Product information

ANCAREZ® 2364

Epoxy Flexibilizer

DESCRIPTION

Ancarez 2364 flexibilizer is a moderate viscosity acrylatefunctional urethane resin. It is stable over long periods of time when mixed with epoxy resin and completely reacted when cured with amine curing agents.

TYPICAL PROPERTIES

Property	Value	Unit	Method
Non Volatile Matter	Clear Liquid		
Colour	< 2	Gardner	ASTM D 1544-80
% Solids	100		
Viscosity @ 77°F	12,500-40,000	cP	Brookfield LVT, Spindle #4 at 6 rpm
Primary Functional Reactive Group	Acrylate Double Bond		
Equivalent Wt	470		
Specific Gravity @ 77°F	1.10		

ADVANTAGES

- High tear resistance, tensile strength, elongation and hardness
- Excellent low temperature performance
- Good moisture resistance
- Can be formulated to a wide range of performance properties

APPLICATIONS

The Ancarez 2364 flexibilizer use level can be varied to meet flexibility and toughness requirements in many applications. The product's moderate viscosity and epoxy compatibility make it especially useful in coatings and civil Engineering applications such as resilient flooring, crack bridging, Bridge decks and secondary containment membranes.

SHELF LIFE

At least 12 months from the date of manufacture in the original sealed container at ambient temperatures. Store away from excessive heat and humidity in tightly closed containers.

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STORAGE AND HANDLING

Refer to the Material Safety Data Sheet for Ancarez 2364 epoxy flexibilizer.

TYPICAL CURE SCHEDULE

5-7 days at ambient conditions.

USE LEVELS

Ancarez 2364 flexibilizer is combined with the epoxy resin on the “A” side of the formulation. At low use levels, Ancarez 2364 flexibilizer can be used to modify epoxy formulations for very tough, resilient systems with high hardness. High levels of Ancarez 2364 flexibilizer give high elongation systems with lower modulus. Effective use levels range from 15% to 80% of the resin side of the formulation.

FORMULATING GUIDELINES

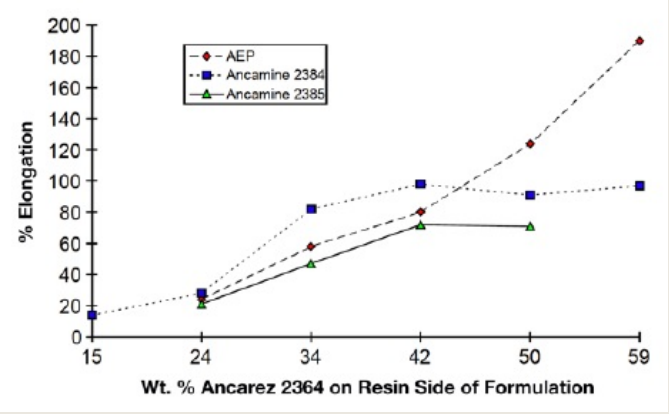
Basic guidelines to formulate with Ancarez 2364 flexibilizer:

Resin “A” Side:
Ancarez 2364
Diluent
Epoxy resin

Hardener “B” Side:
Low functionality amine curing Agent

Formulation flexibility will increase with higher levels of Ancarez 2364 flexibilizer. Tensile elongation values of greater than 160% can be achieved using Ancarez 2364 flexibilizer at 75% of the resin side of the package. Figure 1 shows the effect of flexibilizer level on elongation for selected curing agents after a seven day ambient cure.

FIGURE 1: EFFECT ON TENSILE ELONGATION OF ANCAREZ 2364 FLEXIBILIZER IN FORMULATIONS* WITH SELECTED CURING AGENTS



* Formulation contains standard bisphenol A-based epoxy resin (190 EEW) and 16.7 wt.% EPODIL 748 on resin side
Note: Figure 1 Formulations are found in Appendix I.

High elongation may also be achieved using low use levels of Ancarez 2364 and proper selection of the remaining formulation components. Ancarez 2364 flexibilizer can be used with a wide variety of epoxy resins, diluents, plasticizers and curing agents. Each one of these formulation components will influence the flexibilizing effect of Ancarez 2364, so it is important to understand the influence each has on the final mechanical properties.

