Application Data

MPDiol® Glycol

MPDiol Glycol for High Solids Polyester Coatings

General Information

As a monomer, 2-Methyl-1,3-propanediol (MPDiol® glycol) is a pumpable liquid that reacts with diacids faster than commonly used diols for the synthesis of polyesters. The odd number carbon atoms between the two hydroxyl groups inhibit close packaging in the polymer chains. The unique asymmetric structure of MPDiol affords less crystallizable polyesters with greater transparency.

Key Features and Benefits

Liquid Glycol: MPDiol is supplied as a pure pumpable liquid and requires no additional solvents for processing. In commercial runs water is used as the carrier solvent to dissolve the glycol so that it can be pumped into the reactor. This requires unnecessary processing steps. MPDiol's liquid state eliminates the need for carrier solvent cook-off prior to the addition of diacid in the synthesis of polyesters.

Faster Esterification Rates: The diprimary nature of MPDiol ensures better reactivity with diacids. MPDiol is liquid at 100% solids and is therefore pumpable as supplied. Esterification rates for the same acid value were up to 30% faster with MPDiol.

Low Viscosity Polyester: Polyesters resulting from the reaction of MPDiol with diacids such as adipic, isophthalic, or mixtures thereof show comparable performance with a substantial lowering of viscosity when compared with more common polyesters. This reduces the amount of solvent required in the final formulations making these more environmentally friendly and compliant.

High Solids Polyester Resins Synthesis and Formulation

Two polyester resins were prepared using MPDiol and a blend of adipic and isophthalic acids. The reaction was performed in batch at 210 °C, under nitrogen, with stirring. The acid number was monitored by titration; expected acid number was 10. The resulting resins were compared against a neopentyl glycol (NPG) based resin having the same acid number. (See Table 1) NPG is a commonly used glycol for making polyester resins and is therefore a reasonably good benchmark.

The first noticeable difference between MPDiol and NPG was that it took the MPDiol based resin reactions up to 30 percent less time to reach the desired acid number. Resin A reached the expected acid number after 190 minutes, Resin B after 220 minutes, and the Control took 270 minutes to reach the same number. This is primarily due to the water content in the starting glycol. A cook-off step is generally performed prior to acid addition to dry out the glycol. NPG is commonly made pumpable by adding 10 wt% of water while MPDiol is a pumpable liquid at room temperature and requires no dilution. Prior to esterification MPDiol will require little time for cook-off to dry cutting down processing time.

The properties of the resulting resin, whether MPDiol or NPG based, did not vary significantly for those having the same acid and hydroxyl numbers. MPDiol would therefore be an easy substitute in resin synthesis. Additionally, the resins were varied not only by adding MPDiol but also by varying the amount of isophthalic acid used. When more isophthalic acid was used to replace some of the adipic acid, the ratio of alcohol to acid was kept constant at 57:43, so that no major formulating changes were required. The resulting resin properties were similar to those of the control although the resulting resin is expected to exhibit greater hardness, similar flexibility and weatherability with little effect on stability of the neat and formulated resin.

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Resin Components	*Control*	*A* *Weight Percent*	*B*
MPDiol	—	34.35	33.72
NPG	37.59	—	—
Isophthalic Acid	28.83	30.33	44.68
Adipic Acid	25.33	26.65	13.08
Trimethylolpropane	8.15	8.57	8.42
Hydrated Butyl Tin Oxide	0.10	0.10	0.10
Resin Properties			
Acid Number (mg KOH/g)	7.2	7.2	7.3
Hydroxyl Number (mg KOH/g)	129	138	152
Non Volatile Material, (Wt %)	100	100	100
Gardner Color	<1	<1	<1
Gardner-Holdt Viscosity	>210	>210	>210
Molecular Weight (VPO)	1040	990	1200

Table 1. Resin compositions and properties for both MPDiol and neopentyl glycol based high solids polyester resins.

