

ANCAMIDE® 2853 & 2865 Curing Agents

-Flexible, Powerful & Resilient - YOU MAY EVEN FIND IT UNBREAKABLE.

September 25, 2024

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Agenda

1. Introduction and background (slides 3-6)
2. Ancamide 2853 & 2865 address unmet market needs (slides 7-9)
3. Test results and data (slides 10-17)
4. Regulatory and EHS (slide 18)
5. Summary (slides 19-20)

Why do We Need Flexible Systems?

Diverse Applications

- **Concrete protection** where coatings subjected to a moderate to heavy duty service and frequent movement and stress (30% to >100% elongation)
 - Waterproofing membranes (>100%)
 - Crack bridging (>100%)
 - Bridge deck overlay (>100%)
 - Joint sealants (50-100%)
 - Tough flooring (30-50%)
 - Secondary containment membrane (>100%)
- **Metal protection** (30-50% elongation)
 - Tank linings
 - Industrial flexible coatings
- **Adhesive applications** (30% to >100% elongation)

Available Flexible 2K Technology Comparison

Properties	2K Flexible polyurethanes	2K Flexible polyurea	Standard 2K epoxy
EH&S Profile & handling	Isocyanate	Isocyanate	✓✓✓
Cure speed	✓	✓✓	✓✓✓
Low temp cure	✓	✓✓	✓✓✓
Flexibility/Elongation	✓✓✓	✓✓✓	xxx (<10%)
Hardness	✓	✓	✓✓✓
Moisture tolerance	✓	✓	✓✓✓
Apply thick films in one pass	✓	✓✓	✓✓✓
Direct to concrete adhesion, dry and damp	✓ dry concrete only	✓ dry concrete only	✓✓✓

✓✓✓	good
✓✓	moderate
✓	fair
xxx	poor

How to Enhance Flexibility in 2K Epoxy Systems?

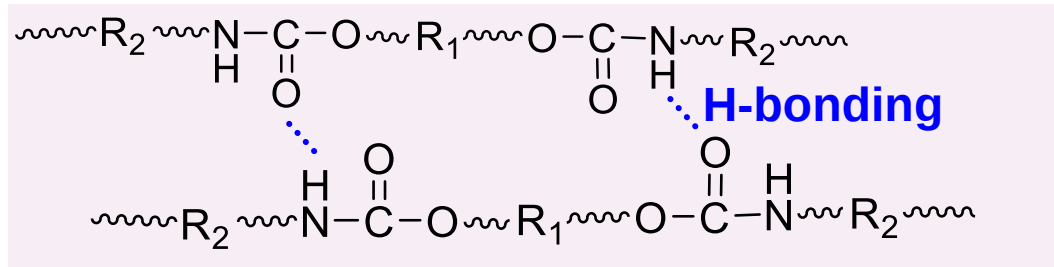
- **Curing agents**
 - Plasticize with **nonyl phenol**
 - **Diminished flexibility** at low temperature, **lower tensile strength**
- **Epoxy resin modifiers**
 - Epoxy functionalized polyurethane, high viscosity
 - Ancarez 2364: increases elongation while maintaining high strength and modulus
 - Reactive diluent at 10-20% level: improves elongation but **reduces strength**
 - mono-epoxide with long alkyl chain Epodil 748; Di-functional epoxide Epodil 749
 - long alkyl chain acrylate: lauryl acrylate, 2-ethylhexyl acrylate

- **Plasticizer**
 - Maintains elongation but **reduces strength**

	% elongation	modulus	strength
↑ Reactive diluent	↑	↓	↓
↑ Functionality	↓	↑	↑
↑ Plasticizer	↔	↓	↓

