Curatives

ETHACURE 300® Curative – Leading Alternative for MOCA Replacement

Obtaining Competitive Performance Characteristics through Optimization and Control

MOCA Regulation

*In November of 2011, 4, 4-methylene-bis-ortho-(2-chloroaniline), MOCA, was categorized as a Substance of Very High Concern resulting in the IARC reclassifying MOCA as a **Class 1 carcinogen** (known to cause cancer). MOCA was then placed in the Annex XIV of REACH and given a sunset date of November 2017. Since then, MOCA is no longer to be stored or sold in the EU without authorization from the European commission.*

Given this change in regulatory status users need a solution, a ***safer*** sustainable alternative.

A *Safer* Option for Users

ETHACURE 300 is a ***low toxicity***, easy-to-handle *liquid* aromatic diamine widely known for its superior properties and extreme versatility in the polyurethane industry.

Polyurethane elastomers cured with E300 have demonstrated a broad range of properties such as high strength, hardness, modulus, and elongation at break point.

E300 formulated with TDI based prepolymers in cast elastomer delivers moderate reactivity, suitable working time, and ideal mechanical properties, making it an ideal alternative for MOCA users.

History of Proven Performance

Polyurethane elastomers cured with E300 have been proven to deliver similar performance to MOCA cured parts. In **Figure 1,** at a 0.85 and 0.95 amine/iso ratio the split tear strength for E300 cured parts exhibit superior performance to MOCA parts. E300 tensile strength and elongation also both closely match MOCA performance. While MOCA cured parts have a minimally higher hardness at these ratios, E300 part hardness is competitive when optimization strategies outlined in the following sections are implemented.

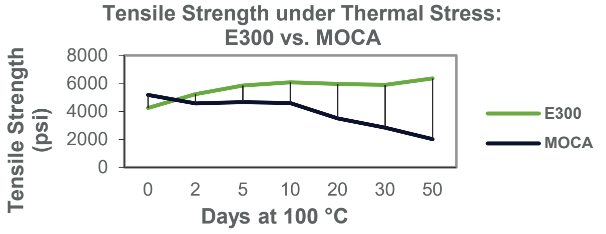
E300 Properties Compared to MOCA

Figure 1: E300 vs. MOCA Polymer Properties

Amine Curative	ETHACURE 300	MOCA	ETHACURE 300	MOCA
Prepolymer %NCO	4.26	4.26	4.26	4.26
Amine/Iso Ratio	0.85	0.85	0.95	0.95
Polymer Properties				
Hardness, Shore A	87	91	88	91
Tensile, psi	5600	5310	5760	5820
M-100 %, psi	1120	1110	1070	1100
M-300 %, psi	2540	2370	2140	2250
Elongation, %	380	390	410	410
Die-C tear, pli	210	260	260	300
Split tear, pli	42	35	80	53
Compression set, %	25	22	31	28
Resilience, %	44	43	45	43

Superior Thermal Aging Performance Compared to MOCA

Figure 2: E300 vs. MOCA Thermal Aging



- In **Figure 2**, E300 and MOCA TDI systems were formulated using an amine/iso ratio of 0.95, and mold temperature of 100°C. Demolding took place after 1/2 hour, and then parts were post-cured at 100°C for 2 hours.
- E300 cured systems demonstrated exceptional performance over MOCA cured polymers after exposure to high temperature over an extended period of time.
- Tensile strength increases approximately 50% in the systems containing E300 during exposure. Whereas, MOCA-cured systems show general declines in tensile strength. After 50 days at 100 °C, MOCA parts exhibit less than half of original tensile strength.

Curatives

ALBEMARLE®

Performance Optimization

Adjusting amine/iso ratio

Optimization is key to maximizing the potential benefits E300 offers formulators when utilized in systems.

When formulating, it is important to select the appropriate amine/iso ratio to generate performance characteristics that best meet user's needs. Altering the amine/iso ratio is an advantageous modification that should be taken into consideration to improve part performance.

In **Figure 3,** using 4.1 *% NCO* TDI-PTMEG prepolymer it was demonstrated that E300 parts perform at optimal levels when an amine/iso ratio of 0.95 is used. This ratio gives the best balance of performance. Evaluations also showed that compression set is increased when a lower ratio is

Adjusting post-cure

A direct and powerful way to alter part performance is to adjust post-cure conditions. By Increasing the time and temperature of the post-cure, E300/TDI polymer performance is greatly increased, particularity tensile, tear, and compression strength. These performance characteristics are displayed in **Figure 4.**

Adjusting NCO content and temperature

Modifying the % NCO of a prepolymer allows formulators to *control* reaction speeds, as well as increase the hardness of E300 parts. In ***Figure 5***, increasing the % NCO from 4.05 % to 5.25 % caused hardness of the elastomer to increase from an 88 Shore A to an 91 Shore A. Utilizing a high % NCO prepolymer is also beneficial because it increases other polymer properties such as tensile, modulus, and tear strength.

E300 being a liquid at room temperature allows users to adjust prepolymer temperature processing. This adjustment is directly related to formulation pot-life.

In ***Figure 6,*** E300/TDI systems were used to demonstrate that a 15 °C drop in prepolymer temperature nearly doubles the working time for formulators. During evaluation, when a 9.5 % NCO was used the pot-life is roughly 2 minutes at 80 °C. When the temperature is adjusted to 65 °C the pot-life doubles to 4 minutes. This trend repeats for prepolymers of lower NCO%.

Making the Switch

Albemarle's team of technical experts are here to assist formulators as they explore MOCA alternatives. We offer starter formulations, tailored recommendations, and committed support through developmental processes.

Figure 3: Effect of Amine/Iso Ratio on E300 Elastomer Performance

Amine/Iso Ratio	0.85	0.95	1.00	1.05
Hardness A (D-676)	88	88	87	87
Tensile psi (D-412)	3870	4758	5149	5205
Elongation % (D-412)	331	398	436	479
Die C Tear psi (D-624)	296	355	367	399
Split Tear psi (D-470)	53	67	68	100
Compression Set % (D-395b)	20	27	36	41
Resilience % (D-263)	46	45	45	45

Figure 4: Effect of Post-cure Conditions on Elastomers Cured with E300

Post-cure condition (hrs./temp ºC)	2/100	18/100	18/120	18/130
Hardness, Shore A- (ASTM-646)	88	88	89	88
Tensile, psi (D-412)	4890	7140	7290	8710
M-100, psi (D-412)	1030	1140	1130	1040
M-300, psi (D-412)	1790	1990	2010	1800
Elongation, % (D-412)	500	410	470	515
Die C Tear, pli (D-624)	340	370	405	515
Split Tear, pli (D-470)	81	88	105	120
Compression Set, % (D-395B)	34	33	33	27
Rebound, % (D-2632)	47	45	45	44

Figure 5: Effect of NCO% on Elastomers Cured with ETHACURE 300

NCO%	4.05	4.77	5.25
Hardness, Shore A- (ASTM-646)	88	90	91
Tensile, psi (D-412)	4400	4950	5060
M-100, psi (D-412)	1050	1260	1390
M-300, psi (D-412)	1970	2400	2600
Elongation, % (D-412)	430	400	400
Split Tear, pli (D-470)	90	80	120
Compression Set, % (D-395B)	34	37	41
Rebound, % (D-2632)	48	45	45

Figure 6: Effect of Temperature on Pot-Life of E300 Systems