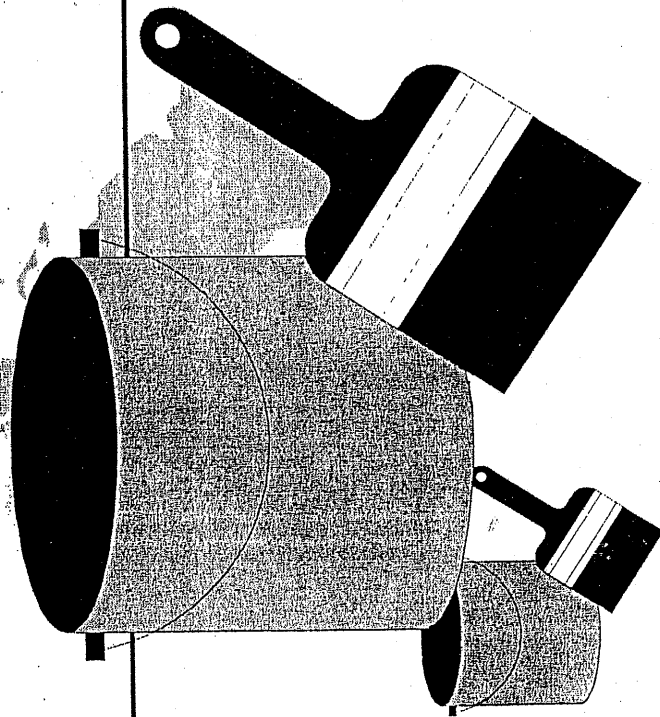
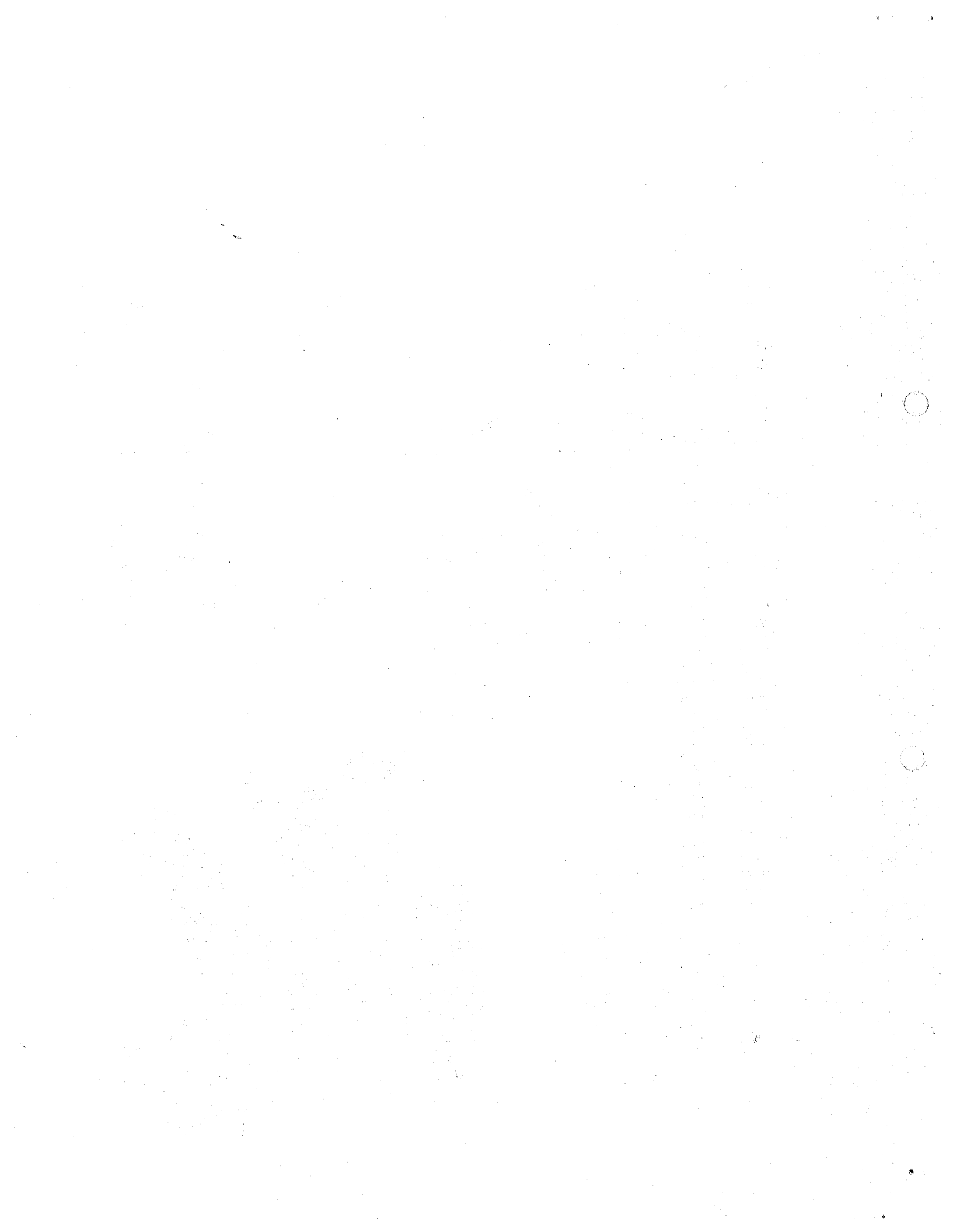