EFFECT OF REACTIVE DILUENTS

A reactive diluent must be used with Ancarez 2364 flexibilizer to achieve maximum tensile elongation. Reactive diluents reduce the formulation viscosity, and both monofunctional (Epodil 748) and difunctional (Epodil 749) diluents can be used effectively in this regard. However, monofunctional reactive diluents are the most effective in maximizing the elongation of formulations. The single reactive site on the diluent helps to control crosslinking, allowing the cured epoxy formulation to yield rather than fracture under load. Effective use levels of monofunctional diluents range from 10% to 20% by weight of the resin side. When using monofunctional diluent levels beyond 25 weight percent of the resin side, however, the formulation loses integrity and becomes cheesy.

The most effective of the monofunctional epoxy diluents is Epodil 748 diluent. Its long aliphatic chain (C12 - C14) also contributes to the flexibility of the cured epoxy. Acrylate functional monomers such as lauryl acrylate and 2-ethylhexyl acrylate can also be used effectively with Ancarez 2364 flexibilizer to increase elongation. The following table Shows the effect of different monofunctional diluents on the 72°F tensile properties after an ambient cure (77°F) for seven days.

TABLE 2: EFFECT OF MONOFUNCTIONAL DILUENTS ON PHYSICAL PROPERTIES

Formulation*	1	2	3
RESIN SIDE (Parts by Weight)			
Bisphenol A-based Epoxy Resin (EEW=190)	47.62	47.62	47.62
Epodil 748 Diluent	16.67	—	—
2-Ethylhexyl Acrylate	—	16.67	—
Lauryl Acrylate	—	—	16.67
Ancarez 2364	35.72	35.72	35.72
HARDENER SIDE (Parts by Weight)			
AEP	16.50	17.92	17.00
Tensile Properties (ASTM D 638-86)			
Strength, psi	3,583	2,700	3,600
Modulus, psi	78,640	158,100	116,800
Elongation, %	58	88	102

* Samples were cured for 7 days at 77°F before testing

EFFECT OF EPOXY RESIN

Ancarez 2364 flexibilizer is most effectively used with low functionality resins such as those based on Bisphenol A and Bisphenol F. High functionality resins such as epoxy novolacs tend to reduce flexibility and elongation.

CURING AGENT SELECTION

Curing agents based on cycloaliphatic amines and low functionality aliphatic amines are the most effective in maximizing flexibility and elongation in formulations containing Ancarez 2364 flexibilizer. Curing agents based on aromatic amines, polyamides, amidoamines and higher ethyleneamines show either poor compatibility or poor elongation in formulations using Ancarez 2364 flexibilizer.

Amine curing agents typically have four or more reactive sites per molecule. To maximize the flexibility of the formulation, the curing agent side should have an average amine functionality of less than four. Amine mixtures with an average number of functional groups less than 4 have been found to be very effective in producing formulations with >100 % elongation.

The following are some curing agents with an average functionality of less than four: Ancamine 2384, 2385, 2390, 1767, 1768, and AEP curing agents. Ancamine 2384 and Ancamine 2385 curing agents have been specifically formulated for use with Ancarez 2364 to give high elongation, tensile strength, tear strength and hardness with fast thin film set and blush resistance. Ancamine 2390 curing agent has been developed to give a flexible formulation in a 1:1 mix ratio with or without the use of Ancarez 2364 flexibilizer.

EFFECT OF PLASTICIZERS

Ancarez 2364 flexibilizer has been designed to give high strength and modulus as well as high elongation. Some applications, however, may require a high elongation with lower modulus. Plasticizers used in moderate amounts (10% to 20% by weight of binder formulation) effectively lower the stiffness and strength of the formulation without adversely effecting the elongation.

The formulating guidelines summarized in Table 3 show how increasing values or levels of each component impact tensile properties.

TABLE 3: TENSILE PROPERTY TRENDS IN FORMULATING WITH ANCAREZ 2364

Component	1	2	3
Ancarez 2364	⇑	⇓	⇓
Reactive Diluent	⇑	⇓	⇓
Functionality	⇓	⇑	⇑
Plasticizer	⇔	⇓	⇓

HIGH FILM BUILD

Applications which require either high film build or sag resistance may be formulated using hydrophobic fumed silica such as Cab-O-Sil TS-720 or Aerosil R204 fumed silica at 0.1% to 1.5% by weight of binder formulation.

