

CONCRETE FLOORS

PRODUCT OVERVIEW



Cardolite



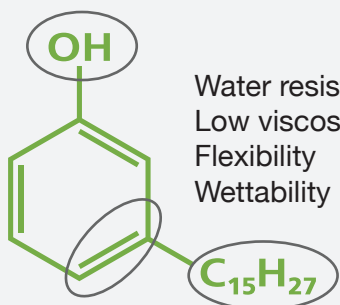
Cardolite Corporation is a privately held manufacturer of the world's largest variety of products derived from cashew nutshell liquid (CNSL). CNSL is an annually renewable resource that does not interfere with the food chain. The unique properties of CNSL are used to develop and produce a wide range of specialty curing agents, resins, and diluents for coatings, adhesives, composites and friction applications.

With 30 years of experience, Cardolite is the leader in the production and development of high quality CNSL based materials across the globe. Cardolite's manufacturing facilities in Newark, New Jersey (USA), Zhuhai, Guangdong (China), and Mangalore, Karnataka (India), have the unique capability to consistently process CNSL from any source to the desired properties.

To further advance CNSL technology, Cardolite operates state-of-the-art research facilities in the USA, China, and India. By using CNSL as a primary building block, these laboratories are able to develop epoxy hardeners, modifiers, and resins for concrete coatings and adhesives with performance advantages over some traditional, petrochemical based chemistries. In addition, these facilities are equipped with application testing machines such as mechanical testers, thermal analysis DSC and TGA, dynamic mechanical analysis, impact and pull off adhesion testers, and QUV and salt spray chambers amongst others. The Technical Service group uses the comprehensive test capability of these laboratories to develop relevant performance data that helps customers accelerate time to market.

Cardolite continues to invest heavily in research, technical support, manufacturing, and market development to meet the ongoing needs of the flooring industry with innovative, renewable CNSL based products.

Low temperature cure
Fast cure
Excellent adhesion



Chemical and thermal shock resistance

Water resistance
Low viscosity
Flexibility
Wettability

CNSL Technology

Cardanol is a unique natural phenolic material obtained by distilling CNSL and serves as the primary building block for Cardolite products. The molecule is composed of an aromatic ring with an OH group and a long aliphatic side chain, which brings valuable intrinsic benefits to coatings and adhesive materials. The aromatic ring provides a strong chemical resistant backbone while the OH group gives high bond strength and good reactivity for fast and low temperature cure. The side chain provides excellent water resistance, good flexibility, low viscosity, and extended pot life. Most Cardolite products are high in bio-content.



Cardolite Products

Cardolite offers a variety of epoxy amine curing agents, epoxy modifiers, and epoxy resins based on CNSL technology for use in the formulation of a wide range of high performance epoxy coatings and adhesives for concrete floors.

The Mannich reaction of CNSL, formaldehyde, and certain amines is called a phenalkamine. Phenalkamines are epoxy curing agents that offer unique benefits to coatings formulators such as fast and low temperature cure, low viscosity solvent free systems, great overall chemical and mechanical properties, excellent water resistance, and very good bond strength under unfavorable conditions. Cardolite phenalkamines are ideal for two component, ambient cured epoxy coatings and adhesives.

Cardolite resin and modifier portfolio is comprised of reactive and non-reactive epoxy diluents and multi-purpose modifiers that not only lower viscosity, but also improve flexibility,

surface tolerance and early water resistance, and can accelerate cure without compromising other properties. Moreover, tests have shown that Cardolite modifiers can be formulated to increase bond strength and improve adhesion on oily or damp surfaces. These products are an excellent alternative to substances of high concern such as nonyl phenol and can be used in one component heat cured adhesives or in two component field applied applications.

Over the last 30 years, Cardolite has pioneered new developments in CNSL technology such as innovative low viscosity, light colored, and faster curing products. In addition, Cardolite has broad expertise and experience supporting, developing, and manufacturing curing agent solutions to fit specific customer needs. If a standard Cardolite product does not function as desired for a specific application, Cardolite can provide formulation technical support and custom modifications.

