

Create a Better Moisture Shield and Prevent Floor Failures



Shafiq Fazel and Shiyong Zheng
Evonik Corporation

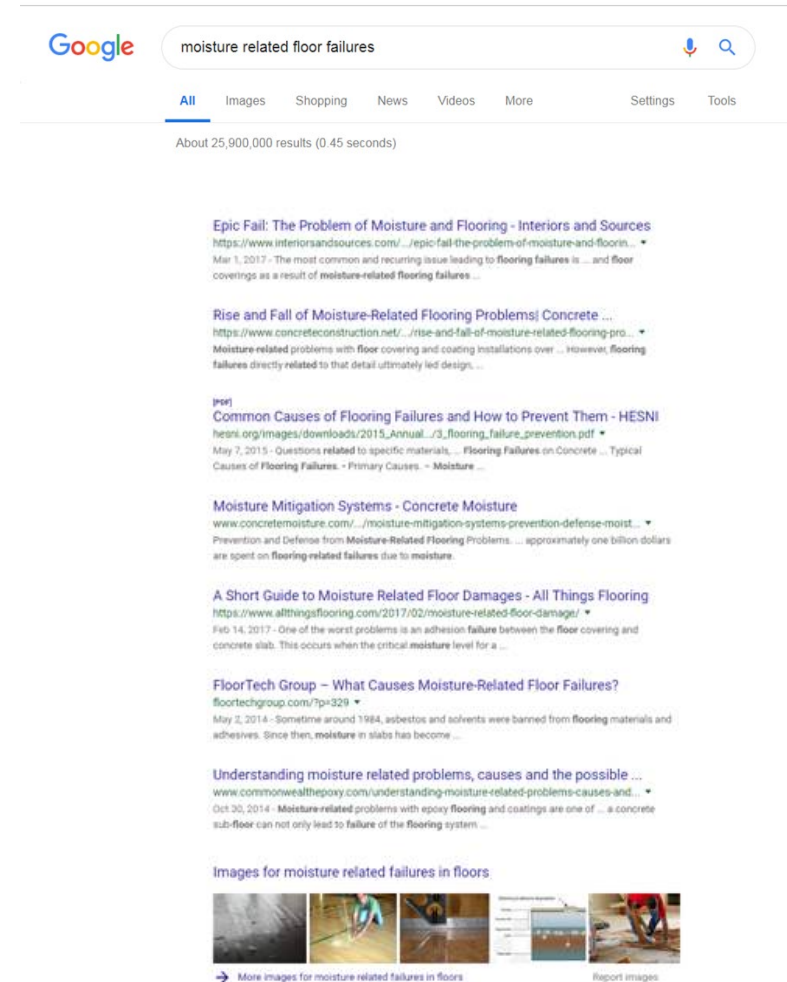
Agenda

- Moisture related floor failures
- Moisture mitigation techniques
- Why use moisture vapor barriers
- Benefits of new Innovative Curing Agents for Moisture Vapor Barrier Systems
- Performance results
- Summary

What Problem are we trying to solve?

- **Moisture related problems with floor coverings and coatings applied over concrete slabs accounts for hundreds of millions of dollars annually.**

- Floor failures
 - Blisters in coatings
 - Disbondment of tiles
 - Wet floor – safety
 - Mold/mildew growth
- Cost of failure to applicators
 - Remove and rebuild
 - Liability



The image shows a Google search interface with the query "moisture related floor failures". The search results page displays approximately 25,900,000 results in 0.45 seconds. Several search results are visible, including:

- Epic Fail: The Problem of Moisture and Flooring - Interiors and Sources** (Mar 1, 2017) - The most common and recurring issue leading to flooring failures is ... and floor coverings as a result of moisture-related flooring failures ...
- Rise and Fall of Moisture-Related Flooring Problems| Concrete ...** (https://www.concreteconstruction.net/.../rise-and-fall-of-moisture-related-flooring-pro...) - Moisture-related problems with floor covering and coating installations over ... However, flooring failures directly related to that detail ultimately led design ...
- Common Causes of Flooring Failures and How to Prevent Them - HESNI** (hesni.org/images/downloads/2015_Annual.../3_flooring_failure_prevention.pdf) - May 7, 2015 - Questions related to specific materials, ... Flooring Failures on Concrete ... Typical Causes of Flooring Failures - Primary Causes - Moisture ...
- Moisture Mitigation Systems - Concrete Moisture** (www.concretemoisture.com/.../moisture-mitigation-systems-prevention-defense-moist...) - Prevention and Defense from Moisture-Related Flooring Problems ... approximately one billion dollars are spent on flooring related failures due to moisture.
- A Short Guide to Moisture Related Floor Damages - All Things Flooring** (https://www.allthingsflooring.com/2017/02/moisture-related-floor-damage/) - Feb 14, 2017 - One of the worst problems is an adhesion failure between the floor covering and concrete slab. This occurs when the critical moisture level for a ...
- FloorTech Group – What Causes Moisture-Related Floor Failures?** (floortechgroup.com/?p=329) - May 2, 2014 - Sometime around 1984, asbestos and solvents were banned from flooring materials and adhesives. Since then, moisture in slabs has become ...
- Understanding moisture related problems, causes and the possible ...** (www.commonwealthpoxy.com/understanding-moisture-related-problems-causes-and...) - Oct 30, 2014 - Moisture-related problems with epoxy flooring and coatings are one of ... a concrete sub-floor can not only lead to failure of the flooring system ...

