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Properties and Processability of High Ammonia Latices

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A systematic study of the physical and chemical properties of samples of mature commercial natural rubber latex concentrate of the high ammonia variety has been carried out. More than forty parameters were measured on each of twenty latices, enabling the current range of variation in each property to be assessed. In many respects the latices were found to be relatively consistent but significantly greater variability was found in their response to the addition of zinc ammine ions. This variability is considered to relate to the variable processing behaviour sometimes observed in the user factories. The results obtained in this study did not reveal any strong relationship of zinc ion sensitivity to any other measured property. It appears, therefore, that sensitivity to zinc ions of high ammonia latex is determined by a combination of several factors the nature of which remains to be determined.

The concept of latex concentrate processability has been presented and discussed in detail in an earlier paper[1]. This paper indicated the need for consistent chemical stability in latex from one batch to another, which is especially important in modern fully automated industrial processes, especially latex dipping. It is known that NR latices vary in their mechanical and chemical stability, but the latter, which is commonly equated with processability, is more variable. This is believed to be due to the unpredictability of the latex-zinc oxide, or zinc ion, interaction. It is known that dissolved zinc is capable of precipitating some of the naturally-occurring stabilisers, principally fatty acid soaps, and that this reduces stability. If the fatty acid soap content of latices was markedly variable, then this could account for irregular processability.

The previous paper in this series examined twenty-one samples of commercial low ammonia latex preserved with zinc oxide and tetramethylthiuram disulphide (LA-TZ type). Many of the common latex properties, such as mechanical stability time (MST) and KOH number in this series were found to be consistent. However, viscosity increases in the presence of zinc ammine ions (ZAAV test) were very variable, and were matched only by similar irregularity in the results for adsorbed ion determinations. It was tentatively suggested from this data that there was a direct relationship between adsorbed soap levels and the sensitivity to zinc salts.

In this paper, the results of a systematic study of twenty samples of commercial high ammonia (HA) latex are summarised. The study included the measurement of most of the *ISO 2004* properties[2] and trace element levels, together with chemical stabilities, serum anion levels, and surface ion estimation by conductimetric titrations. The influence of these properties on the mechanical and chemical stabilities of the latices is discussed. The results obtained here are briefly compared with those obtained for the LA-TZ series of latices.

EXPERIMENTAL

Samples of HA latex concentrates were obtained from European dealers in the period September 1982 to July 1985 and are believed to be representative of the bulk material imported at that time. The latices all generally complied with the requirements of the *ISO 2004* specification.

Tests for total solids content (TSC) dry rubber content (d.r.c.), KOH number, volatile fatty acid number (VFA), MST, and alkalinity

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were carried out according to the methods of *ISO 124, ISO 126, ISO 127, ISO 506, ISO 35* and *ISO 125* respectively. Viscosity measurements were made using a Brookfield LVT viscometer at 25°C at 6 r.p.m. and 60 r.p.m., both on undiluted samples and on samples diluted to 59.0% d.r.c. with water. Stability to zinc was assessed using the German[3] ZST test and a viscosity increase (ZAAV) test. In the latter, the latex was mixed with 0.7 p.p.h.r. of zinc, added as ammoniated zinc acetate (ZAA) solution, and diluted with water to 55% TSC. The viscosity of the mix was measured after 1 h and 24 h of storage at 25°C. The ZAA solution used was prepared as follows:

Zinc acetate dihydrate (analytical reagent grade)	274.4 g
0.880 ammonia solution	400.0 g
Water	to 1000 ml

This solution is 1.25 *M*, or 8.2% by weight, with respect to zinc.

The preparation of serum samples and the analysis of serum anions were carried out as previously described[4]. Carbonate levels were determined by the method of Calvert and Smith[5].

Total nitrogen contents were determined on total solids films prepared after addition of 1% potassium hydroxide to the latex to eliminate ammoniacal nitrogen. Potassium and magnesium contents were measured on separately prepared total solids films with no addition of potassium hydroxide. Measurements of nitrogen and potassium were also made on the cream layer obtained after diluting the latex to 10% d.r.c. with 0.3% potassium alginate solution and centrifuging at 3000 r.p.m. in a bench centrifuge. Conductimetric titrations with potassium hydroxide and ammoniated zinc acetate were carried out as described previously[6].