STARTING POINT FORMULATIONS

The amount of flexibility needed will be determined by the application. The following starting point formulations are presented in three sections based on possible elongation requirements for specific applications:

- **100% and Greater** — Secondary containment membranes, crack bridging, bridge decks
- **50% to 100%** — Construction joint sealants and potting compounds
- **30% to 50%** — Tough flooring, flexible coatings

The following formulations show the versatility of Ancarez 2364 flexibilizer and some of the various curing agents with which it can be formulated. All starting point formulations use standard bisphenol A-based epoxy resin and Epodil 748 diluent. Typically, the system can be formulated with Ancarez 2364 flexibilizer to give between a 2:1 and a 4:1 mix ratio, and Ancamine 2390 curing agent can be used to obtain a 1:1 mix ratio.

100% AND GREATER ELONGATION

(Suitable for secondary containment, bridge decks or crack bridging.)

TABLE 4: 100% AND GREATER ELONGATION

Formulation*	4	5	6	7	8	9
RESIN SIDE (Parts by Weight)						
Bisphenol A-based Epoxy Resin (EEW=190)	33.30	33.30	47.62	35.72	47.62	47.62
Epodil 748	16.67	24.00	16.67	16.67	16.67	16.67
Ancarez 2364	50.00	42.70	35.72	47.62	35.72	35.72
HARDENER SIDE (Parts by Weight)						
Ancamine 2384	28.87	—	—	—	—	—
Ancamine 2385	—	32.85	—	—	—	—
Ancamine 1768	—	—	36.53	32.98	—	23.91
Ancamine 1767	—	—	—	—	69.21	23.91
HANDLING PROPERTIES						
Formulation Mix Viscosity,[1] cP	2,960	1,730	960	1,276	1,700	1,088
Gel Time,[3] min (150 g mass)	83	45	15	18	12	12
Thin Film Set Time,[4] h, 75°F/50% RH	13.0	12.0	6.0	6.5	4.5	5.0
PHYSICAL PROPERTIES						
Shore D[5]	60	55	60	51	38	55
Tensile[2]						
Strength, psi	1,600	1,500	1,560	1,553	777	1,498
Modulus, psi	23,000	17,150	45,140	26,960	1,304	19,720
Elongation, %	100	96	93	118	104	99

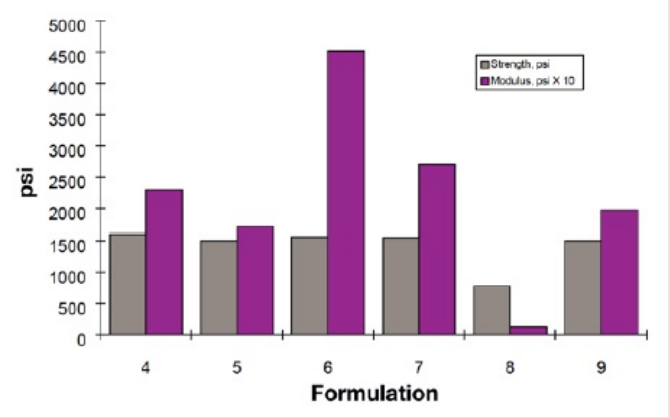
* Samples were cured for 7 days at 77°F before testing

Formulations 4 and 5 offer long pot life with excellent blush resistance at ambient cures. Their combination of hardness, tear strength, tensile strength, modulus and elongation make them good candidates for containment membrane applications.

The mix viscosities of Formulations 6 through 9 allow high filler loading such as that used in some decking applications, while reactivity is suitable for applications requiring rapid turnaround. These formulations also demonstrate how strength, modulus and Shore hardness can be modified without significantly affecting elongation by using the proper selection of Ancamine 1767 and/or Ancamine 1768 curing agents. Using a higher percentage of Ancamine 1767 curing agent will result in a lower modulus.

Tensile properties for this series of formulations are shown in Figure 2.

FIGURE 2: TENSILE PROPERTIES FOR 100 % ELONGATION FORMULATIONS



50% TO 100% ELONGATION

(Suitable for joint sealants and potting compounds.)