Epoxy Curing Agents Phenalkamines for Primers and Self-leveling



Fast Cure in Extreme Weather

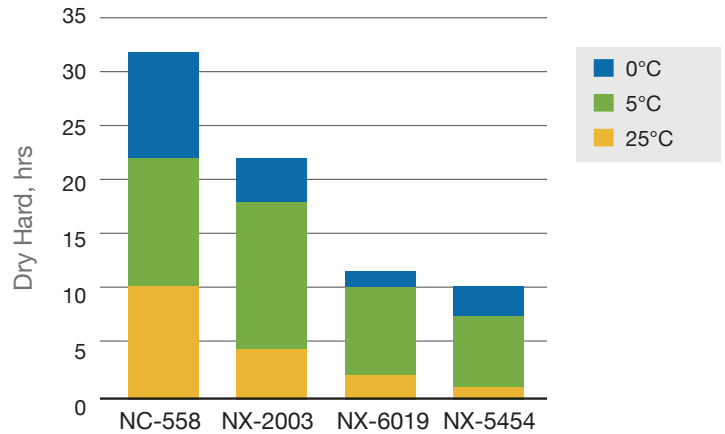
Cardolite phenalkamines exhibit fast cure and hardness development even at freezing temperatures, enable non-critical mix ratios, and show a nice film appearance due to good compatibility with epoxy resins. However, due to the long aliphatic side chain of cardanol, phenalkamines also provide extended pot life and good impact resistance despite the fast cure.

The fast and low temperature cure combined with the good pot life properties of phenalkamines allows for wider floor coating application window and quicker return to service. Moreover, by reaching a high level of crosslinking very quickly and not having a narrow mix ratio, failure risks are lowered and problems are avoided when environmental conditions rapidly change after application.

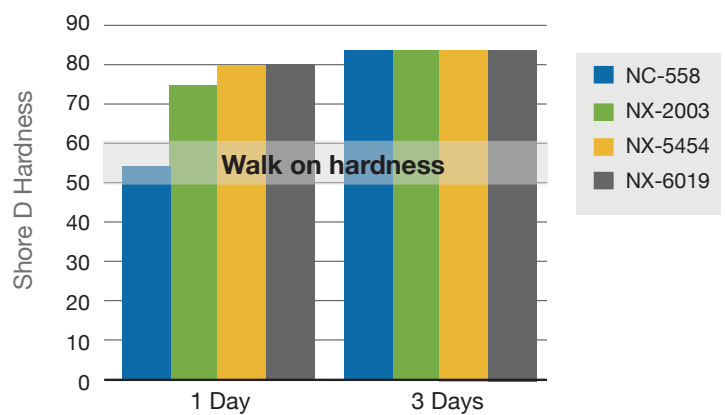
Hydrophobicity

Cardolite curing agents are very hydrophobic due to the long aliphatic chain of the cardanol, which results in excellent water resistance and very low permeability compared to other amine curing agents commonly used in the floor coating industry. The low permeability of systems cured with phenalkamines helps prevent blisters from being formed on the floor coating when water vapor present in the concrete rises to the surface.

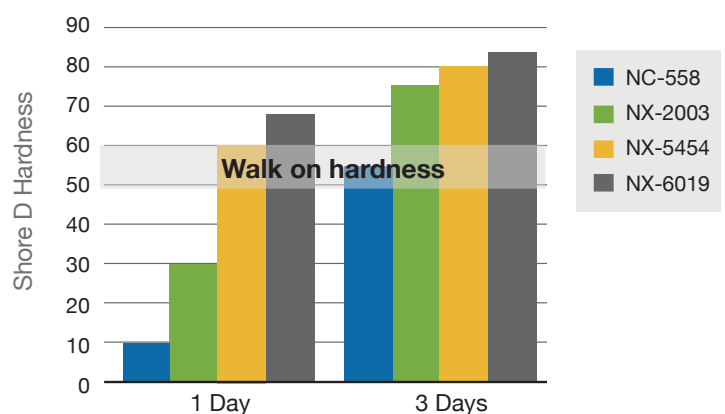
Cure time with Liquid Epoxy (EEW 190)



