CHEMISTRY THAT MATTERS™

NORYL™ SA90 RESIN PROCESSING GUIDELINES

DISSOLUTION IN EPOXY SYSTEMS

SABIC's Specialties Business
Thermosets & Additives

GENERAL BUSINESS USE

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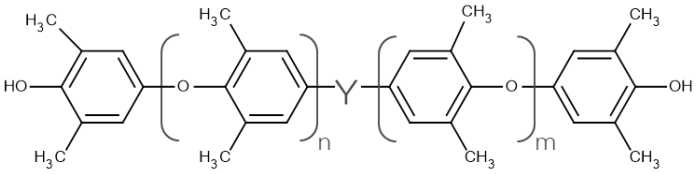
NORYL™ SA90 RESIN – PRODUCT DATA



NORYL SA90 RESIN

NORYL SA90 resin is a low molecular weight bi-functional oligomer with increased hydroxyl functionality based on polyphenylene ether (PPE). It can be used as a reactive component in epoxy, cyanate ester, and urethane thermosets in electronics, coatings, adhesives, and composites applications. It has outstanding solubility in toluene & methyl ethyl ketone(MEK) and a low solution viscosity. Targeted application areas include enhancing the performance (e.g. thermal, dielectric, mechanical, flame retardancy, and moisture uptake properties) of epoxy resins used in electronic packaging which include PCB laminates, copper clad laminates, epoxy prepregs, and protective coatings as well as various other composites applications. NORYL SA90 can also be blended with thermoplastic elastomers and cured elastomers to enhance properties.

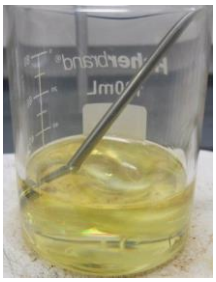
PROPERTIES	TYPICAL VALUES	UNITS	TEST METHODS
THERMAL			
Tg (half width)	140	°C	SABIC method
PHYSICAL			
Specific Gravity	1.02	-	ASTM D 792
Physical Form	PELLET	-	SABIC method
Intrinsic Viscosity	0.09	dl/g	SABIC method
Phenolic End-group Content	21500	ppm	SABIC method
Hydroxy Equivalent Weight (HEW)	840	g/mol	SABIC method
Solubility, Toluene (21°C)	50	wt%	SABIC method
Solubility, Methyl Ethyl Ketone (21°C)	50	wt%	SABIC method
Mn	1600	-	SABIC method
Viscosity, 50 wt% in toluene, 25°C	298	cP	SABIC method
Viscosity, 50 wt% in methyl ethyl ketone, 25°C	160	cP	SABIC method
ELECTRICAL			
Dielectric Constant, 1 MHz	2.54	-	ASTM D 150
Dissipation Factor, 1 MHz	0.0007	-	ASTM D 150

PROCEDURE FOR DISSOLVING NORYL™ SA90 RESIN INTO EPOXY RESINS

STEPS:

1. Charge vessel (beaker) with epoxy resin and place on magnetic hot plate with a stirrer.
2. Heat epoxy resin up to the temperature provided in the tables on subsequent pages.
3. Once the desired temperature is reached, add 25% of the total NORYL SA90 resin to avoid agglomeration. Maintain stirring until NORYL SA90 resin is completely dissolved.

4-6. Repeat step 3, adding 25% at a time, until 100% of the NORYL SA90 resin is dissolved.



Step 3

Step 4

Step 5

Step 6

Photos: Dissolution of 10% NORYL SA90 resin in EPON® resin 164 shown above. The dissolution time for each addition is approximately 20 minutes.

PROCEDURE FOR DISSOLVING NORYL™ SA90 RESIN INTO EPOXY RESINS

OTHER CONSIDERATIONS:

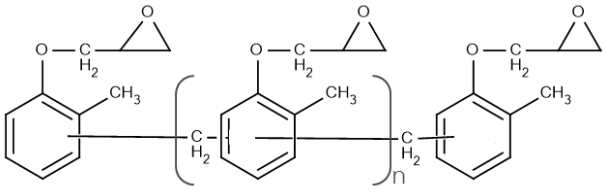
- Using resin kettles and/or round bottom flasks may potentially reduce the dissolution time.

- The starting temperature and dissolution time will be dependent on the type of the epoxy resin and the amount of NORYL SA90 resin. Please refer to the subsequent tables for dissolution time and temperature.

- Minimum dissolution temperature should be above the T_g of NORYL SA90 resin (135-145 °C).

- There may be a reaction between NORYL SA90 resin and epoxy resin during dissolution. The degree of reaction may be dependent on the amount of NORYL SA90 resin, the type of the epoxy resin, the dissolution time and temperature. These studies were completed at lab scale. Please consider reaction rates and temperatures when processing at larger scale.

VISCOSITY RESULTS – EPON® RESIN 164



EPON resin 164
Epoxy Molar Mass :
200-240 g/eq (ASTM D-1652)
Melt Viscosity at 150 °C:
600-1200 cP (ASTM D445)

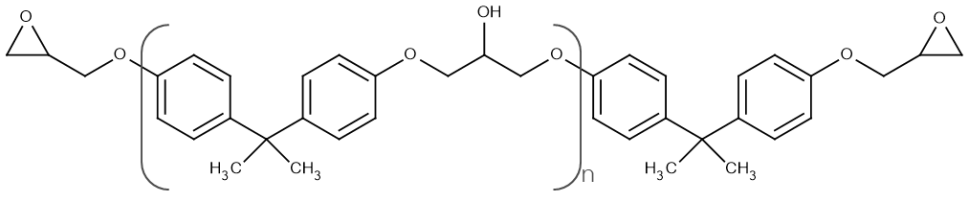
EFFECT OF NORYL™ SA90 RESIN MIX RATIO ON VISCOSITY[1]