TABLE 5: 50% TO 100% ELONGATION

Formulation*	10	11	12	13	14	15
RESIN SIDE (Parts by Weight)						
Bisphenol A-based Epoxy Resin (EEW=190)	80.00	100.00	47.62	50.00	41.70	59.52
Epodil 748	20.00	—	16.67	16.67	16.67	16.67
Ancarez 2364	—	—	35.72	33.30	41.60	23.8
HARDENER SIDE (Parts by Weight)						
AEP	—	—	16.53	—	—	—
Ancamine 1768	—	—	—	—	—	19.04
Ancamine 2384	—	—	—	33.32	—	—
Ancamine 2385	—	—	—	—	34.40	—
Ancamine 1784	—	—	—	—	—	19.04
Ancamine 2390	100.00	107.37	—	—	—	—
HANDLING PROPERTIES						
Formulation Mix Viscosity,[1] cP	1,080	1,908	550	800	2,960	568
Gel Time,[3] min (150 g mass)	30	19	40	35	28	32
Thin Film Set Time,[4] h, 75°F/50% RH	7.0	4.0	15.0	11.5	7.5	11.0
PHYSICAL PROPERTIES						
Shore D[5]	55	70	68	70	65	67
Tensile[2]						
Strength, psi	1,530	3,236	3,583	2,200	2,577	1,543
Modulus, psi	33,800	120,563	78,640	65,820	82,160	39,810
Elongation, %	55	54	58	82	72	63

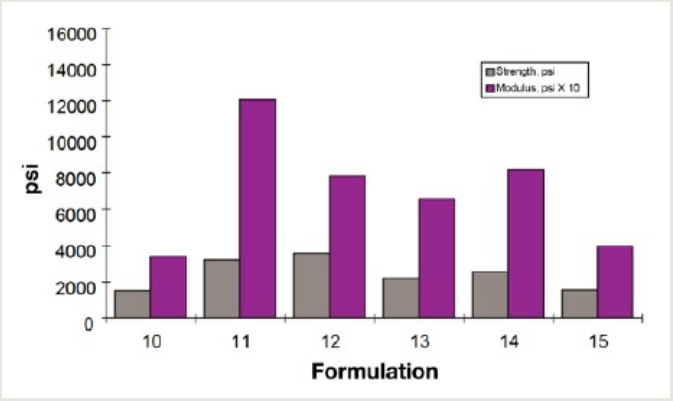
* Samples were cured for 7 days at 77°F before testing

Formulations 10 and 11 use Ancamine 2390 curing agent, a highly flexible curing agent designed to give 1:1 mix ratios when used with standard liquid epoxy resins. As shown in the table, this curing agent can give excellent elongation on ist own. Low viscosity in Formulation 10 is achieved by using Epodil 748 epoxy diluent. Formulation 11 shows that without diluent, Ancamine 2390 curing agent gives a strength and modulus increase of two to three times while maintaining an elongation of greater than 50%. Formulation 11 shows an opaque appearance on cure.

Formulations 12 through 15 utilize Ancarez 2364 flexibilizer for flexibility. These systems offer good working times and some of the lowest formulation viscosities (less than 600 cP) by selecting low viscosity curing agents such as Ancamine 1784 curing agent or aminoethylpiperazine (AEP).

Tensile properties for this series of formulations are shown in Figure 3.

FIGURE 3: TENSILE PROPERTIES FOR 50 % TO 100 % ELONGATION FORMULATIONS



30% TO 100% ELONGATION

Formulations in Table 6 compare unfilled formulations recommended for flooring or coatings with flexibilized versions of the formulations.

TABLE 6: 30% TO 50% ELONGATION

Formulation*	10	11	12	13	14	15
RESIN SIDE (Parts by Weight)						
Bisphenol A-based Epoxy Resin (EEW=190)	80.00	100.00	47.62	50.00	41.70	59.52
Epodil 748	20.00	—	16.67	16.67	16.67	16.67
Ancarez 2364	—	—	35.72	33.30	41.60	23.8
HARDENER SIDE (Parts by Weight)						
AEP	—	—	16.53	—	—	—
Ancamine 1768	—	—	—	—	—	19.04
Ancamine 2384	—	—	—	33.32	—	—
Ancamine 2385	—	—	—	—	34.40	—
Ancamine 1784	—	—	—	—	—	19.04
Ancamine 2390	100.00	107.37	—	—	—	—
HANDLING PROPERTIES						
Formulation Mix Viscosity,[1] cP	1,080	1,908	550	800	2,960	568
Gel Time,[3] min (150 g mass)	30	19	40	35	28	32
Thin Film Set Time,[4] h, 75°F/50% RH	7.0	4.0	15.0	11.5	7.5	11.0
PHYSICAL PROPERTIES						
Shore D[5]	55	70	68	70	65	67
Tensile[2]						
Strength, psi	1,530	3,236	3,583	2,200	2,577	1,543
Modulus, psi	33,800	120,563	78,640	65,820	82,160	39,810
Elongation, %	55	54	58	82	72	63

