

A 3M Company

# Dynamar™ Polyetherdiamine HC 1101

### Introduction

Dynamar Polyetherdiamine HC 1101 is a linear polyether diprimary amine which contains tetramethylene oxide (-C<sub>4</sub>H<sub>8</sub>O-) as the principal recurring unit and has a molecular weight of approximately 10,000.

HC 1101 is characterized as follows.

- Primary amine end group functionality of 2
- High molecular weight
- Low toxicity

HC 1101 can be utilized as the flexible reactive segment in block-type copolymers containing both flexible and rigid segments. It may be readily converted into very tough cured elastomers, for instance, by reaction with epoxy resins having an oxirane equivalence greater than one. The reaction mixtures are characteristically liquids which can be poured, cast or molded and subsequently cured at room temperature, or more rapidly at elevated temperatures. High use levels will form elastomers characterized by the following properties:

- High tensile strength and elongation
- Hydrolytic stability
- Adhesion properties similar to epoxy resins
- Excellent abrasion resistance
- High resilience and low heat build-up during dynamic use
- Wide range of available hardnesses

### Typical Properties (Not for Specification Purposes)

Appearance	Waxy solid
Melting point, °C	.35
Density of melt at 25°C, g/cc	.098
Volatiles, % by weight	.20
Viscosity at 150°F (65°C), poise	.2500
Total amine (meq./gram)	.02

### Reactions

Polyetherdiamine HC 1101 undergoes the usual chemical reactions of aliphatic amines.

It may be reacted with other polymers containing functional groups. For instance, it has been reacted with epoxy resins, diisocyanates, or diacidchlorides to yield high strength elastomers.

The reactive amine end groups on HC 1101 may be changed to other functionalities, such as carboxyl by reaction with cyclic anhydrides, hydroxyl by reaction with olefin oxides or methylol by reaction with formaldehyde.

HC 1101 may be used as a coreactant in condensation reactions, such as epoxy-amine, phenol-formaldehyde and urea-formaldehyde, in order to impart flexibility to otherwise rigid polymers.

## Epoxy-Cured HC 1101

A great number of epoxy resins may be used to cure Polyetherdiamine HC 1101. However, the liquid diepoxide derived from Bisphenol A and epichlorohydrin, with an epoxy equivalent weight of 190 (Epoxy A<sup>1</sup>), has been most often used. Cure may be carried out via an "A" stage technique in which HC 1101, Epoxy A, and Catalyst<sup>2</sup> are mixed in one operation, or via a "B" stage technique in which HC 1101 and Epoxy A are prereacted before addition of catalyst. Gel or demold times range from a few minutes cure at 300°F to several hours cure at room temperature.

Hardness of the epoxy-cured HC 1101 may be varied substantially by the epoxy/HC 1101 equivalents ratio— as shown below:

<b>Formulation</b>	<b>A</b>	<b>B</b>	<b>C</b>
HC 1101, grams	85	70	50
Epoxy A, grams	15	30	50
Catalyst, grams	2	4	5
Epoxy/HC 1101 equivalents ratio	2.3	5.4	13.2

### **Properties ("A" Stage Cure)**

Hardness, Shore A	62	80	90
Tensile Properties			
Strength, psi	3360	3200	3960
100% Modulus, psi	300	880	3790
Elongation, %	340	200	105
Permanent set, %	3	2	6
Bashore rebound, %	75	—	—

Several methods, in addition to varying epoxy/HC 1101 ratio, are available to further alter the properties of epoxy-cured HC 1101, such as:

- Reactive diluents, such as monoepoxides<sup>3</sup>, may be used to lower viscosity of the mix, lower modulus and hardness while increasing toughness of the cured elastomer.
- Aromatic diamines may be used as co-curing agents to improve elevated temperature strength.
- Additives such as blocked isocyanates<sup>4</sup>, diphenyl guanidine, or resorcinol, act as tear strength improvers.
- Certain amine-type anti-oxidants, such as Akroflex C<sup>5</sup>, substantially improve the ability to withstand high temperature aging.

<sup>1</sup> Available from any epoxy resin supplier as the equivalent of Shell Chemicals' "Epon" 828

<sup>2</sup> 2, 4, 6 - tris (dimethylaminomethyl) phenol—available from Rohm and Haas as "DMP"-30

<sup>3</sup> Cardolite NC-513 (3M) — the glycidyl ether of pentadecenyl phenol is especially useful because of its low volatility

<sup>4</sup> For example, "Mondur" S supplied by Mobay Chemical Company

<sup>5</sup> E.I. du Pont de Nemours and Company

## **Applications of Epoxy-Cured HC 1101**

The major properties which characterize epoxy-cured HC 1101 are listed earlier in this data sheet. Other properties which may be of value in specific applications are high moisture vapor transmission rate, high coefficient of friction, low compression set, resistance to steam, ozone, inorganic acids and bases, resistance to degradation by sunlight (when filled), and resistance to thermal aging (240°F with anti-oxidant).

The properties of epoxy-cured HC 1101 suggest many application areas, a few of which are listed below:

- Rollers, textile, paper, etc.
- Flexible joint encapsulation
- Solid tires
- Conveyor belt coatings
- Drive wheels
- Chute linings
- Seamless flooring
- Potting compounds
- Leather coatings
- Mechanical devices involving vibration or oscillation
- Adhesives
- Seals, gaskets, O-rings
- Marine coatings
- Nonskid surfaces
- Foams
- Tie-coats
- Self sealing tanks
- Sealants

## **Handling**

Since HC 1101 is a solid at room temperature, it may be necessary to heat the product to its melting point (35°C) for removal from the container. Mixing with other components may be more convenient if carried out at temperatures of 35°C or above.

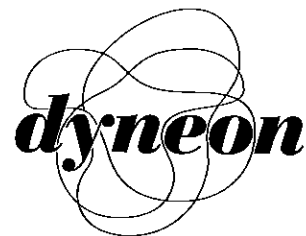
In the handling of HC 1101, proper precautions should be taken to avoid eye and skin contact. The use of eye goggles and rubber gloves is recommended when handling or hand-mixing HC 1101. The heat curing of resin systems containing HC 1101 should be conducted only in ventilated ovens.

In case of accidental eye contact, immediately flush the eyes with plenty of water and call a physician. In case of skin contact, wash with soap and water.

## **Storage**

For maximum shelf life, HC 1101 should be stored at room temperature or below, and exposure to melting point temperature should be held to a minimum. HC 1101 should be protected by flushing the container with nitrogen each time the container is opened, to avoid reaction with atmospheric oxygen. Degradation by oxygen is readily detected by a sharp increase in viscosity.

With proper storage, shelf life of HC 1101 should exceed one year.



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### References

S. Smith, A. J. Hubin, J. J. Hoffman and D. D. Zimmerman, "Polyether Diprimary Amines: A New Class of Elastomeric Resins", presented at ACS Rubber Division Meeting, Montreal, May 1967.

### Technical Information and Test Data:

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