Hardness Development with Liquid Epoxy (EEW 190) at 25°C



Hardness Development with Liquid Epoxy (EEW 190) at 10°C





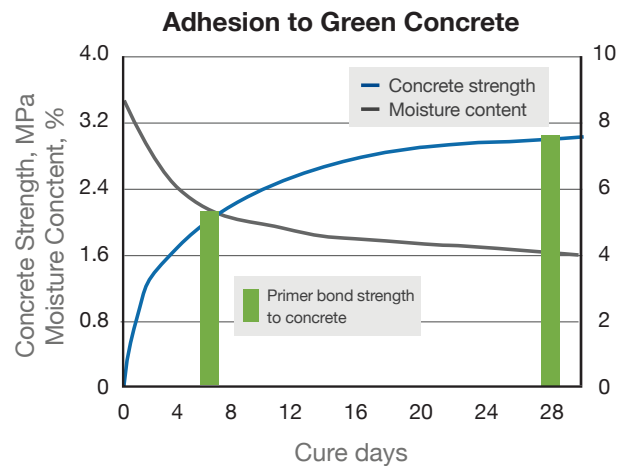
Chemical Resistance

Phenalkamines exhibit excellent chemical resistance to a variety of chemicals due to its aromatic ring and high crosslinking density. The combination of chemical resistance and excellent adhesion to concrete provided by phenalkamines, protects coatings from being damaged by chemical spills or leaks in environments as encountered in factories, platforms, and warehouses. Phenalkamines can be designed to withstand:

- Alcohols & Solvents: ethanol, xylene, gasoline, jet fuel, diesel, toluene, etc.
- Acids & Alkali: sulfuric acid, caustic, hydrochloric acid, etc.
- Others: juices, wines, olive oil, etc.
- Sea water, hot water, and distilled water

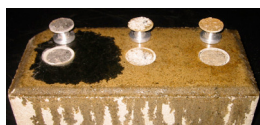
Adhesion to Damp, Oily, and Green Concrete

The hydrophobicity of phenalkamines coupled with fast cure allow floor primers to quickly develop strong bonds to dry, damp, oily, and green concrete. Concrete requires 28 days to fully cure, but primers based on phenalkamines can develop full adhesion with concrete sooner. Adhesion tests need to be done on each system to determine coating earliest application time.



Adhesion to Oily Concrete

Epoxy Phenalkamine Primer	Pull off Adhesion (MPa)	Rupture Mode
7-day cure diesel engine oil contaminated concrete	2.8/4.1 oil/no oil	concrete
7-day cure gasoline engine oil contaminated concrete	4.1/4.1 oil/no oil	concrete



The image shows concrete surface contaminated with diesel oil (left), nothing (middle), gasoline oil (right).

Adhesion to Dry and Damp Concrete

Epoxy Phenalkamine Primer	Pull off Adhesion (MPa)	Rupture Mode
24 hours dry concrete	6.90	50% dolly 50% concrete
3 weeks dry concrete	6.90	Dolly to adhesive
3 weeks damp concrete	3.45	100% concrete



This image shows adhesion failure occurs in the concrete and not between dolly/coating and concrete.

Epoxy Curing Agents Phenalkamines for Top Coats

Weatherability

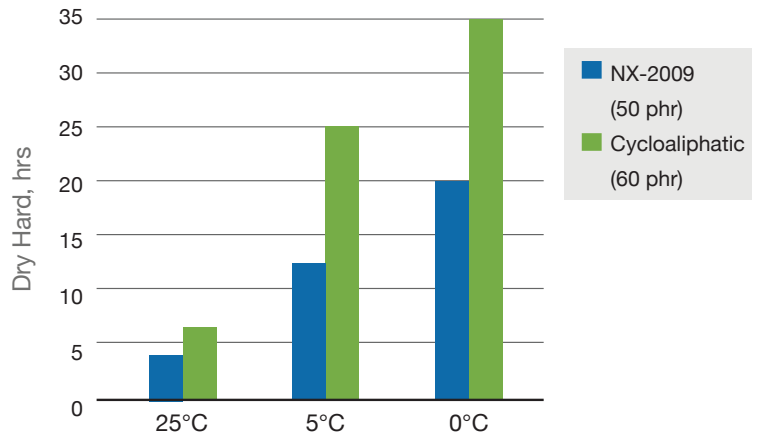
Cardolite offers some specially designed phenalkamines that exhibit good weatherability compared to other amine curing agents. These products show similar or less yellowing than cycloaliphatic curing agents when exposed to sunlight. In addition, these curing agents form a glossy film even at high humidities.