* Samples were cured for 7 days at 77°F before testing

As an example, formulations 16 and 16A are both cured with Ancamine 2143 curing agent. A moderate amount of Ancarez 2364 flexibilizer (25% of the resin side) and additional Epodil 748 diluent are added in formulation 16 and the result is an increase in elongation from 6% to 36% accompanied by a corresponding decrease in strength and modulus. Intermediate strength and modulus values can be achieved by adjusting the levels of Ancarez 2364 flexibilizer and Epodil 748 diluent between the levels used in formulations 16 and 16A.

These same guidelines may be followed for the formulations cured with Ancamine 1618 and Ancamine 2280 curing agents (formulations 17 through 18A).

Physical properties for this series of formulations are found in Figures 4 and 5.

FIGURE 4: FLEXIBILIZING STANDARD FLOORING FORMULATIONS

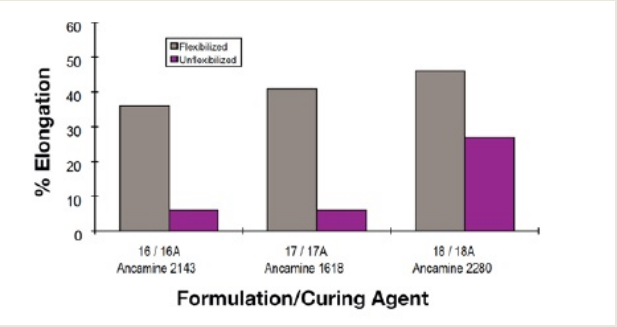
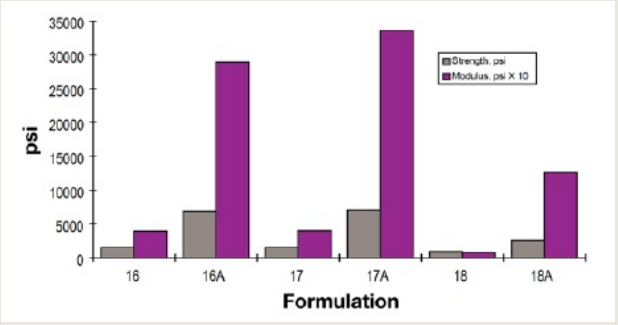


FIGURE 5: FLEXIBILIZING STANDARD FLOORING FORMULATIONS TARGETING 30 % TO 50 % ELONGATION



These formulations were also tested for their performance as coatings. Table 7 gives film properties of Formulations 16 through 18A. The flexibilized formulations show good film formation and gloss with significant improvement in impact resistance.

TABLE 7: FLEXIBILIZED COATINGS

Formulation*	16	16A	17	17A	18	18A
Curing Agent	ANCAMINE 2143		ANCAMINE 1618		ANCAMINE 2280	
Ancarez 2364	Yes	No	Yes	No	Yes	No
HANDLING PROPERTIES						
Formulation Mix Viscosity,[1] cP	1,080	1,908	550	800	2,960	568
Gel Time,[3] min (150 g mass)	30	19	40	35	28	32
Thin Film Set Time,[4] h, 75°F/50% RH	7.0	4.0	15.0	11.5	7.5	11.0
COATING PROPERTIES						
Film Thickness, mil	9-11	9-11	9-12	9-12	9-10	9-10
Gloss[7]						
20°	120	118	104	114	117	120
60°	137	133	143	132	131	137
Impact Resistance,[8] forward, in-lb	> 160	70	160	70	160	110

* Samples were cured for 7 days at 77°F before testing

ADDITIONAL PERFORMANCE DATA

ADHESION TO CONCRETE:Formulations used in civil engineering applications require adhesion to concrete mortar. Ancarez 2364 flexibilizer formulations exhibit good adhesion to concrete under ambient and low temperature cure conditions. Unfilled flexibilized formulations were tested at room temperature for adhesion to damp concrete after curing for seven days at both 72°F and 40°F. Results of the dolly pull-off test (ASTM 4541), including adhesive strength and mode of failure, are shown in Table 8. Formulations 4 and 5 (from Table 34) give excellent adhesion with room temperature cure and good results with low temperature cure.