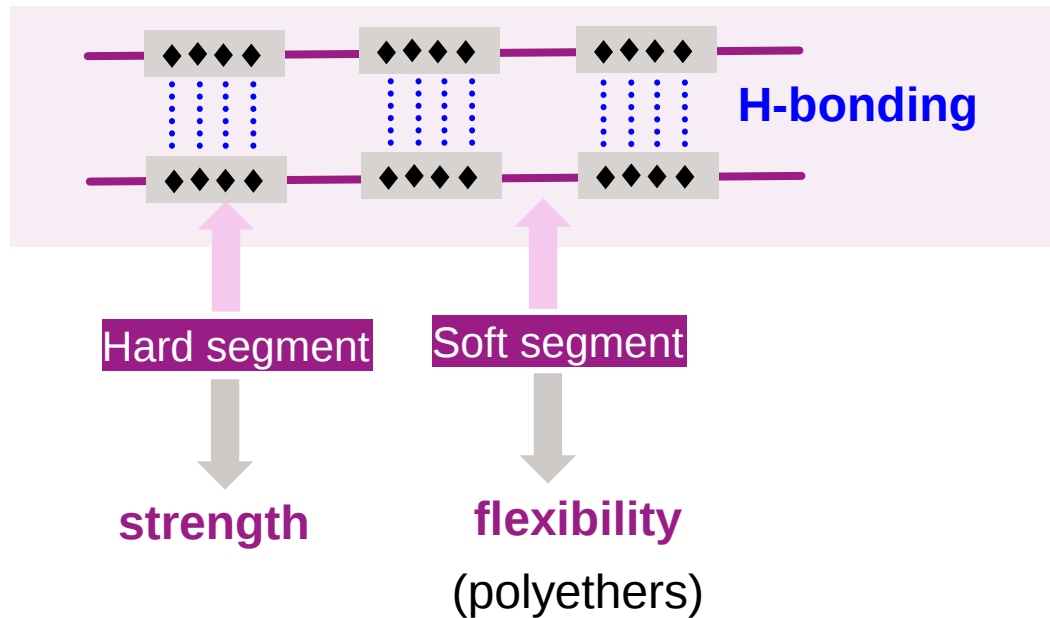
What Makes a Polymer Flexible and Tough?

Polyurethane as an example

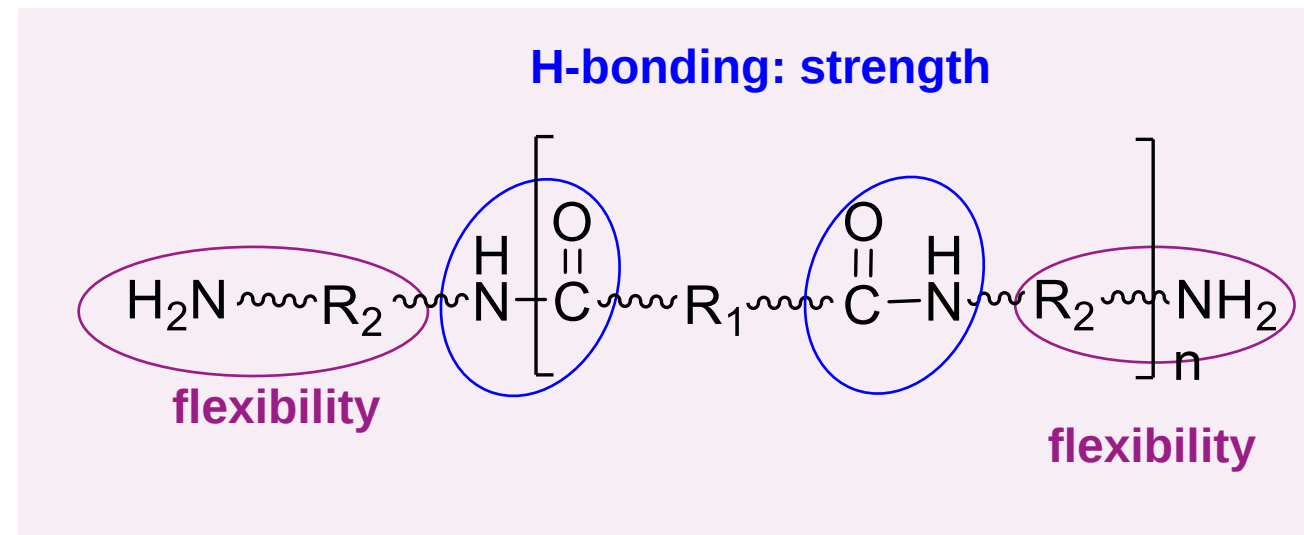


Hydrogen bonding:

- non-covalent “crosslinking”, increased strength



The case of epoxy curing agent: a polyamide



What are the Market Trends and Drivers for 2K Epoxy Systems?