A Practical Look At Adhesives for Casting Urethanes to Metal



Walter C. Wilhelm
Lord Corporation



History

Adhesives Play a Very Essential Role in the Performance of a Cast Urethane Part. Because Urethane Engineered Prepolymers do not Offer the Necessary Adhesion Directly to Insert Materials, Adhesives Have Always been used During the Molding Process to Enhance Adhesion Between the Engineered Resin and the Insert Material.

Required Elements for a Cast Urethane Part

- Oven
- Mold
- Insert
- Adhesive
- Engineered Prepolymer

Engineered Urethane Prepolymer

A Urethane Engineered Prepolymer is a Mixture of an Isocyanate Functional Resin and an Active Hydrogen Curative (Hydroxyl-OH or Amine-NH), that is Formulated to Meet the Demands of the Application, Based on Both Economics and Performance. Some of the Performance Demands Include:

- Abrasion Resistance
- Toughness
- Tear Resistance
- Load-Bearing Ability
- Adhesion between insert and Urethane Prepolymer

Advantage of Urethanes vs Other Materials

Metals

Lighter Weight

Less Noise

Better Wear

Cheaper to Make

Corrosion

Resistance

Plastics

Non-Brittle

Elastomeric Memory

Abrasion Resistance

Rubber

Abrasion Resistance

Tear and Cut Resistance

Higher Load Bearing

Translucence

Ozone Resistance

Pourable; Castable

Harder Durometer

Range

Disadvantages of Polyurethanes

- Certain Chemical Environments
- Moist Hot Environments
- Service at High Temperature

Adhesion

The Interaction that Develops Between Two Dissimilar Surfaces When they Come in Contact With Each Other or the Interfacial Attraction that Develops When Two Surfaces are Held Together. This Attraction can be Accomplished by Intermolecular Attraction (London or van derWaals Forces), Mechanical Interlocking or the Preferred Chemical Reaction.

The Science of Adhesion

The Science of Adhesion is Centered Around How Well an Adhesive Wets Out the Material Surface Being Bonded. The Difference in Surface Energy Between the Adhesive and the Bond Surface is Critical. If the Surface Tension of the Adhesive is Higher Than the Surface Energy of the Bond Surface, Poor Wetting Will Result, Reducing the Chances of Good Adhesion.

Principles of Adhesion

A. Mechanical Adhesion - Adhesion Between Surfaces in Which the Adhesive Holds the Parts Together by an Interlocking Action Like a Jigsaw Puzzle.

B. Chemical Adhesion - The Attraction or Reaction of Molecular Forces Between the Adhesive and Substrate. This Interfacial Attraction can Include Valance, London or van derWaals Forces (Molecular Attraction) or a Chemical Reaction Between the Adhesive and the Material Surface.

