



An Emerald Performance Materials® Company

## Specialty Epoxy Resins, Tougheners and Curatives for Oil and Gas Pipeline Epoxy Coatings

Over the last 5-10 years, safety requirements for industrial pipeline have become more stringent as drilling underground reaches new levels, along with an increasing demand for laying pipeline in extreme cold and high temperature environments. These challenges require advanced technologies and materials that promote higher chemical and temperature resistance, greater toughening and faster curing.

CVC is committed to serving the pipe-coating industry, offering products, experience and technical support specifically designed for plant and field applied pipeline coatings and maintenance. The company has developed a portfolio of epoxy and related products designed to meet new stringent pipeline standards, especially for pipelines carrying oil and natural gas.

Our comprehensive line of offerings includes:

- EPALLOY® Phenol Novolac Epoxy Resins for high chemical and temperature resistance
- HyPox® CTBN Modified Epoxy Adducts for toughness and improved cathodic disbondment
- OMICURE® Curing Agents and Accelerators for high temperature FBE and greater production output
- ERISYS® Epoxy Modifiers for coating flexibility, elongation and enhanced processibility

### Improvement in Cathodic Protection of Girth Weld and FBE Coatings

Earth-buried pipelines are usually expensive investments. To defend against the threat of corrosion, pipelines are protected by coatings and coverings. However, coatings are subject to stress from various chemicals in earth and moisture, which greatly affects the service life of the coating. Cathodic protection is one way to improve coating service life, but even minimal damage to the coating or cracks in the cover, may steadily lead to corrosion. Corrosion causes an electrochemical reaction which leads to a loss of metal integrity. As a result, pipelines become leaky, causing enormous damage to property and environment.

HyPox (CTBN Modified Epoxy Resins) are proven to improve cathodic disbondment and toughness properties at various temperatures in girth weld as well as FBE coatings.

Formulation - Girth Weld Coatings	1	2	3
Standard Bisphenol-A Epoxy	100	80	80
Epalloy 7200- Modified BPA Resin		20	20
HyPox RM 20	0	20	0
HyPox RM 22	0	0	20
Aliphatic amine + Phenalkamine	Stoichiometric		
Rubber Concentration, phr	0	10	10
<b>Average Radial Disbondment (mm)</b>			
At 23°C	18	5	5
At 65°C	>35	12	11

**CVC Thermoset Specialties**

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<b>Formulations- Fusion Bonded Epoxy ( FBE)</b>			
Type 3 Solid BPA Resin ( Epotec YD013)	100	50	65
HyPox RK 820	-	50	-
HyPox RK 84L	-	-	35
OMICURE DDA10	8	8	8
OMICURE U52M	2	2	2
Barium Sulphate	35	35	35
Modaflow	1.5	1.5	1.5
Toughener % in Formulation	0	10	10
Gel time at 180°C, sec	80	60	60
Tg, °C	90	88	100
Flexibility- 180 Comical Mandrel	Fail	Pass	pass
<b>Average Radial Disbondment (mm) , at 23°C</b>	>25	13	10

### High Chemical Resistance Applications

Fracking, the combination of advanced hydraulic fracturing and horizontal drilling, has increased over the past five years as a solution to the sourcing of natural energy. Oil and or gas are released from the earth under high pressure and temperature, and are contaminated with acidic compounds. Current technology trends are to manufacture coatings that can withstand the high temperature and acidity of the materials flowing through the pipeline.

CVC offers Epoxy Phenol Novolacs for chemical resistant coatings, especially where the acid is sulphur-based. Epoxy Phenol Novolacs and Resorcinol Diglycidyl Ether offer excellent protection against acidic chemicals.

