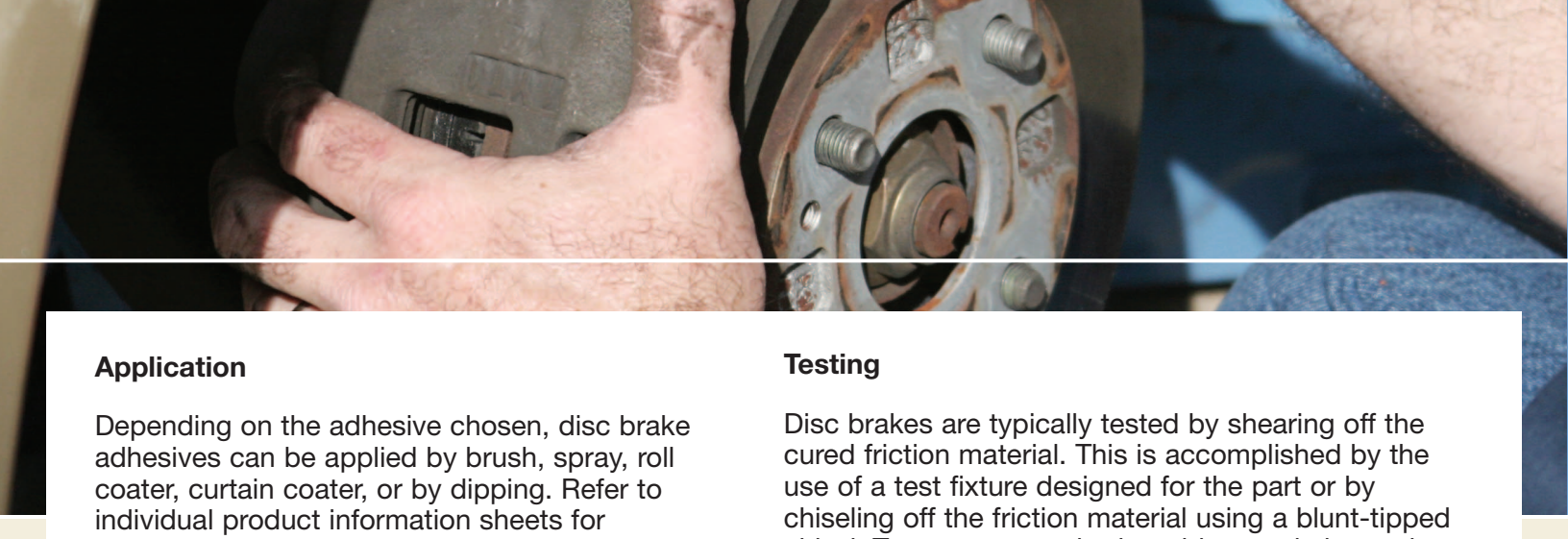
Aqueous cleaning systems are solutions of a small amount of an alkaline cleaner in water. These solutions are heated to 140-180°F (60-82°C). Parts are dipped into the solution for a period of time then removed from the solution and rinsed with water. The rinse water is usually heated as well so that when the parts are removed from the rinse, they dry quickly. Following the rinse, parts are dried with an oven, high velocity air, or a combination of both.

The primary advantage to a solvent cleaning system is low energy usage compared to aqueous systems which require a heated bath. The disadvantages of a solvent system include waste disposal, air quality monitoring, and the possibility of fires if a flammable solvent is used. For these reasons, Henkel recommends the use of aqueous alkaline cleaning.

Henkel's Technical Representatives can provide cleaning chemicals and equipment recommendations along with process suggestions by request.

Following the removal of contaminates, disc brake backing plates should be grit blasted using an aluminum oxide grit to remove surface oxidation and increase the surface roughness of the metal. This step is critical to ensuring high strength bonds. Blasting plates with aluminum oxide grit renders the optimal surface for bonding with Henkel's adhesives.

Other surface preparation techniques include shot blasting the shoes with a wheel abrader. Although shot blasting can provide an adequate bonding surface, this technique does not remove the oxidation layer on the metal surface or rough the surface to the same degree as grit blasting. Using shot instead of grit results in a much more inconsistent bond. Henkel recommends grit blasting over shot blasting because it results in the most consistent bonding surface.



Application

Depending on the adhesive chosen, disc brake adhesives can be applied by brush, spray, roll coater, curtain coater, or by dipping. Refer to individual product information sheets for application instructions and equipment recommendations. Recommended dry film thickness for all disc brake adhesives is 1-3 mil (0.001-0.003", 25.4-76.2 µm)

Drying

Follow drying directions on page 6. These recommendations are applicable to disc brake adhesives as well. In addition to the typical drying cycles, some very resinous adhesives require a "B-stage" or partial cure of the adhesive before the lining material is bonded. Refer to individual product data sheets for information on B-staging.

Curing

Disc brake adhesives are cured somewhat differently then drum brakes. Disc brake shoes are usually bonded in a mold. The coated disc brake backing plate is placed in the mold and either a loose-fill friction compound or a pre-molded puck of friction material is placed over the bonding surface of the core. The mold is closed and 1000-4000 psi (68.9-275.7 kPa) is applied. The part is heated to above 350ºF (177ºC) and cured in the mold for 45 seconds to 5 minutes or more. This initial cure allows the adhesive to start curing and also partially cures the friction compound.

