Short Communications

Recycling Paint Overspray

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The use of recovered paint overspray from the auto industry was investigated. Water and solvent had been removed from the recovered paint by a vacuum treatment process. The acid catalyst had been neutralized by excess base prior to processing. The recovered paint, as supplied, contained contaminant particles of self-crosslinked hardener that were removed by filtration. The cleaned paint was then formulated with additional catalyst and additional crosslinker to replace that which was lost in processing, and solvent (55% solids, 3 lb/gal VOC) to reach application viscosity. The paint was applied to metal test panels and baked at 190°C for 15, 20, or 25 min. The results indicate that the gray recycled paint gave reasonable properties for many expected industrial applications.

INTRODUCTION

About 34,000,000 kg of waste paint sludge is generated by the U.S. automotive industry each year.[1] This waste and similar streams in other industries makes a significant contribution to landfills. In addition to occupying scarce landfill space, waste paint can present an environmental danger through the discharge of toxic materials to the environment. Paint containing lead, chromium, or other toxic heavy metal-based pigments, mercury biocides, or organohalogen compounds may be disposed in landfills or dumped illegally in water or other environmentally sensitive areas. Incineration, though a partial solution, still produces toxic metal containing ash. Removing paint from the waste stream through recycling would have economic and environmental benefits.[2-5]

Among various proposed solutions, one is to recycle the paint sludge into compounding ingredients for automotive sealants and underbody coating materials.[5-7] Hence, the waste generated by the car manufacturing process goes back to the car. This approach utilizes the useful ingredients from the paint sludge and compounds these materials into products that may meet current specifications for paintable sealants and underbody coatings.

Post consumer recycled paint program[8] results indicate that approximately 80% of latex and alkyd waste paint could be recovered by mechanical sorting and segregation of paint and converting into safe, quality recycled paint products.

Commercial Recycling Process

Environmental Purification Industries (EPI) collects paint overspray residue from the auto industry and evaporates water and solvent by application of heat to produce a granular residue that is used as a filler for mastic, asphalt, etc.[9] A new low temperature vacuum process produces a paint residue with the consistency of Silly Putty. To minimize crosslinking during this process, acid catalyst is neutralized by alkaline material. The recovered paint sludge is a mixture of many colors and is gray. It could potentially be used as is or with black pigment. It would appear that the paint sludge will be low cost[9] and could potentially find use in industrial coating applications where variable colors is not a high priority, such as automotive underhood applications, farm implements, tools, etc.

The purpose of this project was to analyze the recovered, vacuum-stripped, paint overspray, determine any deficiencies, correct deficiencies found, formulate it into paint, and evaluate the paint formulations and coatings.

EXPERIMENTAL

Materials

EPI MER® 200 paint sludge was obtained from EPI, Toledo, OH. Solvents used were acetone, butyl acetate, amyl acetate, and n-butanol. Other materials were hexamethoxy-melamineformaldehyde (Resimene® 755 from Monsanto), amine blocked paratoluenesulfonic acid (Nacure® 2500 from King Industries), and a wetting and dispersing agent (BYK® P 104S from BYK-Chemie).

Formulation

The paint residue was soaked in the solvent mixture for 24 hr (paint:solvent ratio 70:30). The paint sludge,

Table 1—Recycled Paint Formualtion

	Weight	Volume
EPI MER 200	540	59.90
Amyl acetate	101.50	11.25
Butyl acetate	71.85	7.95
n-Butanol	57.97	6.45
Acetone	106.95	11.85
BYK -P 104S	5.65	.63
Acid catalyst		
2% of binder	7.55	.84
Crosslinker		
20% extra	26.50	2.90
Total	900.97	99.75
VOC (calculated)	3.09 lb/gal	
Viscosity (Brookfield), cPs	450	
Nonvolatile content, %	57.2	
Pigment/binder ratio	0.43	
Resin/melamine	35/65	

Table 2—Recycled Paint Dry Film Tests

	Hardness	Gloss 60°	Gloss 80°	Impact For	Impact Rev	Thickness
Catalyst, Bake time						
1.5%, 15 min	3B	48	74	160	160	0.842
1.5%, 20 min	B	46	80	120	120	0.752
1.5%, 25 min	B	52	85	140	120	0.954
2%, 15 min	2B	45	74	160	160	0.790
2%, 20 min	B	40	75	140	140	0.686
2%, 25 min	H	48	82	140	120	0.542

additional catalyst, additional crosslinker, and the solvents were mixed and dispersed in a ball mill. Solid particles in the formulations were removed by filtration through a 10-micron bag filter. The formulation used is given in *Table* 1.

Substrate

Cold rolled steel R-36 panels from Q-Panel Company were used in all tests.

Panel Preparation

Coatings of 4 mil wet thickness were applied to the substrate test panels by a multiple clearance applicator (chrome plated steel square) from Paul N. Gardner Co. and cured at 190°C for 15, 20, or 25 min in an electric forced air oven.

Liquid Paint Tests

The viscosity (ASTM D 2196-86) and volatile organic content (VOC, ASTM D 2369-95) of the paints were determined by standard methods.

