

***Poly-G HQEE*[®] Aromatic Diol**
Hydroquinone Di (beta-hydroxyethyl) Ether
 As a Chain Extender for Liquid Cast Urethane Elastomers

Poly-G HQEE[®]* aromatic diol is a symmetrical aromatic diol chain extender. *Poly-G HQEE* aromatic diol imparts good tensile, elongation, hardness, modulus, and resilience properties to polyurethane elastomers. It is used in elastomers for oil well seals, forklift tires, seals for hydraulic cylinders, conveyor lines, skateboard wheels, and other products in which superior physical properties are required.

This publication describes the processing and physical properties of liquid cast urethane (LCU) elastomers extended with *Poly-G HQEE* aromatic diol. It also contains a laboratory procedure for the preparation of samples.

Typical Physical Properties of *Poly-G HQEE*
Aromatic Diol
CAS No. 104-38-1

Structure



Processing LCU Elastomers Extended with *Poly-G HQEE* Aromatic Diol

The preparation of LCU elastomers requires two principal components: a prepolymer terminated with reactive isocyanate groups and a difunctional active hydrogen-terminated chain extender. The prepolymer is based on either a polyester or polyether polyol reacted with an isocyanate (TDI, MDI, or ADI). The chain extender is usually a short chain diamine or diol. TDI prepolymers are usually extended with diamines while MDI prepolymers are usually extended with diols.

| | |
|--------------------------------------|-----------------|
| Physical State | Off-white flake |
| Molecular Weight | 198.2 |
| Hydroxyl Number, Average | 555 |
| Melting Point, °C(°F) | 98 (208) |
| Boiling Point at 0.3mm Hg, °C(°F) | 190 (374) |
| Solubility at 25°C, wt. % | |
| Water | < 1 |
| Acetone | 4 |
| Ethanol | 4 |
| Ethyl Acetate | 1 |
| Hexane | < 1 |
| VM & P Naphtha | <1 |
| Specific Heat cal/g/ °C | 0.4 |
| Melt Density at 110 °C, g/ml | 1.15 |
| Melt Viscosity at 110 °C, cp | 15 |
| Bulk Density of Flake | |
| Loose, g/cc | 0.51 |
| Packed, g/cc | 0.62 |
| Pounds/55 gallons | 250 |
| Hygroscopicity of Flake, % | |
| Dried at 50°C, 34.5 mm Hg for 16 hr. | 0.08 |
| After 168 hr. at 24°C and 66 5 RH | 0.39 |



For example, if *Poly-G* HQEE aromatic diol with an OH# of 555 is to be added to a prepolymer with a % NCO of 6.50 and the desired NCO/OH ratio is 1.1/1, the calculations would show that 14.2 parts of *Poly-G* HQEE aromatic diol should be added to 100 parts of this prepolymer.

$$\text{Eq. wt. of } Poly-G \text{ HQEE} = \frac{56.1 \times 1,000}{555} = 101$$

Amount *Poly-G* HQEE/100 parts prepolymer

$$\frac{6.50 \times 101}{42 \times 1.1} = 14.2$$

Poly-G HQEE aromatic diol can be used with other diols or triols as extender blends to provide improved processibility as shown in Table 1. Although the blending of a liquid or triol with *Poly-G* HQEE aromatic diol may reduce the possibility of *Poly-G* HQEE aromatic diol crystallizing from the system, a processing temperature of 110 °C(230°F) is still recommended for assurance. If an extender is to be used, the equivalent weight of the blend can be calculated as follows:

$$\text{Eq. wt. of blend} = \frac{100}{\frac{\% \text{ extender A}}{\text{eq. wt. of A}} + \frac{\% \text{ extender B}}{\text{eq. wt. of B}}}$$

