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4-Polymer Engineering and Applications

Water-Based Coatings Based on Mixtures of Acrylic Dispersions and Alkyd Emulsions

Patrick J. J. Kivit,[1] *Esteban Aramendia,**[2] *Amadeo A. Cabrera,*[2] *Lucero M. Ríos*[2]

Summary: In this work acrylic dispersions were mixed with alkyd emulsions to obtain coatings that lower the amount of volatile organic compounds (VOC) in surface coatings. The advantage of this approach is that the fast drying of the acrylic is combined with the good film properties of the alkyd. Films produced with an alkyd and a soft acrylic (AA1) did not exhibit good film properties. Whereas, films produced with a hard acrylic (SA1 and AA2) and a soft alkyd gave films with good appearance, appropriate drying times, superior pendulum hardness and promising values of gloss. VOC was calculated below 25 g/L. The novel mixtures may be applied as high gloss enamels for architectural coatings.

Keywords: acrylic; alkyds; blends; coatings; dispersions

Introduction

Replacement of solvent borne surface coatings by their aqueous-based counterparts is in investigation for several decades. The legislative pressure, especially in Europe, has enhanced this research during the last decade. The VOC in coatings has already been reduced by the introduction of water-based emulsion systems. However, this system has some major disadvantages compared to the solvent-based systems, for example worse mechanical properties.

Advantages of alkyd systems are that they have high gloss, hardness and a good durability. This is due to the exceptional film-forming ability and ambient curing of the alkyd film. Furthermore they have a good water and chemical resistance. The disadvantage of alkyd systems is that alkyd coatings are solvent-based and show long drying times.[1]

The idea behind the mixing or hybrid formation of acrylic dispersions and alkyd emulsions is to combine the fast drying of the acrylics and the good film properties of the alkyd and to diminish the negative characters of both coatings. The solvent normally used for the alkyd resin is displaced by the water of the acrylic dispersion. The formed mixture or hybrid should combine the major initial properties of both systems.

Mixtures of both can be made by mixing an acrylic dispersion with an alkyd emulsion. Furthermore an alkyd resin can be slowly added to an acrylic emulsion and stabilized with additional surfactant. Acrylic-alkyd hybrids can be produced by polymerization of the acrylic in presence of the alkyd.

Blending of an alkyd with an acrylic is mainly done by emulsification of the alkyd in the presence of an acrylic dispersion. This is usually done by slowly addition of the alkyd resin to an acrylic dispersion in the presence of additional surfactant.[1,2] The final properties of the blend can be influenced by several parameters and as a result oil in water (o/w) emulsion or a water in oil in water (w/o/w) is formed.[3]

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[1] Department of Chemical Engineering and Chemistry, Eindhoven, The Netherlands
[2] Centro de Investigación en Polímeros, COMEX, Tepexpan, Mexico
E-mail: earamendia@cip.org

It has been shown that blends prepared by this mechanism are not always completely stable. Factors that can affect the stability are the surfactant concentration, the pH[4] and the incompatibility of the alkyds with the acrylics. The alkyd is hydrophobic and can give phase separation after the addition to the acrylic dispersion. Another possibility to mix an alkyd with an acrylic is to mix a stabilized alkyd emulsion with an acrylic dispersion.[5] The advantage of this system is that both polymers are already stable in an aqueous medium and the possibility to get a stable blend increases. So, in this work the strategy of mixing a commercially available water reducible alkyd and different acrylics was used in order to obtain low VOC, high gloss enamels for architectural coatings. This is, to our best knowledge, the most inexpensive method to obtain the goal stated above.

Preparation of Acrylic-Alkyd Blends

The mixing of the acrylic dispersion and the alkyd emulsion was carried out in a 500 ml 3 neck round bottom flask. The mixture was stirred by an electrical stirrer and was heated until 50 °C with a heat mantel with a heat control. The alkyd emulsion was added drop wise to the acrylic dispersion at a constant speed of 400 rpm. Double stir impeller was used during the mixtures. No additional surfactant was used. Afterwards the amount of water was added at the same speed. The blend was stirred after the addition of the alkyd for an additional time of 30 minutes. All acrylic and styrene-acrylic latexes and alkyds with different properties were used; as well as different ratios of acrylic dispersion/alkyd emulsions.

Analysis and Properties of the Samples

The characterization of the samples comprised the analysis of the viscosity, solids weight content, particle size distribution, pH, minimum film formation temperature (MFFT) and thermal stability.

