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UNION CARBIDE

THE DISCOVERY COMPANY

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PLAINTIFF'S EXHIBIT
UC-780

Calidria

Resin-Grade 244

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Asbestos

- Effective thixotrope for polyester spray-up, hand lay-up laminating resins, and gel coats
- Effective thickener for plastisols and organosols used in adhesives, coatings, mastics, and sealants

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Calidria Resin-Grade 244 Asbestos

. . . new, modified asbestos fiber from UNION CARBIDE . . . developed for maximum thickening efficiency and thixotropy in polyester spray-up and hand lay-up laminating resins . . . also an effective thickener for plastisols and organosols used in a broad variety of adhesives, coatings, mastics, and sealants. In many systems, CALIDRIA Resin-Grade 244 Asbestos will not contribute color or opacity—a characteristic that makes it particularly attractive in polyester gel coats.

Though CALIDRIA Resin-Grade 244 Asbestos is designed for use in stir-in mixers, optimum efficiency and lowest cost are obtained through use of high-shear mixers; such as, "Cowles" Dissolvers, sonic dispersers, and homogenizers.

Other desirable features of CALIDRIA Resin-Grade 244 Asbestos include:

- Ease of incorporation
- Reduced dust
- Clear, colorless products at low loadings
- Long term shelf life

Typical physical properties

Specific Gravity	2.45
Moisture Content, % by wt.	2.0, maximum
Nature of Surface Charge	Neutral
Refractive Index, n_D25°C.	1.54 to 1.56
Bulking Value, gallons per 100 lb.	4.8
Dry Bulk Density, lb. per cubic foot	1.0
Standard Package Weight, lb.	10
% Magnetite	0.3
Oil Absorption, lb. DOP/(100 lb. Asbestos)	300-350
Screen Size, Typical; % plus 325 Mesh	Nil
Surface Area, sq. meters per gram	60
Fiber Diameter, microns	0.025
Length/Diameter, microns	200 avg. (1000 maximum)

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Typical applications

Figure 1 COMPARISON OF THICKENING EFFICIENCY OF *CALIDRIA* RESIN-GRADE 244 ASBESTOS WITH THAT OF PYROGENIC SILICA IN POLYESTER RESIN