RESULTS AND DISCUSSION

Latex Properties Defined in *ISO 2004*

Many of the latex characteristics specified in *ISO 2004* have been determined and the results are listed in *Table 1*, together with the mean and coefficient of variation (CV) values.

It can be seen from the results that the factors which may be regarded as totally within the control of the producer, *i.e.* TSC, d.r.c. and alkalinity, showed a relatively low degree of variation. However, all but one of the samples had d.r.c. values under 60.0% and were thus technically outside the *ISO 2004* limit. Factors which are only partially within the control of the producer, *i.e.* MST and VFA number, revealed a greater variation but were still relatively consistent. All the latex samples had mechanical stabilities appreciably above the 650 s limit in *ISO 2004* (1979) but *Sample 13* had a VFA number approaching the specification limit and was obviously not well preserved.

Total Anion Concentrations (KOH Numbers)

A further comparison of potentiometric and conductimetric KOH titrations has been carried out and the results are given in *Table 2*. These confirm the earlier conclusion[6] that conductimetry generally gives higher values than potentiometry in KOH titrations and showed that the increment averaged about 13%, but with a fairly wide variation. The CV values also indicate that conductimetry gives a greater variation in KOH numbers than potentiometry. As with LA-TZ latices, the CV value of conductimetric KOH numbers is closer to the CV value found with the serum ion concentrations than to that of the ISO method.

Volatile Fatty Acid Contents

The VFA numbers determined by the ISO method, *i.e.* by coagulation and acidification followed by steam distillation, may be compared with the volatile acid content determined by ion chromatography (IC). Previously[1] the ion chromatography results were consistently lower than those of the ISO method and the new data shows the same trend *(Table 3)*. The VFA numbers of these HA latices were generally higher and more variable than the LA-TZ latices previously examined.

Viscosity Characteristics

The results of the viscosity measurements are shown in *Table 4*. The values found were quite

TABLE 1. SOME *ISO 2004* SPECIFIED PROPERTIES OF HA LATICES

Latex sample	TSC (%)	D.r.c. (%)	Non-rubber solids (%)	Alkalinity (% aq phase)	pH	VFA (No.)	MST (s)
1	61.61	59.85	1.76	2.00	10.60	0.10	1020
2	61.31	59.92	1.44	1.93	10.60	0.10	1080
3	61.43	59.38	2.05	1.52	10.55	0.04	1070
4	61.27	59.79	1.48	1.42	10.53	0.03	1250
5	61.44	59.84	1.60	1.39	10.60	0.03	1160
6	61.08	59.62	1.46	1.93	10.70	0.06	1380
7	61.35	59.75	1.60	2.01	10.50	0.03	880
8	60.88	59.25	1.63	1.84	10.48	0.05	1185
9	61.30	59.82	1.48	1.92	10.72	0.06	1620
10	61.35	59.89	1.46	1.81	10.77	0.05	1410
11	61.34	59.97	1.37	1.85	10.80	0.09	1130
12	60.83	59.57	1.26	1.78	10.80	0.05	1065
13	61.75	60.17	1.58	1.84	10.78	0.19	710
14	61.82	59.71	2.11	1.68	10.87	0.04	1140
15	61.18	59.61	1.57	2.00	10.90	0.12	1080
16	61.59	59.92	1.67	1.67	10.87	0.04	1450
17	61.15	59.56	1.59	2.06	11.05	0.07	1485
18	61.60	59.74	1.86	1.70	10.68	0.06	863
19	60.96	58.92	2.04	1.16	10.10	0.05	1530
20	60.90	59.05	1.85	1.71	10.18	0.08	848
Mean value	61.31	59.69	1.64	1.76	10.65	0.07	1168
CV (%)	0.47	0.53	14.3	13.4	2.2	57.7	21.3
Specification limit (optional)	61.5 min.	60.0 min.	2.0 max	1.58 min.	— —	0.20 max	650 min.

consistent and showed relatively little variation from sample to sample. They were also broadly similar to the results obtained with LA–TZ latices.

