

SINGAPORE

PATENT SPECIFICATION

(11) 1 471 966

1 471 966

- (21) Application No. 49919/74 (22) Filed 18 Nov. 1974
 (23) Complete Specification filed 12 Nov. 1975
 (44) Complete Specification published 27 April 1977
 (51) INT CL³ C08C 19/22
 (52) Index at acceptance
 C3E 2BX
 C3C 123 151 303 304 453 521 543
 (72) Inventor GEOFFREY THOMAS KNIGHT



(54) TREATMENT OF RUBBER LATEX

(71) We, THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYSIA, a Malaysian Body Corporate, of 260 Jalan Ampang, Kuala Lumpur, Malaysia, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

British Patent Specification No. 1,255,645 discloses the treatment of latex with certain p-nitrosoanilines or p-nitrosophenols to form rubber-bound antioxidant groups which improve the ageing resistance of rubber vulcanizates, particularly after treatment with organic solvents e.g. as in dry-cleaning. The vulcanizates may be prepared directly from the latex (extruded thread, foam) or from dry rubbers prepared from the latex (moulded goods). The treatment disclosed was preferably carried out at temperatures below 50° C, the reaction of the nitroso compound with rubber taking place in the latex or during storage of the wet coagulum at ambient temperature, although reaction during the drying of the coagulum at temperatures from 80° C to 130° C was also described. A major disadvantage of the process is the darkening of the latex, the rubber prepared from it, and rubber vulcanizates when the reaction takes place at temperatures above 50° C.

It is the object of the present invention to provide a process by which p-nitrosoanilines may be reacted with natural rubber latex to produce rubber-bound antioxidant groups without the serious discoloration suffered in the earlier process. The modified latex so produced is suitable for the preparation of light-coloured dry-cleaning resistant latex articles either immediately after the reaction or after storage for periods up to four weeks.

British Patent Specification No. 1,340,673 discloses that certain salts of thiols particularly metal salts of dialkyldithiocarbamic acid, may be used to improve the yield of rubber-bound antioxidants when p-nitrosoanilines or p-nitrosophenols are reacted with dry rubber. We have found that although the addition of

zinc N,N-diethyldithiocarbamate (ZDEC) to latex containing p-nitrosodiphenylamine (NDPA) improves the yield of rubber-bound antioxidant and produces lighter-coloured products, it is necessary to add a hydroxylamine salt such as hydroxylamine hydrochloride or hydroxylamine neutral sulphate in order to prevent the formation of the undesirable dark colouration on storage of the latex. Furthermore, contrary to the previous disclosures, it has been found advantageous to complete the reaction of the nitroso compound with the latex fairly rapidly by heating at temperatures above 50° C. so that the greater part of the reaction is completed quickly as this provides lighter coloured products.

Accordingly, one aspect of the present invention consists of a method of treating natural rubber latex which method comprises reacting rubber in the latex with a p-nitrosoaniline in the presence of a metal dialkyldithiocarbamate characterized by including in the rubber latex, before, during or after the reaction, a hydroxylamine salt in an amount to reduce colouration of the latex on storage. The reaction is preferably performed at a temperature between 50° C. and 70° C. for from $\frac{1}{2}$ to 24 hours, in the presence of the metal dialkyldithiocarbamate and the hydroxylamine salt, preferably either hydroxylamine hydrochloride or neutral hydroxylamine sulphate. The latex may be stored for periods of several weeks without discoloration.

According to the invention, the hydroxylamine salt, e.g. hydroxylamine hydrochloride or neutral hydroxylamine sulphate, may be added to the latex after the reaction with the nitroso compound. This has the advantage that slightly lower amounts of hydroxylamine compound are needed to prevent discoloration during storage.

The rubber latex may be either ammoniated field latex or latex concentrate. The reaction between the nitroso compound and the rubber takes place somewhat more quickly in field latex.