The viscosity of the samples was measured by a Brookfield viscosity meter LVTDV-II. The viscosity in centipoises (CPS) is measured at different rotation speeds (0.5-100 RPM).

The solid weight content was determined by evaporating the volatile species present in the dispersions in a furnace at 105 °C. The solid weight content is calculated by dividing the final weight by the initial weight.

The Particle Size Distributions were measured by Dynamic Light Scattering. The equipment used was a Nicomp^{TM} 380, in use with Nicomp PSS Cw388 (2001), application version 1.71. Samples were prepared by diluting 1 drop of latex in 15 ml ultra pure water. The sample was sonificated in a water bath for 3 minutes before measuring. The pH of the samples was measured on a Metrohm 691 pH meter. Thermal stability of the samples was measured after three and seven days. The viscosity of the samples was measured at a range of rotating speeds (0.5-100 RPM) after being stored at 60 °C for the aforementioned time. The MFFT was measured by applying a 5 μm film of the sample on a substrate having a known temperature gradient. The MFFT was determined by selecting the point where the film stops showing cracks or the point where the films turned transparent. The equipment used was a RhoPoint MFFT Bar 90, with the build in equipment RhoPoint WP Unit, RhoPoint TC9 Unit and a RhoPoint IM Unit. DSC analysis was carried out using a DSCQ2000 from TA instruments. Measurements were carried out in nitrogen atmosphere at a heating rate of 3 °C/min. The value of Tg was calculated from the maximum of the reversible heat-flow versus temperature diagram.

Films of the samples were prepared by the addition of the samples onto glass plates with a doctor blade of 5 μm. For the first set of experiments, no driers were added to the samples. The resulted films were evaluated by visual inspection. The transparency, the cracking and the smoothness were inspected and rated by; 2 very good: 1 good: 0 fairly good: – 1 bad: – 2: very bad.

In a second set of experiments, driers were added to the acrylic-alkyd blends and films were prepared. For measuring the time of drying or curing during film formation a Straight Line Recorder was used. The coating was applied (5 μm) to a glass plate of approximately 30 by 2.5 cm and directly placed on the recorder. A tip was placed on the wet coating and a 3 g weight was put on the tip to increase the pressure on the coating. The tip moved across the coating in a straight line at a constant speed for 24 hour at 25 °C and 50% humidity. All samples were applied at least twice and the drying times were averaged. The four different stages that were determined were the set-to-touch time (stage 1), the tack-free time (stage 2), the dry-hard time (stage 3) and the dry-through time (stage 4).

The time necessary to reach each stage was measured by measuring the length from the starting point to the starting point of the desirable stage. The total length of the glass plate was approximately 12 inches and this agreed with 24 hours of drying.

The hardness of the films was tested by a BYK Gardner Pendulum Hardness Tester. The method used was the König hardness test. The films that were tested were prepared and dried respectively 24 hours and 7 days at 25 °C and 50% humidity before testing. They had a thickness of 5 μm.

For the hardness test a pendulum was brought onto the surface of the film. The pendulum was deflected at 6° and released. The oscillations necessary and the time to go from 6° to 3° were measured. At least two films were measured and the results were averaged.

The hardness is defined as resistance to deformation. Longer damping times indicate that the hardness of the film is higher.[6]

Results and Discussion

Blanks

Different acrylic dispersions were mixed with different alkyd dispersions to investigate the behaviour of the blends. Also the reaction conditions of the mixing were changed. Finally a selection was made of the most promising mixtures to form the paints.

The acrylic dispersions used for the initial research were AA1, SA1 and AA2. AA means all acrylic and SA1 is styrene-acrylic emulsion. The difference between AA1 and AA2 is the Tg of the polymer. AA1 forms a film at room temperature, whereas AA2 and SA1 do not. The alkyd (letter Z in opposition to A from acrylic) emulsions used were ZS, ZM and ZL. These names indicate the oil length of the alkyd: S (short), M (medium) and L (long) respectively. The properties of the initial products are shown in Table 1, including the particle sizes and Brookfield viscosities. The nomenclature of the mixtures was chosen in such a way that the name of the sample indicated the contents of the mixture and the mixing conditions. For example, the initial product in the reactor was put in as first, followed by the name of the product that was added drop wise to the reaction. For example AA2ZLDR2-1 means a mixture of the AA2 acrylic with

Table 1.
Properties of the Initial Acrylic Dispersions and the Initial Alkyd Emulsions.

