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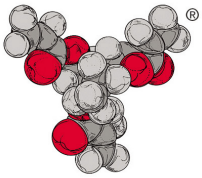

Product Bulletin

# Hydroxyl Terminated Polybutadiene Resins and Derivatives

TOTAL

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**www.sartomer.com**

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# INTRODUCTION

Poly bd® resins are low molecular weight, hydroxyl terminated homopolymers of butadiene. Poly bd® resins are characterized by low volatiles content, low glass transition temperatures, excellent hydrophobicity and a high level of reactive functionality.

The facile reaction of Poly bd® resins with curing agents such as di- and polyisocyanates provides an economical route to the preparation of general-purpose polyurethane elastomers. The unique structure of the Poly bd® resins provides properties which surpass typical polyether and polyester polyol based urethane systems, as well as conventional, general-purpose rubbers. All grades of Poly bd® resins contain unsaturated double bonds that can be cured or crosslinked, and several grades of Poly bd® resin contain epoxide functionality.

Some of the outstanding performance characteristics Poly bd® resins provide to products include:

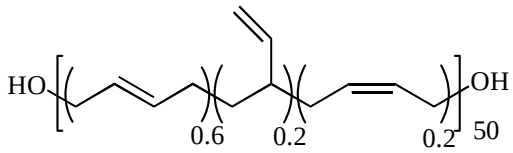
Adhesion to a variety of substrates
Hydrolytic stability
Aqueous resistance to acids and bases
Low temperature flexibility
Low moisture permeability
Low embedment stress
Thermal cycling stability
Electrical insulation properties
High elongation with good elastic recovery.

Poly bd® resins are used in various applications including coatings, construction products, waterproof membranes, electronic and automotive. The Poly bd® resins are used in castable elastomers, caulks, sealants, membranes, foams, adhesives, coatings, propellent binders, potting and encapsulation compounds as well as other rubber –fabricated materials.

Poly bd® resins comply with title 21 (Food and Drugs) of the Code of Federal Regulations, paragraph 175.300, Resinous and Polymeric Coatings.

# Poly bd® R-45HTLO Resin

## HYDROXYL TERMINATED POLYBUTADIENE RESIN




### DESCRIPTION

Poly bd® R-45HTLO resin is a liquid hydroxyl terminated polymer of butadiene with a number average molecular weight of approximately 2800. Poly bd® resins have primary, allylic alcohol groups that exhibit high reactivity in either condensation polymerization reactions or the preparation of derivatives. The degree of polymerization is approximately 50 for the R-45HTLO. Hydroxyl functionality is typically in the 2.4 – 2.6 range for R-45HTLO. Poly bd® R-45HTLO is regulated by the United States Department of Commerce and may not be exported without a license from that organization.

### PRODUCT HIGHLIGHTS

Hydrophobicity
Reactive hydroxyl groups
Low glass transition temperature
Miscibility with asphalt
Low color, high clarity

### PERFORMANCE PROPERTIES

Hydrolytic stabiltiy
Low temperature Flexibility
Low moisture permeability
Resistance to aqueous acids and bases
Excellent adhesion to a variety of substrates
Electrical insulation properties

### SUGGESTED APPLICATIONS

Potting and encapsulation
Adhesives
Sealants
Binders
Waterproof coatings and membranes