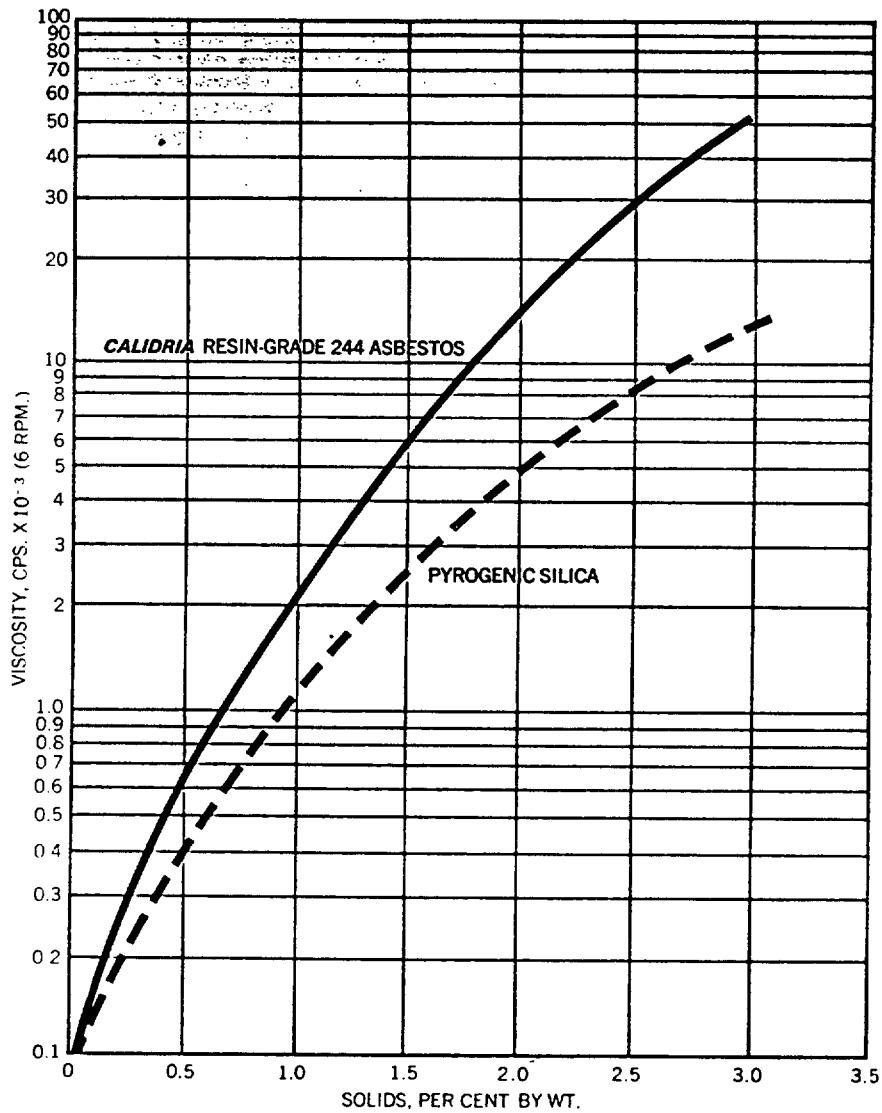


Figure 1 shows the thickening efficiency of CALIDRIA Resin-Grade 244 Asbestos in a typical polyester. Comparison is made with a pyrogenic silica additive. Viscosity data are given in Table 1.

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Figure 2 THIXOTROPIC CHARACTERISTICS IN POLYESTER RESINS