Stability to Zinc Ions

Each latex was tested for mechanical stability in the presence of zinc oxide (ZST) and for viscosity increase in the presence of ammoniated zinc acetate solution (ZAA), as described in the experimental section. The results of these tests are given in *Table 5*.

As for the LA–TZ latices, ZST values showed a moderate variability but the ratio of ZST to MST was less variable and comparable with the variability of the MST values *(Table 1)*. The viscosity increases in the ZAAV test, however, showed moderately high variabilities which did not correlate with the variations in ZST values. It is noticeable that the viscosity increases shown by these latices were generally lower than those of the LA–TZ latices examined previously. In particular, none of the HA latices gelled in the ZAAV test. The causes of these differences will be discussed below.

TABLE 2. COMPARISON OF POTENTIOMETRIC (ISO) AND CONDUCTIMETRIC KOH NUMBERS FOR HA LATICES

Latex sample	KOH No.	
	Potentiometric	Conductimetric
1	0.69	0.72
2	0.63	0.66
3	0.62	0.67
4	0.63	0.70
5	0.63	0.70
6	0.55	0.64
7	0.66	0.64
8	0.61	1.09
9	0.47	0.81
10	0.53	0.62
11	0.63	0.68
12	0.58	0.61
13	0.81	0.88
14	0.69	0.71
15	0.58	0.67
16	0.58	0.62
17	0.59	0.60
18	0.76	0.70
19	0.67	0.68
20	0.69	0.75
Mean value	0.63	0.71
CV (%)	12.3	15.9

Elemental Analyses

Measurements of the nitrogen, phosphorus, magnesium and potassium contents of each of these latices were also made *(Table 6)*. In the case of potassium, measurements were made on the ultracentrifuged sera as well as the total solids films, in order to determine its distribution between serum and particle surface. Insufficient serum was available to permit the same approach with nitrogen and phosphorus analyses so the amounts of these elements associated with the particles were estimated for values obtained from centrifuged cream, as described in the experimental section. These estimates are not considered to be very accurate and merely serve as a guide to the distribution of nitrogen and phosphorus between the two phases of latex. As with LA-TZ, the amount of non-ammoniacal nitrogen in these samples was quite consistent, averaging 0.29% of total solids with a fairly low coefficient of variation. The total phosphorus contents showed a fairly high variation and in all cases were higher than the levels indicated by the serum phosphate ion measurements. The phosphorus levels not accounted for by phosphate ion measurements were much higher

TABLE 3. COMPARISON OF VOLATILE FATTY ACID CONTENTS USING ISO METHOD (STEAM DISTILLATION) AND ION CHROMATOGRAPHY

Latex sample	VFA No.	
	ISO	Ion chromatography
1	0.10	0.08
2	0.10	0.08
3	0.04	0.03
4	0.03	0.03
5	0.03	0.03
6	0.06	0.05
7	0.03	0.06
8	0.05	0.07
9	0.06	0.05
10	0.05	0.03
11	0.09	0.04
12	0.05	0.02
13	0.19	0.21
14	0.04	0.07
15	0.12	0.10
16	0.04	0.07
17	0.07	0.06
18	0.06	0.03
19	0.05	0.02
20	0.08	0.12
Mean value	0.07	0.06
CV (%)	57.7	70.6

