Acrylated Performance Products for Sandable Sealers

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INTRODUCTION

Unsaturated polyesters diluted with styrene or acrylate monomers are commonly used to formulate wood sealers (1-3). The use of acrylate monomer has become more common as it avoids the strong odor as well as the viscosity instability caused by the volatility of styrene.

Although unsaturated polyester systems show poor mechanical properties and low humidity resistance (4) they impart good substrate wetting and adhesion properties (5,6) and they represent an economic alternative to coatings based on acrylate oligomers. It is estimated that 50% of the vehicles used in wood fillers in North America are based on unsaturated polyester resins (7).

Surface Specialties has developed two acrylated experimental products to formulate highly filled wood sealers. These products are characterized by excellent substrate and pigment, and were designed to impart good mechanical properties. We have prepared model wood sealer formulations and compared their performance properties with those obtained with sealers based on unsaturated polyester resins.

Based on our experimental results we conclude that the acrylated experimental products are suitable to formulate sealers with improved reactivity, properties and economics than sealers based on unsaturated polyester resins/acrylate monomer. The economic advantage results from the superior pigment wetting capabilities of the acrylated oligomers that allow the use of higher filler to resin ratio than with the unsaturated polyester/acrylate monomer systems.

EXPERIMENTAL SECTION.

Materials & Formulations

Three commercial products based on unsaturated polyester resin were obtained to compare their performance with the acrylated experimental products developed by Surface Specialties. Typical properties are summarised in Table I.

Table I

Typical properties of products used to formulate wood sealers

Product	Resin (%)	Monomer	Viscosity at 25 ^{o}C (cP)
Unsaturated polyester 1 (UPE1)	60	Difunctional acrylate monomer	2000

Unsaturated polyester 2 (UPE2)	65	Difunctional acrylate monomer	4000
Unsaturated polyester 3 (UPE3)	76	Styrene	1800
Experimental Product 1	100	None	5700
Experimental Product 2	100	None	14000

Experimental Product 2 is a higher viscosity oligomer designed to impart better flexibility and impact resistance than Experimental Product 1.

Tables II and III show the model formulations used for testing. The monomer and oligomer contents were adjusted to give the same resin level at a given filler concentration.

Table II

Sealers containing 34% filler and 23% resin

UPE 1	38.3 %				
UPE 2		35.4%			
UPE 3			30.3%		
Experimental Product 1				23%	
Experimental Product 2					23%
Filler	34	34	34	34	34
Monomer	18.7	21.6	26.7	34	34
Acrylated amine	5	5	5	5	5
Photoinitiator	4	4	4	4	4

Table III

Sealers containing 54% filler and 14% resin

UPE 1	23.3%				
UPE 2		21.5%			
UPE 3			18.4%		
Experimental Product 1				14%	
Experimental Product 2					14%
Filler	54	54	54	54	54
Monomer	13.7	15.5	18.6	23	23
Acrylated amine	5	5	5	5	5
Photointiator	4	4	4	4	4

Methods

Formulations were prepared by blending the required amounts of reagents, adjusting the diluent to obtain the same resin content. The filler was incorporated incorporated at medium speed using a disperser. Viscosity of the formulations at 25 ^{o}C was measured with a Brookfield DV-II+ viscometer at 10 and a 100 rpm, the spindle being selected according to the viscosity range.

Coatings were applied on opacity charts and steel panels with a #12 drawdown bar and cured with an Fusion EPIQ 6000 curing unit using H lamps operated at 300 watt/inch. Cure response was determined by the thumb twist method, the dose being measured with an IL 390B light bug.

Mandrel flexibility, pencil hardness and reverse impact resistance were measured after exposing the samples to 3 times the energy required for curing.

RESULTS AND DISCUSSION

Performance properties

Figures 1 and 2 show the viscosity of the wood sealers based on the different oligomers. Except for the sealers based on UPE 1, pseudoplasticity of the coatings was low or undetectable.

At both filler concentrations the viscosity of the formulas based on the acrylated experimental products is lower than those based on unsaturated polyesters, a consequence of the higher pigment wetting ability of the acrylated oligomers. In particular, the viscosity of the sealers based on UPE/monomer containing 34% filler is similar to the sealers based on the acrylated experimental products containing 54% filler. As a consequence, the sealers based on the acrylated experimental products turn out to be more economical than those based on UPE/monomer even though the resins are more expensive (see later).

The viscosity of the sealers based on UPE 3 is higher than for the formulas based on Experimental Product 1, but the difference is less significant. As a first approximation this viscosity difference will be neglected in the analysis.

