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(54) Title: PIGMENT DISPERSANTS FORMED BY REACTING AN ISOCYANATE WITH A POLY(ETHYLENE GLYCOL) ALKYL ETHER, A POLYESTER OR POLYACRYLATE AND A DIAMINE

(57) Abstract: Pigment dispersants prepared by reacting an isocyanate oligomer having an average functionality of at least three with a polyester or polyacrylate, a poly(ethylene glycol) alkyl ether, and a diamine having a primary amine and a tertiary amine have excellent stabilizing properties and offer a wide formulation latitude with a variety of solvent systems, including polar solvents and water, and are particularly useful as pigment dispersants for paints and coating applications.

**PIGMENT DISPERSANTS FORMED BY REACTING AN ISOCYANATE
WITH A POLY(ETHYLENE GLYCOL) ALKYL ETHER, A POLYESTER OR
POLYACRYLATE AND A DIAMINE**

Background Of The Invention

5 This invention relates to polymeric pigment dispersants prepared by reacting an isocyanate with a hydrophilic poly(ethylene glycol) alkyl ether, a hydrophobic polyester or polyacrylate, and a diamine.

The materials described in this application are cationic dispersants. The cationic substitution allows their use with anionic pigments, particularly carbon black and
10 surface treated organic pigments. In addition, the use of mixed arms provides broader solubility characteristics and utility with a wider range of coatings vehicles. These materials can therefore be considered "universal dispersants".

There are currently several trends in the coatings industry which dictate the need to use cationic dispersants, and are therefore relevant to this invention. First, the
15 use of isocyanate crosslinked coatings is becoming more important because, in part, they generally do not have a cure inhibition problem with cationic dispersants. Also, partially condensed melamine resins show increasing importance as used in coatings, because they are generally not so strongly inhibited by cationic dispersants. Yet another trend is that pigment suppliers are providing more pigments, particularly
20 phthalocyanines, which have anionic surface treatments (i.e., the pigment is acidic) which made cationic dispersants the ideal choice to achieve strong pigment -to- dispersant interaction.

The lack of emphasis in prior work on cationic functional dispersants, particularly those comprising tertiary amines, was at least partly caused by the use of
25 dispersants in industrial and automotive coatings, which were formulated to depend on acid catalysis of melamine resins for crosslinking. Amine functional dispersants usually cause some cure inhibition in such coatings. The urea functionality incorporated using ammonia was sufficiently adsorbed on many pigments and did not interfere with the cure mechanism.

30 The present invention differs from prior art dispersants in that it encompasses a unique combination of hydrophobic arm(s), hydrophilic arm(s) and amine arm(s) functionality on an isocyanate backbone.

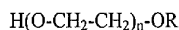
Summary of the Invention

The present invention provides a pigment dispersant consisting essentially of a
35 reaction product resulting from sequentially reacting an isocyanate oligomer having on a statistical average at least three isocyanate groups with:

- (a) a hydrophilic poly(ethylene glycol) alkyl ether;

- (b) a hydrophobic polymer selected from the group consisting of polyesters and polyacrylates; and
- (c) a diamine comprising a primary amine group and a tertiary amine group;

wherein the poly(ethylene glycol) alkyl ether has the general formula



wherein n is an integer between 15 and 67 and R is an alkyl of 1 to 4 carbons and has a number advantage molecular weight ("Mn") between 750 and 3000.

Detailed Description of the Invention

The dispersants described herein are the reaction product of a multifunctional isocyanate with a polyester or polyacrylate, a polyethylene ether and a diamine. The polyester or polyacrylate and polyethylene ether "arms" have widely different solubility profiles and provide entropic stabilization for the dispersant in a wide range of solvent systems. The amine "arm" provides a functional group that can strongly interact with an acidic pigment for dispersion stability. Most preferably, the dispersants of this invention comprise the reaction product described above wherein 10 to 50 mole % of the isocyanate groups on the oligomer are reacted with a polyester or polyacrylate, 3 to 30 mole % are reacted with the poly(ethylene glycol) methyl ether and 30 to 65 mole % of the isocyanate groups are reacted with the diamine, with the proviso that 100% of the isocyanate groups are reacted.