As with other phenalkamines, these products exhibit fast cure and hardness development even at lower temperatures, enable non-critical mix ratio, and provide good impact resistance. They provide excellent water and chemical resistance ensuring top coat durability in industrial environments. Moreover, these curing agents are very resistance to osmotic blistering and provide very good adhesion to primer or concrete. They can also be used in self-leveling coatings to reduce the number of raw materials and inventory.

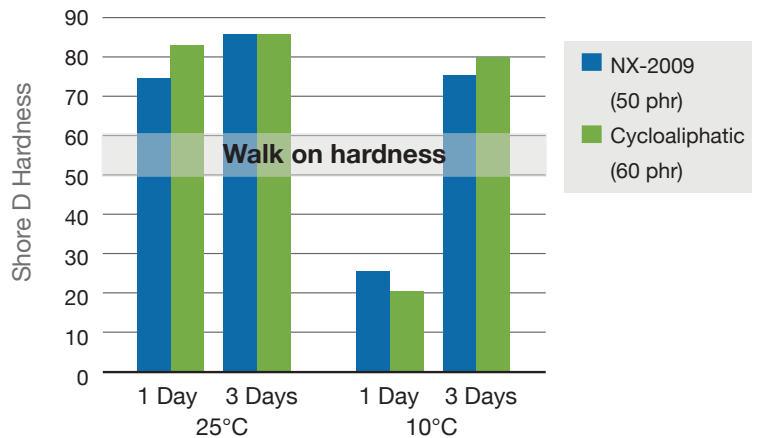
Early Water Resistance

The combination of fast reactivity at a broad temperature range and high hydrophobicity from the cardanol building block results in very good early water resistance in coatings formulated with phenalkamines. This performance property can be of benefit in case of rain or spill shortly after the application of the top coat.

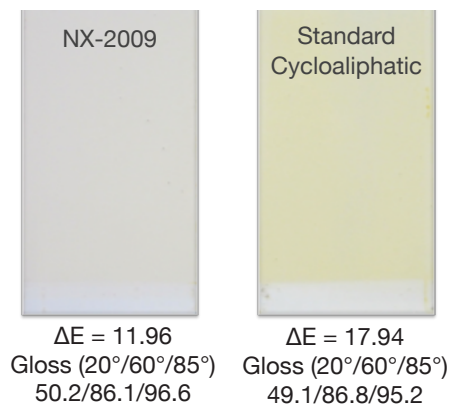
Cure time with Liquid Epoxy (EEW 190)



Hardness Development with Liquid Epoxy (EEW 190) at 25°C and 10°C



Color and Gloss Retention after 59 days exterior exposure (summer)



Phenalkamine Curing Agent Property Selection Chart

Product	Viscosity ¹ @ 25°C (cPs)	Type	Color ² (Gardner)	Amine Value ³ (mg KOH/g)	AHEW ⁴	Gel Time ⁵ (min)	Thin Film ⁶ Dry Hard Time (hours)		
							25°C	5°C	0°C
NC-558	900	solvent free	17	340	95	40	10	22	32
NX-2003	620	solvent free	10	360	95	25	4.5	18.5	22
NX-2003D	700	solvent free	13	357	95	25	4.5	15	24
NX-5454	1,080	solvent free	11	275	133	18	2	7.5	10
NX-6019	1,200	solvent free	11	290	133	20	2.5	10	11.5
NX-2007	265	benzyl alcohol	4	310	113	50	2	16	23.5
NX-2009	370	benzyl alcohol	7	310	95	31	4	12	20.5
Ultra LITE 2009	330	benzyl alcohol	1	277	95	34	6	19	27

¹ASTM D2196 ²ASTM D1544 ³ASTM D2074 ⁴Theoretical based on total product weight ⁵50g at 25°C ⁶ASTM D5895 @ 200 micron