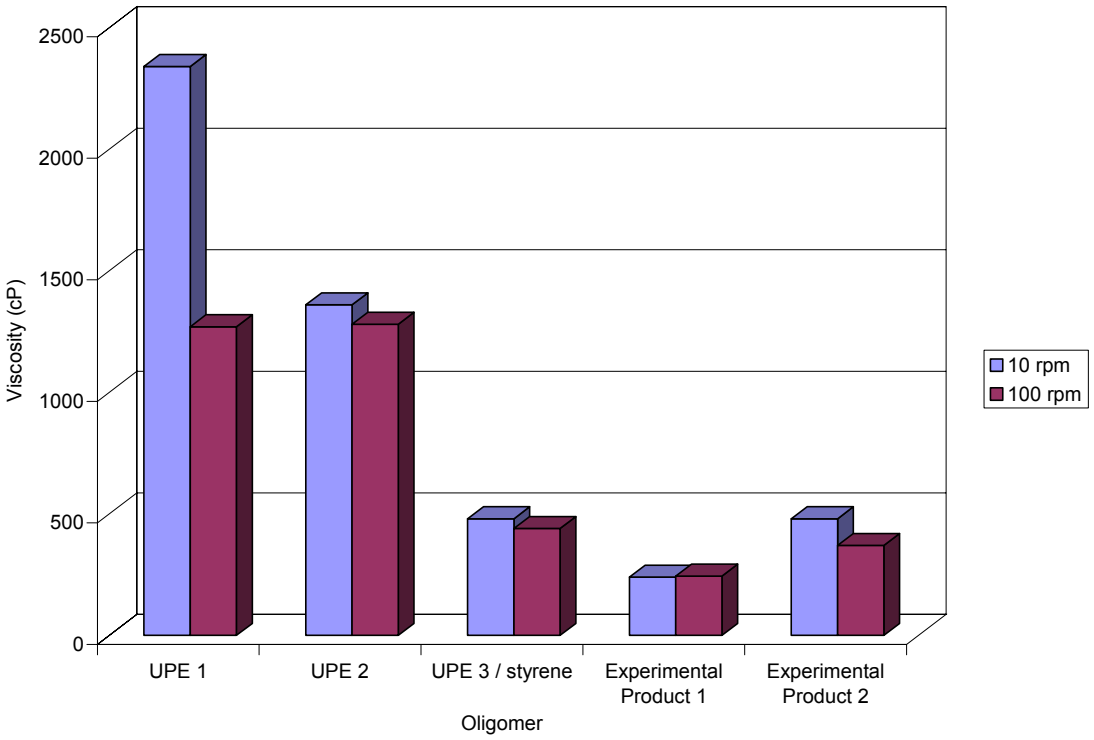

Figure 1

Viscosity of wood fillers containing 34% filler

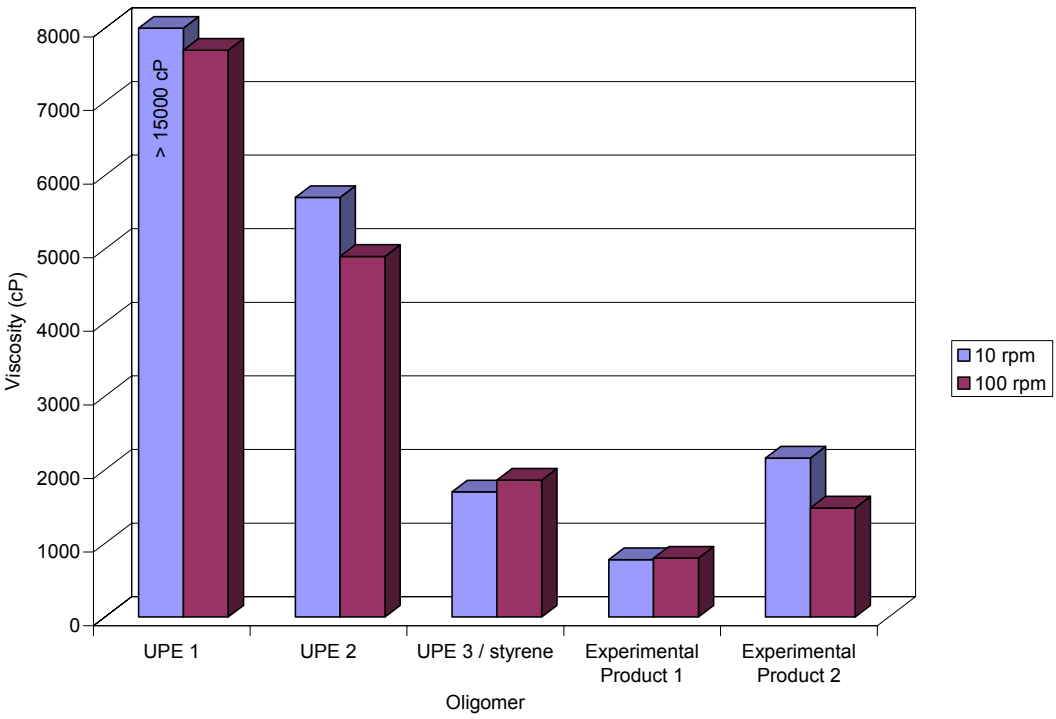

Figure 2

Viscosity of wood fillers containing 54% filler

Figures 3 and 4 show the energy density required for cure, and the reverse impact resistance obtained for the different cured coatings. Pencil hardness was similar