Dry Film Tests

The cured test panels were evaluated for appearance, film thickness (ASTM D 1186-93), gloss (ASTM D 523-89), pencil hardness (ASTM D 3363-92a), solvent resistance (ASTM D 4585-92), impact resistance (ASTM D 2794-93), adhesion (ASTM D 3359-95a), mandrel bend flexibility (ASTM D 522-92), and corrosion resistance using a cyclic salt fog (ASTM D 1654-92).

RESULTS AND DISCUSSION

The recycled paint residue was analyzed and was found to have a pigment to binder ratio of 30:70. The binder was determined to be about 35% melamine/formaldehyde crosslinker, 30% hydroxyl functional styrenated acrylic, 30% caprolactam-based polyol, and about 5% phthalic anhydride-based alkyd. The pigment fraction was about 48% rutile titanium dioxide and miscellaneous other pigments. The paint residue was quite thick and needed to be reconstituted in solvent.

Solvent Selection

The putty-like residue needed to be reconstituted as a paint. A solvent mixture of acetone, butyl acetate, amyl acetate, and butanol were selected for their ability to dissolve the residue and give application viscosity at a moderate VOC.

Catalyst

The addition of about 0.2-1% para-toluene sulfonic acid (PTSA) catalyst on total resin solids is normally recommended for acrylic-melamine bake coatings. As part of the solvent and water vacuum evaporation process, acid catalyst was neutralized with excess alkaline media to prevent paint cure. We found it necessary to add acid catalyst to compensate for the

Table 3—Effect of Additional Crosslinker

	Film Thickness	Gloss 60°	Gloss 80°	Impact For/Rev	Hardness	Prohesion Exposure, Hours to Failure Reading of 3	7 Days' Prohesion S	7 Days' Prohesion U	15 Days' Prohesion S	15 Days' Prohesion U	20 Days' Prohesion S	20 Days' Prohesion U	35 Days' Prohesion S	35 Days' Prohesion U
% Cat, % XL														
15 min														
1.5%, 10%	0.738	44	85	140/160[a]	B	456	7-8	10	7	10	7	10	3	9
1.5%, 20%	0.812	46	85	160[a]	4B	456	7-8	10	6	10	6	10	3	9
2.0%, 10%	0.814	52	88	160[a]	2B	456	7-8	9	6	9	5-6	9	3	9
2.0%, 20%	0.624	46	84	140/130	F		7-8	10	7	10	6	10	3	10
20 min														
1.5%, 10%	0.786	44	83	140/140	H	456	7	9	4-5	9	4	9	3	9
1.5%, 20%	0.676	46	85	160[a]	2B	456	7	10	7	9	7	9	3	9
2.0%, 10%	0.701	53	86	160/140	H	456	7-8	9	4.5	9	4	9	3	8
2.0%, 20%	0.726	44	78	140/140	H	360	6	10	7	10	3	9	3	9
25 min														
1.5%, 10%	0648	37	48	140/110	2H	456	6-7	10	4-5	10	4	9	3	9
1.5%, 20%	0.756	39	81	140/140	2H	456	7	10	6	10	6	10	3	10
2.0%, 10%	0.781	42	83	140/130	H	456	7	10	7	10	7	9	3	9
2.0%, 20%	0.734	39	79	120/120	3H	456	7	9	6	9	6-7	9	3	9

(a) 160/160.

excess base used to neutralize the recovered overspray prior to processing. Coatings with catalyst levels of 1.5% and 2% based on binder solids were cured for 15, 20, or 25 min. *Table* 2 shows the test results. Two percent added catalyst was necessary to reach a pencil hardness of H at a bake time of 25 min. Gloss and impact resistance were acceptable for many applications.

Crosslinker

The paint residue as received gave coatings with bumps on the surface. Paint residue, reduced to about 2500 cPs with solvent blend, was filtered through a 10-micron bag filter to give a paint that produced a coating with excellent appearance and properties.

These bumps were found by infrared spectroscopy to be mostly cured melamine/formaldehyde crosslinker. Since the particles that were removed consisted mostly of cured crosslinker, this would result in a reduction of melamine-formaldehyde crosslinking agent in the recycled paint and would give a lower crosslink density and hardness than expected. To compensate for the loss, additional melamine formaldehyde resin was added. The results in *Table* 3 show the effect of repeating the tests with 10% and 20% additional crosslinker added to the formulations. All of the coatings passed the flexibility test and all gave 5B for adhesion. Twenty percent extra crosslinker increased the coating hardness from H to 3H.

Corrosion Resistance

The coatings contained neutralized acid catalyst. The resulting salts could impart water sensitivity and corrosion problems to the final coating. The corrosion resistance results for this series of coatings are given in *Table* 3. The typical coating failed (reading of three) at the scribe at about 500 hr.

CONCLUSIONS

The filtered recycled paint with additional catalyst and crosslinker added gave gray coatings with good hardness, gloss, impact resistance, adhesion, and flexibility. The coatings failed the Prohesion corrosion test (reading of 3) at the scribe at 456 hr of exposure. The claimed low cost of the product should make it attractive for general industrial use in any application where economics are critical, but where color is not a heavily weighted performance criterion. Recycling paint is environmentally desirable and, according to these preliminary results, is feasible for less demanding applications.

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