UV Curable Polyurethane Dispersion Coatings for Site-Applied Flooring

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Abstract

Ultra Violet Curable Polyurethane Dispersions (UV PUD) were successfully used in waterborne site applied floor coatings. The substrates coated were wood, vinyl and concrete. The coatings were cured using a high intensity UV floor curing unit. The benefits of this environmentally friendly & green technology are very low odor, ultra low VOC, minimum down time, ease of use, operator friendly and high performance coatings.

Introduction

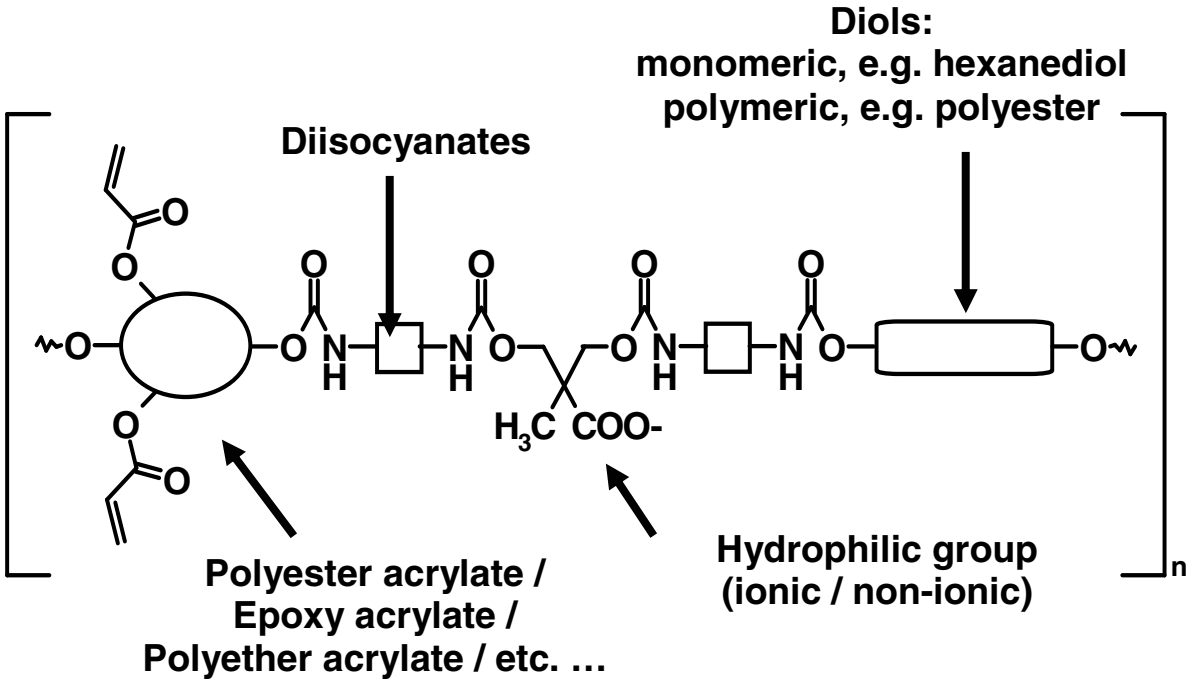
UV curable polyurethane dispersions have become well established in the furniture market and now it is time to introduce these resins to the site-applied flooring industry. UV technology is well known in the OEM flooring industry for its high productivity, chemical resistance and longevity. Other benefits of UV PUDs are ultra low VOC's and low odor. We combined the two excellent chemistries of UV and polyurethane dispersion for coating application in the areas of concrete, vinyl and wood site-applied flooring. This paper will discuss the performance of waterborne UV curable PUD coating cured with full spectrum UV light.

Background

Polyurethane dispersions (PUDs) are well known in the coatings industry. They are one-component (1K) high molecular weight aqueous dispersions and develop properties without the need for additional cross linking. .These 1K PUDs offer many of the outstanding features typically associated with polyurethane coatings. They may be used as a sole resin or blended with other resin systems, such as acrylics. PUDs are fully reacted colloidal polyurethane systems dispersed in an aqueous phase. Emulsification is accomplished by incorporation of anionic groups or non-ionic hydrophilic polyether segments into a backbone of the polyurethane polymer. Film formation occurs at room temperature by evaporation of the water, at which time the polymer particles coalesce.