The preferred nitroso compound is p-nitrosodiphenylamine (NDPA) but an equiva-

lent amount of the reaction product of NDPA with an isocyanate (British Patent Specification No. 1,340,672) or with an acyl halide (Belgian Patent Specification No. 779,810) may be used instead of the free nitroso compound. The level of p-nitrosoaniline used is preferably between 0.1 and 0.5 parts per hundred parts of rubber by weight (pphr) particularly 0.25 pphr.

The metal dialkyldithiocarbamate may be chosen from any of those commercially available, preferably a zinc dimethyl-, diethyl- or dibutyldithiocarbamate, and is preferably used at a concentration of from 0.05 to 0.5 pphr. An amine complex of the zinc dialkyldithiocarbamate, e.g. the di-n-butylamine complex, may be used as envisaged in British Patent Specification No. 1,340,673. On economic grounds the preferred dithiocarbamate is zinc N,N-diethyldithiocarbamate, at a concentration of between 0.1 and 0.25 pphr, preferably 0.15 pphr.

The reaction between the nitroso compound and the rubber latex may be carried out at temperatures between 50° C and 70° C for periods of between 30 minutes at the higher temperature to 24 hours at the lower temperature. Reaction in ammoniated field latex appears to be faster than in latex concentrate, the time for complete reaction at 70° C being estimated as 30 minutes in field latex and two hours in latex concentrate. The preferred reaction conditions on the laboratory scales are 16 hours at 50–55° C, but this can be varied to suit commercial conditions, e.g. during the maturation of compound latex before use in thread and foam production.

The hydroxylamine salt is preferably used in an amount of from 0.05 to 0.5 pphr and may be added to the latex as a 10% aqueous solution with efficient stirring. The preferred additive is hydroxylamine hydrochloride at a level of 0.1 to 0.3 pphr, preferably 0.2 pphr, added after reaction of the NDPA with latex.

The invention also provides a treated natural rubber latex having the following properties:—

a) a half-filled barrel of the latex is stable to storage in air under ambient conditions for 5 days without substantial colouration;

b) the tensile strength of a vulcanized latex article made from the rubber latex remains at at least 60% of its original value during treatment with carbon tetrachloride followed by aging for 3 days at 100° C. in air.

Substantial colouration has occurred when the latex is obviously darkened and this can be perceived without the need for a detailed comparison with a comparable unmodified

sample. The treatment with carbon tetrachloride is a dry cleaning procedure. The foams or other articles are washed for three minutes in carbon tetrachloride, squeezed by compression to remove the excess and then dried at 50° C before being aged for 3 days at 100° C. in air.

It will be understood that this combination of properties has not hitherto been available in natural rubber latex. Commercially available rubber latex articles can have good light colour and good resistance to oxidative degradation, but they lose the degradation resistance on being treated with CCl₄ because the conventional antioxidant is leached out.

Articles made from rubber latex modified by treatment with a p-nitrosoaniline can have good resistance to oxidative degradation, even after treatment with CCl₄, but have hitherto inevitably been badly discoloured. This invention provides for the first time a natural rubber latex of good colour from which are made articles, e.g. latex foam or thread, having good resistance to oxidative degradation even after dry-cleaning.

The invention is illustrated but not limited by the following Examples. Parts and percentages are by weight unless otherwise stated.

EXAMPLE 1.

Preparation of modified latex.

A typical reaction is as follows: p-Nitrosodiphenylamine is added as a 33.3% ball-milled aqueous dispersion to 333g of high ammonia (HA) latex concentrate with stirring until the nitrosoamine has been well dispersed. Zinc N,N-diethyldithiocarbamate is then similarly added as a ball-milled 50% aqueous dispersion, and the mixture stirred for a further 10 minutes. The reaction vessel is covered with a polyethylene sheet to prevent evaporation and heated at 50–55° C. for 16 hours.

After being cooled to room temperature, the latex is slowly treated with a 10% aqueous solution of hydroxylamine hydrochloride with efficient stirring. If the addition is too rapid or the stirring inadequate some coagulation may occur.

EXAMPLE 2.

Effect of hydroxylamine compounds on discolouration.

Hydroxylamine hydrochloride (HH) or neutral hydroxylamine sulphate (HS) was added to latex either before or after the reaction with NDPA and the development of colour noted on storage. The results are shown in Tables 1 and 2.