TABLE 4. VISCOSITY OF HA LATICES

Latex sample	Brookfield viscosity, 25°C			
	As received		At 59.0% d.r.c.	
	60 r.p.m.	6/60 r.p.m. ratio	60 r.p.m.	6/60 r.p.m. ratio
1	77.0	1.99	69.5	1.76
2	78.0	1.87	71.5	1.80
3	71.5	1.75	72.5	1.86
4	73.0	1.92	68.0	1.78
5	73.0	1.81	66.0	2.12
6	66.0	1.74	54.0	1.94
7	73.5	1.81	68.5	1.53
8	69.0	1.83	60.5	1.88
9	66.0	1.67	56.0	1.70
10	62.5	1.66	61.5	1.54
11	86.0	2.01	76.0	1.71
12	64.5	1.74	57.0	1.45
13	116.0	2.12	88.0	2.43
14	73.0	2.11	44.0	1.89
15	86.5	1.45	63.0	1.35
16	91.5	2.40	60.0	1.17
17	76.0	1.45	53.5	1.12
18	90.0	2.22	55.0	1.93
19	74.0	2.05	46.0	1.83
20	81.0	2.16	88.0	2.11
Mean value	77.4	1.89	63.9	1.75
CV (%)	15.8	13.1	18.5	18.3

and less variable than those of the LA–TZ latices.

The amounts of potassium found were moderately high, and contributed on the average a quantity equivalent to 44% of the ammonium ions measured by the conductimetric KOH titration. The results also show that the great majority of the potassium was associated with the serum, where its concentration is relatively constant, as noted by Resing and Lunshof[7]. On the average however, about 12.5% of the potassium appears to be associated with the particle surfaces, although the proportion varies between samples.

The magnesium contents of these latices showed considerable variation and the levels were generally higher than those found with LA–TZ latices but, again, showed no correlation with any stability index.

Serum Anion Concentrations

As described in an earlier paper[6], ammonium-associated serum anion concentrations can be determined by KOH conductimetric titrations of latex serum samples. It is also possible to obtain a value for all serum anion concentrations other than soaps, proteins and amino acids by adding the contribution from ion chromato-

TABLE 5. ZST AND ZAAV STABILITY OF HA LATICES

Latex sample	ZST (s)	ZST/MST ratio	Viscosity ratio, 24 h/1 h	Viscosity ratio, 1 h/59% d.r.c.
1	150	0.147	1.95	1.99
2	180	0.167	2.17	1.71
3	165	0.154	2.28	1.88
4	220	0.170	2.67	1.99
5	200	0.172	2.67	2.05
6	270	0.196	2.61	2.98
7	150	0.170	2.81	2.23
8	195	0.165	2.62	3.09
9	350	0.216	1.48	1.30
10	335	0.240	2.19	1.45
11	265	0.235	1.47	1.25
12	173	0.162	2.10	1.15
13	145	0.204	1.29	1.39
14	195	0.171	1.19	1.57
15	255	0.236	1.09	1.27
16	255	0.176	1.06	2.17
17	265	0.178	1.52	2.52
18	195	0.226	1.44	1.64
19	287	0.178	1.28	1.39
20	218	0.257	1.36	1.02
Mean value	223	0.191	1.86	1.80
CV (%)	26.8	17.1	32.6	32.3

graphy results, carbonate ion measurements and hydroxyl ion concentrations calculated from pH values. The results, of these two types of measurement, expressed as millimoles KOH per 100 g rubber, are shown in *Table 7*. The results confirm previous conclusions that the chromatographic values are significantly lower than the conductimetric values, although the two methods correlate well. The discrepancy between the two methods is about 20% of the KOH titre, although the true difference is much greater because the KOH titration does not measure potassium-associated anions.

Variations in Specific Serum Anions

The individual concentrations of all the ions detected by ion chromatography have been measured together with the carbonate concentrations. The mean values and coefficients of variation for each of these ions are listed in *Table 8*.

These data show that the concentrations of the individual anions varied quite substantially from latex to latex although the citrate and malate levels were relatively consistent. As noted previously, the CV values of individual