Phenalkamine Curing Agent Performance

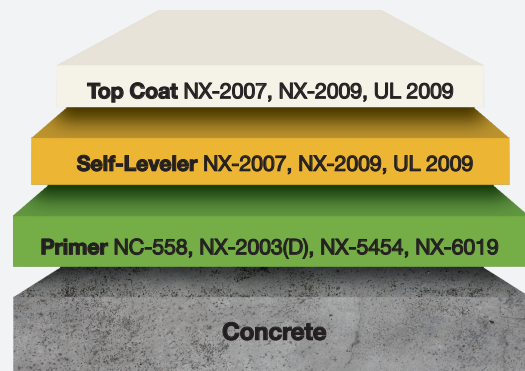
Curing Agent	Tg ⁷ (°C)	Tensile Strength (MPa)	Flexural Strength (MPa)	Compressive Strength (MPa)	Elastic Modulus (MPa)	Lap Shear ⁸ (MPa)
NC-558	61	41	105	56	1,985	21
NX-2003	74	55	94	76	2,384	20
NX-2003D	79	51	108	75	2,309	20
NX-5454	60	47	88	72	2,019	12
NX-2007	70	57	105	88	3,170	14
NX-2009	57	51	101	80	2,500	20

⁷DSC ⁸Sand blasted substrate

Test specimen cured at 40°C for 16 hours with liquid epoxy (EEW 190)

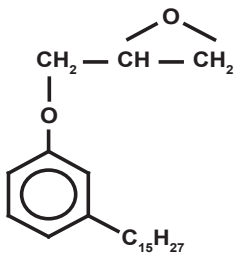
Application Selection Chart

Cardolite offers phenalkamines for all concrete coating layers. Hardeners recommended as primers offer excellent adhesion to green, damp, oil contaminated, and dry concrete. Hardeners suggested as top coats provide excellent UV resistance. All of these products have good self-leveling properties with very low viscosities, fast cure, and friendly mix ratios for easy application. The products indicated on the right are the preferred choices.



Epoxy Diluents and Modifiers

In addition to epoxy curing agents, Cardolite offers a line of cardanol derived epoxy diluents and modifiers that provide tools to formulators looking to add unique properties to their floor coatings.

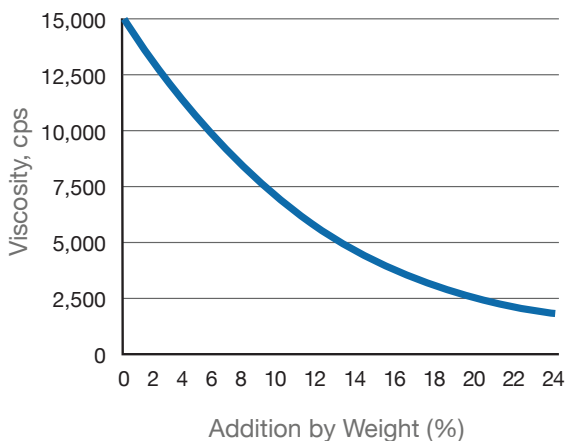


Cardolite NC-513/ Ultra LITE 513

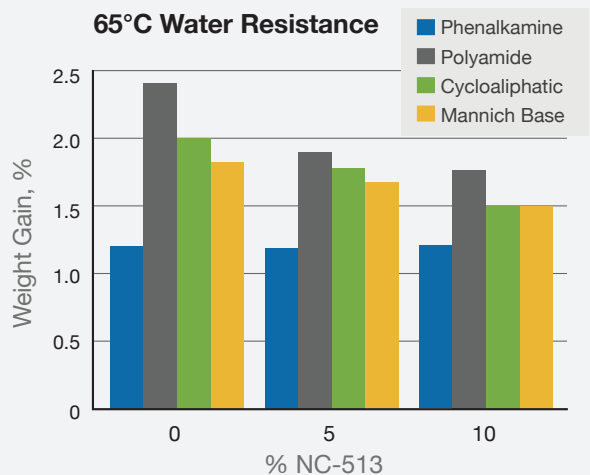
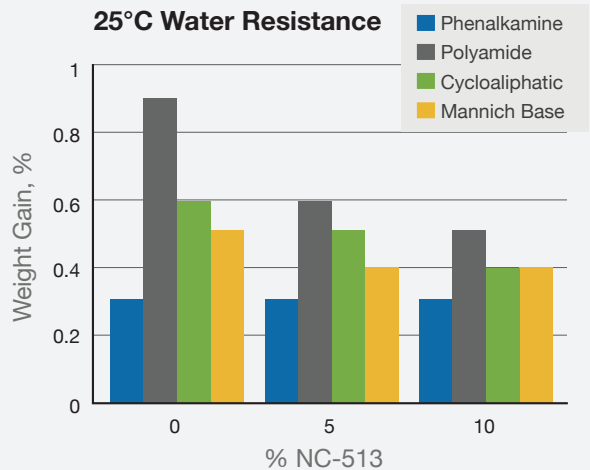
Cardolite Ultra LITE 513 and NC-513 are low viscosity, monofunctional epoxy reactive diluents that can be used to