At the bottom, there is a section for "Images for moisture related failures in floors" with a grid of images and a "Report images" link.

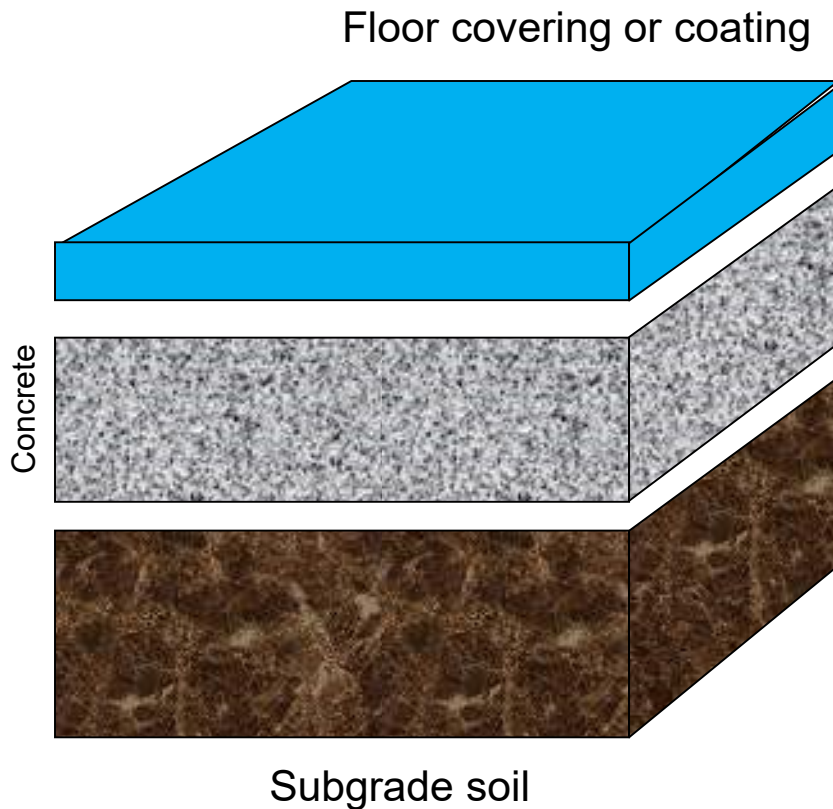
Concrete and Moisture

- Moisture Source

- Ground/soil
- Concrete

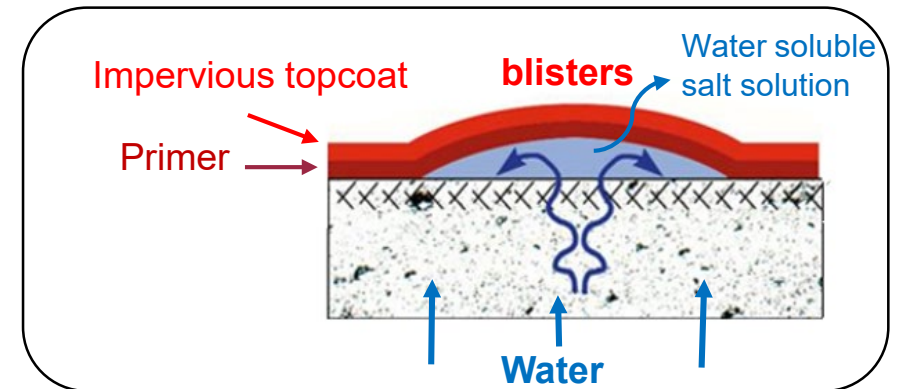
- Concrete composition

- Air / Porosity ~1-7%
- Water ~ 12 -16%
- Cement ~ 10-15%
- Fine Aggregate
- Sand ~ 30-80%
- Coarse Aggregate
- Stone ~ 0-50%



- Moisture vapor drivers

- **Hydrostatic Pressure** = Upward water pressure when concrete is placed below ground (water) level
- **Osmotic cell** = A pressure-build generated by concentration gradient over membrane
- Required for osmotic cell:
 - Water pressure (capillary osmosis)
 - Semi-permeable membrane (concrete)
 - Soluble component(s) (salts)