After the initial press cure, disc brakes are placed in an oven and post-baked at 400-450ºF (204-232ºC) for 4-8 hours. This step completes the cure of the adhesive and friction compound.

Testing

Disc brakes are typically tested by shearing off the cured friction material. This is accomplished by the use of a test fixture designed for the part or by chiseling off the friction material using a blunt-tipped chisel. Tests are run at both ambient and elevated temperatures – typically 400ºF (204ºC). The primary indication of a good adhesive bond is deep lining failure. This means that a substantial amount of friction material remains on the backing plate after the puck has been sheared off. There should be no bare metal showing on the bonded surface.

Refer to the following chart to help troubleshoot bonding problems:

Bare metal failure is evident.

Look For....	Causes	Remedies
Patches of bare metal.	Surface contamination.	• Examine cleaning bath and replace cleaning solution if necessary. • Lengthen time in cleaning bath or increase temperature of bath. • Check grit or shot for oil contamination. Replace grit or shot if necessary.
	Inadequate surface roughness.	• Check backing plates after the grit or shot blasting step. • Inspect for relative roughness of the part. • Replace worn or contaminated shot or grit.
	For low density lining formulations, adhesive was absorbed into lining.	• B-stage adhesive prior to molding. • Choose a different adhesive. Some products do not flow as much as others during cure. • Contact Henkel Technical Representatives for recommendations and procedures. • Replace worn or contaminated shot or grit.
Shallow lining failure. Only a thin layer of lining is left on backing plate.	Incomplete cure. Adhesive will wipe off with methyl ethyl ketone after cure.	• Increase cure time and/or temperature.
	Cure temperature was ramped up too quickly.	• Lower cure temperature and increase mold time.
	Low pressure during cure.	• Increase pressure.
	Not enough adhesive.	• Test dry film thickness of adhesive. • Increase amount if necessary.
	Adhesive was dried too hot after coating.	• Adhesive should not exceed surface temperate of 300ºF during drying cycle.

Friction Paper Bonding

Products

Product Name	Base Polymers	Color	% Solids (Weight)	% Solids (Volume)	Viscosity	Application	Solvent System
Aqualock® AL6000™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	28-32%	27%	5000-7000 cps.	Brush, Spray, Curtain Coat, Roll Coat	Water
Aqualock® AL6002™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	28-32%	26%	15000-18000 cps.	Brush, Spray, Curtain Coat, Roll Coat	Water
Aqualock® AL6004™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	26-30%	25%	3500-7000 cps.	Brush, Spray, Curtain Coat, Roll Coat	Water
Aqualock® AL6700™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	32-36%	29%	300-800 cps.	Brush, Spray, Curtain Coat, Dip	Water
Plastilock® PL605-F™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	100%	100%	Film	Film	Solvent-Free
Plastilock® PL700™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	27-31%	21.5%	2000-2400 cps.	Brush, Spray, Curtain Coat, Roll Coat	Methyl Ethyl Ketone, n-Butyl Acetate, Isopropyl Alcohol
Plastilock® PL606M™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	29-31%	28%	1200-1900 cps.	Brush, Spray, Curtain Coat, Roll Coat	Toluene, n-Butyl Acetate, Isopropyl Alcohol
Plastilock® PL605-4™ Adhesive	Phenolic Resin and Nitrile Rubber	Black	29% min.	30%	4000-6000 cps.	Brush, Spray, Curtain Coat, Roll Coat	Methyl Ethyl Ketone, Isopropyl Alcohol

Surface Preparation

All metal surfaces must be clean of protective oils and other contamination. A solvent or aqueous cleaning system is used to remove these contaminates. Henkel is a full-service supplier of these chemistries.

Solvent-based cleaning systems use mineral spirits, methylene chloride, n-propyl bromide, or other solvents that dissolve oils. These chemicals do not require heating for use. Usually, the parts are immersed in a bath of solvent for a period of time then withdrawn from the bath and dried either at ambient temperature or with moderate heat of 120°F (49°C).

Aqueous cleaning systems are solutions of a small amount of an alkaline cleaner in water. This solution is heated to 140-180°F (60-82°C). Parts are dipped into the solution for a period of time then removed from the solution and rinsed with water. The rinse water is usually heated as well so that when the parts are removed from the rinse, they dry quickly. Following the rinse, parts are dried with an oven, high velocity air, or a combination of both.

The primary advantage to a solvent cleaning system is low energy usage compared to aqueous systems which require a heated bath. The disadvantages of a solvent system include waste disposal, air quality monitoring, and the possibility of fires if a flammable solvent is used. For these reasons, Henkel recommends the use of aqueous alkaline cleaning.