TABLE 6. ELEMENTAL ANALYSES OF HA LATICES

Latex sample	Nitrogen (% of TS)		Phosphorous (p.p.m. of TS)		Magnesium (p.p.m. of TS)	Potassium (% of TS)	
	Total	Surface[a]	Total	Surface[a]		Total	Serum
1	0.26	0.15	375	190	36	0.18	0.15
2	0.26	0.14	355	200	41	0.17	0.14
3	0.24	0.15	252	246	20	0.22	0.14
4	0.31	0.15	330	137	12	0.21	0.17
5	0.30	0.15	315	91	10	0.21	0.17
6	0.38	0.12	327	231	28	0.20	0.15
7	0.28	0.13	313	108	25	0.18	0.15
8	0.30	0.14	361	157	29	0.20	0.19
9	0.32	0.15	393	390	31	0.16	0.14
10	0.28	0.13	405	111	31	0.18	0.15
11	0.30	0.15	518	96	100	0.18	0.17
12	0.30	0.14	465	454	90	0.18	0.12
13	0.22	0.18	363	204	15	0.23	0.17
14	0.33	0.15	352	211	62	0.19	0.18
15	0.20	0.11	360	265	15	0.17	0.17
16	0.29	0.12	552	156	22	0.20	0.16
17	0.29	0.14	299	143	13	0.20	0.15
18	0.25	0.15	480	130	70	0.20	0.22
19	0.33	0.15	550	220	97	0.18	0.16
20	0.34	0.16	510	125	17	0.18	0.18
Mean value	0.29	0.14	394	193	38	0.19	0.16
CV (%)	14.8	10.9	22.4	48.7	76.6	9.4	13.5

[a]Estimated from elemental content of centrifuged cream

ions are much greater than that of the total ion concentration, as evidenced by the serum KOH titre values in *Table 7*.

Adsorbed Anion Concentrations

By subtraction of the serum KOH titre from the latex KOH titre the quantity of KOH equivalent to the ammonium-associated anions on the particle surfaces can be derived. The data for this calculation are given in *Table 9* where it is shown that the mean adsorbed anion titre is 2.73 mmoles KOH per 100 g rubber and its coefficient of variation is 60.7%, much greater than the corresponding value for LA-TZ latices. It is also clear that 10%–20% of the ammonium ions in HA latices are associated with adsorbed anions and the remainder with the serum anions. These results again demonstrate, as for LA-TZ latices, that the variability of adsorbed anion titres is much higher than that of both total and serum anion values.

ZAA Titrations

The technique of titration with ammoniated zinc acetate solution (ZAA solution) was used

TABLE 7. TOTAL SERUM ANION CONCENTRATIONS OF HA LATICES

Latex sample	Anion concentration (mmoles KOH/100 g rubber)	
	Conductimetric	Separate ion determination
1	10.98	8.44
2	10.33	8.34
3	11.00	7.56
4	11.24	7.89
5	11.27	7.16
6	8.98	7.05
7	9.70	9.52
8	12.54	9.64
9	8.48	7.47
10	7.26	7.88
11	10.10	8.99
12	9.37	6.98
13	12.36	12.67
14	10.68	7.09
15	10.34	7.30
16	10.24	6.38
17	8.97	8.71
18	10.67	9.30*
19	10.35	8.63*
20	9.77	7.74
Mean value	10.23	8.24
CV (%)	12.2	16.9

TABLE 8. AVERAGE VALUES OF SERUM ANION CONCENTRATIONS

Anion	Mean concentration (mmoles/litre serum)	CV (%)
Carbonate	22.25	40.9
Acetate	12.81	91.9
Malate	9.28	34.5
Succinate[a]	5.45	65.4
Citrate	5.04	40.7
Formate	4.67	67.5
α Glycerophosphate	2.81	32.7
Glucose-1-phosphate[b]	2.24	43.5
Phosphate[c]	2.01	66.9
Oxalate	1.16	31.2
Chloride	1.10	89.8
Sulphate	0.58	50.2
Hydroxide	0.51	46.4