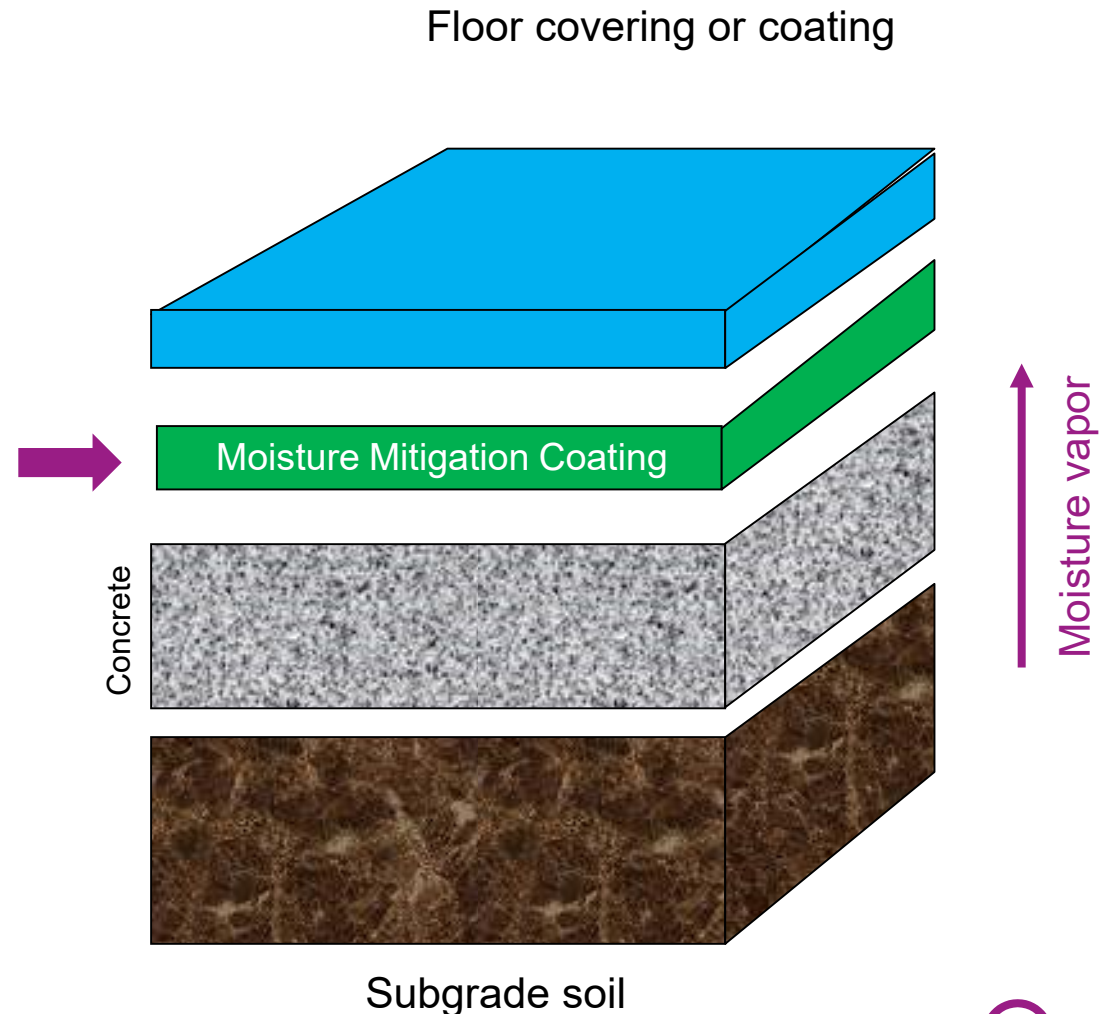
Moisture Mitigation Technique

▪ Moisture Vapor Permeable (“Breathable”)

- Allows moisture vapor from concrete/ground soil to diffuse through
- Very good technique for concrete with high potential of osmotic pressure
- Subsequent layers (coating & floor covering) need to be “breathable” to avoid failures

▪ Moisture Vapor Barrier (“Blocking”)

- Restricts moisture vapor from concrete and/or ground soil to diffuse through
- Very good technique when subsequent layers are non-breathable (applies to most flooring systems)
 - Seamless Flooring (ex. Broadcast, Terrazzo etc.)
 - Floor coverings (ex. Tiles, Carpet, Laminate etc.)