TABLE 8: BOND STRENGTH** RESULTS FOR FLEXIBILIZED FORMULATIONS

Cured Over Damp Concrete for Seven Days at Indicated Temperature

Formulation*	**14**		**15**	
RESIN SIDE (Parts by Weight)				
Epoxy Resin (EEW=190)	33.3		33.3	
Epodil 748 Diluent	16.7		24.0	
Ancarez 2364	50.0		42.7	
HARDENER SIDE (Parts by Weight)				
Ancamine 2384	28.87		—	
Ancamine 2385	—		32.85	
HANDLING PROPERTIES				
Gel Time,[3] min, 150g mass	83		45	
Formulation Mix Viscosity,[1] cP	2,960		1,730	
RESULTS				
Cure Temp.,°F	72	40	72	40
Strength, avg. psi	437	239	324	204
Failure Mode, M/C/P***	M	C	C	C

*Note: Samples were cured for 7 days at indicated temperature before testing

** Bond strength to ASTM C 109 cement mortar run according to ASTM D 4541

*** M = failure in the cement mortar , C = cohesive failure in the bond line, P = failure in the cement / aggregate surface paste

PERFORMANCE STABILITY

Many of the proposed applications for the Ancarez 2364 flexibilizer-modified formulations may be exposed to adverse conditions such as high temperatures and moisture. Several formulations were tested to determine the impact on physical properties of this type of exposure. The formulation components and tensile properties of preexposed samples are given in Table 9.

TABLE 9: PERFORMANCE OF SELECTED FORMULATION PRIOR TO ENVIRONMENTAL EXPOSURE

Formulation*	12	19	20
RESIN SIDE (Parts by Weight)			
Epoxy Resin (EEW=190)	47.62	35.7	23.8
Epodil 748 Diluent	16.67	16.67	16.67
Ancarez 2364	35.72	47.6	59.5
HARDENER SIDE (Parts by Weight)			
AEP	16.53	14.9	13.2
HANDLING PROPERTIES			
Formulation Mix Viscosity,[1] cP	550	760	1,000
Gel Time,[3] min (150 g mass)	40	51	60
Thin Film Set Time,[4] h, 75°F/50% RH	15.0	—	—
PHYSICAL PROPERTIES			
Shore D[5]	68	62	50
Tensile[2]			
Strength, psi	3,583	2,176	1,539
Modulus, psi	78,640	40,110	17,320
Elongation, %	58	124	190

* Samples were cured for 7 days at 77°F before testing

EXPOSURE TO ELEVATED TEMPERATURE: Formulations 12, 19 and 20 were cured for seven days at 77°F prior to exposing test samples to 140°F for another seven days. The samples were allowed to cool to 77°F and then were tested for tensile properties. Table 10 shows slight changes in strength and elongation and moderate changes in modulus. Overall, the results show that formulations based on Ancarez 2364 flexibilizer exhibit good stability for this type of elevated temperature exposure.

EXPOSURE TO WATER: The same formulations were immersed in water for up to seven days. After seven days immersion, samples from each formulation were tested immediately for ambient tensile properties. Weight change as a percent is given in Table 10 for one and seven days along with the tensile properties. As can be seen, water absorbed into the samples acts as a plasticizer causing a drop in strength and modulus and an increase in elongation.

Another set of the samples from each formulation was soaked for seven days in water and allowed to stand at 72°F and 50% relative humidity for an additional seven days. The samples were tested for tensile properties after this period, and each formulation showed at least 80% recovery of the original tensile properties.

These results demonstrate excellent performance stability exhibited in flexibilized formulations even at high levels of Ancarez 2364 flexibilizer.