for all formulas (7 – 8 H), and all cured samples passed the Mandrel test. Because of the high viscosity of the fillers based on UPE 1 and UPE 2 containing 54% filler their properties were not determined.

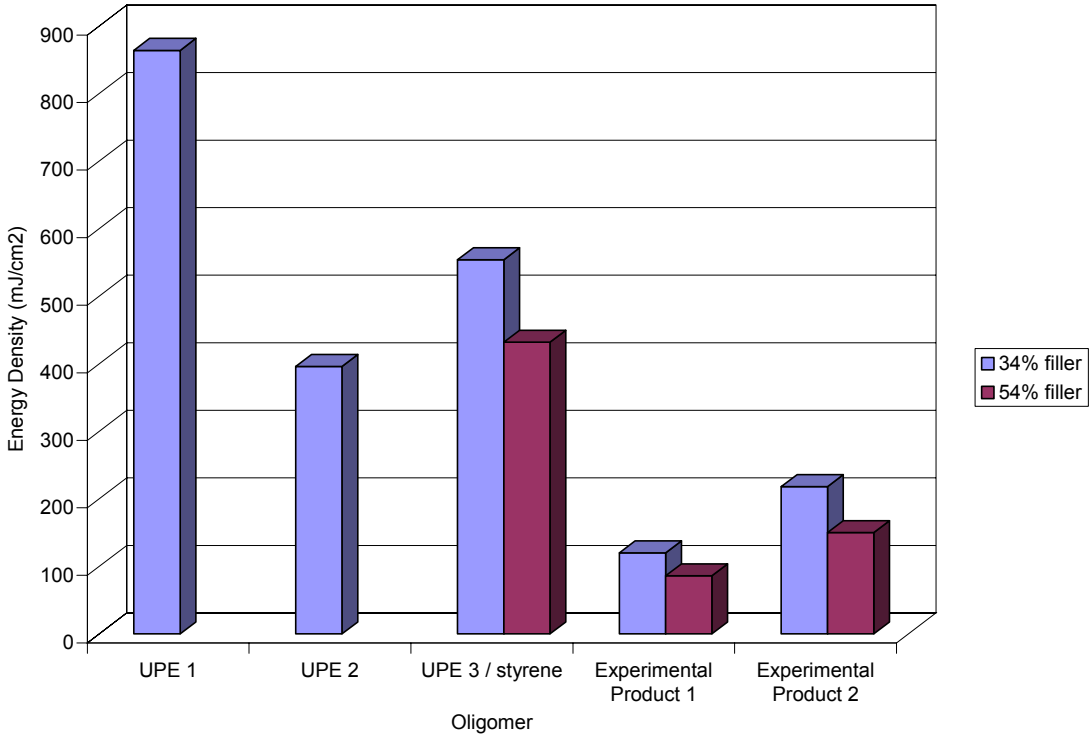

Figure 3

Energy density required for curing. Lamps operated at 300 watt/inch.
Formulations shown in Tables II and III