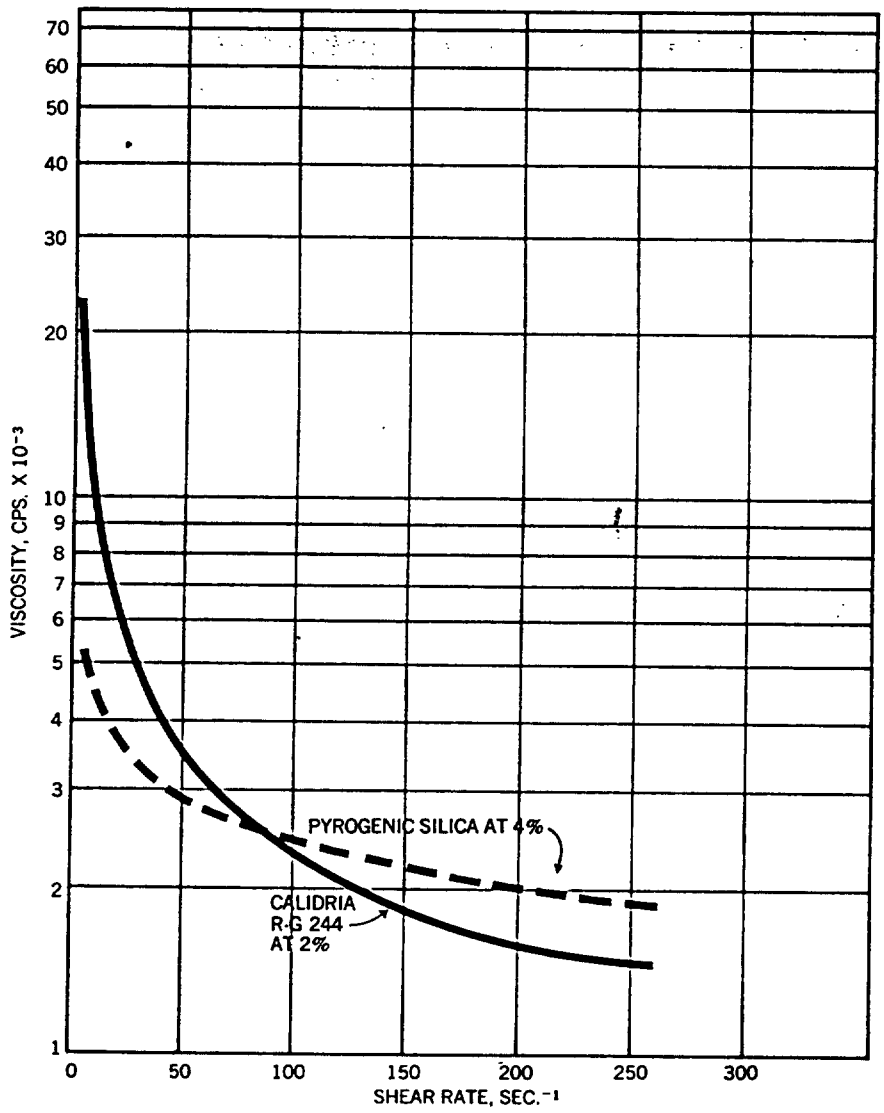


Figure 2 shows the viscosity profile of CALIDRIA Resin-Grade 244 —polyester systems as compared to a system containing pyrogenic silica. Better flow at high shear rates, during pumping and spray-up, and better anti-sag properties when at rest are illustrated.

Use of CALIDRIA Resin-Grade 244 in promoted polyester resins

Accelerators normally used in promoted resins may cause abnormally low viscosity and thixotropy when mineral thickeners are used. These properties may be enhanced in CALIDRIA R-G 244 systems by adding a small concentration of polyhydroxyl compounds, i.e. about 0.3 per cent by weight of ethylene glycol. In addition to higher viscosity and thixotropic index, viscosity stability is also improved.

Ultrasonic dispersion of CALIDRIA Resin-Grade 244

Good dispersion of CALIDRIA R-G 244 in polyester laminating resins can be obtained with an "Econosonic" Disperser operating at a pressure of 300 psi. Pressures above 300 psi. tend to reduce viscosities obtainable. In general, CALIDRIA R-G 244 requires less energy for adequate dispersion than comparable concentrations of pyrogenic silica.

A "Cowles" Dissolver may be used to incorporate CALIDRIA R-G 244 at 3500 rpm., with a 3-inch impeller and a 3-quart sample container, in 5-10 minutes. At 1 per cent loading, mixing time can extend for one hour without degrading; and at 2 per cent loading, up to 30 minutes. Longer mixing periods or properly scaled-up equipment should adequately mix larger batches.

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Table 1

VISCOSITY DATA AT VARIOUS SOLIDS CONCENTRATIONS OF *CALIDRIA* RESIN-GRADE 244 ASBESTOS IN A TYPICAL POLYESTER FORMULATION

CALIDRIA RESIN-GRADE 244 ASBESTOS, % BY WT.	BROOKFIELD VISCOSITY AT 25°C., CPS.; MODEL LVF, NO. 4 SPINDLE				THIXOTROPIC INDEX 2/20
	RPM.				
	2	6	20	60	
0	100	100	100	100	1.0
0.5	1,400	730	390	270	3.6
1.0	3,600	2,000	890	630	4.0
1.5	11,000	5,600	2,300	1,600	4.8
2.0	26,000	15,000	5,200	3,500	5.1
2.5	58,000	30,000	11,000	6,200	5.3
3.0	100,000	54,000	20,000	OFF SCALE	5.0

Typical heat-curable vinyl sealant formulation

CALIDRIA Resin-Grade 244 Asbestos is recommended as a heat stable anti-sag agent in plastisol automotive sealer formulations. It may be used as a direct replacement for colloidal silica or similar thixotropes. There is no adverse effect on adhesion to steel.

As an effective thixotrope in typical heat-curable vinyl sealants, CALIDRIA Resin-Grade 244 Asbestos imparts a high degree of anti-sag and promotes adhesion.

A suggested heat-curable vinyl sealant formulation[a] is the following:

INGREDIENT	PER CENT BY WEIGHT
BAKELITE Vinyl Dispersion Resin QYLF-2	24.54
BAKELITE Vinyl Solution Resin VMCC	3.92
"Elvacite" 2044[b]	0.98
"Hycar" 1411[c]	0.37
"Camel White"[d]	29.20
FLEXOL Plasticizer 10-10	29.20
FLEXOL Plasticizer TCP	2.70
"Monomer X-970"[e]	4.91
"Mark" LL[f]	0.49
CALIDRIA Resin-Grade 244 Asbestos	3.68
"Dicup" R[g]	0.01
	100.00

Dissolve BAKELITE Vinyl Resin Solution VMCC in FLEXOL Plasticizer 10-10 at about 100°C. Dissolve "Elvacite" 2044 in FLEXOL Plasticizer TCP at 100°C. Mix the two solutions and all the other ingredients together in a pony, "Hobart", or similar mixer.