TABLE 10: PERFORMANCE OF SELECTED FORMULATIONS AFTER ENVIRONMENTAL EXPOSURE

Formulation	**12**		**19**		**20**	
77°F Performance After 7 Days at 140°F	**Actual**	**(% Change)**	**Actual**	**(% Change)**	**Actual**	**(% Change)**
Tensile[2]						
Strength, psi	3,593	(<1%)	2,382	(+9%)	1,587	(+3%)
Modulus, psi	58,280	(-26%)	45,640	(+14%)	23,500	(+36%)
Elongation, %	59	(<1%)	92	(-25%)	179	(-6%)
77°F Performance After H_2O Exposure						
1 Day, weight % change	0.74		0.98		1.19	
7 Days, weight % change	2.38		2.85		3.26	
TENSILE PROPERTIES[2] after 7 Days Exposure						
Strength, psi	2,231	(-37%)	1,240	(-43%)	545	(-64%)
Modulus, psi	60,570	(-23%)	20,540	(-49%)	13,530	(-22%)
Elongation, %	81	(+37%)	122	(-2%)	243	(+28%)

LOW TEMPERATURE PERFORMANCE

Some of the applications for the Ancarez 2364 flexibilizer-modified formulations may be exposed to extremely low temperatures where embrittlement is a concern. Several formulations were tested at 14°F to determine the Impact on physical properties. The formulation components and tensile properties are given in Table 11.

TABLE 11: LOW TEMPERATURE PERFORMANCE OF SELECTED FORMULATIONS

Formulation*	4	21	5	22	10
RESIN SIDE (Parts by Weight)					
Bisphenol A-based Epoxy Resin (EEW=190)	33.30	59.00	33.30	50.00	80.00
Epodil 748	16.67	16.67	24.00	16.67	20.00
Ancarez 2364	50.00	24.33	42.70	33.33	—
HARDENER SIDE (Parts by Weight)					
Ancamine 2384	28.87	35.7	—	—	568
Ancamine 2385	—	—	32.85	36.8	—
Ancamine 2390	—	—	—	—	100.0
HANDLING PROPERTIES					
Formulation Mix Viscosity,[1] cP	2,960	1,220	1,730	2,440	1,080
Gel Time,[3] min (150 g mass)	83	34	45	25	30
Thin Film Set Time,[4] h, 75°F/50% RH	13.0	9.0	12.0	7.0	7.0
PHYSICAL PROPERTIES					
Shore D[5]	60	75	55	75	55
Tensile[2]					
Strength, psi @ 77°F	1,600	4,400	1,500	3,780	1,530
Strength, psi @ 14°F	3,755	8,680	4,390	7,960	3,240
Modulus, psi @ 77°F	23,000	109,800	17,150	125,700	33,800
Modulus, psi @ 14°F	90,950	185,600	103,890	190,350	87,840
Elongation, % @ 77°F	100	28	96	47	55
Elongation, % @ 14°F	52	9	34	10	22
Tg,[9] °F, DMA	-40/117	-40/138	-31/106	-31/136	-31/ 27

* Samples were cured for 7 days at 77°F before testing

Tensile testing at 14°F shows that the highly flexibilized Formulations 4, 5 and 10 retain a significant amount of their room temperature flexibility.

CYCLIC TESTING: Coating applications which use a multicoat approach, such as secondary containment, require intercoat adhesion through seasonal cycles. To determine whether Ancarez 2364 flexibilizer formulations would maintain their bond to a rigid topcoat, an unpigmented multicoat system was applied to one foot by two foot concrete blocks and subjected to hot/cold cyclic testing.

An amidoamine-cured primer was first applied to sandblasted concrete blocks at 5 mils and allowed to cure overnight. This was overcoated with 20 mils of either Formulation 4 or 5 of Table 3 (formulated with Ancamine 2384 and 2385 curing agents). These flexibilized formulations were allowed to cure for 24 hours before a 20 mil chemically resistant topcoat was applied. The topcoat was a formulation based on a bisphenol F resin and multifunctional Ancamine 2280 curing agent. This three-coat system was allowed to cure for an additional seven days prior to cyclic testing.

The coated concrete blocks were placed in a freezer for 24 hours at 14°F. The blocks were then removed and immediately placed in an oven at 100°F / 50% relative humidity for 24 hours. Even after 20 cycles (40 days) the coatings showed no signs of delamination. Core samples were drilled at the end of the test and attempts to physically pry the layers apart were unsuccessful. Ancarez 2364 flexibilizer-modified formulations showed excellent intercoat adhesion to both the primer and the rigid, chemically resistant topcoat.