Moisture Vapor Barrier Definitions

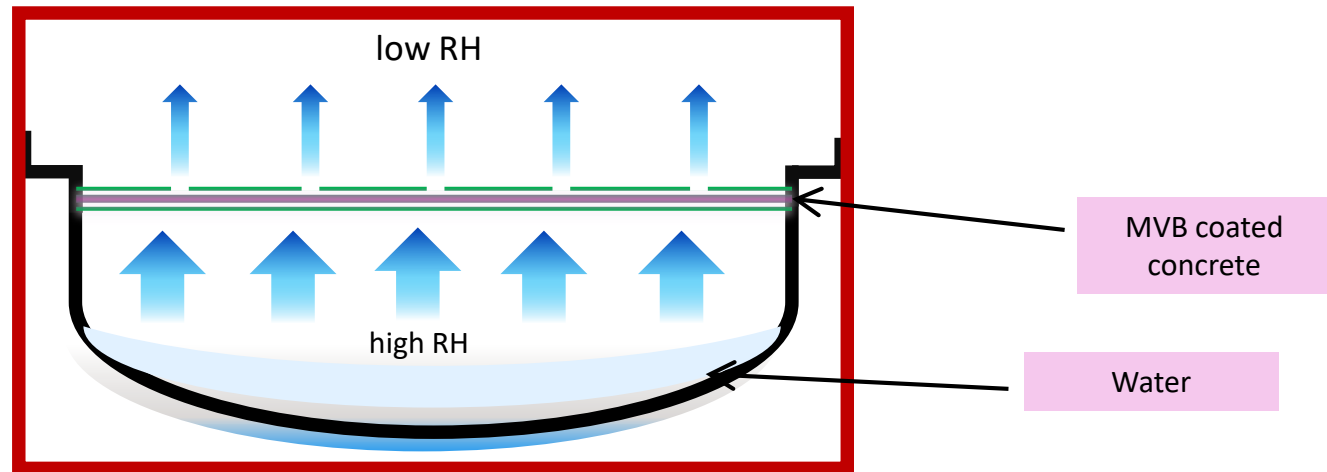
- A standard practice established in 2013 for two-component resin based membrane-forming **moisture mitigation systems** for use under resilient floor coverings (ASTM F3010)
 - Outlines performance and application of liquid applied moisture vapor reduction systems under floor coverings
 - The ability of a material to suppress the diffusion of moisture vapor is measured in units known as "perms" or permeability
 - Specifies moisture vapor permeance of ≤ 0.1 perms (**ASTM E-96 - 13**)
 - The International residential code - **Class I moisture vapor retarder** : <0.1 perms ($\text{grains} \cdot \text{h}^{-1} \cdot \text{ft}^{-2} \cdot \text{inHg}^{-1}$)

Moisture vapor transmission

$$\text{MVT} = \Delta\text{Mass} / (\Delta\text{time} \times \text{surface area of sample})$$

Moisture vapor permeance

$$\text{MVP} = \text{MVT} / \text{vapor pressure differential across sample}$$



Wet Cup Method

Market Trends Drive New Product Innovations



Better products: Enhanced performance

- Improved adhesion
- Better mechanical property
- Improved chemical resistance
- Enhanced UV- resistance
- Improved color stability



Improved productivity: Fast turn-around time

- Fast cure at low temperature
- Wider application window
- Reduced downtime
- Simplified handling/application
- Less surface preparation
- Simplified maintenance



Eco-friendly: Environmentally and user friendly

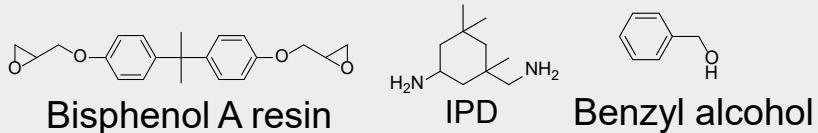
- Low or plasticizer free
- Low VOC, low emission
- Improved worker safety
- “green” or sustainable products

New Innovative Curing Agent Development for Epoxy Coatings

Thermoset Epoxy Coatings = Epoxy Resin (Part A) + Curing Agent or Hardener (Part B)

Current Technology

- Diamine (adducted) + Plasticizer



- **Advantages**

- Complete conversion of epoxy/amine reaction
- Increase compatibility

- **Disadvantages**

- Emission of benzyl alcohol/other plasticizers
- Increased moisture vapor transmission



New Technology

- Proprietary Diamine
 - Internally plasticized
 - Requires low to no plasticizers

- **Advantages**

- Retains advantages of current technology
- Low emissions
- Improved moisture vapor barrier

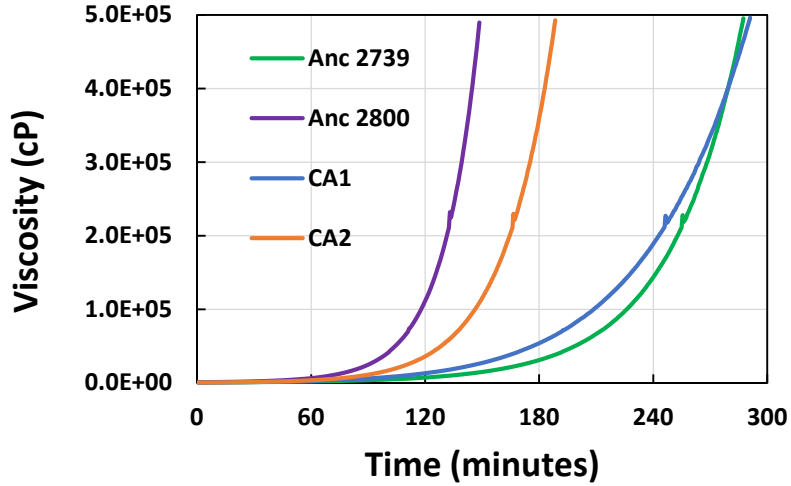
New Curing Agents Based on Internal Plasticized Technology