Resin System	Composition, %	Curing Agent					
		624CE	670CE	676CE	PAC 1693	PAC 2280	HY 265
		% weight gain/loss after 28 days in 98% sulfuric acid at 28C					
EPALLOY 8230	100	-0.9	-0.9	-24.0	0.5	0.4	-11.9
EPALLOY 8250	100	0.4	-0.7	-15.8	-0.1	-0.1	-3.0
EPALLOY 8230 / ERISYS RDGE	70/30	-0.3	0.5	-9.5	0.5	0.4	1.0
EPALLOY 8250 / ERISYS RDGE	75/25	0.3	-0.2	-7.4	0.3	0.3	-0.0

**Standard LER cured material after 24hrs in 98% sulfuric acid at 25°C**



**EPALLOY 8240 based cured material after 28 days in 98% sulfuric acid at 25°C**



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## Low Temperature Fast Cure Epoxy Formulations

EPALLOY 7200, a chemically modified liquid epoxy resin, provides a means for cure acceleration in low (including subzero), ambient, and elevated temperature cure systems. Acceleration in EPALLOY 7200 is not dependent on additives, which can cause a decrease in chemical resistance and Tg. The modification of Epalloy 7200 imparts higher reactivity through catalyzation of the epoxy reaction.

Advantages of EPALLOY 7200:

- Faster tack free time, hardness development and improved chemical resistance in coatings, enabling faster return to service
- Fast cure formulations without the use of polymercaptan and acrylated epoxy that provide for improved water resistance, lower cost, and less odor
- Improved water spot resistance with standard curing agents at RT and sub-ambient conditions

## High Tg Coating Applications

Oil and gas fluids contain solid particulates such as inorganic salts, partially polymerized oils, including waxes and paraffins, as well as silicas, dirt, greases and acidic compounds. Some of these particulates dissolve in the fluid while some remain in suspension. Traveling through pipelines, these particulates become aggressively corrosive projectiles. Coatings designed for internal pipeline application must be engineered to be tough against the high impact created by these fast moving particulates. CVC offers range of Epoxy Phenol Novolacs for high Tg and high chemical resistance coating applications:

PRODUCT	Functionality	Tg, HyPox °C
EPALLOY 8220	2.05	129
EPALLOY 8225	2.05	129
EPALLOY 8230	2.15	131
EPALLOY 8240	2.35	145
EPALLOY 8250	2.60	160
EPALLOY 8330	3.60	198
EPALLOY 9000 + LER (30/70)	-	203
EPALLOY 9000 + LER ( 40/60)	-	>240
Sample cured with PACM at 100°C / 1hr, 200°C/4 hrs		