Table 1. Physical Properties of Elastomers Extended With *Poly-G* HQEE Diol or Triol Blends

| Extender | HQEE | HQEE / TMP* (90/10) |
|--|--------------|---------------------|
| Shore Hardness, A/D | 92/49 | 90/48 |
| Tensile, psi (mPa) | 4,100 (28.3) | 6,000 (41.4) |
| Elongation, % | 610 | 550 |
| Tensile Stress, psi (mPa) | | |
| at 100% elongation | 1,510 (10.4) | 1,250 (8.6) |
| at 200% elongation | 1,930 (13.3) | 1,755 (12.7) |
| at 300% elongation | 2,350 (16.2) | 2,364 (16.3) |
| Split Tear, pli | 230 | 140 |
| Compression Set, % | 17.5 | 19.1 |
| MDI – polyester polyol prepolymer, 6.5% Free NCO | | |
| NCO/OH Ratio 1.1/1 | | |
| *Trimethylolpropane | | |

Laboratory Procedure For Preparing LCU Elastomers Extended with *Poly-G* HQEE Aromatic Diol

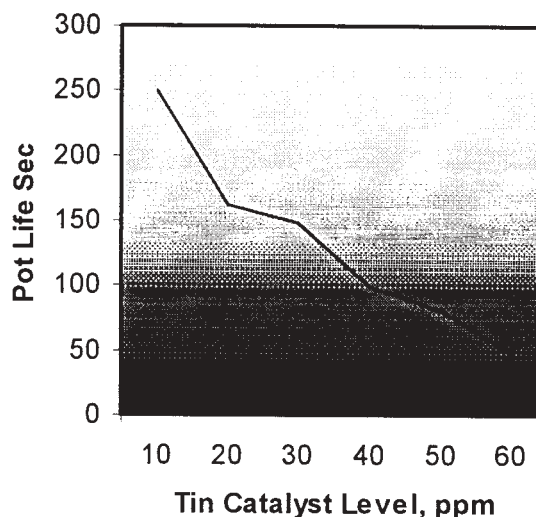
To prepare an elastomer laboratory sample (200g), the following equipment is required: hot plate, two thermometers, two containers suitable for heating the prepolymer and *Poly-G* HQEE aromatic diol, vacuum desiccator, vacuum pump, spatula, eye-dropper, weighing balance, small torch, mold, oven, and a well-ventilated work area (hood). The following procedure is suggested.

1. Using the %NCO of the prepolymer, OH# of *Poly-G* HQEE aromatic diol, and the desired NCO/OH ratio, calculate the amount of prepolymer and *Poly-G* HQEE aromatic diol required to make the elastomer sample.
2. Weigh the exact amount of prepolymer into the larger container (32-oz. can), and to the smaller container (4-oz can), add slightly more *Poly-G* HQEE aromatic diol than needed.

3. Heat the prepolymer, *Poly-G* HQEE aromatic diol, spatula, eyedropper, and mold to 110°C (230°F).
4. Degas the prepolymer in the vacuum desiccator at 28 in. Hg for two to three minutes and then reheat to 110°C (230°F). Degas and reheat *Poly-G* HQEE aromatic diol similarly.
5. Place the container holding the prepolymer on the balance and add the exact amount of *Poly-G* HQEE aromatic diol using the eyedropper for the last 0.5g. Stir the mixture, scraping the sides and bottom of the container with the spatula. Degas the mixture if pot life is sufficiently long. This step should be performed quickly to prevent cooling below the *Poly-G* HQEE aromatic diol crystallization point.
6. Pour the mixture into the preheated mold and with the torch, lightly flame the molten elastomer surface to break air bubbles. If the mold is deep, pour the mixture down the mold edge and flame the mixture as it flows into the mold.
7. If an open cast mold is used, place the mold containing the mixture in an oven and cure at 110° – 127°C (230° – 260°F). If compression molding is being done, observe the cure of the mixture until the surface can be dented with a spatula or a small section can be cut from the surface using a “V” technique. At this point, close the mold, apply pressure, and cure at 110° – 127 °C (230° – 260°F).