Enhanced Performance

- High flexibility
- Low temperature flexibility
- Good chemical resistance
- Excellent coating appearance



Efficiency

- Fast return to service
- Low temperature cure
- High surface tolerance
- Robust application



EHS, Eco and User Friendly

- Low to zero VOC
- No substance of high concern
- Renewable raw materials
- Sustainability

Market’s Unmet Need for a Flexible and Tough Epoxy with Fast Cure Speed and Enhanced EHS Profile

Requirements	Commercial Product A	Commercial Product B	Commercial Product C	Commercial Product D	Commercial Product E
Fast return to service Fast cure speed with diluted LER 5-6 h @ 77F	✓✓	✓✓✓	xxx	✓	xx
High elongation >80%	xxx	✓✓✓	✓✓✓	✓✓✓	✓✓✓
High tensile / tear strength >2000 psi / > 200 psi	xxx	✓✓✓	✓✓✓	xxx	✓✓✓
High Shore D hardness >60	✓✓	✓✓✓	xx	✓	xxx
Low temperature flexibility	✓✓✓	xxx	✓✓✓	✓✓✓	✓✓✓
Enhanced EHS profile - No health hazard pictogram - Does not contain nonyl phenol, bisphenol A, salicylic acid, etc.	xxx	xxx	✓✓✓	✓✓✓	xxx

Ancamide 2853 & 2865 Address Unmet Needs in Flexible 2K Epoxy Systems

Ancamide 2853

- Very high elongation (~180%)
- High tensile strength >2000 psi
- 100 - 130 PHR using LER/Epodil 748 (90/10 wt)
- Nonylphenol free
- Bio-content 40%

Ancamide 2865

- High elongation (~90%)
- High tensile and tear strength
- Low viscosity
- 85 - 95 PHR using LER/Epodil 748 (90/10 wt)
- Nonylphenol free, 20% bio-content

Ancamide 2853



180% elongation
Higher viscosity
Darker color

Ancamide 2865



90% elongation
Lower viscosity
Lighter color

Ancamide 2853 & 2865 - New Flexible and Tough Curing Agents

Properties	Ancamide 2853	Ancamide 2865
EH&S/VOC	No nonylphenol	No nonylphenol
Neat viscosity (mPa.s)	2865	375
HEW	225-255	165-185
Color	<14	<6
phr	100-130	85-95
phr for the tests	130	90
Mix Viscosity (mPa.s)	3016	750
Shore D (7d/23 °C)	70	70
Gel Time (minutes)	51	33
Dry Times : 23 °C (TFST) (hours)	6.0	5.5
Dry Times : 10 °C (TFST) (hours)	11	10

Part A Resin - 90:10 wt of LER:Epodil 748

Ancamide 2853 & 2865 – Flexible and Tough

Properties	Ancamide 2853	Ancamide 2865
phr for the tests	130	90
Tg by DSC (°C) (7 day cure) at 23 °C	2	2
at 10 °C	2	2
Degree of cure by DSC 7 day at 23 °C	>95%	>95%
at 10 °C	>90%	>90%
Tensile strength (psi) (ASTM D638)	2105	2530
Elongation at break (%) (ASTM D638)	186	82
Low temp flexibility (< 0 °C)	Pass	Pass
Die-C tear initiation (lb/in) (ASTM D624C)	298	419
Trouser tear propagation (lb/in) (ASTM D1938)	234	793