The isocyanate oligomer may be linear, branched or alicyclic. Isocyanurates that may be used in this invention to provide the isocyanate oligomer include toluene diisocyanate ("TDI"; Desmodur IL), hexamethylene diisocyanate ("HDI"; Desmodur 3300); mixtures of TDI and HDI (Desmodur HL), and biuret of hexamethylene diamine (Desmodur N). These may be obtained from sources indicated in the Examples.

The isocyanate oligomers must have an average functionality of three or more, meaning that a molecule of the isocyanate contains, on statistical average, at least three free isocyanate groups. The average functionality, as opposed to the absolute number of isocyanate groups, is used because the isocyanates are obtained as isomeric mixtures of isocyanates having 3, 4, 5 or more functional groups. The average functionality can be determined experimentally by titrating to determine the weight % of isocyanate, determining the number average

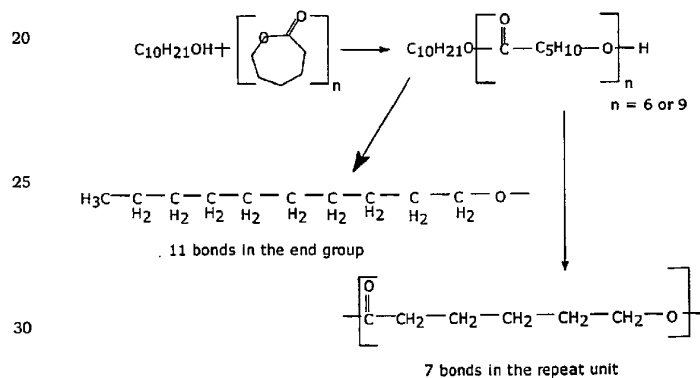
molecular weight ("Mn") of the oligomer (such as by Gel Permeation Chromatography "GPC"), and then calculating the average number of isocyanate groups.

The dispersants of this invention are prepared by sequentially reacting the polyester or polyacrylate, the poly(ethylene glycol), and the diamine with the selected isocyanate oligomer. At the conclusion of the synthesis, all of the isocyanate groups have been reacted.

The polyesters suitable for use in the invention have the general formula:



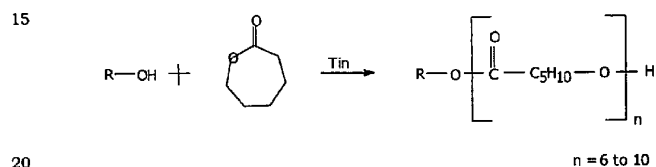
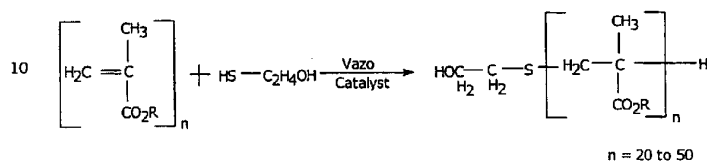
where R is an alkyl of 1 to 12 carbons and n is an integer of 6 to 10. These polyesters are conveniently prepared by reacting caprolactone with an alcohol. The length of the polyester arm for any particular dispersion is determined by a balance between its being long enough to give good pigment dispersion and yet not so long that it crystallizes too readily to produce an unstable solution. A typical synthesis of the polyester arm using n-decanol and caprolactone, is shown in the following figure:



The length of the arm containing six repeat units (i.e., n = 6) is calculated at 6.63 nm and the length of the arm containing nine repeat units (n = 9) is 9.25 nm.

Polyacrylates useful in the present invention are hydroxy-terminated (meth)acrylic polymers. Such polymers are prepared by reacting (meth)acrylic

monomers with 2-mercaptoethanol in the presence of a free radical initiator. Azo initiators such as azobisisobutyronitrile (VAZO® 64, E. I du Pont de Nemours & Co., Wilmington, DE) are particularly useful. Other useful monomer compositions and initiating conditions are described in U.S. Pat. No. 4,032,698, the disclosure of which is incorporated herein in its entirety. The preparation of the polyacrylate arm is illustrated schematically by the following equations:

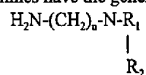


Poly(ethylene glycol) alkyl ether polymers useful in this invention are those having the general formula



where n is an integer of 15 to 67 and R is an alkyl of 1 to 4 carbons, preferably methyl. The poly(ethylene glycol) alkyl ethers have a number average molecular weight ("Mn") between 750 and 3000, preferably between 900 and 2500, and all ranges encompassed therein. The poly(ethylene glycol) alkyl ethers have a single hydroxyl functional group. Such polymers are commercially available from Aldrich Chemical and other sources. Alternatively, poly(ethylene glycol) alkyl ether polymers can easily be prepared using conventional techniques well known to those skilled in the art.