(a) D. K. Sausaman, *et al*, "Special Report XP-75"; Union Carbide, Chemicals and Plastics, Bound Brook, New Jersey.

(b) Acrylic resin; Du Pont, Wilmington, Delaware

(c) Powdered rubber; B. F. Goodrich, Akron, Ohio

(d) Calcium carbonate; H. T. Campbell and Son's Corporation, Baltimore, Maryland

(e) Polymerizable monomer; Rohm and Haas, Philadelphia, Pennsylvania

(f) Stabilizer; Argus Chemical Corporation, Brooklyn, New York

(g) Catalyst; Hercules, Wilmington, Delaware

UNION CARBIDE THE DISCOVERY COMPANY

UNION CARBIDE CORPORATION
ASBESTOS
270 PARK AVENUE, NEW YORK, N. Y. 10017

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Resin-Grade 144 Asbestos

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- Effective, low-cost thickening agent and thixotrope for epoxy resin systems
- Imparts excellent aging characteristics to epoxy resin systems
- Effective with amine hardeners

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Typical physical properties

Specific Gravity, g. per ml.	2.45
Moisture Content, % by wt.	2.0, maximum
Surface Area, sq. meters per gram	60, appr.
Reflectance, G. E. Brightness	72-76
Nature of Surface Charge	Electropositive (cationic)
pH in Water	9.5
Bulking Value, gallons per 100 lb.	4.8
Oil Absorption (DOP), pounds per 100 lb.	120
Refractive Index, n_D 25° C.	1.54-1.56
Wet Bulk Density in Water, ml.	
as received, 20 g. per liter; 3-hr. settling	700
after dispersion, 2 g. per liter; 1-hr. settling	900-1,000
Dry Bulk Density, lb. per cubic foot	4
Shipping Density, lb. per cubic foot	12-14
Standard Package Weight, lb.	35

Resin and amine hardener evaluation

METHOD OF INCORPORATING THE THIXOTROPE:

In preparing the test samples used in determining data for Tables 1, 2 and 3, the thixotrope—Resin-Grade 144 Asbestos—was added to the liquid resin or hardener at 25°C. and dispersed in a "Cowles" Dissolver at 2400 rpm. for 5 minutes.

VISCOSITY MEASUREMENTS:

Viscosities of the prepared test samples were measured on a Brookfield Model RVF Viscometer at 2 and 20 rpm.

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Table 1 shows performance data of bisphenol-based resins, BAKELITE ERL-2774 and ERL-2795, with up to 4 PHR. of Resin-Grade 144 Asbestos. Vertical drawdown was excellent, and even higher asbestos loading should result in even higher vertical drawdown.

Table 1 THICKENING OF BISPHENOL-BASED RESINS WITH RESIN-GRADE 144 ASBESTOS

Ingredient	Parts by Weight											
BAKELITE ERL-2774 Resin-Grade 144 Asbestos	100 1			100 2			100 3			100 4		
Brookfield RVF Viscosity, cps. X 10^{-3}	RPM. 2	RPM. 20	Thixotropic Index (T. I.) (a)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)
24 hours	34	22	1.5	137	39	3.5	250	53	4.7	464	87	5.3
7 days	32	20	1.6	132	36	3.6	244	54	4.5	430	76	5.7
30 days	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	480	94	5.1
Vertical Drawdown, mil (c)												
Room Temperature	(b)			(b)			(b)			125		
45 days	(b)			(b)			(b)			125		

Ingredient	Parts by Weight											
BAKELITE ERL-2795 Resin-Grade 144 Asbestos	100 1			100 2			100 3			100 4		
Brookfield RVF Viscosity, cps. X 10^{-3}	RPM. 2	RPM. 20	Thixotropic Index (T. I.)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)
24 hours	18	3.8	4.7	38	6.3	6.0	70	11	6.4	91	13	6.9
7 days	16	3.7	4.3	35	6.8	5.1	68	12	5.5	122	22	5.5
30 days	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	125	25	5.0
Vertical Drawdown, mil												
Room Temperature	(b)			(b)			(b)			80		
45 days	(b)			(b)			(b)			70		

(a) Thixotropic Index (T. I.) = $\frac{\text{viscosity at 2 rpm.}}{\text{viscosity at 20 rpm.}}$

(b) Not run.