Factors That Affect Adhesion

- Temperature
- Humidity
- Surface Preparation
- Contamination
- Energy
- Curing Adhesive Under Stress
- Solvent Dilution
- Mold Release
- Prebake Cycle

Factors That Affect Adhesion (Con't)

- Layover
- Cure Cycle
- Post Bake Cycle
- Bond Area
- Adhesive Thickness
- Finishing Process
- Adhesive / Material Compatibility
- Adhesive Flexibility / Modulus
- Tg - Glass Transition Temperature
- Environments

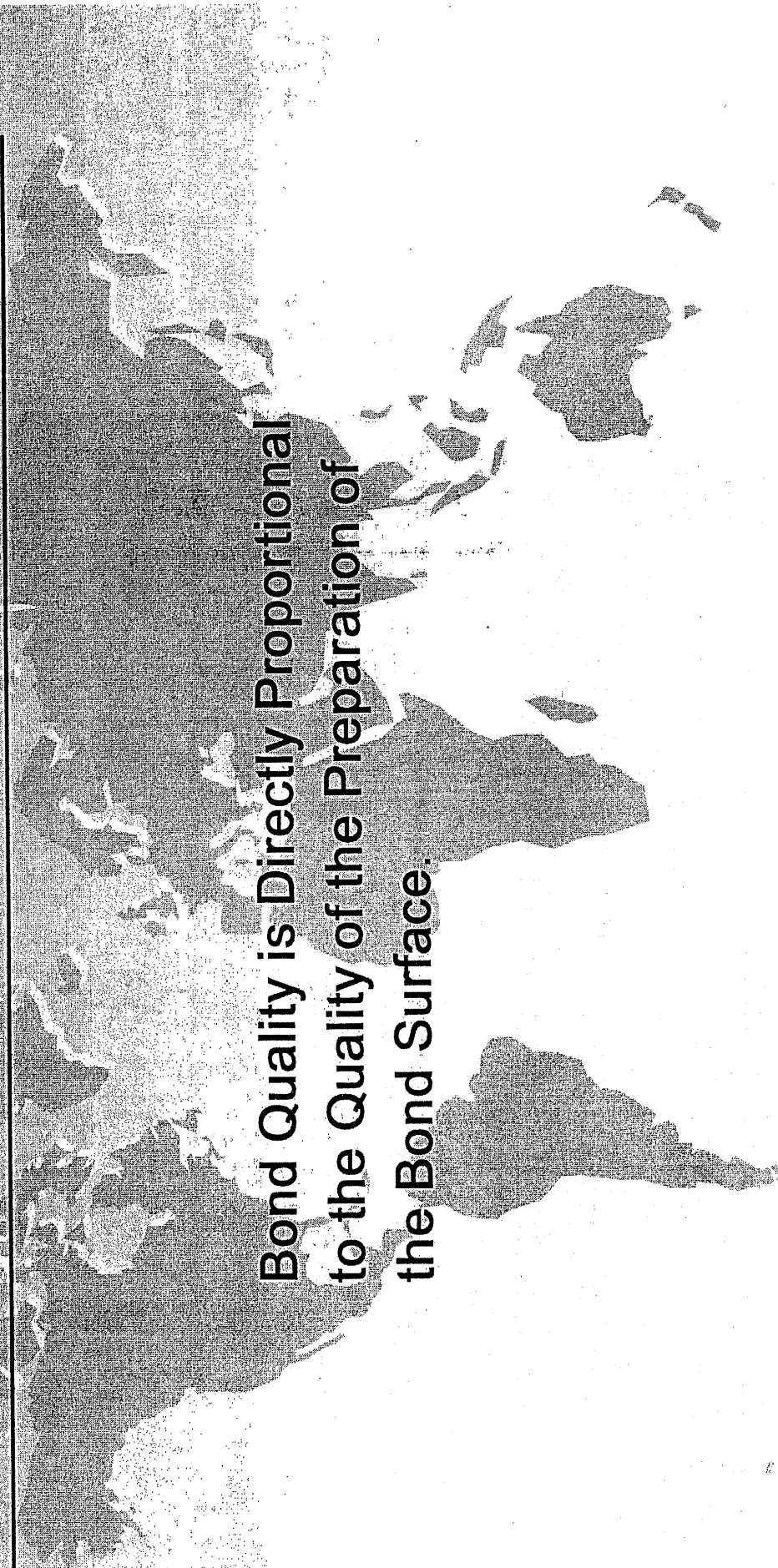
Surface Preparation

Certain Adhesives Offer the Benefit of Adhering to Minimum or Non-Prepared Surfaces.