increase flexibility, impact resistance, and water resistance. These reactive diluents are ideal for formulating low emission and low odor solvent-free floor coatings. Their good reactivity means that these diluents react completely into the epoxy network, which can increase the bond strength. Ultra LITE 513 is a lower viscosity, higher purity, and lighter color version of NC-513. Both grades have a similar chemical make-up and have favorable labeling. They are excellent replacements for toxic or environmentally unfriendly glycidyl ether based diluents.

**NC-513 and Ultra LITE 513 Dilution Curve
(25°C with Liquid Epoxy Resin, EEW=191)**

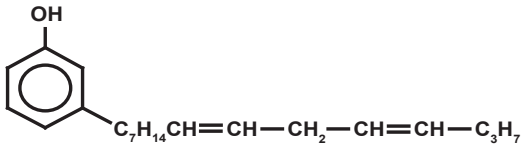


Cardolite NC-513/ Ultra LITE 513 Water Resistance





Cardolite NX-202x Series

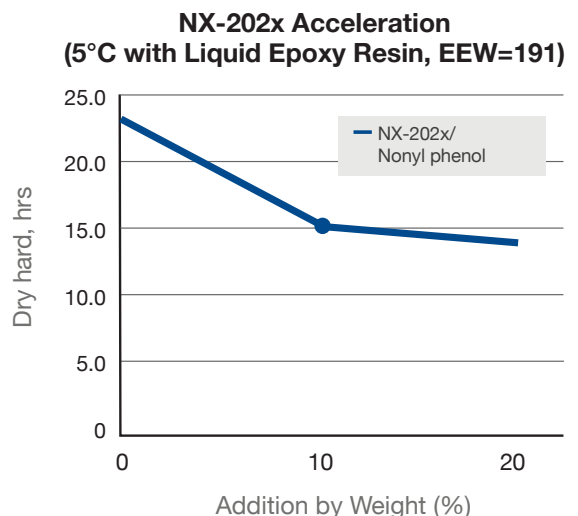
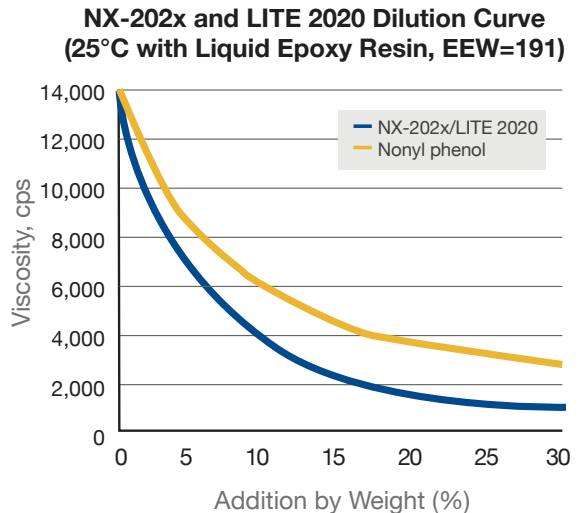
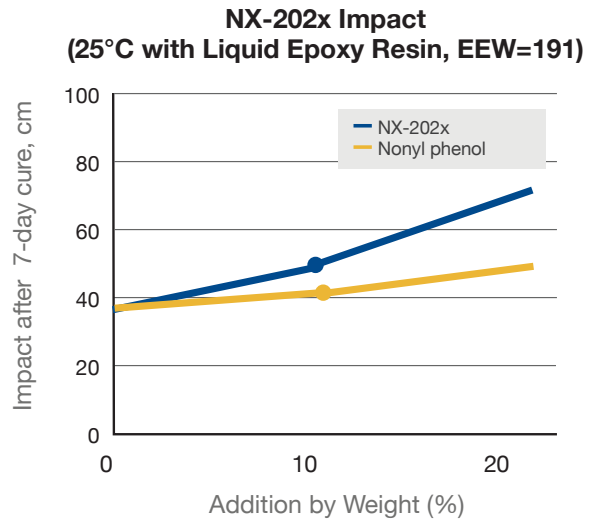