**Poly bd® R-45HTLO Resin**
**TYPICAL PHYSICAL AND CHEMICAL PROPERTIES**

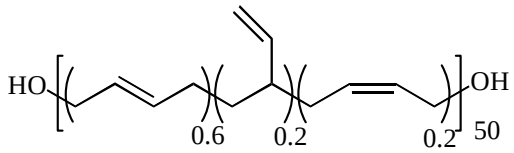
| | |
|---|---|
| Nonvolatile Material, wt% | 99.9 |
| Viscosity, mPa·s @ 23°C | 8000 |
| Viscosity, mPa·s @ 30°C | 5000 |
| Hydroxyl Number, mg KOH/g | 47.1 |
| Hydroxyl Value, meq/g | 0.84 |
| Hydroxyl Functionality | 2.4-2.6 |
| Molecular Weight, $M_n$ | 2800 |
| Polydispersity, $M_w/M_n$ | 2.5 |
| Water, wt% | 0.02 |
| Specific Gravity @ 23°C | 0.901 |
| Iodine Number, g/100g | 400 |
| Glass Transition Temp. (Tg), °C | -75 |
| Solubility, g/100 ml of solvent @ 25°C | |
| Mineral Spirits | >50 |
| Toluene | >50 |
| Chloroform | >50 |
| Methyl Ethyl Ketone | >50 |
| Ethyl Acetate | >50 |
| Acetone | <10[(1)] |
| Hexane | >50 |
| Aromatic 100 | >50 |
| Isopropanol | <10[(1)] |

[(1)] Cloudy: 5% solution also cloudy

**Regulatory Notice**
Poly bd® R-45HTLO is regulated by the United States Department of Commerce and may not be exported without license from that organization.

# Poly bd® R-45M

## HYDROXYL TERMINATED POLYBUTADIENE RESIN




### DESCRIPTION

Poly bd® R-45M is a liquid, hydroxyl terminated polymer of butadiene with a number average molecular weight of approximately 2800. Poly bd® resins have primary, allylic alcohol groups that exhibit high reactivity in either condensation polymerization reactions or the preparation of derivatives. The degree of polymerization is approximately 50 for R-45M. Hydroxyl functionality is typically in the range of 2.2 to 2.4 for R-45M. This resin is regulated by the United States Department of State and may not be exported without a license from that organization.

### PRODUCT HIGHLIGHTS

Low glass transition temperature
Hydrophobicity
High solids loading
Low color, high clarity

### PERFORMANCE PROPERTIES

Low temperature flexibility
Excellent adhesion to metal
Excellent dispersion of fillers

### SUGGESTED APPLICATIONS

Binders for military applications.

**Poly bd® R-45M**
**TYPICAL PHYSICAL AND CHEMICAL PROPERTIES**

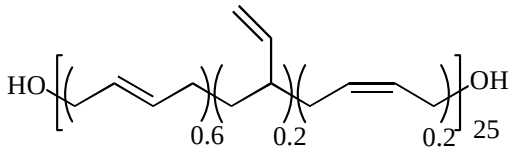
| | |
|---|---|
| Nonvolatile Material, wt% | 99.9 |
| Viscosity, mPa·s @23°C | 7000 |
| Viscosity, mPa·s @30°C | 4400 |
| Hydroxyl Number, mg KOH/g | 40.4 |
| Hydroxyl Value, meq/g | 0.72 |
| Hydroxyl Functionality | 2.2-2.4 |
| Molecular Weight, $M_n$ | 2800 |
| Polydispersity, $M_w/M_n$ | 2.2 |
| Water, wt% | 0.02 |
| Specific Gravity @23°C | 0.899 |
| Iodine Number, g/100g | 400 |
| Glass Transition Temp. (Tg),°C | -76 |
| Solubility | |
| Mineral Spirits | >50 |
| Toluene | >50 |
| Chloroform | >50 |
| Methyl Ethyl Ketone | >50 |
| Ethyl Acetate | >50 |
| Acetone | <10[(1)] |
| Hexane | >50 |
| Aromatic 100 | >50 |
| Isopropanol | <10[(1)] |

[(1)] Cloudy: 5% solution also cloudy.

**Regulatory Notice**
Poly bd® R-45M is regulated by the United States Department of Commerce and may not be exported without license from that organization.

# Poly bd® R-20LM Resin

## LOW MOLECULAR WEIGHT HYDROXYL TERMINATED POLYBUTADIENE RESIN




### DESCRIPTION

Poly bd® R-20LM Resin is a low viscosity, low molecular weight liquid, hydroxyl terminated polymer of butadiene. Poly bd® resins have primary, allylic alcohol groups that exhibit high reactivity in either condensation polymerization reactions or the preparation of derivatives. The degree of polymerization is approximately 25 for the Poly bd® R-20LM and the molecular weight is 1200. This product is regulated by the United States Department of Commerce and my not be exported without a license from that organization.