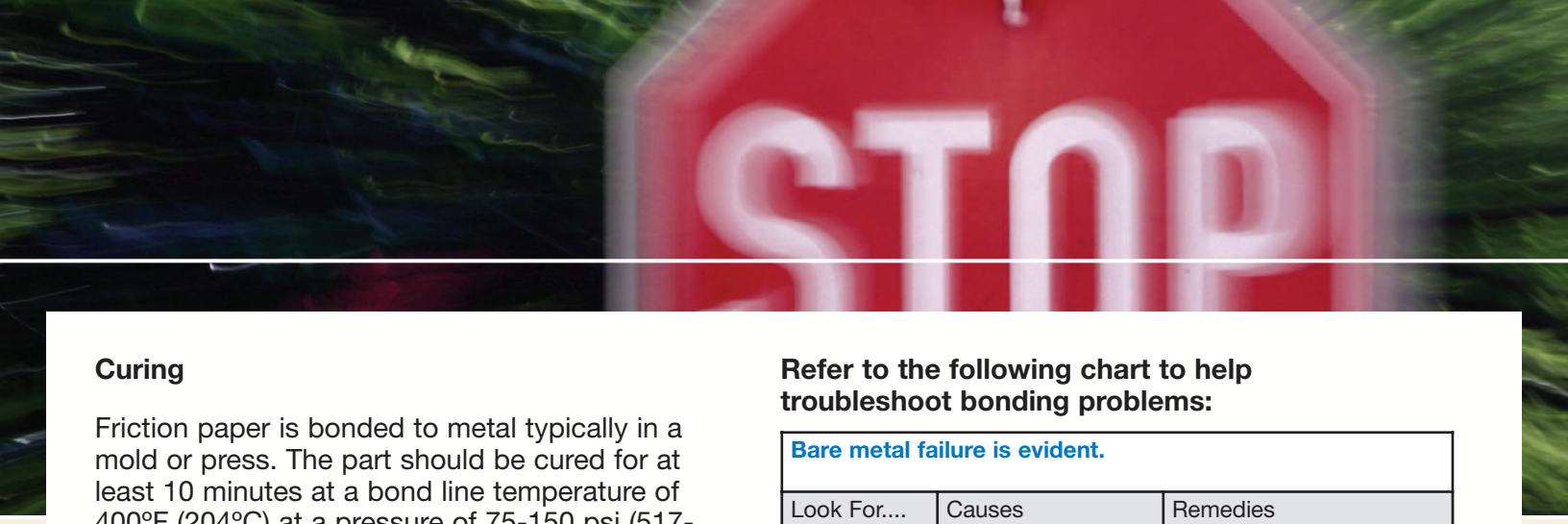
Henkel's Technical Representatives can provide cleaning chemicals and equipment recommendations along with process suggestions by request.

Application

Depending on the adhesive chosen, friction paper adhesives can be applied by brush, spray, roll coater, curtain coater. The adhesive can be applied to either the friction paper or the metal ring. Coating the ring with adhesive will minimize absorption into the friction paper. Refer to individual product information sheets for application instructions and equipment recommendations. Recommended dry film thickness for friction paper adhesives is 0.5-3 mil (0.0005-0.003", 12.7-76.2 µm).

Drying

Follow drying directions on page 6. These recommendations are also applicable to friction paper adhesives.



Curing

Friction paper is bonded to metal typically in a mold or press. The part should be cured for at least 10 minutes at a bond line temperature of 400ºF (204ºC) at a pressure of 75-150 psi (517-1034 kPa). Some lining compositions may require more time and/or temperature to achieve an adequate bond.

Testing and Troubleshooting

To check the bond strength of clutch or transmission parts, use a chisel to attempt to remove the friction material from the metal or if the part is relatively thin, bend it around a mandrel. The friction material should be very difficult to remove. Depending on the lining composition, some amount of lining material should remain on the metal.

Refer to the following chart to help troubleshoot bonding problems:

Bare metal failure is evident.		
Look For....	Causes	Remedies
Large patches of bare metal.	Surface contamination.	• Examine cleaning bath and replace cleaning solution if necessary. • Lengthen time in cleaning bath or increase temperature of bath.
	For low density lining formulations, adhesive was absorbed into lining.	• B-stage adhesive prior to molding. • Choose different adhesive. Some products do not flow as much as others during cure. • Contact Henkel Technical Representatives for recommendations and procedures. • Replace worn or contaminated shot or grit.
	Incomplete cure. Adhesive will wipe off with methyl ethyl ketone after cure.	• Increase cure time and/or temperature.

Henkel recommends that you test all new adhesive applications under simulated or actual end use conditions to ensure the adhesive meets or exceeds all required product specifications. This data was generated under highly controlled laboratory conditions, and may not represent actual assembly conditions. Since assembly conditions may be critical to adhesive performance, it is also recommended that testing be performed on specimens assembled under simulated or actual production assembly conditions.

Sustainability – The Foundation of Henkel

Henkel is founded on a deep commitment to deliver services and chemical products that consistently exceed customer expectations.

The guiding principles of Henkel inspire long-term customer relationships based on reliability, credibility and mutual trust. This trust is earned by the continued practice of putting the customer first and working to discover new, more effective solutions every day.

With more than 50,000 employees, including 3,000 chemists and engineers, Henkel continues to expand its diversified range of products and services. Facilities in over 80 countries help ensure Henkel remains a global market leader.