TABLE 1

Storage discoloration of modified HA latex concentrate:
All additives present during reaction at 50°C for 16 hours

NDPA	Additives pphr		HS	Colour observed on storage after		
	ZDEC	HH		2 days	5 days	21 days
0.3	0.15	—	—	purple	—	—
0.3	0.15	—	—	purple*	—	—
0.3	0.15	0.1	—	none	sl. purple	purple
0.3	0.15	0.15	—	none	none	sl. purple
0.3	0.15	0.20	—	none	none	none
0.3	—	0.20	—	purple	—	—
0.2	0.15	0.2	—	none	none	none
0.4	0.15	0.2	—	sl. purple	purple	—
0.3	0.15	—	0.2	none	none	sl. purple

* Compound matured 16 hours at room temperature before reaction.

TABLE 2

Storage discoloration of modified HA latex concentrate:
reaction at 55°C for 16 hours before addition of hydroxylamine compound

NDPA	Additive pphr		HS	Colour observed on storage after			
	ZDEC	HH		2 days	5 days	21 days	30 days
0.25	0.15	—	—	purple			
0.25	0.15	0.10	—	none	none	sl. purple	purple
0.25	0.15	0.15	—	none	none	sl. purple	purple
0.25	0.15	0.20	—	none	none	none	sl. purple
0.25	0.15	0.25	—	none	none	none	sl. purple
0.25	0.15	—	0.10	none	none	sl. purple	purple
0.25	0.15	—	0.20	none	none	none	sl. purple
0.25	0.15	—	0.25	none	none	none	sl. purple

EXAMPLE 3.

Properties of rubbers obtained from modified HA latex concentrate.

Latex modified according to the conditions of Table 2 was coagulated at pH5 by the addition of 10% aqueous formic acid, the coagulum washed and creped by three passes on a creping mill, crumbled by the addition of castor oil (3 passes) and dried at 60° C for 48 hours. The Plasticity Retention Index

(PRI) accelerated storage hardening (DP) and Lovibound Colour Index (LCI) were measured on the rubbers before and after extraction with acetone for 24 hours. The LCI of dried films cast from the latex before coagulation was also measured. The results given in Table 3 show that the addition of hydroxylamine hydrochloride improves the colour of both the cast film and the rubber without decreasing the rubber-bound anti-

5

10

15

20

oxidant activity, which is shown by the high level of PRI after acetone extraction. The viscosity stability usually associated with the addition of HS or HH is also found in these rubbers.

5

TABLE 3

Properties of modified rubbers from HA latex concentrate

Additives (pphr)			Cast film LCI	Unextracted			Extracted	
NDPA	ZDEC	HH		PRI	DP	LCI	PRI	LCI
—	—	0.2	4.5	39	2	3	0	—
—	0.15	0.2	4.5	23	6.5	3	0	—
0.3	0.15	—	16	61	6	12	77	10
0.3	0.15	0.2	12	54	5	10	81	9

EXAMPLE 4.

Properties of vulcanizates prepared from modified rubbers.

- 10 Modified rubbers were prepared by the reaction of HA latex concentrate with NDPA (0.25 pphr) and ZDEC (0.15 pphr) at 50° C for 16 hours, hydroxylamine hydrochloride (0.1 pphr) added after cooling and the latex
- 15 coagulated and dried as in Example 3. Test sheets were prepared from the gum and white formulations using either modified rubber or SMR 5 as the control.

- 20 The latex was not stored before use, but was in fact storage stable without discoloration for at least 21 days. The antioxidant used was N - isopropyl - N' - phenyl - p - phenylene-diamine, and in all eight different vulcanizates

were prepared. The initial and aged physical properties are shown in Table 4.

Comparison of the results for vulcanizates B with C, and of F with G, shows that the modified rubber prepared with only 0.25 pphr of NDPA gives aging resistance in the unextracted vulcanizate equivalent to that obtained with 1 pphr of a conventional antioxidant. Comparison of vulcanizates C with D and G with H shows that the addition of further antioxidant to the modified rubber has little effect.