### PRODUCT HIGHLIGHTS

Reactive hydroxyl groups
Hydrophobicity
Low glass transition temperature
High solids loading
Low color, high clarity

### PERFORMANCE PROPERTIES

Hydrolytic stability
Low moisture permeability
Resistance to aqueous acids and bases
Low temperature flexibility
Electrical insulation properties

### SUGGESTED APPLICATIONS

Potting and encapsulation
Adhesives
Sealants
Waterproof coatings and membranes

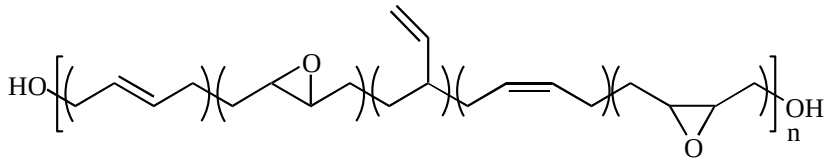
**Poly bd® R-20LM Resin**
**TYPICAL PHYSICAL AND CHEMICAL PROPERTIES**

| | |
|---|---|
| Nonvolatile Material, wt% | 99.9 |
| Viscosity, P @ 30°C | 14 |
| Hydroxyl Number, mg KOH/g | 101.0 |
| Hydroxyl Value, meq/g | 1.8 |
| Hydroxyl Functionality | 2.4-2.6 |
| Molecular Weight, $M_n$ | 1200 |
| Polydispersity, $M_w/M_n$ | 2.0 |
| Water, wt% | 0.05 |
| Specific Gravity @23°C | 0.913 |
| Iodine Number, g/100g | 420 |
| Glass Transition Temp. (Tg),°C | -70 |
| Solubility | |
| Mineral Spirits | >50 |
| Toluene | >50 |
| Chloroform | >50 |
| Methyl Ethyl Ketone | >50 |
| Ethyl Acetate | >50 |
| Acetone | <10[(1)] |
| Hexane | <50 |
| Aromatic 100 | >50 |
| Isopropanol | <10[(1)] |

[(1)] Cloudy: 5% solution also cloudy.

# Poly bd® 600E

## EPOXIDIZED, HYDROXYL TERMINATED POLYBUTADIENE RESIN




### DESCRIPTION

Poly bd® 600E is an epoxidized polybutadiene resin offering the compounder a variety of functionalities for formulating finished products. The 600E resin is hydroxyl terminated and brings hydrophobicity, flexibility and water resistance to urethane applications. In addition, oxirane oxygen groups on the polymer backbone allow it to be used as the sole resin in epoxy formulations or in combination with bisphenol A or cycloaliphatic epoxy resin formulations, where 600E resin improves the flexibility and impact resistance. These epoxy groups will cure with Lewis acids or anhydrides. Primary and secondary amines are not recommended as curing agents. This product is regulated by the United States Department of Commerce and may not be exported without a license from that organization.

**Poly bd® 600E**
**TYPICAL PHYSICAL AND CHEMICAL PROPERTIES**

| | |
|---|---|
| Oxirane Oxygen, % | 3.5 |
| Epoxy Value, meq/g | 2.2 |
| Specific gravity | 1.01 |
| Viscosity, mPa.s @ 30°C, max | 7000 |
| Epoxy Equivalent Weight | 460 |
| Water, wt% | 0.05 |
| Hydroxyl Value | 1.7 |
| Molecular Weight | ~1300 |