APPENDIX I

FORMULATIONS FOR FIGURE 2:
ANCAREZ 2364 FORMULATIONS CURED WITH AEP

Formulation*	23	12	24	19	20
RESIN SIDE (Parts by Weight)					
Bisphenol A-based Epoxy Resin (EEW=190)	59.5	47.6	41.3	35.7	23.8
Epodil 748	16.7	16.67	16.7	16.67	16.7
Ancarez 2364	23.8	35.7	42.0	47.6	59.5
HARDENER SIDE (Parts by Weight)					
AEP	18.1	16.5	15.7	14.9	13.2
PHYSICAL PROPERTIES					
Shore D[5]	75	68	65	62	50
Tensile[2]					
Strength, psi	5,239	3,583	2,950	2,176	1,539
Modulus, psi	102,300	78,640	58,650	40,110	17,320
Elongation, %	24	58	80	124	190

* Samples were cured for 7 days at 77°F before testing

ANCAREZ 2364 FORMULATIONS CURED WITH ANCAMINE 2384

Formulation*	25	21	13	26	4	27
RESIN SIDE (Parts by Weight)						
Bisphenol A-based Epoxy Resin (EEW=190)	68.3	59.0	50.0	41.7	33.3	25.0
Epodil 748	16.7	16.7	16.7	16.7	16.7	16.7
Ancarez 2364	15.0	24.3	33.3	41.6	50.0	58.3
HARDENER SIDE (Parts by Weight)						
Ancamine 2384	38.2	35.7	33.2	31.1	28.9	26.7
HANDLING PROPERTIES						
Formulation Mix Viscosity,[1] cP	1,000	1,220	800	960	2,960	1,500
Gel Time,[3] min (150 g mass)	27	34	35	69	83	111
Thin Film Set Time,[4] h, 75°F/50% RH	8.0	9.0	11.5	12.0	13.0	15.5
PHYSICAL PROPERTIES						
Shore D[5]	80	75	70	67	60	40
Tensile[2]						
Strength, psi	6,037	4,410	2,200	1,800	1,600	1,300
Modulus, psi	344,000	109,800	65,820	38,000	23,000	15,000
Elongation, %	14	28	82	98	100	97
Tear[10]	90,950	3,755	185,600	103,890	190,350	87,840
Strength, lb	*	*	187	144	125	98

* Samples were cured for 7 days at 77°F before testing

ANCAREZ 2364 FORMULATIONS CURED WITH ANCAMINE 2385

Formulation*	28	22	14	29
RESIN SIDE (Parts by Weight)				
Bisphenol A-based Epoxy Resin (EEW=190)	59.0	50.0	41.7	33.3
Epodil 748	16.7	16.7	16.7	16.7
Ancarez 2364	24.3	33.4	41.6	50.0
HARDENER SIDE (Parts by Weight)				
Ancamine 2385	39.5	36.8	34.4	31.9
HANDLING PROPERTIES				
Formulation Mix Viscosity,[1] cP	2,000	2,440	2,960	4,370
Gel Time,[3] min (150 g mass)	20	25	28	36
Thin Film Set Time,[4] h, 75°F/50% RH	6.5	7.0	7.5	9.5
PHYSICAL PROPERTIES				
Shore D[5]	78	75	65	45
Tensile[2]				
Strength, psi	5,626	3,780	2,577	1,900
Modulus, psi	273,500	125,700	82,160	36,650
Elongation, %	21	47	72	71
Tear[10]		3,755	190,350	87,840
Strength, lb	—	—	—	141

* Samples were cured for 7 days at 77°F before testing

Footnotes:
(1) ASTM D 445-83, Brookfield, RVTD, Spindle #4
(2) ASTM D 638-86
(3) Techne GT-4 Gelation Timer
(4) BK Drying Recorder
(5) ASTM D 2240-86
(6) ASTM D 695-85
(7) ASTM D 523-85
(8) ASTM 2794-90
(9) Glass Transition Temperature, Tan ∂ maxima of Dynamic Mechanical Analysis, DMA
(10) ASTM D 1938

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