The superiority of the rubber-bound antioxidant is shown in the extracted vulcanizates by comparison of the tensile strength retention of vulcanizates C and D with A and B or G and H with E and F.

25

30

35

40

TABLE 4
Vulcanizate properties of modified NR rubbers

Formulation (parts by weight)	A	B	C	D	E	F	G	H
SMR 5	100	100	—	—	100	100	—	—
Modified Rubber	—	—	100	100	—	—	100	100
Stearic Acid	2	2	2	2	2	2	2	2
Zinc Oxide	5	5	5	5	5	5	5	5
Sulphur	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
C.B.S.	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Nonox ZA (Trade Mark)	—	1.0	—	1.0	—	1.0	—	1.0
Whiting	—	—	—	—	50	50	50	50
Titanium dioxide	—	—	—	—	5	5	5	5
Cure time for all samples 40'/140°C								
Initial Physical Properties:								
T.S. (MN/m ²)	26.2	26.8	23.7	25.6	19.5	18.7	18.6	19.0
M.300 (MN/m ²)	1.7	1.7	2.0	2.0	2.1	2.1	2.6	2.2
E.B. (%)	825	830	710	705	730	730	630	710
Aged 1 day at 100°C								
T.S. retained (%)	59	90	89	89	78	89	84	84
M.300 retained (%)	118	135	105	115	105	114	92	114
E.B. retained (%)	78	83	86	84	88	87	87	76

TABLE 4 (Continued)

Formulation (parts by weight)	A	B	C	D	E	F	G	H
Extracted 24 hrs. with acetone then aged 1 day at 100°C								
T.S. retained (%)	31	30	94	90	39	42	93	99
M.300 retained (%)	100	118	130	150	86	100	92	118
E.B. retained (%)	70	69	84	78	82	82	78	75

SMR 5 is a grade of Standard Malaysian Rubber.

C.B.S. is N-cyclohexyl-2-benzothiazyl sulphenamide.

EXAMPLE 5.

Properties of moulded foam prepared from modified HA latex.

- 5 Moulded foams were prepared from normal or modified HA latices using the following formulation, dispersions and solutions being aqueous:

	Dry weight
10 Latex	500
Zinc oxide (50% dispersion)	15
Sulphur (50% dispersion)	12.5
ZDEC (50% dispersion)	5.0
ZMBT (50% dispersion)	5.0
Potassium oleate (20% solution)	12.5
Trimene Base (50% solution)	(8 ml)
Sodium silicofluoride (20% dispersion)	(5 ml)
Antioxidant (50% dispersion)	varies

- 20 ZMBT is zinc mercaptobenzthiazole. TRIMENE is a Trade Mark.

The performance of latex modified as in Example 4 was compared with normal HA latex concentrate with various levels of a

conventional antioxidant, the samples being 25 as shown in Table 6.

TABLE 6.
Latex foam samples.

Foam	Latex	Antioxidant (pphr)
J	HA	0
K	HA	0.5
L	HA	1.0
M	Modified HA	0
N	Modified HA	0.5

The foams were aged at 100° C in air before and after washing and dry-cleaning treatment, the property measured being the retention of compression modulus (Table 7). The washing cycle consisted of washing with a detergent for 15 minutes in a washing machine, followed by rinsing three times in warm water before spin drying and drying at 50° C. The dry cleaning cycle consisted of washing in carbon tetrachloride, squeezing dry and drying at 50° C. Ageing was carried out after one or two cycles.

TABLE 7

Ageing of moulded foams at 100°C

Retention of compression modulus (%)

Ageing days	Wash 1			Wash 2			Clean 1			Clean 2									
	J	K	N	J	K	N	J	K	N	J	K	N							
1	59	80	86	95	88	53	71	77	88	87	58	86	93	116	44	56	67	108	108
2	44	65	76	88	76	32	57	62	69	67	38	72	83	120	26	32	38	102	105
3	39	63	74	86	73	33	50	59	61	57	30	68	81	121	74	34	32	98	99
4	30	54	68	79	65	36	44	52	51	46	36	52	69	115	130	64	37	83	88
5	34	50	64	72	58	50	38	48	45	41	62	50	64	108	u	134	49	78	80
6	39	47	61	64	43	83	42	48	43	44	135	43	57	105	u	u	129	70	74
7	49	43	55	57	41	128	46	45	42	52	u	41	52	97	u	u	u	65	66

u=untestable

The results show that the modified latex foams survive the washing and dry cleaning tests better than the protected unmodified foams, and that the addition of more antioxidant to the modified latex is unnecessary.