The cure time for uncatalyzed *Poly-G* HQEE aromatic diol extended MDI systems varies from 30 to 120 minutes depending on the reactivity of the prepolymer and the ratio of the part volume to surface area. Tin or amine catalysts can be used to accelerate cure (see Figure 2.). After demolding, samples should be postcured at 110°C (230°F) for 16 hours and aged under ambient conditions for 7 days before testing.

Figure 2. Pot life of a *Poly-G* HQEE – Extended Polyester – MDI Prepolymer at 110 °C (230°F) as a Function of Stannous Octoate Concentration



Trouble Shooting

If defects are observed in the elastomer sample, the following guides may be helpful.

1. **Starring.** The appearance of white spots or “snowflakes” is usually caused by pouring the mixture into a cool mold at 110°C (230°F). However, this may occur if the mixture has cooled too much during step 5.
2. **Sinks.** Surface indentations on compression-molded samples is usually caused by closing the mold too early; however, they can occur if the ingredients are not sufficiently mixed or high exotherm temperatures develop during molding.
3. **Warping.** Curling of compression-molded samples after being removed from the mold is usually caused by closing the mold too long after the mixture reached the stage of being easily dented as previously described.

The following precautions should be taken to obtain optimum results when using *Poly-G* HQEE aromatic diol :

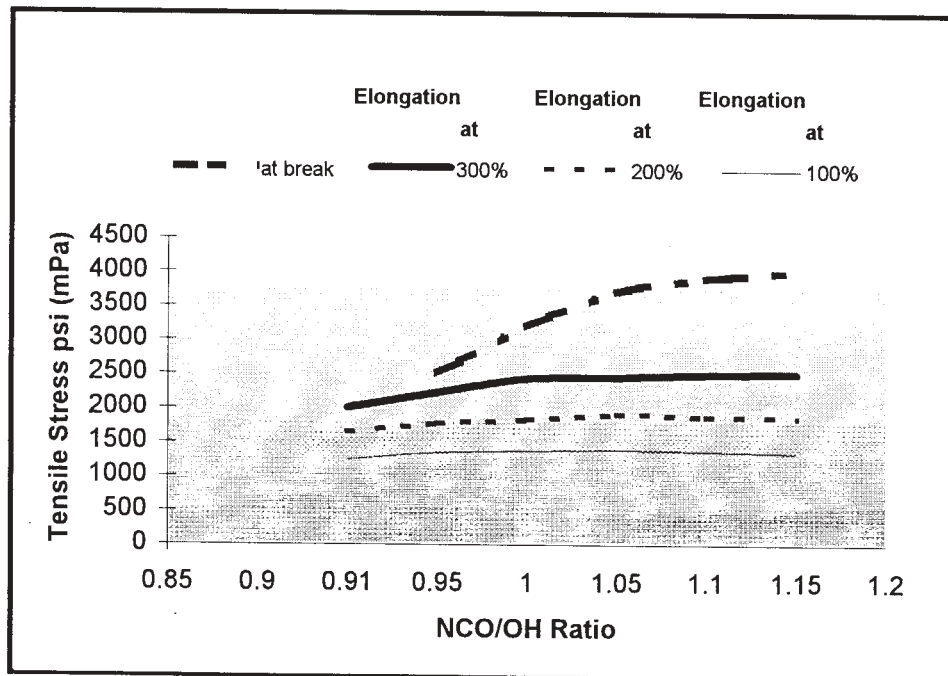
Temperature: Molten *Poly G* HQEE aromatic diol does not supercool. It must be maintained at a temperature above its melting point, preferably 110°C(230°F) at all times in the entire processing operation to prevent crystallization.

The *Poly-G* HQEE aromatic diol melt tank should be uniformly heated and mildly agitated to prevent skimming on the surface. The prepolymer should be preheated to 110°C(230°F) before the *Poly-G* HQEE aromatic diol is added and the resultant blend should be maintained at 110°C (230°F).