Product	Solids Content	pH	Oil Length	Volume Particle Size	Viscosity	Thermal Stability
	%			nm	mPa·s (20 RPM)	
AA1	51	8.1	x	147.0	708	Passed
SA1	47	8.3	x	101.2	3310	Passed
AA2	51	8.3	x	165.5	194.5	Passed
ZS	42	5.8	Short	87.1	1006	Failed
ZM	50	5.0	Medium	187.9	308	Failed
ZL	60	5.4	Long	366.8	2175	Passed

the ZL alkyd (long oil alkyd) in a ratio 2:1 acrylic/alkyd. D means that was diluted with water so that all the mixtures produced had the same solids content.

Mixtures

The thermal stability results of the mixtures are shown in Table 2. The table shows the viscosities measured at 20 RPM after keeping the blends for 1, and 7 days at 60 °C. A mixture is stable when the increase of the viscosity is within 25%. No decrease of viscosity had to be remarked, within a 10% error. For all the blends it is indicated whether the mixture passed or did not pass the thermal stability test.

The results indicate that all the mixtures made with the alkyd ZS are unstable, both for the blends with AA1 and the blends with SA1 as the acrylic. These mixtures show coagulum after being stored at 60 °C for three days. In the case of AA1ZSDR1-2, this mixture does not show coagulum, but the sharp decrease in viscosity is shown. This might be expected, because the ZS alone is the alkyd that exhibits the poorest thermal stability. For this reason, no mixtures of ZS with AA2 were carried out.

All the other mixtures made with the acrylic AA1 were stable. This includes the mixtures made from the alkyds ZM and ZL, in spite of ZM as a pure product is not stable.

For the blends prepared form the acrylic SA1 and the alkyd ZM, SA1ZMDR2-1 and SA1ZMDR1-1 were not stable, whereas SA1ZMDR1-2 was stable.

For SA1 and ZL only SA1ZLDR2-1 was not thermally stable, whereas SA1ZLDR1-

Table 2.
Thermal Stability results with the Acrylics AA1, AA2 and SA1 and the Alkyds ZS, ZM and ZL.

Thermal Stability				Film Appearance
(Viscosity in mPa.s at 20 RPM after 1 and 7 days)				
Product	1th day	7th day	Pass/Not Pass	Good/Medium/Bad
AA1ZSDR2-1	155	23.5	Not Pass	Bad
AA1ZSDR1-1	196	30	Not Pass	Bad
AA1ZSDR1-2	317.5	173	Not Pass	Bad
AA1ZMDR2-1	48	56.5	Pass	Bad
AA1ZMDR1-1	51	52.5	Pass	Bad
AA1ZMDR1-2	45	53	Pass	Bad
AA1ZLDR2-1	27	26	Pass	Medium
AA1ZLDR1-1	22	22	Pass	Bad
AA1ZLDR1-2	27.5	27.5	Pass	Bad
SA1ZSDR2-1	368	x	Not Pass	Bad
SA1ZSDR1-1	366	x	Not Pass	Bad
SA1ZSDR1-2	454	x	Not Pass	Bad
SA1ZMDR2-1	130	178	Not Pass	Medium
SA1ZMDR1-1	85	115	Pass	Good
SA1ZMDR1-2	60	67.5	Pass	Good
SA1ZLDR2-1	80	65	Not Pass	Bad
SA1ZLDR1-1	54	61	Pass	Medium
SA1ZLDR1-2	63	64	Pass	Medium
AA2ZMDR2-1	42.5	38	Pass	Medium
AA2ZMDR1-1	38	42	Pass	Good
AA2ZMDR1-2	41	40	Pass	Good
AA2ZLDR2-1	22.5	21	Pass	Bad
AA2ZLDR1-1	21	22.5	Pass	Bad
AA2ZLDR1-2	26	24	Pass	Medium

1 and SA1ZLDR1-2 were stable. The trend is as follows: By increasing the amount of ZL the thermal stability of the mixture is increased. On the other hand, all the samples containing the AA2 were thermally stable.

Films were cast and were evaluated according to the appearance to the naked eye. The presence of cracks, film defects and haziness were investigated. The films made with ZS all gave very poor results and in all cases bad films were formed. This may be an indication of a poor incompatibility between an alkyd with a low oil length and an acrylic latex. This conclusion is supported by the fact that the latex blends of ZS did not pass the thermal stability tests.