EXAMPLE 6.

Natural rubber latex, modified according to the invention, was compounded in field trials and run through a commercial latex thread plant. The product was compared with commercial latex thread.

Composition of modified latex:

HA latex concentrate	100	parts dry weight
60 d.r.c.	0.3	" "
NDPA	0.15	" "
ZDEC	0.10*	" "
Hydroxylamine sulphate	"	" "

* added as two equal amounts see procedure.

Modification procedure:

The NDPA (33.3% aqueous dispersion) and ZDEC (50% aqueous dispersion) were added with stirring to the HA concentrate, and stirring was continued for 15 mins. The latex was then heated with 'live' steam whilst slow stirring was continued. The temperature was raised to 80° C and then the source of steam was removed and the latex allowed to cool to room temperature (~ 4 hrs, on 10 gal scale). Use of live steam results in dilution of latex, hence after addition of 0.05 (dry weight) hydroxylamine sulphate (5% aqueous soln) the latex was recentrifuged. To the freshly concentrated latex was added an additional 0.05 parts of hydroxylamine sulphate

and the latex was stored for one week in full drums before being compounded:—

Compounding of latex for thread manufacture:

ZDEC (50% in water)	0.3
Zinc oxide (50% in water)	1.0
Titanium dioxide (40% in water)	7.5
Antioxidant	0.5
Blue colour	slight.

15

5

Dry weight
(pphr)

Modified latex (60 drc)	100
Potassium hydroxide (10% in water)	0.5
Potassium oleate (20% in water)	1.0
Sulphur (50% in water)	0.5
ZMBT (50% in water)	1.5

10

The compounded latex was run through a commercial latex thread plant. The resulting latex thread had a good light colour indistinguishable from commercial latex thread. The two threads were subjected to an accelerated aging test both before and after "dry cleaning" (washing in excess of CCl_4 and drying at 50°C), with the following results.

20

Aging results in Thread.

% Retention of Tensile strength, samples aged at 100°C in air.	Time of aging (days)	Commercial Control Thread		Modified Thread	
		Original	After dry-cleaning	Original	After dry-cleaning
	1	74	56	86	76
	2	60	8	81	76
	3	67	6	76	67

WHAT WE CLAIM IS:—

1. A method of treating natural rubber latex which method comprises reacting rubber in the latex with a p-nitrosoaniline in the presence of a metal dialkyldithiocarbamate characterized by including in the rubber latex, before, during or after the reaction, a hydroxylamine salt in an amount to reduce colouration of the latex on storage.

2. A method as claimed in claim 1, wherein the reaction is performed at a temperature of from 50°C to 70°C for from $\frac{1}{2}$ to 24 hours.

3. A method as claimed in claim 1 or claim 2, wherein the p-nitrosoaniline is used in a concentration of from 0.1 to 0.5 parts by weight per 100 parts of rubber.

4. A method as claimed in any one of claims 1 to 3, wherein the metal dialkyldithiocarbamate is used in a concentration of from 0.05 to 0.5 parts by weight per 100 parts of rubber.

5. A method as claimed in any one of claims 1 to 4, wherein the hydroxylamine salt is hydroxylamine hydrochloride or hydroxylamine neutral sulphate.

6. A method as claimed in any one of claims 1 to 5, wherein the hydroxylamine salt is used in a concentration of from 0.05 to 0.5

parts by weight per 100 parts of rubber.

7. A method as claimed in any one of claims 1 to 6, wherein from 0.1 to 0.3 parts, by weight per 100 parts of rubber, of hydroxylamine hydrochloride is added to the rubber latex after completion of reaction between the rubber and the p-nitrosoaniline.