## Curing Agents and Accelerators for Powder Coatings

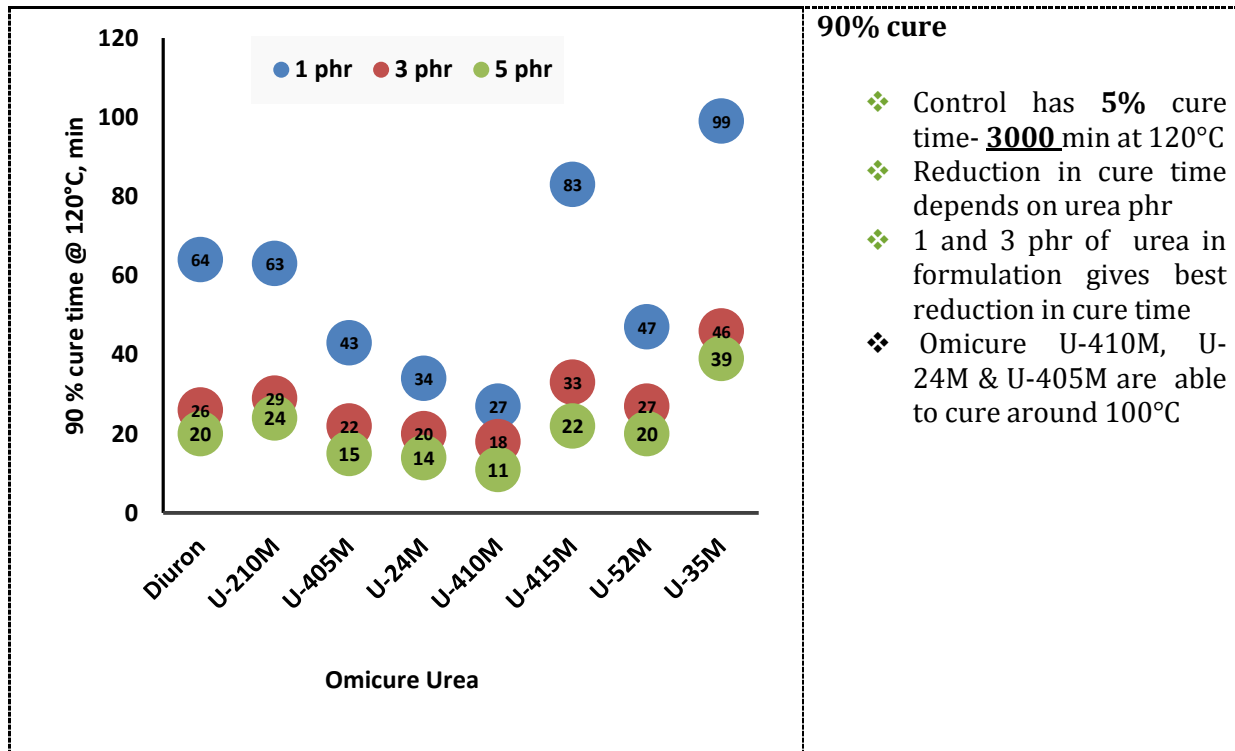
FBE coating formulations require heat to cure and develop optimum properties. Formulators using FBE are continually searching for products that will cure at lower temperature or in shorter time. Lower cure temperatures enhance cost savings by reducing energy usage. Shorter cure times allow increases in production line speed, also resulting in cost savings.

Using OMICURE Substituted Ureas to accelerate a OMICURE Dicy cure, allows the FBE applicator to cure at lower temperatures and at faster rate:

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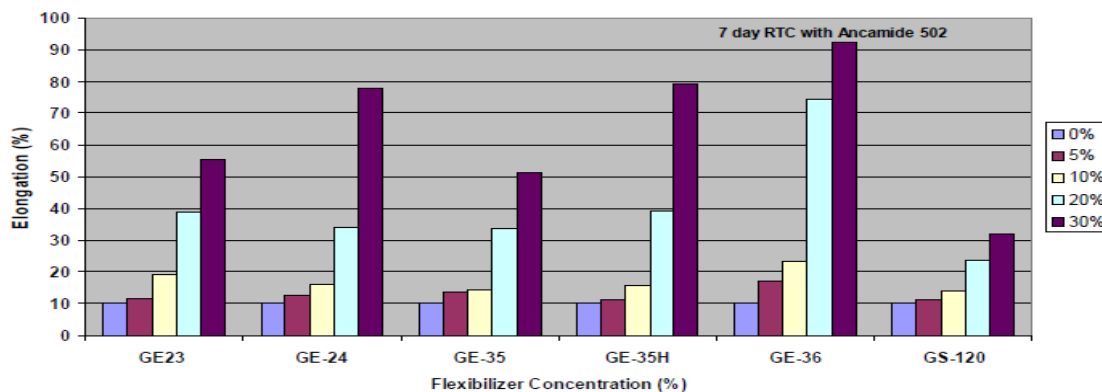


### Improving Coating Flexibility for Improved Pipeline Transportation and Installation Process

The choice of modifier should be based on which product gives the most desired balance of flexibility, temperature resistance and elongation. CVC offers the largest selection of epoxy modifiers suitable for every application. Erisys GE36 is highlighted as a product highly suited for pipe coatings, improved installation and transportation flexibility.

Tg (°C) vs % modifier in standard BPA resin	0	5	10	20	30
ERISYS GE-24 (Polypropylene glycol diglycidyl ether)	116	108	93	77	64
ERISYS GE-36 (Polypropoxylated glycerine triglycidyl ether)	116	108	106	105	102
Cured with TETA: gel at RT + 2hrs at 100C					

### Tensile Elongation with Flexibilizer by Type



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