All process lines should be heated to 110°F (230°C) and insulated to prevent cold spots that might cause *Poly-G* HQEE aromatic diol to crystallize and clog the lines or result in an inaccurate mix ratio. The temperature of the mold, especially its surface, should be 110°C(230 °F) to prevent defects in the resultant elastomer.

Mix Ratio: With diamine/TDI systems, the mix ratio can vary considerably; however, with diol/MDI systems, the equivalent weight ratio of prepolymer to chain extender (NCO/OH ratio) should be between 0.9/1 and 1.1/1. To achieve optimum properties in elastomers based on *Poly-G* HQEE aromatic diol /MDI systems, it is suggested that the NCO/OH ratio be as close to 1.1/1 as possible. (See Figure 1.)

Figure 1. Effect of NCO/OH Ratio on Tensile Stress of a *Poly-G* HQEE-Extended Elastomer (MDI/ Polyester Prepol)



Calculations for Diol Extender

To help fabricators of polyurethane products determine how much diol extender is needed for the desired NCO/OH ratio, suppliers furnish hydroxyl numbers (OH#) with diol extenders and the percent of available isocyanate (%NCO) with prepolymers. With this information and the following equations, the amount of diol extender to be added to 100 parts of prepolymer can be calculated as follows:

1. Equivalent weight of diol extender equals:

$$\frac{56.1 \times 1,000}{\text{OH\#}}$$

2. The amount of diol extender/100 parts of prepolymer equals:

$$\frac{\% \text{ NCO} \times \text{eq. wt. of extender}}{42 \times \text{NCO/OH ratio}}$$



SUMMARY

Poly-G HQEE aromatic diol offers excellent performance with a wide range of MDI-prepolymers and yields polyurethane elastomers that have a wide range of hardness combined with exceptional compression set, resilience, and tear resistance. *Poly-G* HQEE aromatic diol can be processed in commercially available mixing and metering equipment having good temperature and mix ratio controls. Blending other diols or triols with *Poly-G* HQEE aromatic diol minimizes temperature control requirements and reduces defects in molded parts.

How to Order

To place an order for delivery in the U.S. or Canada and to get fast answers on order status or product availability, call our toll free number: 800-636-3786 or contact your Arch Sales Representative.

After your first order, you will be assigned your own Arch Customer Service Representative. When you call back, simply ask for your Customer Service Representative by name. If you call evenings (after 4:30 pm Eastern time) or on weekends or holidays, your message will be recorded and your Representative will contact you at the beginning of the next business day.

Storage and Handling

Poly-G HQEE aromatic diol is off-white flakes, chips and powder. It has a melting point of 98°C (208°F) and an autoignition temperature of 467°C (874°F). *Poly-G* HQEE aromatic diol is hygroscopic and consideration should be taken to store the product in a tightly closed container in a cool dry place. To help prevent moisture absorption, a desiccant bag is included in the drum. It is also important that the drum and liner be resealed if only part of the *Poly-G* HQEE aromatic diol is used. *Poly-G* HQEE aromatic diol is also sensitive to light (UV) and will turn yellow-brown in the presence of light.

For More Information

Technical Service

Technical service is available to facilitate further use of *Poly-G* HQEE aromatic diol. If you have a specific question, or need further information, please write or call Urethane Technical Service, Arch Chemicals, Inc. P.O. Box 547, Brandenburg, KY 40108-0547, Phone: 800-370-9674.

Or visit our web site at:
www.archurethanes.com



Please refer to the Material Safety Data Sheet (MSDS) for complete information on Storage and Handling, Toxicological Properties, Personal Protection, First Aid, Spill and Leak Procedures, and Waste Disposal. To order an MSDS, call the Arch Chemicals sales office listed below or the MSDS Control at (800) 511-MSDS. Before using or handling this product, the MSDS should be thoroughly reviewed.

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* Arch Chemicals, Inc. 501 Merritt 7 Norwalk CT 06856-5204

Sales Headquarters

ARCH CHEMICALS, INC.

501 Merritt 7, P.O. Box 5204 Norwalk, CT 06856-5204

PHONE: (203) 229-2951