Suitable diamines useful in the invention are those having a primary amine and a tertiary amine. Such diamines have the general formula:

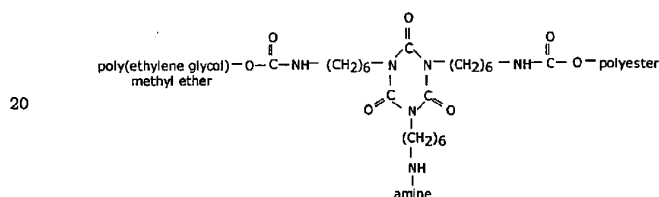


$$\text{H}_2\text{N}-\underset{\text{H}_2}{\text{C}}-\underset{\text{H}_2}{\text{C}}-\underset{\text{H}_2}{\text{C}}-\text{N}$$
$$\text{H}_2\text{N}-\underset{\text{H}_2}{\text{C}}-\underset{\text{H}_2}{\text{C}}-\underset{\text{H}_2}{\text{C}}-\text{N}$$
$$\text{H}_2\text{N}-\underset{\text{H}_2}{\text{C}}-\underset{\text{H}_2}{\text{C}}-\underset{\text{H}_2}{\text{C}}-\text{N}\begin{matrix} \text{CH}_3 \\ \text{CH}_3 \end{matrix}$$

3-Dimethylamino propylamine

1-(3-aminopropyl)imidazole is the most preferred. It has the complexing activity of pyridine, but is more basic. It has a relatively low equivalent weight, and is commercially available. In the experimental results reported herein, it was necessary to use a 10 to 15% calculated excess of isocyanate to ensure complete consumption of all of the diamine used in the last step of the synthesis.

15



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grinding, attritor grinding or two or three roll milling. The resulting pigment dispersion has a pigment to dispersant binder weight ratio of 100/1 to 100/500.

Any of the conventional pigments used in paints can be used to form the pigment dispersion such as metallic oxides like titanium dioxide, iron oxides of various colors, zinc oxide, carbon black, filler pigments such as talc, china clay, barytes, carbonates, silicates and a wide variety of organic pigments such as quinacridones, phthalocyanines, perylenes, azo pigments, indanthrones, carbazoles such as carbazole violet, isoindolinones, thioindigo reds, benzimidazolinones, metallic flakes such as aluminum flake, pearlescent flakes and the like.

It may be desirable to add other optional ingredients to the pigment dispersion such as antioxidants, flow control agents, rheology control agents such as fumed silica, microgels, UV stabilizers, screeners, quenchers and absorbers. The pigment dispersions can be added to a variety of solvent borne or aqueous coating compositions such as primers, primer surfacers, topcoats which may be monocoats or basecoats of a clear coat/base coat finish. These compositions preferably have an acrylic polymer or polyester polymer or a blend of these types of coating vehicle as the film forming constituent and may also contain crosslinking agents such as blocked isocyanates, isocyanates, alkylated melamines, epoxy resins and the like. Other film forming polymers can also be used, such as acrylourethanes, polyester urethanes, polyethers and polyether urethanes that are compatible with the pigment dispersion.

The following examples illustrate the invention. All parts and percentages are on a weight basis unless otherwise indicated. Molecular weights are determined by gel permeation chromatography using polystyrene as the standard and tetrahydrofuran as the carrier solvent.

EXAMPLES

Unless otherwise specified, all chemicals and reagents were used as received from Aldrich/Sigma Chemical Company, Milwaukee, WI.

1-(3-aminopropyl)imidazole	BASF, Ludwigshafen, Germany
4-(3-aminopropyl)morpholine	Huntsman Corp., Austin, TX
3-dimethylamino propylamine	Huntsman Corp., Austin, TX

Test Methods

Knoop Hardness Number (KHN)

The KHN values were the result of an indenter hardness measurement as described in ASTM D1474.