[a] Not detected in eight latices *(Samples 3-7, 13, 16, 17)*

[b] Not detected in *Sample 12*

[c] Not detected in two latices *(Samples 19, 20)*

TABLE 9. CONDUCTIMETRIC KOH TITRES OF LATICES AND SERA

Latex sample	Titres (mmoles KOH/100 g rubber)		
	Latex	Serum	Surface
1	13.16	10.98	2.18
2	12.02	10.33	1.69
3	12.29	11.00	1.29
4	12.88	11.24	1.64
5	12.87	11.27	1.60
6	11.66	8.98	2.68
7	11.80	9.70	2.10
8	20.00	12.54	7.46
9	14.88	8.48	6.40
10	11.35	7.26	4.09
11	12.34	10.10	2.24
12	11.08	9.37	1.71
13	16.04	12.36	3.68
14	13.06	10.68	2.38
15	12.33	10.34	1.99
16	11.33	10.24	1.09
17	11.00	8.97	2.03
18	12.86	10.67	2.19
19	12.56	10.35	2.21
20	13.72	9.77	3.95
Mean value	12.96	10.23	2.73
CV (%)	16.0	12.2	60.7

to assess the total amount of soap in the latex[6]. Such measurements have been done on all of these latices and the results are shown in *Table 10.*

It can be seen that although the ZAA titres of latices and sera are moderately variable the difference between the two titres, expressed as adsorbed stearic acid content in the table, is very highly variable. This variability is even greater than that found with the independent measurement of total surface anions described above. The significance of these results will be discussed later.

Electrical Conductivity

The electrical conductivities of each latex, after dilution to 30% d.r.c. with its own serum, and of each serum sample have been measured and the results are shown in *Table 11.* The electrical conductivities of the HA latices and their sera did not vary greatly between samples. This conclusion is consistent with the measurements of total serum anion concentrations *(Table 7)* which also revealed relatively low coefficients of variation.

It can be shown that at a d.r.c. of 30%, *i.e.* a dispersed phase volume fraction of 0.3226, the ratio of the serum conductivity to that of the latex would be 1.71 if the particle surface conductivity was negligible[6]. This ratio, designated CR30, has been calculated for all these latices and is shown in *Table 11.* In most cases the measured ratio was close to 1.71 indicating that electrical double layer conductivity was zero or negligibly small. Only about three of the latices *(Samples 2, 3* and *16)* can be considered to differ significantly from the theoretical value, compared with eight out of twenty-one LA-TZ latices[1].

Comparison of HA and LA-TZ Latices

In many properties, *i.e.* TSC, d.r.c., KOH number, viscosity, non-rubber solids content (NRS), alkalinity, pH and MST, HA and LA-TZ latices show similar variabilities and, except for alkalinity and pH, similar average values. As noted above, the VFA numbers of HA latices however, tend to be higher and more variable than those of the LA-TZ latices tested previously. This confirms the efficacy of the zinc oxide/tetramethylthiuram disulphide system as a preservative for latex.

HA latices appear less stable to zinc ions than LA-TZ latices when judged by their ZST values or ZST/MST ratios but appear much more stable in the ZAAV test. The latter effect is probably attributable to the higher ammonia content of the HA latices as the addition of ammonia to LA-TZ latices produces measurable improvements in ZAAV values *(Table 12).*

TABLE 10. TITRATIONS WITH AMMONIATED ZINC ACETATE SOLUTION

Latex sample	Latex titre (mmoles Zn/100 g rubber)	Serum titre (mmoles Zn/100 g rubber)	Surface titre as stearic acid (g/100 g rubber)
1	0.71	0.60	0.06
2	0.15	0.01	0.31
3	1.48	1.30	0.10
4	2.76	2.20	0.31
5	2.09	1.80	0.17
6	1.17	0.12	0.60
7	1.46	1.20	0.14
8	3.97	2.50	0.82
9	2.68	1.70	0.55
10	1.42	0.97	0.26
11	1.92	1.50	0.24
12	1.89	1.50	0.23
13	3.48	1.90	0.89
14	2.10	1.60	0.28
15	2.52	2.20	0.14
16	3.76	3.70	0.00
17	3.19	2.90	0.40
18	3.18	2.33	0.48
19	2.93	2.30	0.27
20	3.98	2.15	1.04
Mean value	2.34	1.72	0.36
CV (%)	46.4	51.8	78.2

The total serum anion concentrations tend to be a little higher for HA latices than for LA-TZ latices, but the differences are not large. Glucose-1-phosphate was detected in nineteen of the twenty HA latices but in only six of the twenty-one LA-TZ latices.