Adhesives Presently Used for Casting Urethanes to Metals Require that the Bond Surface be Free of Oils, Grease, Mold Release and Loose particles. In Other Words, Bond Quality is Directly Proportional to the Quality of the Surface Preparation.

Surface Preparation

**Bond Quality is Directly Proportional
to the Quality of the Preparation of
the Bond Surface.**



Surface Preparation

Methods of Preparing a Materials Surface
For Casting Urethanes:

Mechanical

Blasting - Degrease, Blast,
Degrease

Chemical

Zinc or Iron Phosphatization

Galvanizing

Dichromate

Preparing the Bond Surface of an Insert Material

- Degrease with a Solvent or Aqueous Cleaner and Use a Proper Rinse.
- AlO₂ Grit Blast
- Degrease with a Solvent or Aqueous Cleaner and Use a Proper Rinse.
- Apply Adhesive to the Existing Surface or After a Zinc or Iron Phosphatization. If A Zinc or Iron Phosphatization is required, Rinse with Deionized Water Before Applying the Adhesive.
- Compatibility Between the Adhesive and the Bond surface is Critical. Make Sure the Nature of the Bond Surface (Acidic or Basic) is Right for the Adhesive You are Using.

Adhesive

A Material in the Form of Film, Low Viscosity Liquid, High Viscosity Liquid or Paste, Either Organic or Inorganic, Capable of Holding Materials together by Surface Attachment.

The five most Important Properties of an Adhesive

- Molecular Weight
- Tg - Glass Transition Temperature
- Surface Energy
- Compatibility Between the Adhesive
and Inset Material
- Morphology

Methods of Applying Adhesives for Casting Urethanes to Metals

- Brush*
- Roller
- Spray
- Dip
- Tumble

*Used the Most

What Ever Method is used to Apply an Adhesive, Controlling the Dry film Thickness is very Important.

Testing Adhesive Used for Casting Urethanes to Metals

Test

- ASTM D429-B (45 Degree Peel Test)

Environments

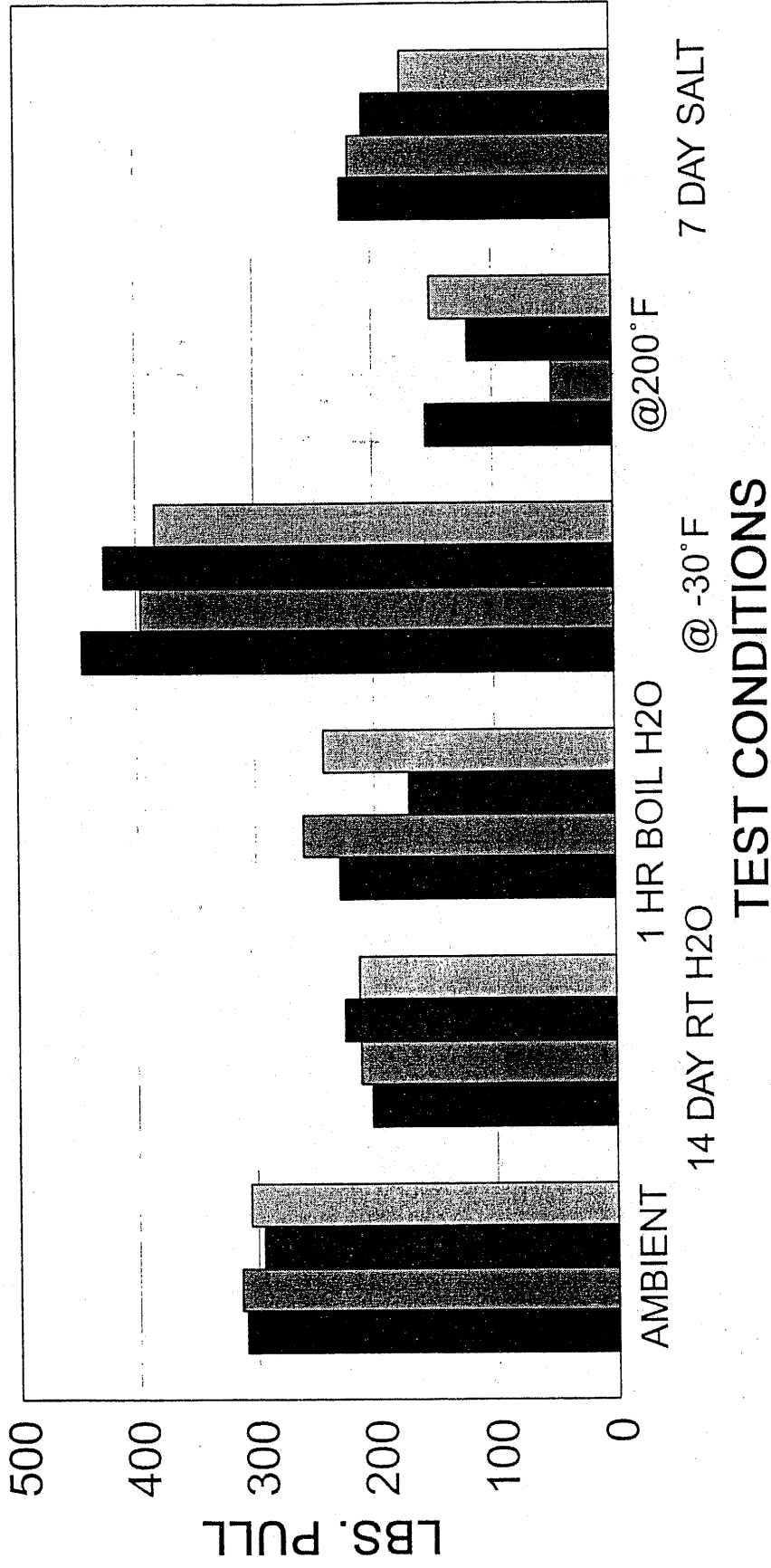
- Primary (70F)
- @ -30F
- @ 200F
- 7 Days in NSS (Salt Fog)
- 14 Day 100F/100%RH