Gardner-Holdt Viscosity (GH)

The GH viscosity were determined using a comparative set of viscosity standards to obtain a bubble tube match. The method is described in ASTM D 1545-76.

Molecular Weight by Size Exclusion Chromatography:

The standards used were 0.1% of polystyrene of 3.04M, 1.03M, 330K, 156K, 66K, 28.5K, 9.2K, 3.25K, 580 molecular weight. A point to point calibration was used with these narrow molecular weight standards.

- 5 Tetrahydrofuran was used as the solvent. A Waters 410 RI detector (Milford, MA) was used for the measurements. The columns used were from Polymer Laboratories, Inc. (Amherst, MA) (part #1110-6500). The column heater temperature was 30°C. The detector temperature was 35°C. The flow rate was 1.0 ml/min. with an injection volume of 100 µl of the 0.1% solution of
- 10 experimental polymer in THF. The samples were filtered through a 0.5 µm Millipore filter before being run.

Amine Number Determination:

- A 2 g sample was diluted with 25 ml of THF. Ten drops of 0.1% bromophenol blue indicator was then added and the solution titrated to a blue to yellow end point with 0.1 N aqueous hydrochloric acid.

Amine # = cc Titrant x Normality x 56.1/sample wt.

Example 1: polyester of 6:1 mole ratio of caprolactone to n-decanol

- 20 The following materials were combined in a 2 liter flask fitted with a stirrer thermocouple and condenser. The condenser was topped with a nitrogen inlet to maintain a constant pressure of nitrogen in the flask.

Component	Weight, grams
n-decyl alcohol	253.2
10% dibutyl tin dilaurate in caprolactone	2.4
Caprolactone	1094.0

- 25 The materials were heated with stirring to 140°C over about 25 minutes and held at 140 to 147°C for three hours. The product formed was a white wax which remelted to a clear liquid when heated at 60°C, and was 99.28% solids, with a calculated OH# = 66.5 (for a 6/1 mole ratio of caprolactone to n-decanol), and a calculated Mn=843.2.

Example 2: polyester of 9:1 mole ratio of caprolactone to n-decanol

- 30 Example 1 was repeated using 9 moles of caprolactone for every 1 mole of n-decanol. The resulting product was 99.7% solids, had a calculated OH# of 47 and a calculated molecular weight of 1186.

35

Example 3: polyester of 10:1 mole ratio of caprolactone to n-decanol

Example 1 was repeated using 10 moles of caprolactone for every 1 mole of n-decanol. The resulting product was 99.6% solids, had a calculated OH# of 43 and a calculated molecular weight of 1300.

5

Example 4: monohydroxy poly(methyl methacrylate)

A monohydroxy acrylic arm can be prepared by the following solution feed process:

10

Charge:

Part	Component	Weight, g.	Function
I	ethyl acetate	360.5	Solvent
II	azobis isobutyronitrile	1.64	Initiator
	2-mercaptoethanol	14.06	OH source
	ethyl acetate	50.0	Solvent
III	methyl methacrylate	600.0	Monomer

Charge part I to a 2 liter reactor fitted for reflux and two feed streams.

- 15 Bring the ethyl acetate to reflux under a nitrogen blanket and concurrently feed part II over 200 minutes and part III over 185 minutes while maintaining reflux. Continue heating at reflux for an additional 30 minutes. Complete conversion of the reactants will occur to produce a clear solution with a 60% nonvolatile content. The calculated OH number of the solids is 16.4. The estimated end to
- 20 end length of the product is 8 nanometers. The calculated molecular weight is 3421.

Example 5: monohydroxy poly(n-butyl methacrylate)

- 25 A monohydroxy acrylic arm with lower viscosity and improved solubility in low polarity solvents can be prepared by the following solution feed process:

Charge:

Part	Component	Weight, g.	Function
I	ethyl acetate	529.3	Solvent
II	azobis isobutyronitrile	1.64	Initiator
	2-mercaptoethanol	14.06	OH source
	ethyl acetate	50.0	Solvent
III	n-butyl methacrylate	853.2	Monomer

Charge part I to a 2 liter reactor fitted for reflux and two feed streams. Bring the ethyl acetate to reflux under a nitrogen blanket and concurrently feed part II over 200 minutes and part III over 185 minutes while maintaining reflux.