The main difference between AA1 and AA2 used is the Tg. AA2 and SA1 both have a much higher Tg than AA1 and therefore is expected that SA1, a hard polymer, to have low mobility. For AA1 the opposite holds true; AA1 is a soft polymer with high mobility. It now can be speculated that soft polymers give rise to phase separation during film formation. An evidence for the bad compatibility is the transparency of the films showing haze. This may indicate the existence of microdomains of different chemical structures. The bad compatibility can also be the cause for the cracks observed in the films. The acceptable smoothness might be by migration of the alkyd to the surface making an uniform and uneven film. This is confirmed taking a look top the mixtures using the all acrylics with the ZL.

The best film properties were obtained with the blends of SA1 and AA2 with the alkyd ZM. This may confirm the idea that for balanced film properties a hard acrylic and a soft alkyd are necessary to promote film coalescence. The oil length of the alkyd may also play a role and ZM is preferred.

After this initial screening some of the acrylic-alkyd blends containing AA1 or SA1 in combination with ZM or ZL were dried after the addition of driers to see the effect of the driers on the blends.

Table 3.
Drying times for Acrylic-Alkyd mixtures containing Driers.

AA1ZMDR2-1	Film 1	Film 2	Average
Stage 1	x	x	x
Stage 2	0:10	0:30	0:20
Stage 3	0:35	1:07	0:51
Stage 4	1:45	x	*1:45*
SA1ZLDR1-1	**Film 1**	**Film 2**	**Average**
Stage 1	x	x	x
Stage 2	0:15	0:15	0:15
Stage 3	1:35	1:25	1:30
Stage 4	5:45	3:40	*4:42*

Selection of Drier Concentration in the Acrylic-Alkyd Mixtures

The concentrations of driers to be used in the blends were optimized for each of the alkyd used. The concentrations resulted from this optimization work were directly applied to the mixtures and verified if the same concentrations were adequate. Mixtures were chosen randomly. The drying times shown in Table 3 are appropriate and represent interesting advantages in drying time versus pure alkyds.

For example, for AA1ZMDR2-1 and SA1ZLDR1-1 stage 4 was achieved in less than 5 hours. The X means no data, as drying proceeded faster than expected and when it was measured the film already had passed that stage.

Most Promising Mixtures

After the initial screening, SA1ZMDR1-1, SA1ZMDR1-2, SA1ZLDR1-1, SA1ZLDR1-2, AA2ZMDR1-1, AA2ZMDR1-2 and AA1ZLR2-1 mixtures were chosen. This choice was mainly based on the film properties observed in the initial screening. In addition, AA1ZLDR2-1 was chosen to have one mixture containing the acrylic AA1. This mixture did not show a good drying time, but the film properties were the best of all the films containing AA1. The mixtures were produced to have approximately 44 w% of solids. The exact values are shown in Table 4. In this table, the particle sizes of the mixtures are shown. It can be seen that all the mixtures have very low viscosity and most of them have

Table 4.
Properties of the Mixtures with Driers.

Product	Solid Content	pH	Viscosity	Particle size
	%		mPa·s (20 RPM)	nm
AA1ZLDR2-1DRY	43.97	7.59	22	152
SA1ZMDR1-1DRY	44.13	6.91	52.5	141
SA1ZMDR1-2DRY	43.97	6.52	37	165
SA1ZLDR1-1DRY	44.02	7.6	44	208
SA1ZLDR1-2DRY	44.07	7.48	51	203
AA2ZMDR1-1DRY	44.55	6.83	29	168
AA2ZMDR1-2DRY	44.49	6.23	30.5	178

average particles sizes lower than 200 nm. Calculating the average particle size taking into account the number of particles placed in the mixture, there is a good agreement, except in the cases where the alkyd ZL was used. For these mixtures, a smaller particle size than expected was obtained.

New mixtures were made of these blends and the driers were added to the acrylic dispersion before the mixing took place. The way the drier was added did not have a significant effect on final properties.

The film properties of the blends containing the driers are shown in Figure 1. Films were rated according to transparency, crack resistance and surface smoothness. +2 was for an outstanding film, -2 for a poor film and 0 for an intermediate film.