- **Ancamine® 2739** and **Ancamine® 2800**: solvent free epoxy curing agent based on **built-in, internal plasticized, non-emissive** technology
 - **Features:** low emission, high conversion, tailored cure speed, excellent moisture vapor barrier
 - **Benefits:** emission compliant, fast turn-around time, and cost effective
- CA1 and CA2: benchmark curing agents having ~40% benzyl alcohol, high degree of conversion
 - CA1 for ambient cure
 - CA2 for cure down to 10C

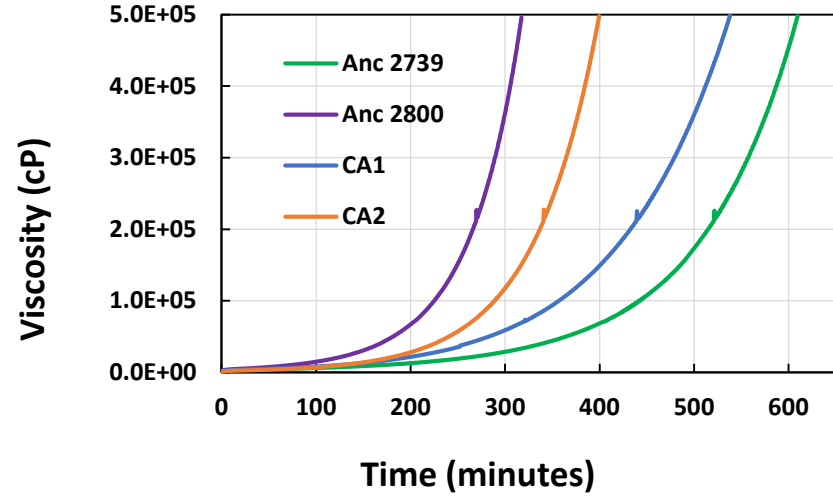
	Ancamine® 2739	Ancamine® 2800	CA1	CA2
AHEW/{H}	95	84	115	95
Gel Time (minutes)	71	35	80	30
Viscosity (cPs)	350	400	400	190
Mix Viscosity (cPs)	669	775	668	450
Thin film set time (h) (BK phase 3)				
23 °C	9.5	5.4	11	7.5
10 °C	17.5	10.8	20	16