- 5 Continue heating at reflux for an additional 30 minutes. Complete conversion of the reactants will occur to produce a clear solution with a 60% nonvolatile content. The calculated OH number of the solids is 11.62. The estimated end to end length of the product is 8 nanometers. The calculated molecular weight is 4828.

10

The materials for the preparation of the acrylic arms can be obtained from Aldrich Chemical Co.

Comparative Example A

15

As a comparison, a dispersant was prepared by reacting an isocyanate with a polyester and a diamine. The comparative dispersant did not contain a poly(ethylene glycol) alkyl ether arm. The following reaction was done at sub-reflux in a nitrogen blanketed reactor. A 1 liter flask was fitted for portionwise addition of the amine solution. The following charge was used:

20

Part	Component	Wt., grams
I	polyester from Example 1	105.98
	Methoxypropyleneglycol acetate, <0.05% water	300.00
	Desmodur IL	155.52
II	1-(3-aminopropyl)imidazole	16.26
	Methoxypropyleneglycol acetate, <0.05% water	88.91
III	1-(3-aminopropyl)imidazole	0.80

- 25 There was an excess of about 14% isocyanate used. Part of this was used in a final hit of 1-(3-aminopropyl)imidazole (Part III) to give a theoretical excess of 11.3% of isocyanate. The ultimate fate of the balance of the isocyanate is unknown, but based on the absence of IR peaks specific to isocyanate, reactive isocyanate groups are not in the product.

Part I was charged to the flask and heated under nitrogen for 2 hours at 70°C. Parts II and III were then added according to the following log:

Time, min.	Temperature, °C	Comments
0	61	73.6 g of II added (70%)
10	57	Addition complete, heat on
25	60	IR shows isocyanate
40	58	10.52 g of II added (10%)
55	55	IR shows isocyanate
65	55	10.52 g of II added (10%)
80	56	IR shows isocyanate
90	55	10.52 g of II added (10%)
105	56	IR shows isocyanate
145	56	Part III added, =5% excess
160	56	No isocyanate, rxn complete

The product solution had the following characteristics:

Test	Result
% Solids (wt)	30.46
GH Viscosity (Stokes)	C-1/4 (0.80)
Amine Number solution (solids)	11.3 (37.01)
Theoretical amine number, on solids	38.2
KHN of film	1.65

5 Example 6:

A dispersant in accordance with the invention was prepared by reacting an isocyanate with a polyester from Example 2, a poly(ethylene glycol) methyl ether ($M_n = 2,000$), and a diamine. The dispersant was at least as good as that of Comparative Example A, but the presence of the poly(ethylene glycol) methyl ether arm makes the dispersant more compatible with polar solvents and water.

10

Reactant	Active group	MW	Conc., Meq/gm
polyester from Example 2	OH	1183.0	0.845
poly(ethylene glycol) methyl ether	OH	2000	0.500
1(3-aminopropyl)imidazole	NH ₂	125.18	7.99
Desmodur IL (Bayer Corp.)	NCO	787	3.81

This reaction was also done at sub-reflux in a nitrogen blanketed reactor.

The 1 liter flask was fitted with a dropping funnel for portionwise addition of the amine solution. The following charge was used:

15

Part	Component	Weight, grams
I	polyester from Example 2	102.05
	Methoxypropyleneglycol acetate, <0.05% water	300.00
	Poly(ethylene glycol) methyl ether, Mn = 2000	14.65
	Desmodur IL	135.05
II	1-(3-aminopropyl)imidazole	15.77
	Methoxypropyleneglycol acetate, <0.05% water	99.14

- Part I was charged to the flask and headed under nitrogen for 2.5 hours at 70°C. Part II was then added according to the following log. In this experiment, even though the calculation showed that 14.6% excess isocyanate was being used, all of the isocyanate was used up by the charge so that no additional amine was needed (i.e., no Part III was needed as in Comp. Ex. A above).