8. A method as claimed in any one of claims 1 to 7, and substantially as hereinbefore described in any one of the Examples.

9. Natural rubber latex when treated by the method of any one of claims 1 to 8.

10. Rubber vulcanizates prepared from the natural rubber latex claimed in claim 9.

11. A treated natural rubber latex having the following properties:—

a) a half-filled barrel of the latex is stable to storage in air under ambient conditions for 5 days without substantial colouration;

b) the tensile strength of a vulcanized latex article made from the rubber latex remains at at least 60% of its original value during treatment with carbon tetrachloride followed by aging for 3 days at 100°C in air.

12. Vulcanized articles made from the latex claimed in claim 11.

STEVENS, HEWLETT & PERKINS.



* C L M S *

and the latex was stored for one week in full drums before being compounded:—

Compounding of latex for thread manufacture:

	Dry weight (pphr)
Modified latex (60 drc)	100
Potassium hydroxide (10% in water)	0.5
Potassium oleate (20% in water)	1.0
Sulphur (50% in water)	0.5
ZMBT (50% in water)	1.5

ZDEC (50% in water)	0.3
Zinc oxide (50% in water)	1.0
Titanium dioxide (40% in water)	7.5
Antioxidant	0.5
Blue colour	slight

15

The compounded latex was run through a commercial latex thread plant. The resulting latex thread had a good light colour indistinguishable from commercial latex thread. The two threads were subjected to an accelerated aging test both before and after "dry cleaning" (washing in excess of CCl_4 and drying at 50°C), with the following results.

20

Aging results in Thread.

% Retention of Tensile strength, samples aged at 100°C in air.	Time of aging (days)	Commercial Control Thread		Modified Thread	
		Original	After dry-cleaning	Original	After dry-cleaning
		74	56	86	76
	2	60	8	81	76
	3	67	6	76	67

WHAT WE CLAIM IS:—

1. A method of treating natural rubber latex which method comprises reacting rubber in the latex with a p-nitrosoaniline in the presence of a metal dialkyldithiocarbamate characterized by including in the rubber latex, before, during or after the reaction, a hydroxylamine salt in an amount to reduce colouration of the latex on storage.

2. A method as claimed in claim 1, wherein the reaction is performed at a temperature of from 50°C to 70°C for from $\frac{1}{2}$ to 24 hours.

3. A method as claimed in claim 1 or claim 2, wherein the p-nitrosoaniline is used in a concentration of from 0.1 to 0.5 parts by weight per 100 parts of rubber.

4. A method as claimed in any one of claims 1 to 3, wherein the metal dialkyldithiocarbamate is used in a concentration of from 0.05 to 0.5 parts by weight per 100 parts of rubber.

5. A method as claimed in any one of claims 1 to 4, wherein the hydroxylamine salt is hydroxylamine hydrochloride or hydroxylamine neutral sulphate.

6. A method as claimed in any one of claims 1 to 5, wherein the hydroxylamine salt is used in a concentration of from 0.05 to 0.5

parts by weight per 100 parts of rubber.

7. A method as claimed in any one of claims 1 to 6, wherein from 0.1 to 0.3 parts, by weight per 100 parts of rubber, of hydroxylamine hydrochloride is added to the rubber latex after completion of reaction between the rubber and the p-nitrosoaniline.

8. A method as claimed in any one of claims 1 to 7, and substantially as hereinbefore described in any one of the Examples.

9. Natural rubber latex when treated by the method of any one of claims 1 to 8.

10. Rubber vulcanizates prepared from the natural rubber latex claimed in claim 9.

11. A treated natural rubber latex having the following properties:—

a) a half-filled barrel of the latex is stable to storage in air under ambient conditions for 5 days without substantial colouration;

b) the tensile strength of a vulcanized latex article made from the rubber latex remains at at least 60% of its original value during treatment with carbon tetrachloride followed by aging for 3 days at 100°C in air.

12. Vulcanized articles made from the latex claimed in claim 11.

STEVENS, HEWLETT & PERKINS.