### PRODUCT HIGHLIGHTS

Multiple functionality
Compatibility with other epoxy resins

### PERFORMANCE PROPERTIES

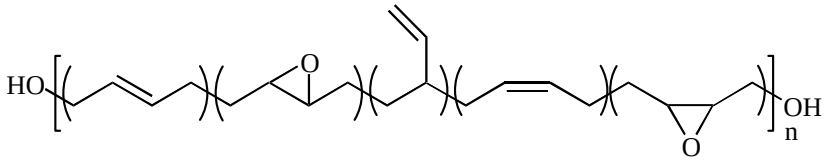
Flexible epoxy systems
Hydrophobicity
Aqueous acid and base resistance.
Adhesion to a variety of substrates
Excellent water resistance

### SUGGESTED APPLICATIONS

Adhesives
Electronic coatings
Flexibilization of epoxy systems

# Poly bd® 605E

## EPOXIDIZED, HYDROXYL TERMINATED POLYBUTADIENE RESIN




### DESCRIPTION

Poly bd® 605E is an, epoxidized polybutadiene resin offering the compounder a variety of functionalities for formulating finished products. The 605E resin is hydroxyl terminated and brings hydrophobicity, flexibility and water resistance to urethane applications. In addition, oxirane oxygen groups on the polymer backbone allow it to be used as the sole resin in epoxy formulations or in combination with Bisphenol A or cycloaliphatic epoxy resin formulations, where 605E resin improves the flexibility and impact resistance. These epoxy groups will cure with Lewis acids or anhydrides. Primary and secondary amines are not recommended as curing agents. Poly bd® 605E resin may be used as a reactive oligomeric additive in cationically cured coatings to impart high flexibility. This product is regulated by the United States Department of Commerce and my not be exported without a license from that organization.

**Poly bd® 605E**
**TYPICAL PHYSICAL AND CHEMICAL PROPERTIES**

| | |
|---|---|
| Oxirane Oxygen, % | 6.5 |
| Epoxy Value | 3.5 |
| Specific Gravity | 1.01 |
| Viscosity, mPa.s @ 30°C | 22,000 |
| Epoxy Equivalent Weight | 300 |
| Water, wt% | 0.05 |
| Hydroxyl Value, meq/g | 1.74 |
| Molecular Weight | 1300 |

### PRODUCT HIGHLIGHTS

Most highly epoxidized Poly bd® resin
Multiple functionality
Low viscosity
Compatibility with other epoxy resins
UV cationic cure

### PERFORMANCE PROPERTIES

Flexible epoxy ststems
Hydrophobicity
Aqueous acid and base resistance
Adhesion to a variety of substrates
Excllent water resistance

### SUGGESTED APPLICATIONS

Adhesives
Electronic coatings
Flexibilization of epoxy systems

**Reactions At the Hydroxyl Groups**
The primary, predominantly allylic hydroxyl functionality in Poly bd® resins can be utilized in both polymerization and derivatization reactions as indicated in the diagram on page 10 as reaction a).

**Polyurethanes**
Poly bd® resins are readily chain extended with di and polyisocyanates to produce polyurethanes with a wide range of mechanical properties. Typical one-shot and prepolymer techniques can be employed. The end products have excellent hydrolytic stability, low temperature flexibility, and can be extended with a wide range of organic and inorganic materials including hydrocarbon oils and inorganic fillers.

**Ester Derivatives**
Ester derivatives can be prepared by reaction of Poly bd® resins with the appropriate carboxylic acids, acid chlorides, anhydrides or by transesterification. Acrylate and methacrylate derivatives, for example, can be homo-polymerized or copolymerized with vinyl monomers to yield a spectrum of products.

**Reactions at the Alkene Groups**
The carbon - carbon bond unsaturation in Poly bd® resins, which is predominantly internal, can be utilized in both polymerization and derivatization reactions, as illustrated in b in the diagram on page 10.