Part A Resin - 90:10 wt of LER:Epodil 748

Tailorable Strength and Flexibility

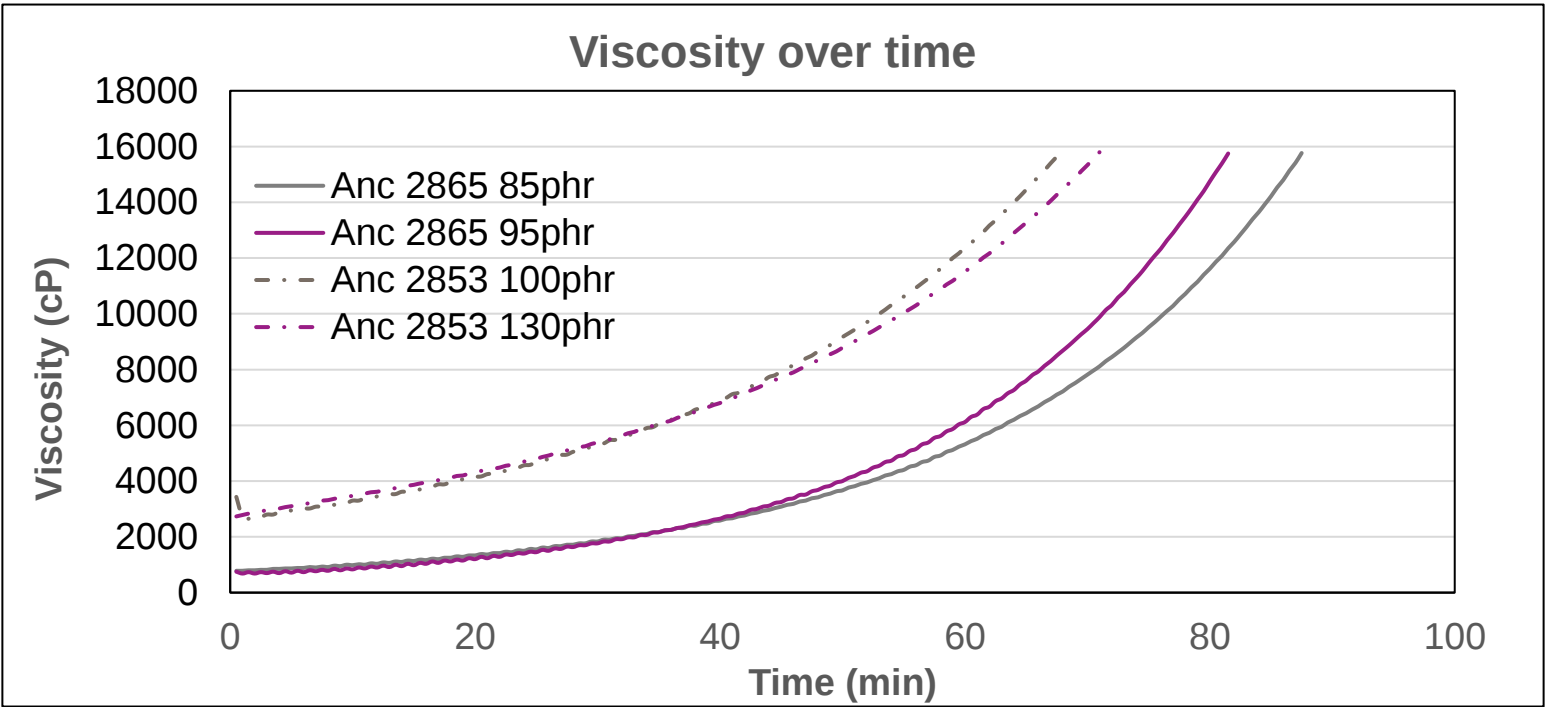
– via varying mix ratio (PHR) of resin and curing agent

Properties	Ancamide 2853 with diluted liquid resin 90/10 wt LER/Epodil 748		
PHR	130	115	100
Tensile (psi) - ASTM D638	2105	2678	3801
Elongation (%) - ASTM D638	186	98	84
Die C tear strength (lb/in) - ASTM D624C	298	Not tested	582

Properties	Ancamide 2865 with diluted liquid resin 90/10 LER/Epodil 748		
PHR	95	90	85
Tensile (psi) - ASTM D638	2139	2530	2600
Elongation (%) - ASTM D638	90	82	73
Die C tear strength (lb/in) - ASTM D624C	314	419	549
Trouser tear strength (lb/in) - ASTM D1938	644	793	Not tested