High Solids, Polyesters

These MPDiol based polyester resins were expected to be less crystalline and that resulting film would be softer, more flexible, and transparent. A change in the isophthalic acid content was expected to toughen the films with only slight yellowing. The results showed that the NPG control and Resin A, a direct substitution of NPG for MPDiol, exhibit similar performance with the exception of lower formulated viscosity and softer films. (See Table 2) Additionally, at higher isophthalic content, Resin B, the resulting coating formulations between the MPDiol and Control resins have similar viscosity. There are some differences, however, in performance such as a gain in adhesion and hardness in Resin B at the expense of a 16% change in the yellow index. (See Figure 1) Noteworthy is that this formulation was prepared twice using two solvent blends; one with aromatic solvent and the other an alcohol. It was observed that using a blend containing alcohol provided lower viscosity and better resin solubility. For this reason the formulations and results shown are for a blended solvent using 48% n-butanol, 44% methyl isobutyl ketone, and 8% propylene glycol methyl ether.

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Formulation Parameters	*Weight %*		
Resin		38.80	
Cymel 303		9.70	
R-900 TiO_2		32.51	
n-Butanol		8.83	
MIBK		8.09	
p-TSA (80% Solid)		1.67	
FC-430 (25% Solids)		0.40	
Test Specifications	*Control*	*A*	*B*
Average Film Thickness	1.0	0.9	1.1
Pencil Hardness	5H	4H	6H
Sward Hardness	37	19	42
T-Bend			
Phosphated Steel	4T	4T	4T
% Adhesion Loss	30	35	15
Primed Aluminum	2T	2T	2T
% Adhesion Loss	0	0	0
Direct/Reverse Impact	160/160	160/160	160/160
Viscosity			
Brookfield (cPs)	254	101	192
Zahn #4 (sec)	160	113	171
Ford #4 (sec)	622	435	665
Gloss 60°	95	95	98
Cross Hatch Adhesion	4.5	4.5	5.0
Wt/gal	11.7	11.7	11.5
% Solids	82	82	82
VOC (LB/gal)	2.06	2.11	2.04

Table 2. Formulations and film properties for three high solids polyesters; two test resins based on MPDiol glycol and the control, a neopentyl glycol based polyester.

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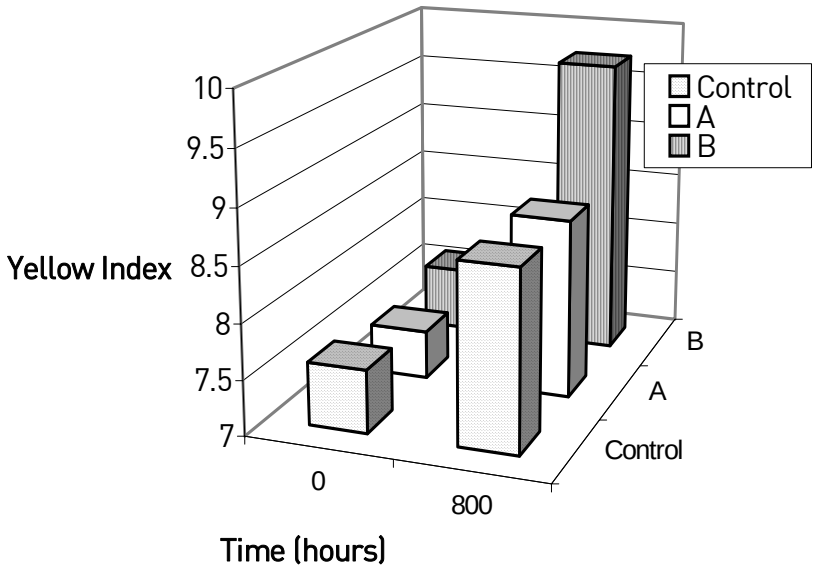

Figure 1. Change in Yellow Index after 800 hours of exposure testing of the three high solids polyesters. MPDiol glycol test polyesters as compared to the neopentyl glycol based control.

Summary

MPDiol presents a viable alternative glycol with excellent property enhancement to fit the polyester resins manufacturers' and formulators' needs for new generation lower cost production and environmentally compliant polyesters.

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