Time, min.	Temperature, °C	Comments
0	74	57.46 g of Ex. 2 added (50%)
10	72	Addition complete
25	60	IR showed isocyanate
35	59	28.73 g of Ex. 2 added (25%)
45	56	Addition complete
60	50	IR showed small isocyanate peak
70	47	28.73 g of Ex. 2 added (25%)
80	45	Addition complete
95	41	No isocyanate, reaction complete

- The product solution had the following characteristics:

Test	Result
% Solids	30.16
GH Viscosity (Stokes)	H-1/4 (1.92)
Amine Number solution (solids)	10.94 (37.27)
Theoretical amine #	35.34
KHN of film	0.80

- The lower percent of Desmodur IL, the hard component in the reaction (33.76% versus 36.48%) is thought to account for the lower hardness. This is the result of the use of the longer arms in this product.

- Example 7:** Example 6 was repeated, except that 4-(3aminopropyl)morpholine was used as the diamine.

Example 8: Example 6 was repeated except that Desmodur HL was used as the isocyanurate.

Example 9: Example 8 was repeated except that 3-aminomethyl pyridine was used as the diamine.

Example 10: Example 8 was repeated except that 3-dimethylamino propylamine was used as the diamine.

Bottle grinds with 40 parts of dispersant to 100 parts of pigment (except carbon black where 125 parts dispersant was used). The dispersions were allowed to settle overnight and the dispersed material examined at 200-400 x for extent of flocculation. The results are found in the table below, with the values as shown in the key:

Table 2: Dispersant Activity

Pigment Name and Source	Dispersant					
	Comp. Ex. A	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8
Blue 15:2, Ciba; (CAS# 855-12-3)	0	0	0	0	0	0
Blue 15:2, Ciba; (CAS# 436-78-6)	0	0	1	0	0	0
Red 101, BASF	0	0	3	0	0	0
Black 7, Columbia	0.5	1	3	0	0	0
Red DPP, Ciba	1.5	0	0.5	3	3	3
Quinacridone, Ciba	0	0	0	0	0	0
Blue 15:4, Clariant	0	0	0	0	0	0
Green 7, Sun Chemical	0	0	0	0	0	0
Red 179	0	0	0	0	0	0
Rutile TiO ₂ , DuPont	0	0	0	0	0	0
Violet 19, Ciba; (CAS# 51-03-0)	3	2	0.5	0	0	2.5
Violet 19, Ciba; (CAS# 784-63-8)	0	0.5	2.5	0	0	0
Yellow 154, Clariant	0.5	1.5	0	0	0	3
Yellow Fe ₂ O ₃ , Bayer	0	0	0			
Yellow 184, Ciba	0	0	0.5	0	0	0

Key

0 deflocculated, Brownian motion
 1 slightly flocculated
 2 moderately flocculated
 3 severely flocculated

Pigment Manufacturers:

	Ciba	Ciba Specialty Chemicals Pigments Division, Newport,
	DE	
5	BASF	BASF Corp., Charlotte, NC
	Columbian	Columbian Chemicals Co., Marietta, GA
	Clariant	Clariant Corp., Charlotte, NC
	Sun Chemical	Sun Chemical Corp., Cincinnati, OH
10	Bayer	Bayer Corp., Pittsburgh, PA

Example 11:

- Example 6 was repeated to prepare a dispersant having a higher content of poly(ethylene glycol) methyl ether. Assuming an average isocyanate functionality of 6, the dispersant will contain, on average, 0.5 moles of the hydrophobic polyester arms, 0.9 moles of the hydrophilic poly(ethylene glycol) methyl ether arms and 2.2 moles of the imidazole groups.