A PUD can be utilized in a number of chemical scenarios that include the following:
1) non functional PUDs
2) self crosslinking PUDs
3) hydroxyl functional PUDs utilized in a 2 K water based polyurethane and
4) UV functional PUDs

The UV PUD is actually produced via a technique known as the "acetone process". This technique allows the manufacture of the prepolymer in acetone and during a later step the removal of the acetone via distillation. The resulting UV PUD results in an ultra low VOC and VHAPS product. Scheme 1 depicts the typical structure of the 1K UV PUD.



Scheme 1: 1K UV Curable Polyurethane Dispersion

The concept of a one component UV curable floor coating is illustrated below.

UV Light Objectives

- portable and user friendly
- low to moderate cost
- worker safety
- efficiency & speed

Coating Objectives

- one-component
- high performance
- adhesion, appearance
- physical drying properties
- low VOC's
- user friendly

Benefits

- Productivity
  - less floor downtime
- Performance
  - No-post-cure required
- Cost
  - Reduced labor
- Environmental & green image

Experimental

Formulations

Waterborne UV Curable formulation was prepared by mixing the UV PUDs with rheological modifiers, flow & wetting aids and photoinitiators. The formulation was kept overnight to de-aerate before use. Two different formulations were tested for this study.

Application

The waterborne formulation was typically poured and spread using a squeegee. The coating will physically dry under normal air conditions. The applicator can even gently walk over the dried area without damaging the coatings. One or two coats were applied based on the substrate requirement and application area.

Equipment

High-intensity UV curable equipments were used to cure the coatings. Representative equipments are shown in the pictures below.

Results

Chemical Resistance

Table 1. Chemical Resistance Spot Test of UV Curable Clearcoats (panels tested same day as cure)

System	Time	Waterborne UV Formulation 1	Waterborne UV Formulation 2
10% Acetic Acid	4 hrs	Soft	No Effect
	24 hrs	Soft	Blistered
10% H_2SO_4	4 hrs	No Effect	No Effect
	24 hrs	No Effect	No Effect
10% HCl	4 hrs	No Effect	No Effect
	24 hrs	No Effect	No Effect
14% NH_4OH	4 hrs	Soft	Soft
	24 hrs	Soft	Soft
50% NaOH	4 hrs	No Effect	No Effect
	24 hrs	No Effect	No Effect
IPA	4 hrs	Soft	Soft

	24 hrs	Soft	Soft
MEK	4 hrs	Blistered	Blistered
	24 hrs	Blistered	Blistered
Betadine	4 hrs	Stained	Stained
	24 hrs	Stained	Stained
Gasoline	4 hrs	No Effect	No Effect
	24 hrs	No Effect	No Effect

Table 2: Chemical Immersion Test of WB UV Curable Clearcoat

Description		**Waterborne UV Formulation 1**	**Waterborne UV Formulation 2**
Skydrol	1 day	Slight Blister	Slight Blister
	4 days	Slight Blister	Slight Blister

Tables 1 and 2 showed that the UV cured coatings had good chemical and stain resistance needed for household and medium duty industrial applications.

Table 3: Taber Abrasion Resistance (CS-17, 1kg, panels tested after 7 days)

Description		**Waterborne UV Formulation 1**	**Waterborne UV Formulation 2**
Loss (mg)	1000 cycles	31.4	32.2
	500 cycles	13.2	14.0

Table 4: Pendulum Hardness of WB UV Clearcoats

Description		**Waterborne UV Formulation 1**	**Waterborne UV Formulation 2**
Day 1	Seconds	54.1	81.7
Day 3	seconds	86.3	109.2
Day 6	seconds	107.3	119.9

Table 5: Gloss level of WB UV Clearcoats

Description	Waterborne UV Formulation 1	Waterborne UV Formulation 2
60° Gloss	93	93

Tables 3, 4 and 5 show that durable coatings with good hardness and high gloss could be achieved with waterborne UV curable coatings formulation.

Application Examples:

Applications of waterborne UV curable clearcoats on wood and vinyl floors are shown in the pictures below.


UV FLOOR CURE


BULLDOG

Conclusions

Waterborne UV curable coatings were successfully developed for site-applied floor coating applications. UV Curable Polyurethane Dispersions are excellent binders that provide high performance in high intensity UV cure floor applications. Durable coatings with good gloss can be obtained. Various field trials confirmed the robustness of this system in real world applications.

References

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