Comparable Working Time across Different Mix Ratio

	Ancamide 2853		Ancamide 2865	
phr	100	130	85	95
Gel time (min.)	48.3	51.5	33	33.6
Mix viscosity (cP)	2883	3016	850	700
Time to reach 10,000 cP (min.)	53	55	77	71



Tensile Recovery Study

Ancamide 2853



Original

50% pull

80% pull

Ancamide 2865



Original

50% pull

80% pull

ASTM D638 test



After recovery back to original size (60 °C 1h, ambient 2h)

Tensile Recovery and Temperature Effect

Tensile Recovery

	Ancamide 2853 (85phr)		Ancamide 2865 (130phr)	
	50% pull	80% pull	50% pull	80% pull
% tensile strength recovery to original	95%	85%	90%	80%
% elongation recovery to original	95%	80%	93%	80%

Temperature Effect

	Ancamide 2853 (85phr)		Ancamide 2865 (130phr)	
	50 °C for 2h	70 °C for 2h	50 °C for 2h	70 °C for 2h
% tensile strength relative to original	95%	95%	90%	95%
% elongation relative to original	95%	95%	92%	95%

ASTM D638 test, **original** sample: cure 7days at ambient

Flexibility on Display – Seeing is Believing



Original



Twist



Time to recover

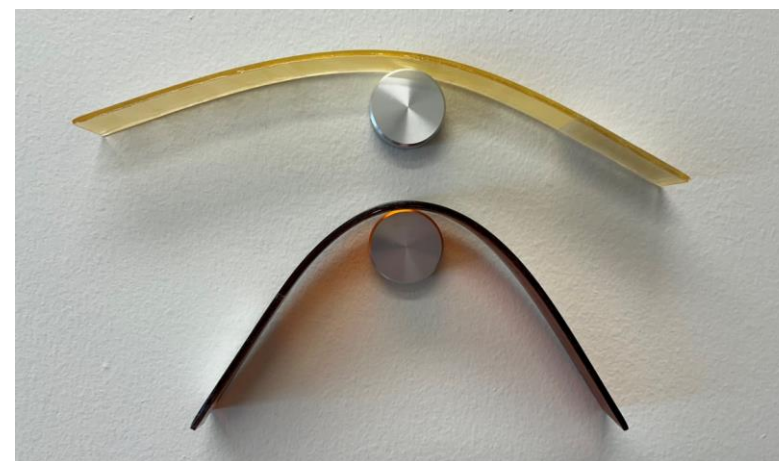
Ancamide 2853 - 7 minutes

Ancamide 2865 - 20 minutes

Hanging on vertical wall



1 minutes



6 minutes

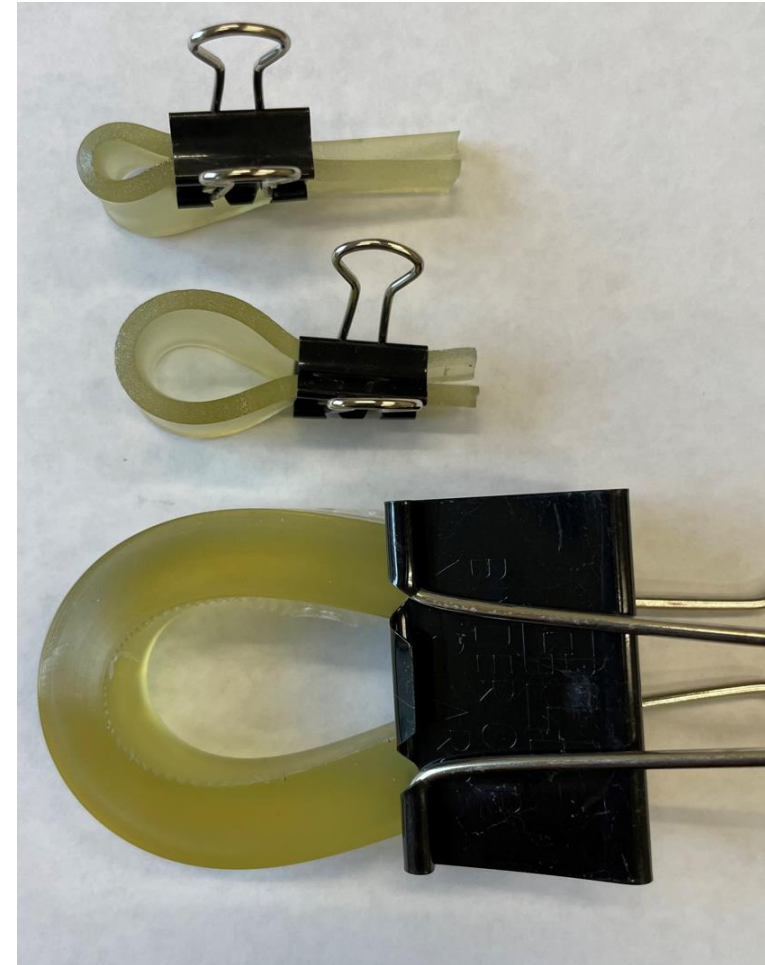
Long Term Flexibility

Ancamide 2853



2-year-old sample

Ancamide 2865



1-year-old sample

Regulatory Status and EHS Profile

Ancamide 2853

Australia AICS:	On or in compliance with the inventory
Canada DSL Inventory List:	On or in compliance with the inventory
China Inv. Existing Chemical Substances:	On or in compliance with the inventory
Japan (ENCS) List:	On or in compliance with the inventory
Korea Existing Chemicals Inv. (KECI):	On or in compliance with the inventory
New Zealand Inventory of Chemicals:	On or in compliance with the inventory
Philippines PICCS:	On or in compliance with the inventory
Taiwan Chemical Substance Inventory:	On or in compliance with the inventory
