



Epoxy Waterborne Compositions Modified by Hydroxyurethanes

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Abstract: Compositions of receiving and using waterborne epoxy - NIPU coating were developed. Experiments to study the compatibility of components in the waterborne epoxy - NIPU coatings were carried out. The optimum ratio of the components of the composition, in order to obtain the necessary physical and mechanical properties of the coating was determinate. The optimal compositions were recommended for industrial application.

Key words: coating, epoxy & nonisocyanate polyurethane, waterborne system, physical and mechanical properties.

Although the technology of water borne has been around formany years, great advances have occurred in the last decade [1-3].

Gone are the days where additive suppliers had little or any knowledgef waterborne epoxy systems. Today, the combination of high-performance waterborne resins and hardeners, with fit-for-purposeadditives and co-solvents, gives formulators the opportunity to get thehighest performance you can expect from epoxy and still adhere to environmental regulations at the same total cost. Regulatory initiatives to meet clean air standards continue to be the main impetus for coating formulators to consider waterborne epoxy systems. This aggressive regulatory environment is nothing new and hasbeen the case for over 20 years, since the passing of the Clean Air Actin 1990. Today, the US Environmental Protection Agency (EPA),

Ozone Transport Commission (OTC), California Air Resources Board (CARB) and South Coast Air Quality Management District (SCAQMD) continue to set more and more restrictive limits on the Volatile Organic Compound (VOC) content in architectural and industrial maintenance

(AIM) coatings. However, there is a change in the air again. Asset owners and architects are now exercising new drivers for change, creating a high demand for green and sustainable products that can be certified. No longer is it just a legislative requirement that is pushing for change, but consumer demand. The benefits of waterborne epoxy systems versus conventional epoxy systems are now quite often the deciding factor in coating selection by decision makers. For example, we have found many cases where the following benefits have been the key factors in favor of waterborne epoxy systems:

- Ultra low VOC
- Very low odor
- Non-flammable/non-combustible
- Fast dry and re-coat
- Ease of cleanup (no solvents needed)
- Balanced overall performance properties

If these types of benefits can be obtained at an equivalent or slightly increased cost, owners and contractors will always choose waterborne systems. The key aspect for proper performance and ultimately, user satisfaction, is the proper selection of epoxy resin and curing agent for the targeted application and substrate.

Water borne Epoxy (WBE) compositions are a unique set of products that enable the compiler to produce liquid curable materials with required viscosity, without the use of volatile organic compounds (VOCs).

This article describes the work in developing amines cure WBE compositions, which contain hydroxy-urethane modifier (HUM) [4-10].

Novel hydroxyurethane modifiers (HUM) for "cold" cure epoxy composite materials were synthesized. Properties of modified epoxy materials were studied by physical-mechanical and physical-chemical methods. It is established that the compositions with HUM demonstrate a significant increase in speed of curing process, as well as



non-trivial increase in abrasion resistance and a marked improvement in strength properties. Other characteristics, such as chemical resistance, are not worse. General concept of generating new multifunctional modifiers was created. The HUM, which possesses a wide range of hydrogen bonds, embedded in epoxy polymer network without a direct chemical interaction [4].

We studied the influence of the nature and content of the HUM on the properties of materials. Enrichment of different polymer dispersions were also investigated.

New modified compositions can be used in most conventional applications, such as coatings, floorings, adhesives, etc. without sacrificing performance.

Known waterborne epoxy composition consisting of water-base dispersions containing an epoxy resin, pigments, surfactants, other additives and aqueous emulsion of hardener. The use of water-based epoxy compositions instead of epoxy coatings with solvents eliminates the loss of large amounts of solvents. Such compositions are less toxic and fire- and explosive proof in use.

These compositions have a high viability, coatings characterized by good physical, mechanical and barrier properties, and they are widely used in many industries.

Hexion's EPI-REZ™ Epoxy Waterborne Resins and EPIKURE™ Curing Agents for waterborne systems are an unique portfolio of products that are compatible with each other, and allow the formulator to develop waterborne formulations that in many instances are capable substitutes to formulations containing a high portion of Volatile Organic Compounds [2].

These combinations can generally be diluted to a desired solids level simply with water addition. Due to their high degree of compatibility with many components, EPI-REZ Waterborne Resins and/or EPIKURE Curing Agents can also be formulated with wetting agents, additives, cosolvents and coupling agents to obtain formulations for fast dry as well as high after cure corrosion resistance and superior adhesion to various substrates.