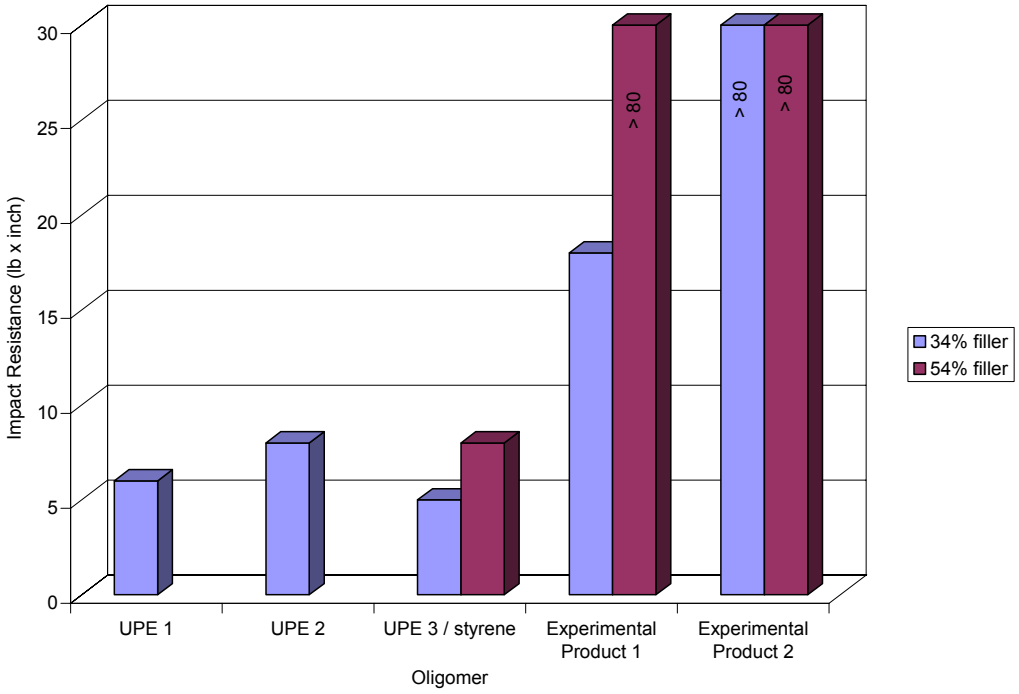

Figure 4

Reverse impact resistance of the cured coatings
Formulations shown in Tables II and III

As can be seen from Figures 3 and 4, the sealers based on the acrylated performance products are 3-5 times more reactive than those based on unsaturated polyesters and shows better impact resistance, the latter effect being more significant for Experimental Product 1 when the filler concentration is 54%. Experimental Product 2, being more flexible, shows impact resistance greater than 80 lb x inch at both filler concentrations.

Economic Analysis

As the results presented in the previous section show the performance properties of the sealers based on the acrylated experimental products are superior to those obtained with unsaturated polyesters. Whether a user switches from one system to the other depends on the cost associated with this higher performance. Table IV shows the relative cost of the different raw materials calculated from current market prices.

Table IV

Relative cost of raw materials used in wood sealers
Market price of UPE 2 is used as reference

Product	Relative price

UPE 1	1.03
UPE 2	1.00
UPE 3	0.59
Experimental Product 1	1.24
Experimental Product 2	1.36
Filler	0.06
Monomer	0.76
Acrylated amine	1.58
Photoinitiator	4.12

Figure 5 shows the relative cost calculated for the formulations shown in Tables II and III.

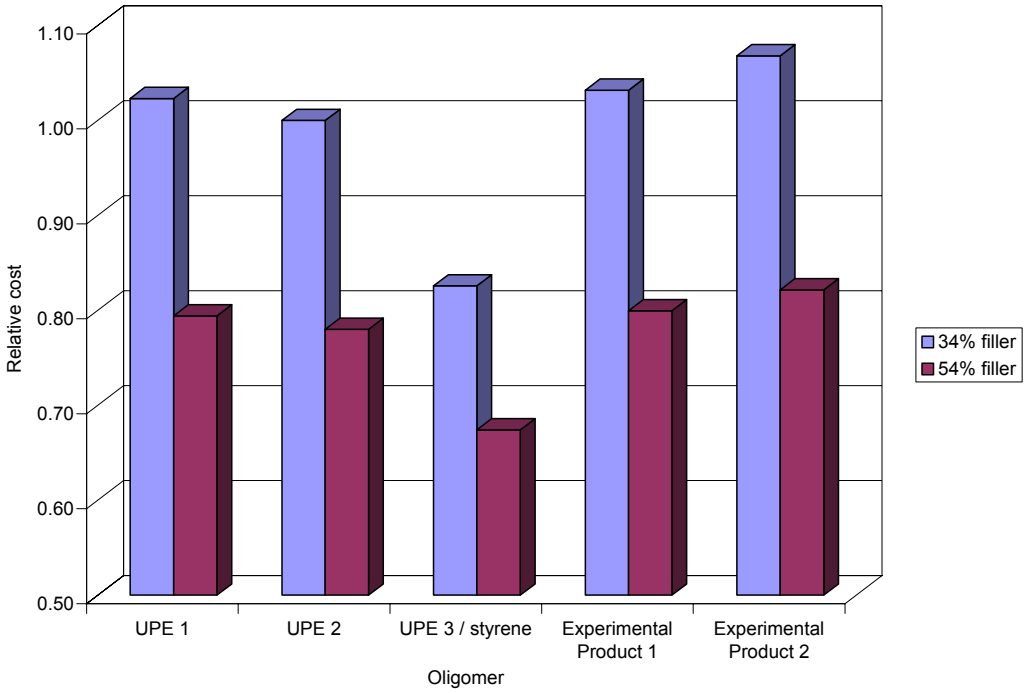

Figure 5

Relative cost of wood sealers. Formulations in Tables II and III
Calculated cost of sealer based on UPE 2 containing 34% filler is used as reference