Cardolite NX-202x products are low viscosity multipurpose resin modifiers. The long hydrophobic aliphatic side chain of the cardanol molecule gives these products a very low viscosity and provides excellent early water resistance and corrosion protection. By using NX-202x products as epoxy diluents and accelerators, high solids or solvent free formulations can be achieved with enhanced workability and faster cure without sacrificing other performance properties. In addition, the flexibility of the side chain helps increase impact resistance of the final coating.

Different Grades Available:

- NX-2024: low odor, light color cardanol
- NX-2025: low odor, light color, high purity cardanol
- Ultra LITE 2023: Gardner color 1, wet color stable
- NX-2023: Gardner color ≤ 6 , wet color stable
- NX-2023D: Gardner color ≤ 10 , wet color stable

These products are a good alternative to synthetic phenolic diluents that have unfavorable labeling.

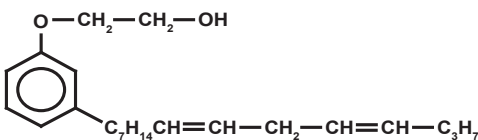


Epoxy Diluent, and Modifier Property Selection Chart

Product	Type	Typical Color ¹ (Gardner)	Typical Viscosity ² (cPs)	Typical Volatile Loss ³ or Solids (%)	EEW	Hydrolyzable Chlorine (%)
NC-513	Reactive diluent	11	50	≤ 0.5	425 - 575	≤ 2
Ultra LITE 513	Reactive diluent	1	24	≤ 0.5	≤ 450	≤ 1
NC-514	Epoxy resin	17	25,000	≤ 3	350 - 500	≤ 2
NC-547	Epoxy novolac resin	18	28,000	≤ 2	550 - 850	≤ 2.5
LITE 2020	Nonreactive resin modifier	12	90	≥ 97 (solids)	-	-
LITE 2100	Hydrocarbon resin modifier	4	450 - 750	≤ 1	-	-
LITE 2100R	Hydrocarbon resin modifier	4	500 - 1000	≤ 1	-	-
NX-2023D	Nonreactive resin modifier	10	100	≥ 99.5 (solids)	-	-
NX-2023	Nonreactive resin modifier	5	60	≥ 99.5 (solids)	-	-
Ultra LITE 2023	Nonreactive resin modifier	1	50	≥ 99.5 (solids)	-	-
NX-2024	Nonreactive resin modifier	4 - 9	50	≤ 0.5	-	-
NX-2025	Nonreactive resin modifier	≤ 5	50	≤ 0.5	-	-

¹ ASTM D1544, ² ASTM D2196 at 250C, ³ ASTM D2369-98, * LITE 2020 and LITE 2100 not approved for sale in Europe

Cardolite LITE 2020*



Cardolite LITE 2020 is a low viscosity multipurpose resin modifier. This resin is non-volatile and is therefore useful for formulating environmentally friendly solvent free coatings. Due to its unique chemical structure, LITE 2020 is more efficient than traditional hydrocarbon resins in reducing viscosity despite being higher in viscosity. Its hydrophobic nature allows for good corrosion resistance and early water resistance.

Cardolite LITE 2100*(R)

Cardolite LITE 2100(R) are low color and low viscosity cashew nutshell liquid modified hydrocarbon resins designed to enable high solids and solvent free formulations by lowering the viscosity of epoxy resins more efficiently than typical phenol based hydrocarbon resins and by improving overall system compatibility for better film formation. These products can increase hardness development of the coating while providing improved flexibility and impact resistance. Moreover, LITE 2100(R) show very good UV resistance with excellent gloss retention for use in lighter color coatings.

Notes:





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