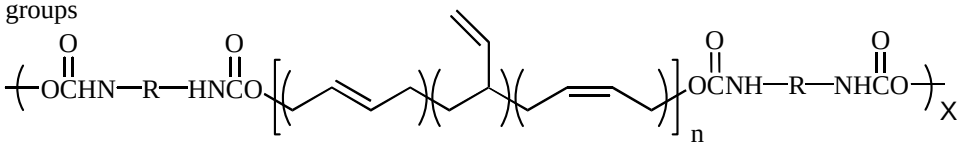
Oxidative Crosslinking – Poly bd® resins are reactive under oxidative conditions to yield internally cross linked, film forming materials. Coatings derived from such processes can range from flexible to brittle compositions.

Epoxidation — Oxirane derivatives are prepared by the relation of Poly bd® resins with Epoxidation systems such as peracetic acid. The epoxide content can be varied to yield products containing both oxirane and unsaturated groups. The resulting products can be cured by the reaction of the epoxide groups and/or the hydroxyl groups. These materials can also be used in combination with other epoxy resins to produce a variety of products as shown in the diagram on page 10 as reaction b.

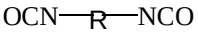
**Addition to Double Bonds**
Other reactions common to olefinic unsaturation, in theory, are applicable to Poly bd® resins. For example addition of thiols to the double bond gives unique functional derivatives.