Identifying Modes of Failure in the Castable Urethane industry

- SB = Stock Break - Failure of the Elastomer Through its Cross Section, Inside or Out Side the Bond Area.
- COH = Cohesive Failure - A Film of Adhesive is Left on Both the Elastomer and Insert Material
- RC = Elastomer to Cement Failure
- CM = Cement to Metal Failure
- PM = Primer to Metal Failure
- CP = Cement to Primer Failure

BOND PERFORMANCE

Testing per ASTM D429-B (2 "/min @ 45 degree peel)
Adiprene®(Uniroyal) L167/MOCA cured to GBS

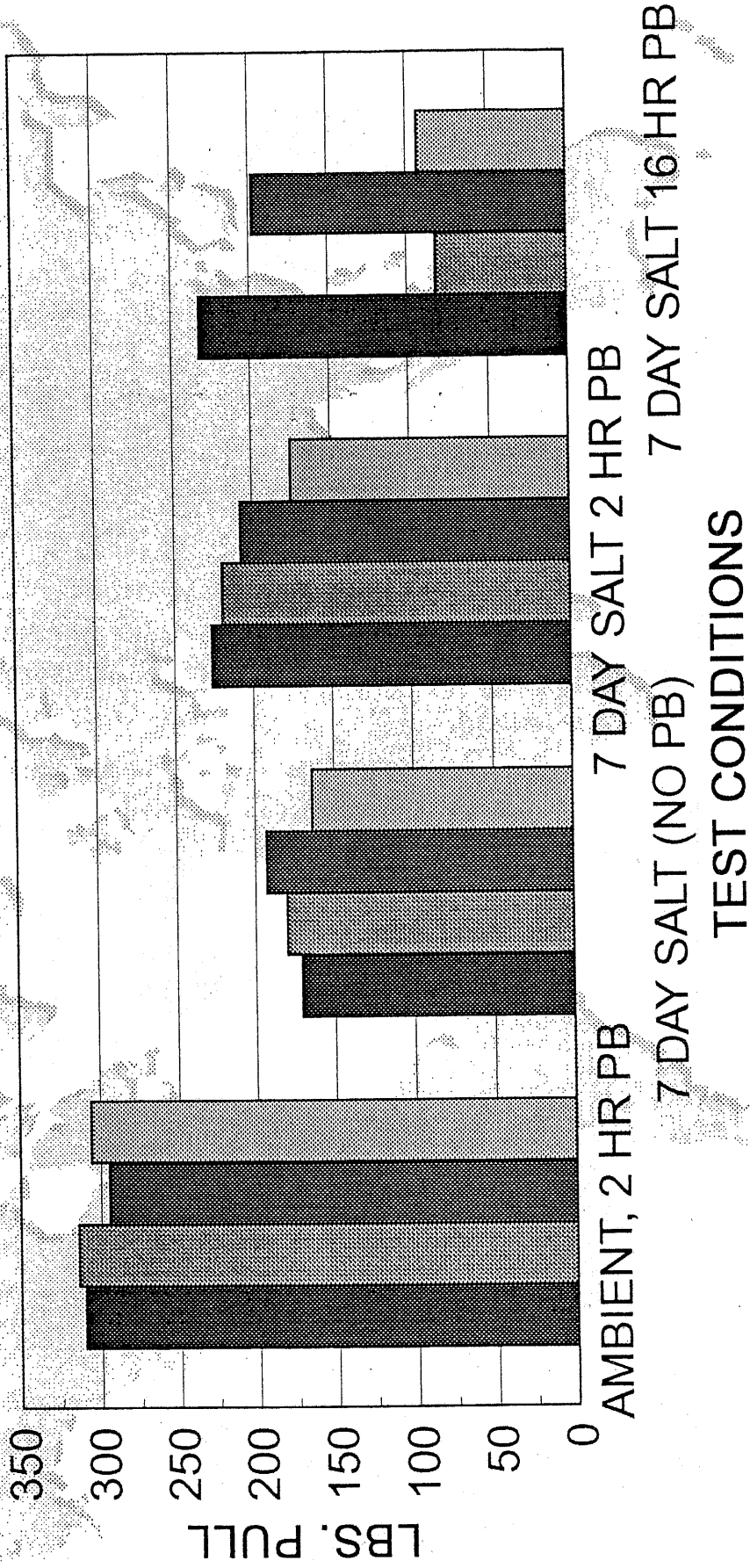


ADH #1 ADH #2 P #1/ADH #1 P #1/ADH #2

ALL PARTS WERE PREBAKED 2 HOURS AT 250°F

BOND PERFORMANCE

Testing per ASTM D429-B (2 "/min @ 45 degree peel)
Adiprene®(Uniroyal) L167/MOCA cured to GBS