Anc 2739 and Anc 2800— Tailored Speed of Property Development

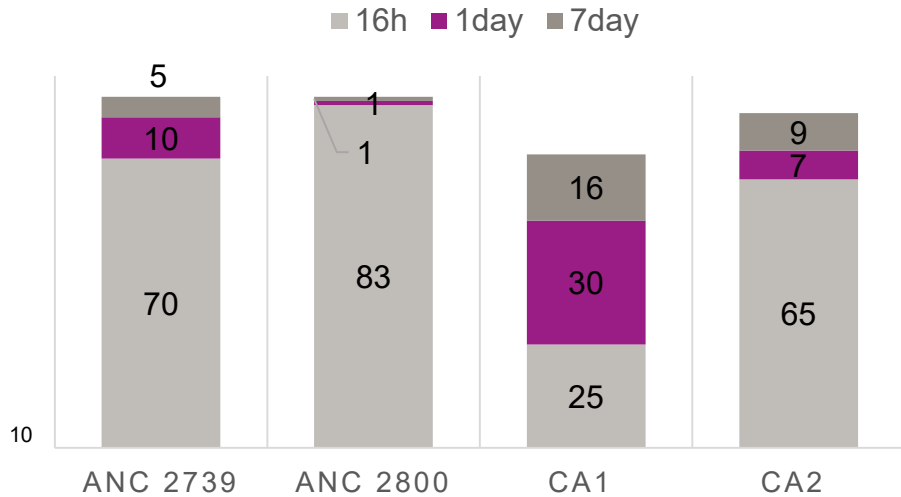
Viscosity build at 23C



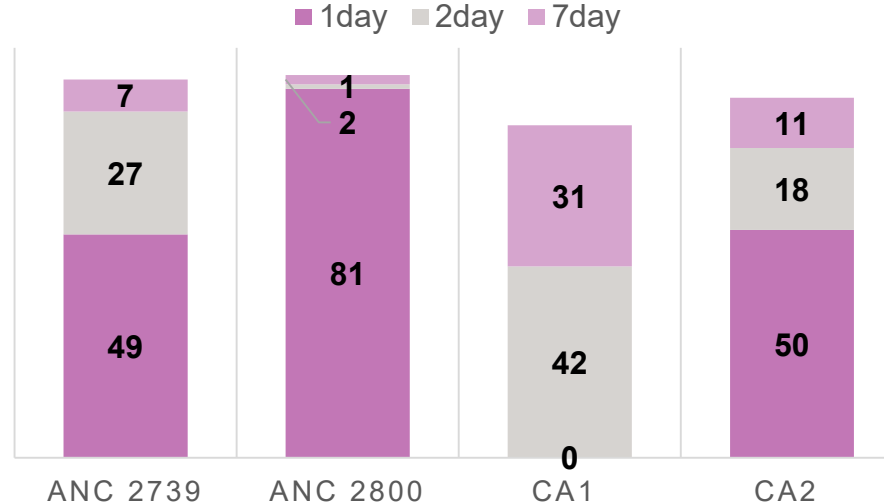
Viscosity build at 10C



Shore D hardness build at 23C



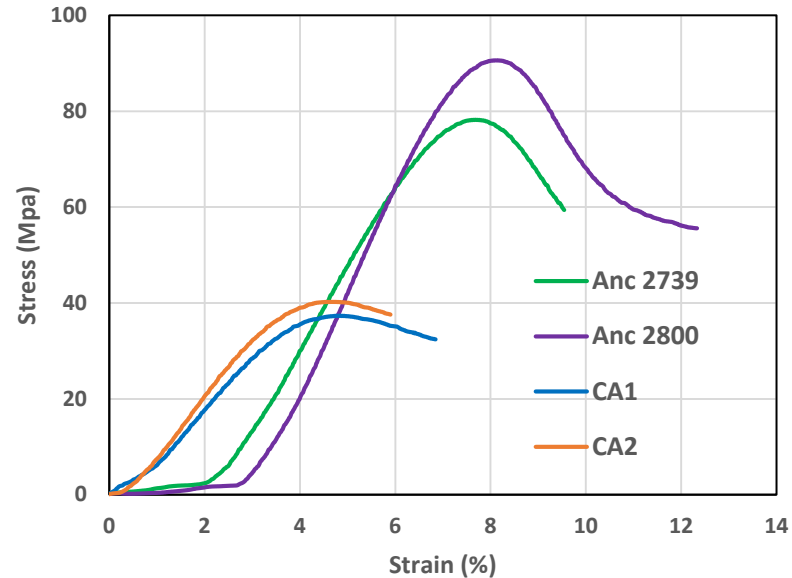
Shore D hardness build at 10C



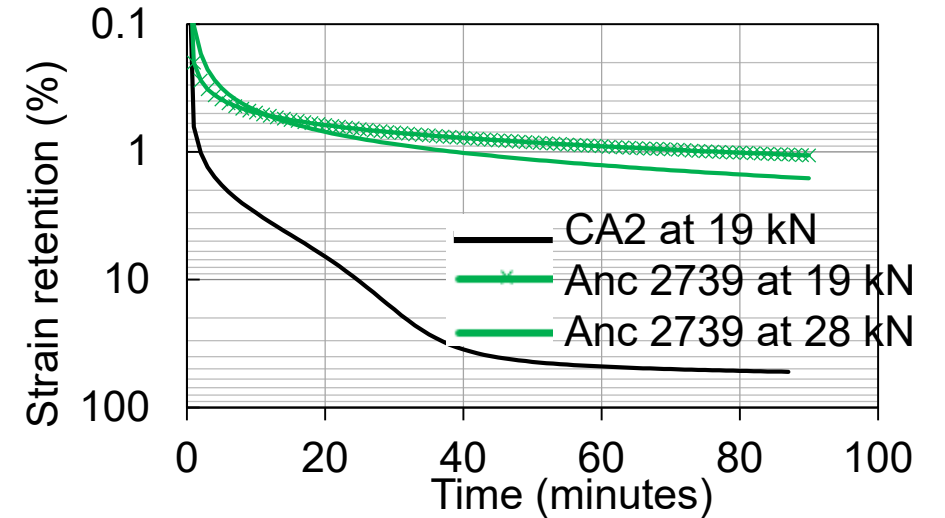
Anc 2739 and Anc 2800 Possess Excellent Mechanical Properties

— High Compressive Strength and Excellent Creep Resistance

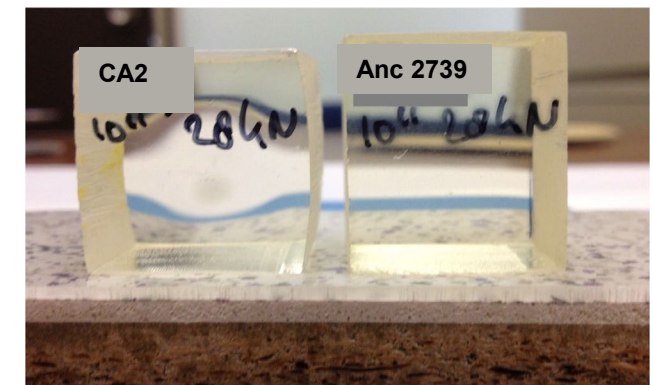
High compressive strength and elongation%



Excellent creep resistance



Curing agents	Anc 2739	Anc 2800	CA1	CA2
Compressive strength (MPa)	78	90	37	40
Compressive modulus (GPa)	2.1	2.3	1.1	1.3
Strain (%)	7.7	8.0	4.8	4.6