Latex Processability

The data presented in *Tables 1–11* represent the measurement of over forty parameters for twenty HA latex samples. This permits the summarising of properties and composition of a 'typical' HA latex, as it may reasonably be assumed that these samples are representative of current commercial imports into Europe. Such a summary is set out in *Table 13*.

Many of the conventional properties, as given in *Tables 1–3*, show that HA latex is a consistent latex with properties that do not vary widely. However, of central interest in this study are the results given in *Table 5* which relate to the processability of the latices. As with LA-TZ latices, the ZST values are seen to relate strongly to the MST results whereas the ZAAV viscosity increase figures appear to be completely unrelated. The concentration of aqueous phase ammonium ions would be expected to influence stability to zinc but clearly it is not the

TABLE 11. ELECTRICAL CONDUCTIVITIES OF HA LATICES AND SERA

Latex sample	Conductivity (mmhos, 25°C)		Conductivity ratio (CR 30)
	Latex (30% d.r.c.)	Serum	
1	8.68	14.33	1.65
2	8.68	13.98	1.61
3	8.77	13.60	1.55
4	9.47	16.10	1.70
5	9.56	15.30	1.60
6	8.88	15.10	1.70
7	9.42	16.10	1.71
8	9.42	16.10	1.71
9	7.89	13.50	1.71
10	8.36	14.30	1.71
11	10.88	18.60	1.71
12	8.45	14.45	1.71
13	10.88	18.60	1.71
14	8.80	15.40	1.75
15	9.16	15.20	1.66
16	9.33	15.30	1.64
17	8.35	14.20	1.70
18	10.67	19.10	1.79
19	9.86	17.25	1.75
20	9.48	16.50	1.74
Mean value	9.25	15.65	1.69
CV (%)	9.0	10.60	3.4

TABLE 12. EFFECT OF ADDITION OF AMMONIA TO AN LA-TZ LATEX ON ITS ZAAV VISCOSITY INCREASE

Ammonia content (% of aqueous phase)	ZAAV ratio (24 h : 1 h)
0.5 (as received)	2.84
0.8	1.76
1.0	1.50
1.3	1.47
1.7	1.49
2.0	1.11

dominant factor, possibly because it is relatively constant.

The ZAAV ratio shows a moderately high coefficient of variation but is much less variable than that of the LA-TZ latices examined earlier. This indicates either that HA latices are inherently less variable, in their response to zinc ions, than LA-TZ latices or that the ZAAV test is less discriminating with HA latices due to their higher ammonia contents. In further contrast to LA-TZ latices, the ZAAV ratios for HA latex do not suggest any significant correlation with either KOH surface titres or

TABLE 13. COMPOSITION AND PROPERTIES OF A 'TYPICAL' COMMERCIAL HA LATEX

Item	Latex (% by weight)	Total solids film (% by weight)
Rubber[a]	59.67	97.61
Protein, etc.[b]	1.06	1.73
Soaps[c]	0.23	0.38
Salts	0.40	0.28[d]
Ammonia	0.68	—
Water	37.96	—
TSC (%)	61.31	—
D.r.c. (%)	59.67	—
Non-rubber solids (%)	1.64	—
pH	10.65	—
Alkalinity (% aqueous phase)	1.76	—
MST (s)	1168	—
VFA No.	0.07	—
KOH No.	0.63	—

[a] As measured by d.r.c.

[b] Includes carbohydrates, amino acids, sugars

[c] Calculated as ammonium stearate

[d] Assuming carbonate, acetate and formate are volatilised

ZAA surface titres. In fact, no immediately obvious correlation can be found for the ZAAV ratios of HA latices, which leaves the cause of the variations obscure at present. It appears that a combination of several factors may be determining the ZAAV ratio but the nature of these factors has yet to be determined. They could, for example, include the influence of the nature of the adsorbed soaps, as at least five different fatty acid soaps are known[8] to be present in latex. The current study is being extended to improve the techniques for determining the soap level on the latex and on the particle surface, and to identify its various components.

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