The first observation made for the films containing the driers was that the films were not or were less sticky than the films produced without the driers. From Figure 1 it can be remarked that the visual appearance of the films of SA1 and ZM were more or less the same with and without driers. This also held true for the films of AA2 and ZM. For SA1ZLDR1-2 film appearance was better after the addition of the drier. The transparency for this film showed the same trend as SA1ZLDR1-1 and was worse, but the cracking and the smoothness were better for SA1ZLDR1-2 after the addition of driers. An explanation can be that this film contained more alkyd and as a result the drier had more effect on the film formation of this blend. In addition ZL must be more sensitive to the driers than ZM, because this effect is not observed for the film properties of the films containing ZM.

For AA1ZLDR2-1 only the crack resistance was a bit better after the addition of the driers. The effect of the drier is low, because the concentration of alkyd is low.

To sum up, the films containing ZM as the alkyd showed more or less the same film properties for the blends with and without driers. Only the smoothness of the films changed a bit because of faster drying. The films made with the blends containing SA1 and ZL showed a decrease in the transparency of the films. The film that had a ratio 1-1 did not show more noticeable changes, but the film with ratio 1-2 showed improved crack resistance and smoothness.

Tg's and MFFT's of the Mixtures

The Tg's of the selected blends were measured with and without addition of driers. Results are shown in Table 5. The Tg's of the blends SA1ZMDR1-2DRY and SA1ZLDR1-2DRY were not detected in a temperature range of −80 °C to 100 °C.

The most important result was that two Tg values were found for the mixtures containing the acrylic AA2 and only one for the mixtures containing SA1.

A second observation was that all the Tg values reported are lower than the Tg of the pure acrylic dispersions. The Tg1 values of the mixtures containing AA2 came close to the Tg values of the pure acrylic. This implies that these samples contained domains of pure acrylic, whereas the second

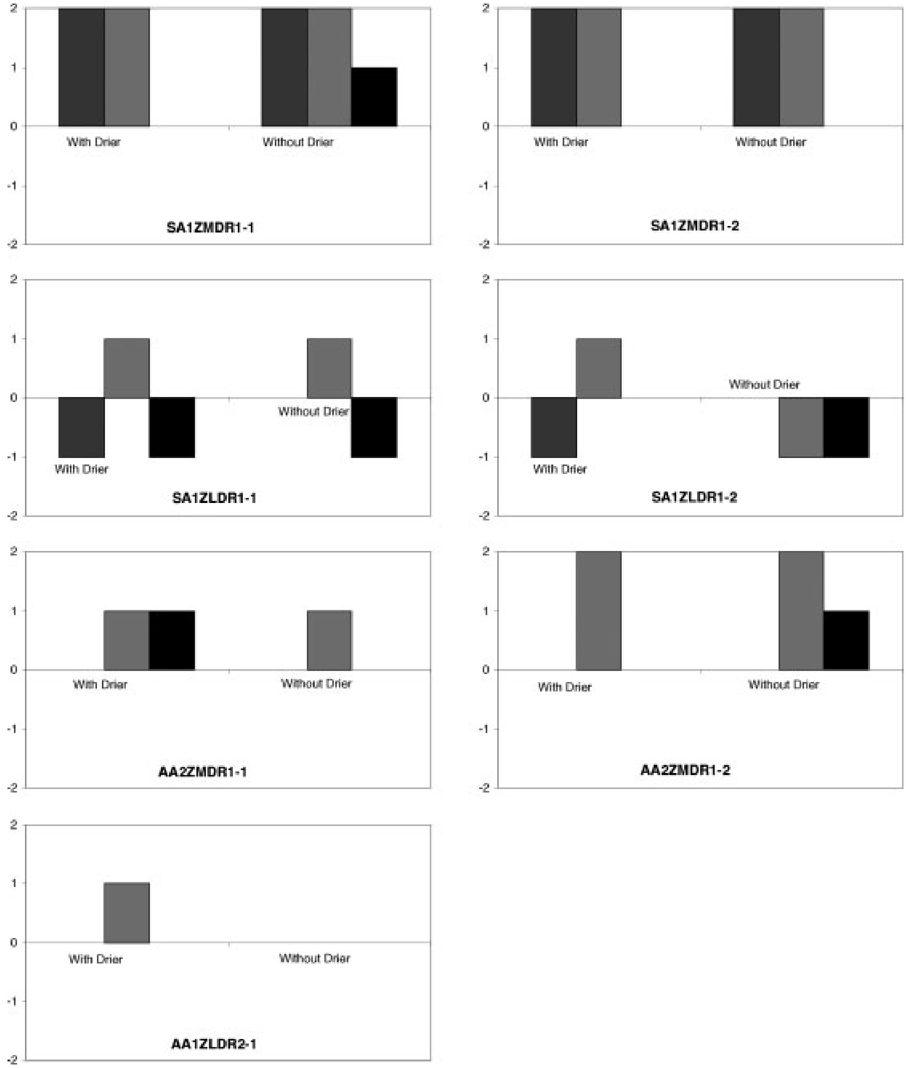

Figure 1.
Film Properties of the Selected Films With and Without Driers. ■ Transparency; ■ Crack Resistance; ■ Smoothness

domain was a homogeneous mixture of alkyd and acrylic.