Reactant	Conc., Meq/gm	Weight	MEQ of Functional Group	Mole % of isocyanate consumed
polyester from Ex. 2	0.845	15.99	13.51	13.91%
poly(ethylene glycol) methyl ether, Mn 2,000	0.50	48.35	24.18	24.89%
1(3-aminopropyl)imidazole	7.99	7.44	59.45	61.20%
Desmodur IL	3.81	28.22	107.52	

- This reaction was done at sub reflux in a nitrogen blanketed reactor. The 1 liter flask was fitted with a dropping funnel for portion wise addition of the amine solution. The following charge was used:

Part	Component	Wt., gm	% of Solids
I	polyester from Ex. 2	47.97	16.00
	Poly(ethylene glycol) methyl ether Mn 2000	145.06	48.40
	Desmodur IL	169.31	28.20
II	I-(3-aminopropyl) imidazole, BASF	22.31	7.4
III	isopropyl alcohol	215.35	
IV	Tetrahydrofuran	75	
V	water	100	
VI	water	100	

Part I was charged to the flask and headed under nitrogen for 3 hours at 70°C. Although it became fairly viscous, it was still easy to stir. IR indicated an appropriate drop in isocyanate had occurred. Part II was then added over about 3 minutes at about 70 °C. The temperature rose to 75 °C, and the mixture became very viscous. Part III was added, then part IV without preventing the material from becoming gel like. Only when part V was added did the mixture begin to thin and go into solution. It was held for 96 hours at 25 °C with occasional stirring as it dissolved. Finally part VI was added to thin the clear light yellow solution for filtration through a stainless steel mesh paint filter.

The product solution had the following characteristics:

Test	Result
% Solids	34.8
Theoretical solids	34.3
GH Viscosity (Stokes)	K-1/2 (2.6)
Theoretical amine #, on solids	33.3

This clear solution became colloidal when diluted to 10% with water. The diluted material was hazy and not entirely free of large particles.

5

Example 12: Dispersant with Methyl Methacrylate and Methoxy PEO 2000 Arms

10 This dispersant can be prepared using the following charge. A theoretical excess of 10% Desmodur IL is included.

<u>Part</u>	<u>Component</u>	<u>Weight, grams</u>
I	Poly(methyl methacrylate) with OH from first acrylic example, above	570
	Methoxypropyleneglycol acetate, <0.05% water	900
	Poly(ethylene glycol) methyl ether, Mn-2000	200
	Desmodur IL	174
II	1-(3-aminopropyl)imidazole	12.5
	Methoxypropyleneglycol acetate, <0.05% water	100

15 Charge part I to the reactor and heat under nitrogen for 2.5 hours at 70 °C. Then charge part II. Heat at 60 °C for 1.5 hours to complete the reaction. The product will have a non-volatile content of 33%. The amine number on solids will be about 8.74.

This material will be a good dispersant for acidic pigments and would be particularly suitable for use in acrylic lacquers.

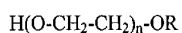
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Where the terms "comprise", "comprises", "comprised" or "comprising" are used in this specification, they are to be interpreted as specifying the presence of the stated features, integers, steps or components referred to, but not to preclude the presence or addition of one or more other feature, integer, step,
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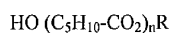
The claims defining the invention are as follows:

1. A pigment dispersant consisting essentially of a reaction product resulting from sequentially reacting an isocyanate oligomer having on a statistical average at least three
5 isocyanate groups with:
- (a) a hydrophilic poly(ethylene glycol) alkyl ether;
 - (b) a hydrophobic polymer selected from the group consisting of polyesters and polyacrylates; and
 - (c) a diamine comprising a primary amine group and a tertiary amine group;
- 10 wherein the poly(ethylene glycol) alkyl ether has the general formula



- wherein n is an integer between 15 and 67 and R is an alkyl of 1 to 4 carbons
15 and has a number advantage molecular weight ("Mn") between 750 and 3000.

2. The dispersant of claim 1, wherein the polyester has the general formula



- 20 where R is an alkyl of 1 to 12 carbons and n is an integer of 6 to 10.

3. The dispersant of claim 1, wherein the polyester is prepared by reacting caprolactone and n-decanol in a mole ratio of 6:1.

4. The dispersant of claim 1, wherein the polyester is prepared by reacting caprolactone and n-decanol in a mole ration of 9:1.

5. The dispersant of claim 1 wherein the polyester is prepared by reacting caprolactone and n-decanol in a mole ratio of 10:1.

6. The dispersant of claim 1, wherein the isocyanate oligomer is a linear, branched or alicyclic isocyanate or biuret prepared from the group consisting of toluene diisocyanate, hexamethylene diisocyanate, biuret of hexamethylene diamine, and mixtures

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8. The dispersant of claim 1, wherein the diamine has the general formula



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