Reactions Of Poly bd Resins

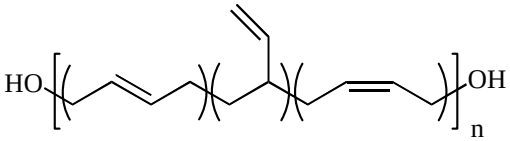
a.) At the hydroxyl groups



Poly bd - based polyurethane

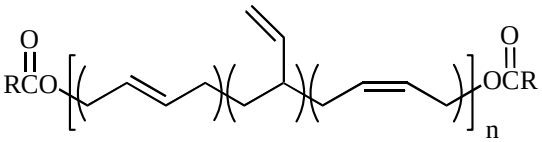


Diisocyanate



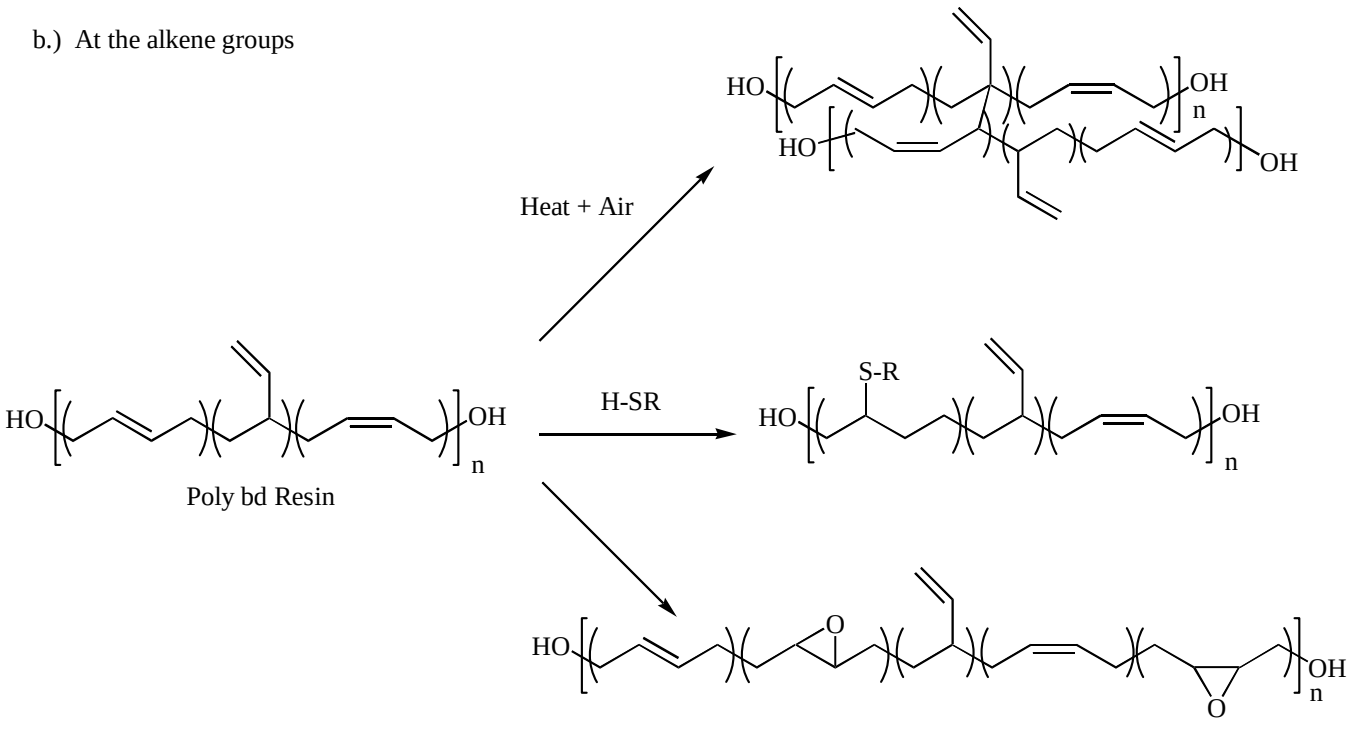
Poly bd Resin

Carboxylic Acid,
Acid Chloride Or Anhydride



Poly bd - based Ester

b.) At the alkene groups



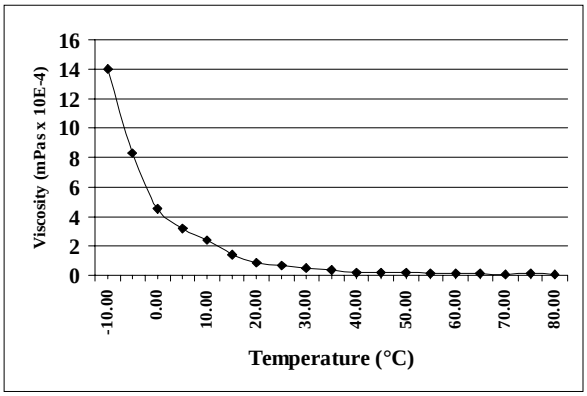
Poly bd Resin

Poly bd 600E and 605E

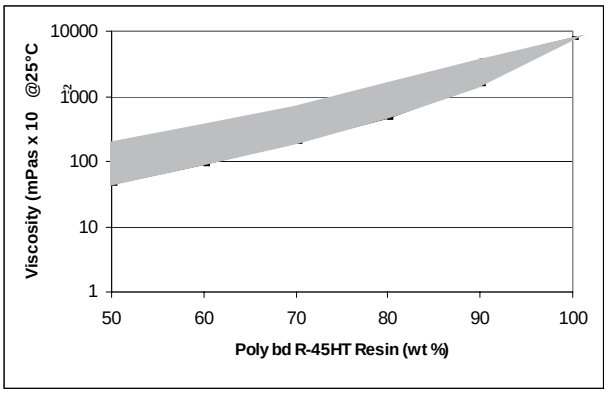
# Typical Viscosity Properties of Poly bd® Resins

Poly bd® is a viscous liquid at room temperature. To facilitate transfer of Poly bd® resins, the viscosity can be reduced by heating the neat resin as in the figure below or by cutting with solvent.

Poly bd® R-45HTLO Resins Viscosity as a Function of Temperature




Poly bd® R-45HTLO Resins-Solutions Viscosity Envelope



## TOXICOLOGY AND SAFE USE INFORMATION

### I. General

Poly bd® R-45HTLO, R-45M and R-20LM resins are liquid, hydroxyl-terminated homopolymers of butadiene. These resins are only slightly combustible with flash points greater than 400°F (205°C). They exhibit excellent stability if properly handled and stored.