However, water-based epoxy compositions' resistance to impact, bending and abrasion is low, which reduces the coating durability.

OBJECTS AND METHODS

The following raw materials were used:

-epoxy resin DER 324 (standard diglycidyl ether of bisphenol A,(Dow Chemical, USA)

-cycloate A (aliphatic tricyclocarbonate, (Polymate Ltd, Israel)

-propylene carbonate(Huntsman, USA)

-ancamine 2280 (Air Products, USA)

- ancamine 2608 (Air Products, USA)

- ancamine K- 54 (Air Products, USA)

-Ti-pure R-706 (pigment, Chemours, USA)

-Hum (hydroxyurethane modifier (Polymate Ltd, Israel)

-Nephelinesyeniteminex 4 (filler,Uniminorporation, USA)

-Disperbyk 194/019 (Wetting and dispersing additives, BYK Inc USA)

-WB Hardeners DEH 800,804,805,810,813 (Dow Chemical, USA)

Testing were carry out by the following standards:

-Hardness (Shore D) (ASTM D2240)

Tensile strength, MPa(ASTM D638 M)

-Elongation at Break % (ASTM D638 M)

-Wear resistance, mg (ASTM D4060)

The aim of our work was to increase the resistance of the WBE coating to abrasion, bending and impact, as well as to increasecoating elasticity, the possibility of applying it on the fresh concrete.

To achieve this target we tested the options of inclusion in HNIPU aqueous dispersion compositionhydroxy-urethane modifiers (HUM), which allowpreserving the advantages of epoxy coatings, and acquiring the useful properties of urethanes.

Considering the possibility of introducing HUM in WBE composition HUM, we concluded that in this case it is not possible to add a modifier in an aqueous dispersion part - whether it is an epoxy part or amine part, since under the influence of the water, modifier hydrolyzes and loses its advantages. Therefore, the shelf life of such formulations will be short. From this aspect, the decision was to add HUM in part which does not contain water, whether it is amine or epoxy part.

Thus, the following compositions were developed:

Option 1: A simple addition of water to an existing composition HNIPU.

Table 1

No	PART A base			PART B hardener				PROPERTIES					
	DER-324	Cycloate A	PC	Anc.2 280	Anc. 2608	Anc. K-54	% Water	Pot Life min	Appearance	Tensile strength MPa	Elongation %	Hardness Shore D	Wear, mg
3824	55	5	2	22	12	4	0	90	gloss	30	9	74	25
3842	55	5	2	22	12	4	5	80	gloss	30	12	72	25
3842	55	5	2	22	12	4	10%	60	gloss	20	8	67	27
3842	55	5	2	22	12	4	20%	30	semi-gloss	25	5	70	28
3842	55	5	2	22	12	4	30%	20	sticky	-	-	-	-

Experimental results show that the optimum addition of water into existing HNIPU composition is 10-20%. It has practically no effect on the physic or chemical properties of the coating, accelerates the curing time and allows reducing the viscosity of the system without the use of organic solvents.

Option 2

A composition where PART A contains EPOXY RESIN and HUM, and PART B - hardener that contains aqueous emulsion of the amine with adduct.

After a number of tests, the optimal ratio of the components was selected for these compositions. See tables 2, 3.

Table 2 shows the HNIPU water-dispersed composition with addition of HUM - 10% of epoxy resin content:

Table 2

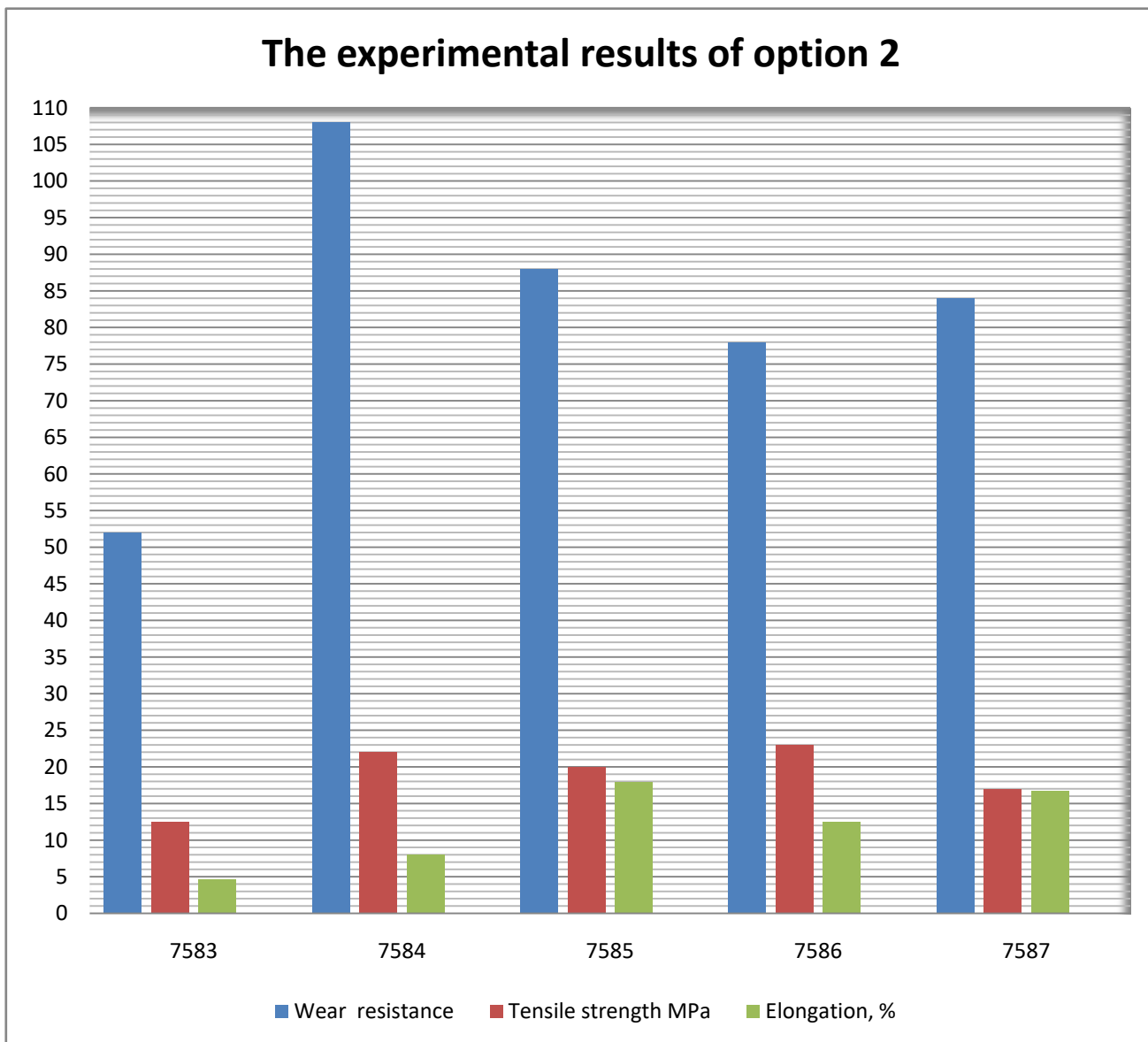
No. of sample	PART A base		PART B hardener					Viscosity Part A, Part B CPs
	EPOXY RESIN DER-324	HUM	Ti-Pure R-706 PIGMENT	Nepheline-Syenite Minex 4 FILLER	DISPER-BYK 194/BYK-019	WB-HARDENER	Water	
7583	25	2.5	10	15	6/1	DEH 804	18	B=1080 A=240, A+B= 1200
7584	25	2.5	10	15	6/1	DEH 810	25	B=1080, A= 540, A+B= 1270
7585	25	2.5	10	15	6/1	DEH 800	30	B=1080, A=1240 A+B= 1800
7586	25	2.5	10	15	6/1	DEH 805	30	B=1080, A=1000 A+B= 2350
7587	25	2.5	10	15	6/1	DEH 813	25	B=1080, A= 1700 A+B= 2350

The experimental results of option 2:

Table 3

No sample	PotLife	Appearance	Tensile strength MPa	Elongation, %	Pencil Hardness	Wear resistance
7583	1h	matt	12,5	4,6	2H	52
7584	1,5h	glossy	22	8	2H	108
7585	1,5h	semi-gloss	20	18	2H	88
7586	40 min	matt	23	12,5	2H	78
7587	40 min	semi-gloss	17	16,7	2H	84

Fig.1



Conclusions

Compositions of receiving and using waterborne epoxy-urethane coating were developed. Experiments to study the compatibility of components in the waterborne epoxy-urethane coatings were performed. The optimum ratio of the components of the composition, in order to obtain the necessary physical and mechanical properties of the coating was determined. The laboratory batch tests of waterborne epoxy-urethane coat-

ings, by applying the compositions to wet concrete samples were provided. The positive results were obtained.

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