ADH #1 ADH #2 P #1/ADH #2

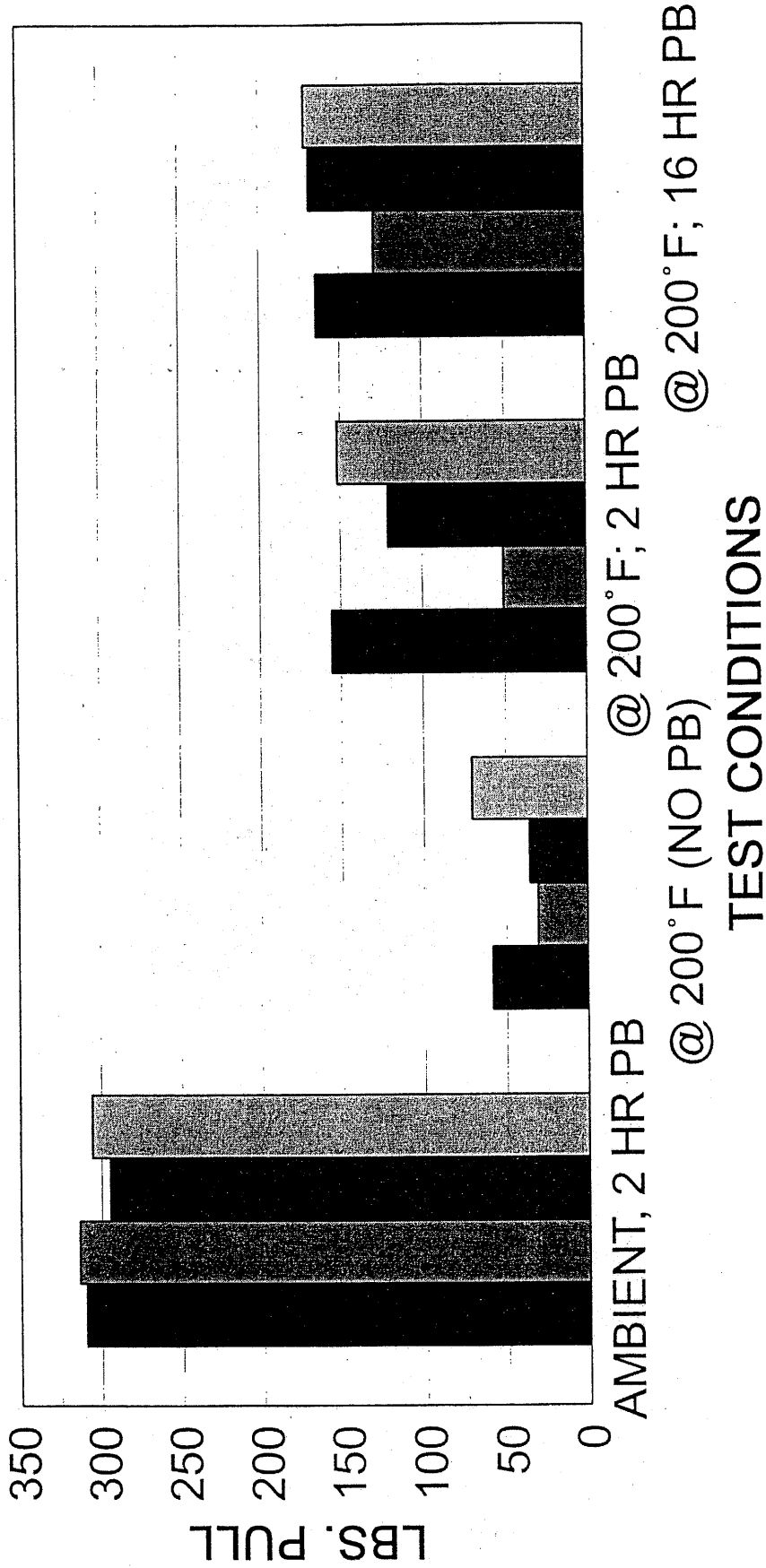
ALL PARTS WERE PREBAKED AT 250°F UNLESS NOTED

CHEMLOK[®] ADHESIVES FOR

CASTING URETHANES TO METAL

Testing per ASTM D429-B (2 "/min @ 45 degree peel)

Adiprene[®] (Uniroyal) L167/MOCA cured to GBS



■ CH213 ■ CH218 ■ CH219/CH213 ■ CH219/CH218

ALL PARTS WERE PREBAKED AT 250° F UNLESS NOTED

Molding Castable Urethanes

Step # 1 Prepare the Bond Surface.

Step # 2 Coat the Insert with Adhesive or Primer then Adhesive. Allow Sufficient Time

Between the Application of Primer and Top Coat for the Solvent to Flash.

Step # 3 Prebake the Adhesive Coated Insert at 250F. The Amount of Time Will Depend on the Mass of the Insert.

Step # 4 Store Prebaked Inserts in a Dry, Clean Environment Free of Dust and Mold release.

Molding Castable Urethanes (Con't)

- Step # 5 Prepare Mold; Clean and Apply Mold Release.
- Step # 6 Preheat the Mold and Insert in Separate Ovens to Minimize the Chance of Mold Release Contaminating the Bond Area of the Insert.
- Step # 7 Place Insert into the Mold.
- Step # 8 Mix the Urethane Resin and Hardener, then Pour them into the Mold.

Molding Castable Urethanes (Con't)

Step # 9 Cure the Mixed Resin per the Manufacturers Recommendation.

Step # 10 Demold Parts

Step # 11 Post Bake the Parts per the Suppliers Recommended Time and Temperature.

Step # 12 Prepare the Mold for the Next Casting.

Repairing Cast Urethane Parts

- Clean Damaged Areas; Remove Loose Material and Wash with Solvent.
- Apply Adhesive.
- Repairing Urethane to Metal - Adhesive May Require a Prebake.
- Repairing Urethane to Urethane - Allow Adhesive to Air Dry for 30 to 60 min. at RT or 5 min. at RT + 15 min. at 200 F.
- Pour Urethane into Damaged Area.
- Cure 30 min. @ 212 F.
- Post Bake 90 min. @ 212 F.