The cost of the sealers based on the acrylated experimental products are higher than for UPE/acrylate monomer systems at any given filler concentration. However, as indicated earlier, the viscosity of the sealers based on UPE/monomer containing 34% filler is similar to the viscosity of the sealers based on the acrylated experimental products containing 54% filler.

Comparing the cost of formulations having similar viscosity (acrylated experimental products containing 54% filler with UPE/monomer containing 34% filler), it can be seen

there is a significant cost advantage of the wood sealer based on the acrylated experimental products, see Figure 6.

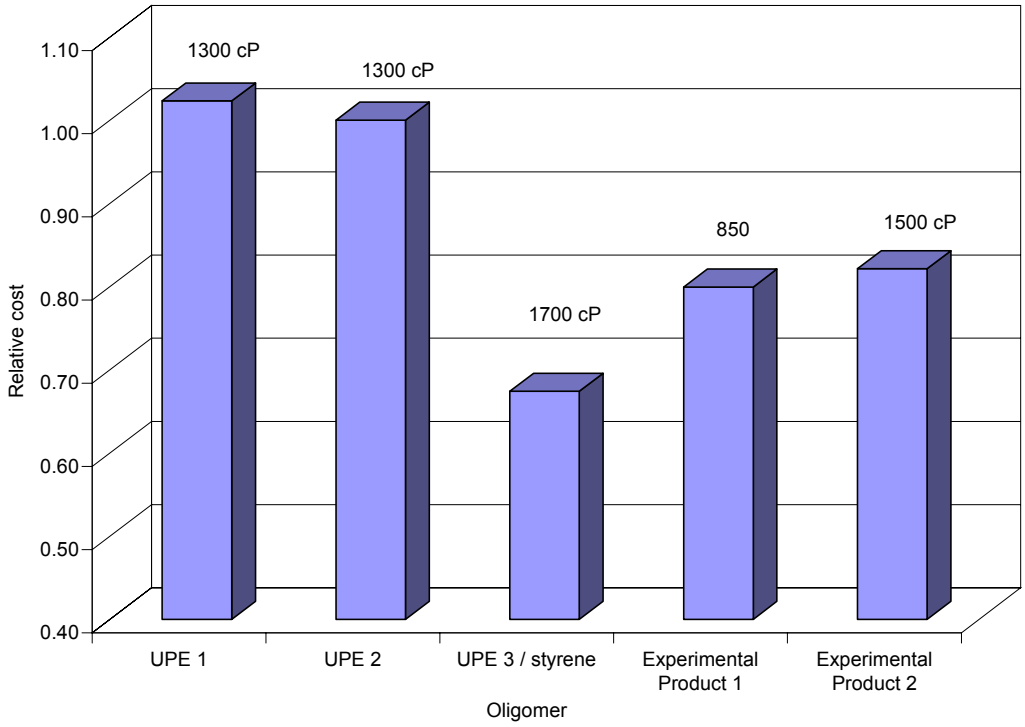

Figure 6

Relative cost of wood sealers having similar viscosity. Formulations in Tables II and III
Calculated cost of sealer based on UPE 2 containing 34% filler is used as reference
Viscosity of the sealers at 25 ^{o}C is indicated above the bars

A different situation exists when comparing sealers based on the acrylated performance products with UPE/styrene systems as the cost is significantly lower. The feasibility of switching needs to be analysed on a case by case basis, although the general trend in wood finishing is to discontinue the use of UPE/styrene sealers because of high odor, low cure speed and poor line stability. The use of UPE/styrene sealers in commercial lines normally requires the viscosity to be adjusted every 30-45 minutes.

CONCLUSIONS

Our experimental results indicate that the sealers based on the acrylated experimental products show higher reactivity and better properties than those based on unsaturated polyester resins. In addition, a sealer based on the acrylated experimental products can be more economical than a sealer based on unsaturated polyester/acrylate monomer system even though the cost of the acrylated oligomer is higher. This result is a

consequence of the superior pigment wetting capabilities of the acrylated experimental products, which allows incorporation of higher filler concentrations while maintaining a suitable application viscosity.

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