### Drum Storage

Poly bd® resins are supplied in 55-gallon non-returnable, open-head steel drums having an epoxy phenolic lining. Storage of the drums out of direct sunlight at temperatures between 50°F (10°C) and 90°F (32°C) is recommended. Due to the viscosity of the products heating may be required to facilitate removal from the drums. Exposure of the drum or contents to temperature in excess of 150°F (66°C) should be avoided. As a result, the use of band or bayonet heaters should be avoided due to the possibility of localized overheating and the resultant oxidative crosslinking and viscosity increase. Suggested methods of heating include the use of hot boxes or water baths. After opening and removal of a portion of the contents it is recommended that the vapor space in the drum be flushed with an inert gas, such as dry nitrogen, prior to reclosure.

Poly bd® resins should be stored in nitrogen padded vessels to prevent moisture contamination and oxygen degradation. Elevated temperatures can result in thermal degradation. The storage vessel should be constructed of 300 series stainless steel or epoxy-lined carbon steel.

Since the polymers are viscous, lines must be sized carefully and positive displacement pumps are necessary. Lines should be electrically traced and insulated. Suction heaters are often used to assure good supply to the pump. Traced piping and heater skin temperatures should not exceed 150°F (66°C).

### II. Bulk Storage– Detail

Poly bd® resins are best stored in low pressure cone roof tanks under slightly positive nitrogen pressure. The material should be stored at ambient temperature (50 to 90°F for 10 to 32°C) so insulation is often advantageous. The tank should be located in a sheltered area to help minimize heat gain and heat loss.

Level indicators should be provided as well as a high level alarm to warn of over-filling the tank.

The bottom of the tank should be sloped to the pump suction and sump. The section nozzle should be at such an elevation that normal piping layout will put the center line of the nozzle at the center line of the pump. A recirculation line with a back pressure control valve will allow safe operation without requiring pump shut-down.

Pumping out the heel, when service or inspection of the tank is required, should be by use of the scavenger line if the suction line is located above the bottom of the tank.

Lines should be sized carefully, allowing for the viscosity of the product.

The use of a suction heater between the tank and pump is recommended to assure good pump operation. The maximum temperature of the product should not exceed 150°F (66°C). Therefore, the use of live steam is not recommended. Hot condensate may be used without overheating the exchanger tube walls. Another possibility is the use of electric heaters which can control the sheath (heating surface) temperature. Where condensate or hot water is used for heating, precautions must be taken to prevent water contact with the product.

Before the pump is shut-down, the suction heater should be shut-off and product pumped through to remove the residual heat before the circulation is stopped. This procedure will prevent loss of quality due to “heat-soaking” the product which can result in product crosslinking and viscosity increase.

No internal coils, bayonets or other heating devices should be installed.

## III. Materials of Construction

A. Tanks

Storage vessels may be made of stainless steel, or epoxy lined carbon steel.

Small vessels are usually fabricated from stainless steel while large storage tanks are more economically fabricated in epoxy-lined carbon steel.

Tanks should be insulated to minimize heat loss and heat gain.

B. Pumps

In general, 300 series stainless steel positive displacement pumps such as Sier-Bath brand double screw pumps or Viking brand gear pumps are recommended. These units are equipped with external bearings which give good service life and are easily in spected and repaired.

C. Heat Exchanger

Product-wetted parts of heaters should be constructed of 300 series stainless steel.