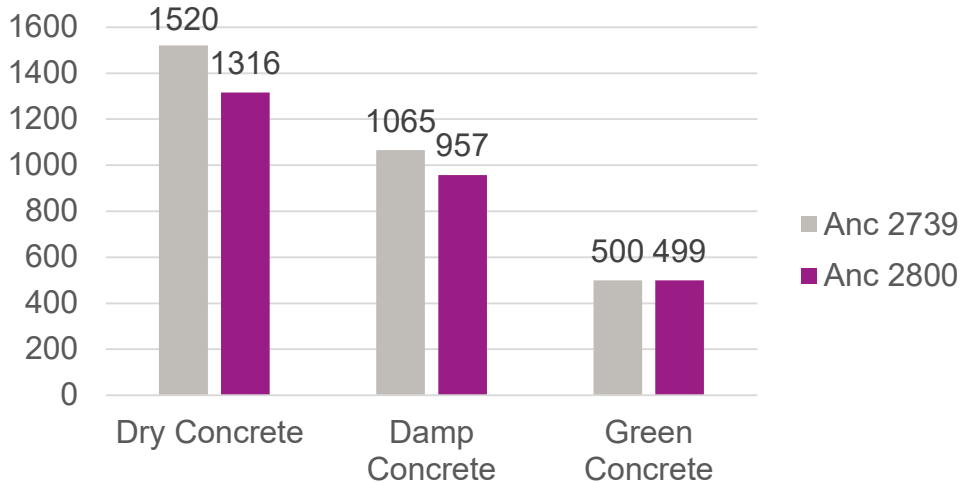
ASTM D695, clear castings, cured with bisphenol A/F resin/ Epodil 748, EEW195, η 900 cPs.

Anc 2739 and Anc 2800 Starting Point Formulation and Basic Properties

Part A		Anc 2739	Anc 2800
Epoxy resin	BisA resin	80.0	80.0
Reactive Diluent	Epodil 748	10.0	10.0
Reactive Diluent	Epodi 749	10.0	10.0
Air Release (optional)	Silicone polymer	0.3	0.3
Part B			
Curing Agent		50	44
Total parts		155	144
Technical data			
Mix ratio A/B	By wt.	2/1	70/30
	By vol.	1.91	2.16
Mixture density (lbs/gal)		9.4	9.4
Mix viscosity (cP)		594	500
Gel time (minutes)		85	41

Anc 2739 and Anc 2800 Show Excellent Adhesion to Dry, Damp and Green Concrete

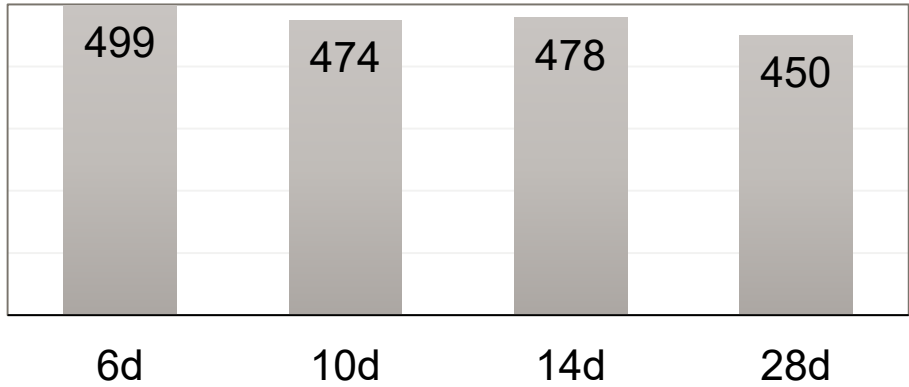
Adhesion to concrete (psi)*



*** ASTM D7234 – All are bulk concrete failures**



Anc 2800: Adhesion to green concrete (psi)*



Concrete surface profile (International Concrete Repair Institute) – CSP3

Excellent Carbamation Resistance and Intercoat Adhesion

Carbamation resistance

	Anc 2739	CA1
1d/2d/7d at 23C	5/5/5	4/4/4
1d/2d/7d at 10C	3/4/5	3/4/4/



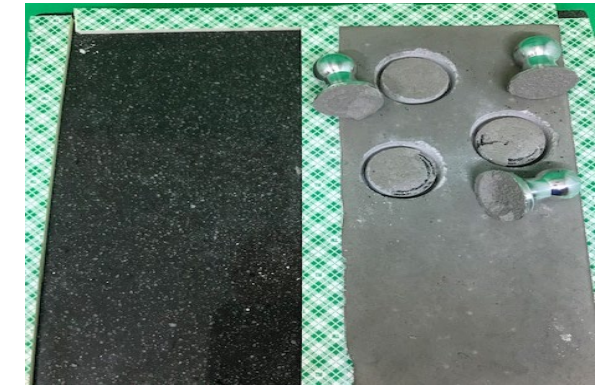
Carbamation resistance following wet patch method (ISO 2812), Scale 1-5 (5=best)

Intercoat adhesion

Primer	Anc 2739	Anc 2800
Topcoat: aliphatic polyurea¹		
Topcoated at 4 hrs	MVB not cured	5A
Topcoated at 24 hrs	5A	5A
Topcoat: Cementitious Overlay²		
Topcoated at 6 hrs	MVB not cured	299 psi
Topcoated at 24 hrs	261 psi	314 psi

¹ASTM D3359: 5A/Best (no peeling or removal of coating), 1A/Worst (complete removal coating);