US TSCA Inventory:	On or in compliance with the inventory

Ancamide 2865

Australia AICS:	On or in compliance with the inventory
Canada DSL Inventory List:	On or in compliance with the inventory
China Inv. Existing Chemical Substances:	On or in compliance with the inventory
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Philippines PICCS:	On or in compliance with the inventory
Taiwan Chemical Substance Inventory:	On or in compliance with the inventory
US TSCA Inventory:	On or in compliance with the inventory

EHS profile

Hazard symbols and health hazards

Skin Corrosion/Irritation
Serious Eye Damage/Eye Irritation
Skin sensitizer

Category 1B
Category 1
Category 1

Acute toxicity (Oral)
Skin Corrosion/Irritation
Serious Eye Damage/Eye Irritation
Skin sensitizer

Category 4
Category 1B
Category 1
Category 1

Ancamide 2853 & 2865 Fulfil Market's Unmet Needs in 2K Flexible Epoxy

	2K Flexible polyurethanes	2K Flexible polyurea	Standard 2K Epoxy	Ancamide 2853 & 2865
EH&S Profile	Isocyanate	Isocyanate	✓✓✓	Alkylphenol free
Cure speed	✓	✓✓	✓✓✓	✓✓✓
Low temp cure	✓	✓✓	✓✓✓	✓✓✓
Flexibility/Elongation	✓✓✓	✓✓✓	xxx (<10%)	✓✓✓
Hardness	✓	✓	✓✓✓	✓✓✓
Moisture tolerance	✓	✓	✓✓✓	✓✓✓
Ability to apply thick films in one pass	✓	✓✓	✓✓✓	✓✓✓
Direct to concrete adhesion, dry and damp	✓ dry concrete only	✓ dry concrete only	✓✓✓	✓✓✓

Key Features of Ancamide 2853 & 2865

Main Features

- High elongation with fast cure speed
- Fast hardness development and high hardness
- Excellent tensile and tear strength
- Low temperature flexibility ($< 0^{\circ}\text{C}$)
- EH&S friendly (no alkyl phenols, and other CMR substances)
- Sustainable bio-based raw materials, contains bio-content 20-40%

Additional Features

- Excellent adhesion to concrete (dry and damp)
- Low VOC
- Low mix viscosity for easy handling
- Ability to apply thick films in one pass
- Used with standard liquid epoxy resin and diluent



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