EPON resin 164		10 wt-% NORYL SA90 Resin	20 wt-% NORYL SA90 Resin	30 wt-% NORYL SA90 Resin	40 wt-% NORYL SA90 Resin
Dissolution Temp.		190 °C	190 °C	190 °C	190 °C
Total Dissolution Time:		30 min	60 min	85 min	90 min
Temp (°C)	**Viscosity (cP)**				
200	185	480	980	2,275	12,100
190			1,650	4,350	32,700
180	360	1,175	3,075	8,900	80,250
170	625	1,950	6,450	23,500	240,000
160	1,018	3,685	14,400	66,000	
150	1,710	7,875	35,500	176,000	
140	3,300	17,925	96,000		
130	7,850	45,700	305,000		
120	20,400	135,000			
110	66,000	436,000			
100	213,000				

[1] Viscosities were measured using a Brookfield Viscometer at elevated temperatures

Epoxy Molar Mass and Melt Viscosity @ 150°C obtained from EPON resin 164 datasheet

VISCOSITY RESULTS – EPON® RESIN 828



EPON Resin 828
Epoxy Equivalent Weight : 185-192 g/eq (ASTM D-1652)
Viscosity at 25 °C: 110 -150 P (ASTM D445)

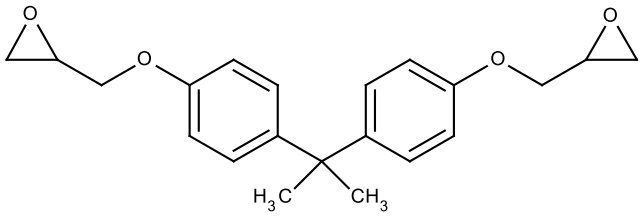
EFFECT OF NORYL™ SA90 RESIN MIX RATIO ON VISCOSITY[1]

EPON resin 828		10 wt-% NORYL SA90 Resin	20 wt-% NORYL SA90 Resin	30 wt-% NORYL SA90 Resin	40 wt-% NORYL SA90 Resin
Dissolution Temp.		155 °C	155 °C	155 °C	155 °C
Total Dissolution Time:		50 min	100 min	200 min	280 min
Temp (°C)	Viscosity (cP)				
150		13	43	170	825
130		25	93	475	
125					3,540
100	40	100	445	3,250	62,500
75	120	433	2,885	40,400	235,000
60				368,000	
50	635	4,150	52,750		
30	5,900	68,000			
25		186,000			
23	17,000				

[1] Viscosities were measured using a Brookfield Viscometer at elevated temperatures

Epoxy Molar Mass and Viscosity @ 25ºC obtained from EPON resin 828 datasheet

VISCOSITY RESULTS – D.E.R.® 332 EPOXY RESIN



D.E.R. 332 epoxy resin
Epoxy Molar Mass :
171-175 g/eq (ASTM D-1625)
Viscosity at 25 °C:
4000-6000 cP (ASTM D445)

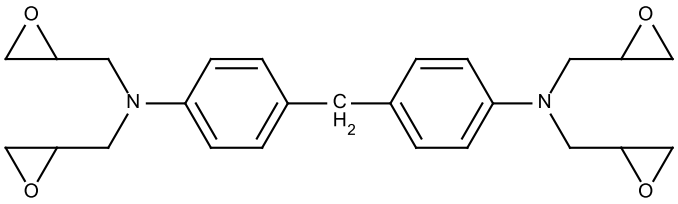
EFFECT OF NORYL™ SA90 RESIN MIX RATIO ON VISCOSITY[1]

D.E.R. 332 epoxy resin		10 wt-% NORYL™ SA90 Resin	20 wt-% NORYL SA90 Resin	30 wt-% NORYL™ SA90 Resin	40 wt-% NORYL™ SA90 Resin
Dissolution Temp.		150 °C	150 °C	150 °C	150 °C
Total Dissolution Time:		30 min	50 min	95 min	160 min
Temp (°C)	Viscosity (cP)				
160	0	8	23	83	315
150	3	8	30	110	480
130	5	15	63	280	1,540
100	18	65	278	1,630	18,600
80					200,000
75	65	250	1,525	16,000	358,000
60				105,000	
50	355	1,952	21,075		
40			94,500		
35			231,000		
25	5,550				
21		116,000			

[1] Viscosities were measured using a Brookfield Viscometer at elevated temperatures

Epoxy Molar Mass and Melt Viscosity @ 25ºC obtained from D.E.R. 332 resin datasheet

VISCOSITY RESULTS – TGDDM



TGDDM (Sigma-Aldrich)
Epoxy Molar Mass: 109 - 117 g/eq
Viscosity at 50 °C: 3000 - 6000 cps

EFFECT OF NORYL™ SA90 RESIN MIX RATIO ON VISCOSITY[1]

TGDDM		10 wt-% NORYL™ SA90 Resin	20 wt-% NORYL™ SA90 Resin
Dissolution Temp.		160 °C	190 °C
Total Dissolution Time:		50 min	150 min
Temp. (°C)	Viscosity (cP)		
160		45	360
150	15	55	600
130	35	125	1,830
100	140	605	18,350
90			63,750
75	648	3,630	
50	5,300	40,000	
30	61,375	158,000	
25	137,000		

[1] Viscosities were measured using a Brookfield Viscometer at elevated temperatures

Epoxy Molar Mass and Melt Viscosity @ 25°C obtained from D.E.R. 332 resin specification sheet

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