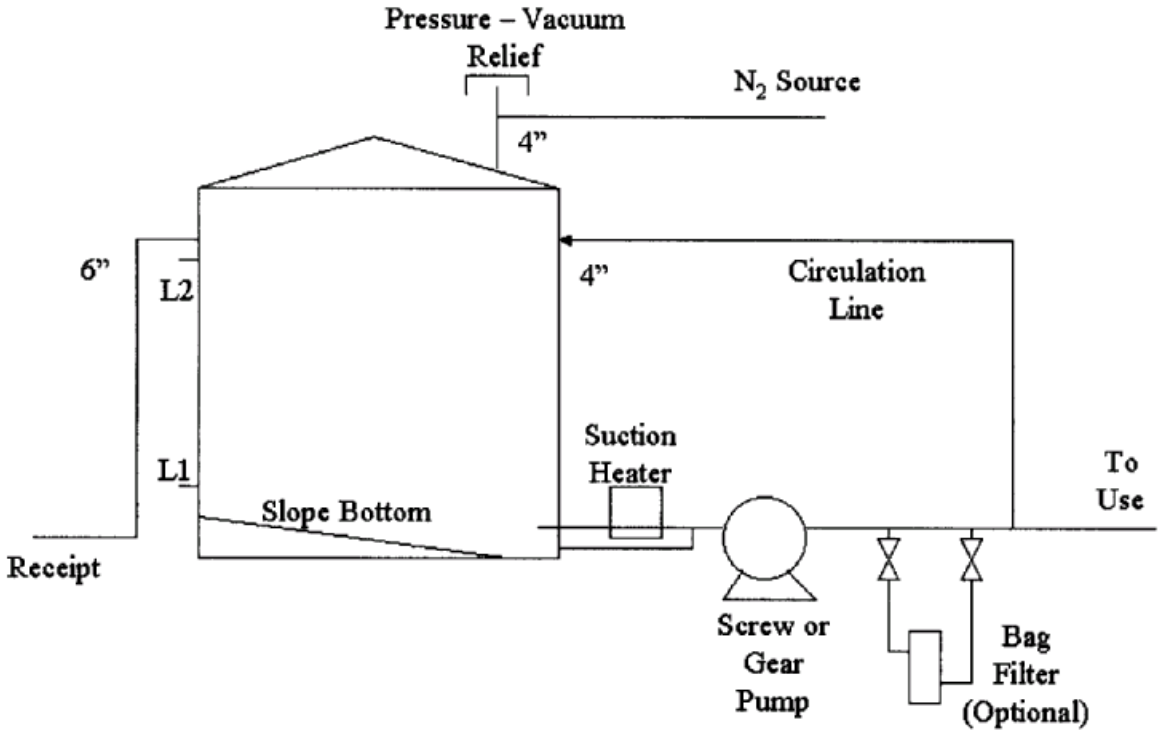
D. Piping

Lines should be adequately sized considering the viscosity of the material being handled. Electrical tracing and insulation should be provided where lines are exposed to low temperatures. Piping should be 300 series stainless steel.

## IV. Tank Truck Shipments

Clean, dry, insulated stainless steel trailers, preferably equipped for rear or center off-loading (subject to availability), should be specified. Product is loaded at 140-150°F (60-66°C). Depending on the outside temperature, the product temperature will decrease approximately 5-10°F (3-6°C) per day. Since a minimum off-loading temperature of 120°F-(49°C) is recommended, in-transit heating will usually be required during cold weather. Clean and dry pumps and hoses should be used for product discharge. Positive displacement, double screw or gear pumps and 3 inch hoses and connections are recommended. A minimum 60 gpm pump size is suggested. Off-loading may be assisted by the application of dry nitrogen pressure to the truck

## Poly bd® Typical Tank Arrangement



# Supplemental Poly bd® Literature

Technical literature including starting formulations, technical papers, product bulletins, and material safety data sheets are available to optimize the use of Sartomer's products.

Literature can be obtained through Sartomer's cusotmer service group (1-800-SARTOMER) or our web site (www.sartomer.com).

Sartomer offers these additional documents discussing our Poly bd® resins to aid in formulating.

The Poly bd® Resin in Urethane Elastomers
Poly bd® Resins Starting Formulations
Poly bd®Resins in Electrical Applications
Poly bd® Resins in Adhesives
Poly bd® Resins in Foam Applications
Polyurethane Gels from Poly bd® Resins
Poly bd® R-45VT - Vinyl Terminated Polybutadiene
Poly bd® 600E and 605E - Epoxidized Polybutadienes
Poly bd® Storage and Handling

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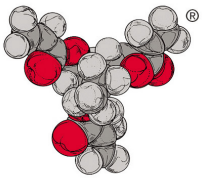
*Our name means tailor-made.™*



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Good Chemistry at Work

ISO 9001:2000
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