Designers Philosophy

- Know Your Materials
- Know the Environments the Assembly Will be Exposed to
- Design the Part for Maximum Shear Forces
- Specify Production Instructions
- Educate Workers
- Incorporate Preventive Maintenance Procedures into the Manufacturing Process
- Establish Quality Control Procedures

Future Adhesives for Casting Urethanes to Metals

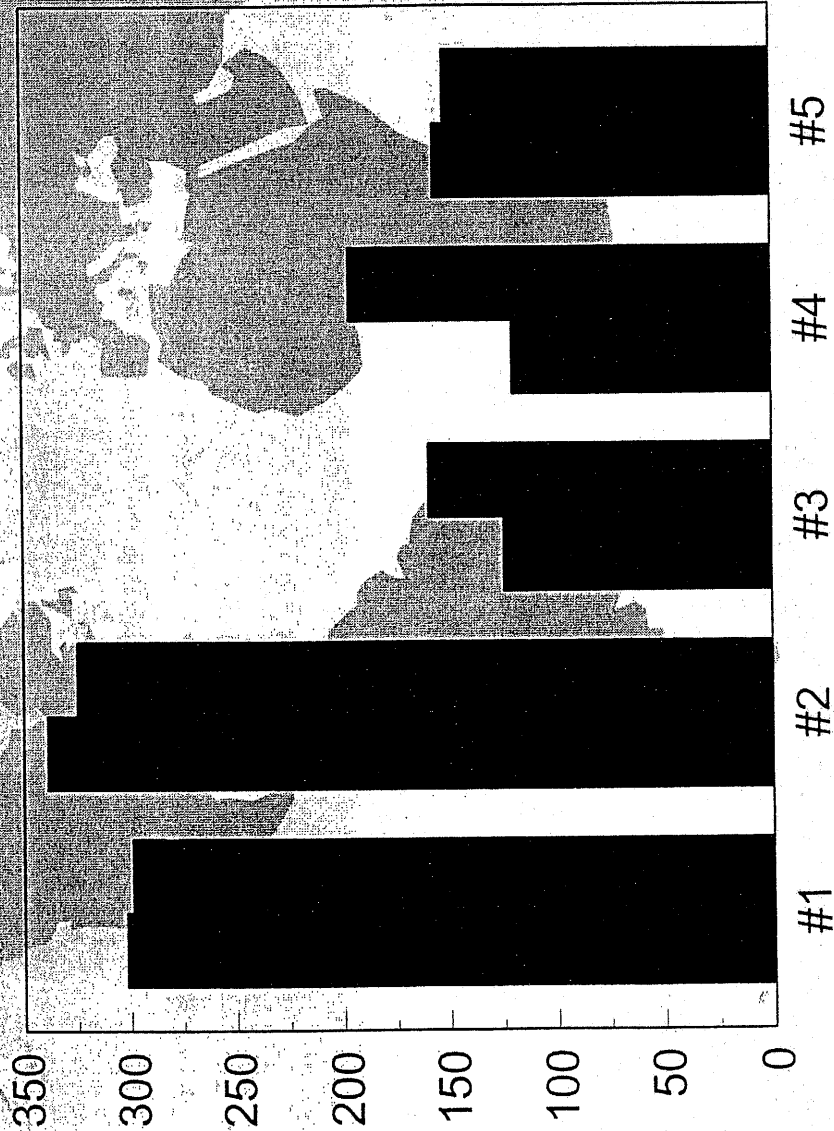


Waterborne

Chemlok® EP6962-62 Performance

ASTM D429-B, Grit Blasted Steel, Adiprene® (Uniroyal) L167/MOCA-cured

PULL VALUES (PLI)



■ Chemlok 213

■ Chemlok EP6962-62

#1 - Primary Adhesion

#2 - @ -30F Temperature

#3 - @ 200F Temperature

#4 - 7 day Salt-Spray

#5 - 14 days @ 100F/100%RH

TESTS PERFORMED

Summary

- Adhesion is Directly Proportional to the Quality of the Surface Preparation.
- Selecting the Right Adhesive is Essential to Assure Good Bond Quality.
- The Science of Adhesion is Based on the Wetting Performance of the Adhesive.
- Many Factors Can Affect Adhesion
- Tomorrow's Adhesives for Casting Urethanes to Metal are Waterborne Systems