The mixtures of SA1 only exhibit one Tg which was between 4 °C and 19 °C in absence of driers. The lowest Tg value corresponded to a higher amount of alkyd, as expected. It seemed that in the case of mixtures containing the acrylic SA1 the samples were homogenous and the alkyd plasticized the acrylic polymer.

The Tg could not be detected for the samples containing SA1 with driers in the ratio 1:2. This was because the alkyd crosslinked the entire film and even the acrylic part was not detected. For the ratio 1:1 this was not the case, because the amount of alkyd was not sufficient to crosslink the whole system.

The results also showed that the addition of the driers lower the Tg of the blends in the case where crosslinking of the system did not occur.

Table 5 also shows the MFFT values of some of the mixtures. It must be remarked

Table 5.
Tg's and MFFT's of the Selected Mixtures. N.D. is Not Detected.

Product	DRY		Without Driers		
	Tg 1	Tg 2	Tg 1	Tg 2	MFFT
	°C	°C	°C	°C	°C
AA1ZLDR2-1	6.5	x	7.5	x	<0
SA1ZMDR1-1	10.0	x	15.8	x	12.0
SA1ZMDR1-2	N.D.	x	4.3	x	5.8
SA1ZLDR1-1	12.1	x	19.5	x	<0
SA1ZLDR1-2	N.D.	x	10.9	x	<0
AA2ZMDR1-1	48.3	16.6	53.2	3.8	9.5
AA2ZMDR1-2	51.6	2.3	52.1	2.3	5.0

that the MFFT's were measured without the addition of driers. All the MFFT's measured for the mixtures containing ZM were in between 5 °C and 15 °C. These values were close to the values reported by DSC and this gives credibility to the DSC measurements. Only the MFFT's of the mixtures containing ZL had a value lower than 0 °C and could not be detected for that reason. Probably the high oil length of ZL plasticizes the acrylic to a high extend and lowers the values of the MFFT's.

Hardness

The König hardness of the films made is measured after 1 and after 7 days of drying at 25 °C and a humidity of 50%. The results are shown in Table 6 and Table 7 without and with driers respectively. The averaged oscillations and the averaged time are shown. The target of the hardness is 22 seconds. This value is reported to be a good value for Mexican customers.

The first observation that is made from both Tables is that hardness decreased with increasing alkyd concentration. Both SA1 and AA2 are hard acrylics and a soft alkyd was added to these acrylics, so the decrease of hardness with increasing alkyd concentration was likely to occur. Also from

Table 6.
Averaged Hardness of the Selected Mixtures Without Driers.

Product	After 1 Day		After 7 Days	
	Oscillations	*Time (s)*	*Oscillations*	*Time (s)*
AA1ZLDR2-1	2	5	3.5	7
SA1ZMDR1-1	16	23	15.5	23
SA1ZMDR1-2	6	11	7	12
SA1ZLDR1-1	2.75	6	6	10
SA1ZLDR1-2	2.5	5.5	4	8
AA2ZMDR1-1	10.25	16.25	14	21.5
AA2ZMDR1-2	4.25	8.25	6.5	11.5

Table 7.
Averaged Hardness of the Selected Mixtures With Driers.

	König Hardness			
Product	After 1 Day		After 7 Days	
	Oscillations	*Time (s)*	*Oscillations*	*Time (s)*
AA1ZLDR2-1DRY	3.5	11	4.5	8.5
SA1ZMDR1-1DRY	21.5	32.5	29	42.5
SA1ZMDR1-2DRY	13.5	21.5	20	30
SA1ZLDR1-1DRY	12.5	20.5	25.5	38
SA1ZLDR1-2DRY	8	13.5	17.5	26
AA2ZMDR1-1DRY	18.5	27.5	33.5	48.5
AA2ZMDR1-2DRY	10	16	18.5	28

Table 6, it is clear that the mixture of SA1 and ZM at the ratio 1-1 formed a hard film after 1 day with 16 oscillations. The hardness of SA1 with ZM at the ratio 1-2 was low, but it must be considered that these results are obtained without addition of driers.