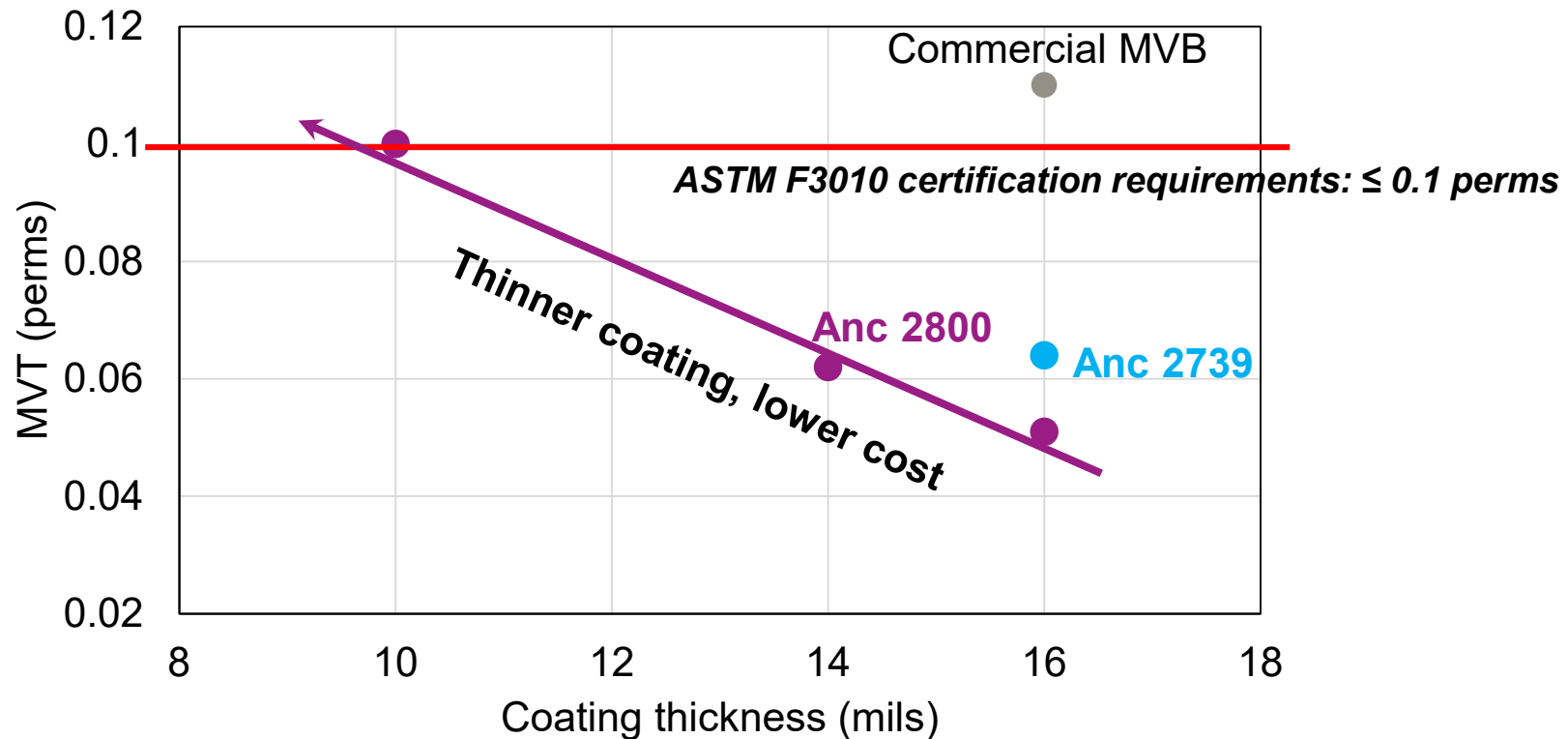
²ASTM D7234, All samples show overlay cohesive failure.



Anc 2739 Cementitious overlay on Anc 2739

Faster Turn-Around Time, and Cost Effective

- Both Anc 2739 and Anc 2800 show excellent moisture barrier property as thin coating
- Anc 2800 can be applied 30-35% less to meet ≤ 0.1 perms rating – significant cost-in-use savings



Testing done by independent lab for moisture vapor transmission (MVT), ASTM E-96

Anc 2739 and Anc 2800 are Excellent Moisture Vapor Barrier Choices

- Excellent moisture vapor barrier under seamless thermoset flooring systems (e.g. epoxy terrazzo, epoxy/polyurea broadcast) and floor coverings (e.g. tile, vinyl, laminate, hardwood etc.)

Game changing curing agents

- High performance
- Environmental friendly
- Cost effective

Ancamine 2739

- Low viscosity
- Carbamation resistance
- Long pot-life
- Very low emissions
- Excellent adhesion to concrete
- LEED V4. Compliant

Faster



Ancamine 2800

- Lower film thickness
- Faster drying time
- Good pot-life
- Very low emissions
- Excellent adhesion to concrete

QUESTIONS?



EVONIK

POWER TO CREATE