The hardness of the films made from SA1 and ZL without driers were low with approximately 3 oscillations. This was also the case for the hardness of AA1ZLDR2-1 with 2 oscillations. For AA2 with ZM the hardness of the ratio 1-1 was more reasonable and the hardness of the ratio 1-2 was low after 1 day of drying.

The hardness of the films without driers after 7 days is increased compared to the ones after 1 day. Only the films consisting of SA1 and ZM did not show a clear increase of the hardness. None of the mixtures reached the required hardness after seven days without addition of driers.

Table 7 shows the hardness of the films with the addition of the driers. It is remarked that the hardness increased after the addition of the driers for all the samples. After 7 days all the films containing drier showed an increase in hardness. All the films with the ratio 1:1 had a good hardness after this drying time. The films SA1ZMDR1-1DRY and AA2ZMDR1-1DRY had a very high hardness with 29 and 33.5 number of oscillations respectively. The hardness of the films with the ratio 1:2 was reasonable, but the hardness of the film AA1ZLDR2-1DRY still was very low. An explanation for the poor result of AA1ZLDR2-1 is that the acrylic AA1 is a soft acrylic and does not contribute to the hardness like SA1.

The effect of the drier is clearly seen from these results. For the films containing the alkyd ZM the hardness doubled when the drier was added. This is essentially true for 1 day drying as well as drying for 7 days.

For the films containing the alkyd ZL and the acrylic SA1 the effect of the driers is even more important, because the oil length in ZL is 73%. The hardness of the films without the driers was low with respectively 6 and 4 oscillations after 7 days of drying. For the films with driers these values were respectively 25.5 and 17.5 oscillations. The hardness of these films is improved with a factor of 4 after the addition of the driers. This is not observed for AA1ZLDR2-1DRY.

Table 8.
Results of Gloss Measurements of the Selected Mixtures.

Product	Gloss 60°	VOC (g/L)	Number of Tg detected
SA1ZMDR1-1DRY	73.9	20	1
SA1ZMDR1-2DRY	81.4	20	0
SA1ZLDR1-1DRY	76.4	21	1
SA1ZLDR1-2DRY	88.1	21	0
AA2ZMDR1-1DRY	47.1	20	2
AA2ZMDR1-2DRY	50.4	20	2
AA1ZLDR2-1DRY	50.6	19	1

Gloss

The gloss of the mixtures was measured after drying for 24 hours at an angle of 60° after being formulated into paint. The results are shown in Table 8. The set value for the gloss was 85. The formulation into a paint remains is a proprietary but it is being formulated below a VOC lower than 25 g/L as it can be seen in Table 8 for all the mixtures studied.

According to these preliminary results one mixture (SA1ZLDR1-2DRY) exceeded the target; and exhibited a very high gloss with 88.1. The target for the gloss was 85 at 60°. There are other samples, however, that they are close to the target and may reach the desired values just by making some adjustments in the formulation of the paint.

It is remarked that the gloss improved with increasing alkyd concentration and that there is a direct correlation with the amount of Tg found in the mixture. If the film is totally crosslinked (no Tg) gloss is maximized.

Conclusions

In this work mixtures of acrylic dispersions and alkyd emulsions are produced, where the alkyd is fed into the reactor containing the alkyd. The initial screening of the mixtures showed that in order to obtain good film properties a hard acrylic has to be mixed with a soft alkyd.

After the initial screening, seven mixtures were selected and driers were added to these mixtures. The addition of driers to the mixtures in general does not have a remarkable influence on the appearance of the film. For film hardness it is concluded that it increases with increasing Tg. Gloss of the final films of the paints depends on the particle sizes of the mixtures and the compatibility of the components of the mixture. The more Tg are detected, the lower the gloss, meaning that a higher compatibility of the components in the mixture improves the gloss.

The most promising mixtures are SA1ZLDR1-2, SA1ZMDR1-1 and SA1ZMDR1-2. The last two nearly reach the set value for the gloss, both contain good film properties and the hardness of the mixture containing the ratio 1:1 meet the target value and the mixture with ratio 1:2 came close to it. The first one had both good value of gloss and hardness.

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