(c) Vertical Drawdown: A 2-inch wide drawdown was made on a horizontal sandblasted steel panel. The panel was immediately raised to a vertical position and any sag noted. If no sag occurred in 10 minutes, the procedure was repeated and the thickness increased until sagging occurred.

Table 2 presents data that show the effectiveness of Resin-Grade 144 Asbestos as a thickener of several types of BAKELITE amine hardeners. Generally, other thickeners are not effective with amine hardeners.

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Table 2 THICKENING OF AMINE HARDENERS WITH RESIN-GRADE 144 ASBESTOS

Formulation	Parts by Wt. BAKELITE ZZL-0814.....100 Resin-Grade 144 Asbestos.....4			Parts by Wt. BAKELITE ZZL-0820.....100 Resin-Grade 144 Asbestos.....4			Parts by Wt. BAKELITE ZZL-0854.....100 Resin-Grade 144 Asbestos.....4		
Brookfield RVF Viscosity, cps. × 10^{-3}	RPM. 2	RPM. 20	Thixotropic Index (T. I.)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)
24 hours	187	36	5.3	67	32	2.1	102	23	4.5
7 days	172	34	5.1	66	32	2.1	104	23	4.6
30 days	177	34	5.2	67	35	1.9	104	24	4.4
Vertical Drawdown	**Mil**			**Mil**			**Mil**		
Room Temperature (R. T.)	70			40			40		
50°C.	20			—			—		
80°C.	—			40			40		
30 days at R. T.	70			40			40		
30 days at 80°C.	—			40			40		

Table 3 shows the thickening of a low-viscosity, cyclo-aliphatic epoxide, BAKELITE ERL-4221, with Resin-Grade 144 Asbestos and "Armac" C, a long chain aliphatic amine salt. BAKELITE ERL-4221 is the exception that requires an amine salt to be used with Resin-Grade 144 Asbestos for viscosity build-up or thixotropic stabilization.

Table 3 THICKENING OF A LOW-VISCOSITY, CYCLO-ALIPHATIC EPOXIDE WITH RESIN-GRADE 144 ASBESTOS AND "Armac" C

Ingredient	Parts by Wt.
BAKELITE ERL-4221	100
Resin-Grade 144 Asbestos	7
"Armac" C	5

Brookfield RVF Viscosity, cps. × 10^{-3}	RPM. 2	RPM. 20	Thixotropic Index (T.I.)
Initial	262	42	6.3
8 Weeks at 25°C.	268	36	7.4
7 Weeks at 40°C.	243	38	6.4

systems evaluation

BAKELITE ERL-2774/ZZL-0814

With a Resin-Grade 144 Asbestos loading of 4 per cent on both resin and hardener, it was possible to hold a 70-mil thickness at room temperature. Higher loadings on the amine should result in much higher vertical drawdown.

BAKELITE ERL-2774/ZZL-0820

A 4-per cent loading of Resin-Grade 144 Asbestos resulted in a 40-mil thickness that did not sag within 40 minutes at 80°C. The system was gelled at that time.

BAKELITE ERL-2774/ZZL-0854

With a 4-per cent loading of Resin-Grade 144 Asbestos, it was possible to hold a 40-mil thickness at 80°C. until gelled (65 minutes).

Resin-Grade 144 Asbestos

. . . a highly purified fiber product that is an effective, low-cost thickening agent and thixotrope for epoxy resin systems. By means of a special refining technique developed by UNION CARBIDE, Resin-Grade 144 Asbestos is made completely grit-free and non-abrasive—this latter characteristic makes it especially valuable in spray application.

Other desirable features of Resin-Grade 144 Asbestos include:

- Disperses easily in liquid resin or hardener with a "Cowles" Dissolver or similar mixers
- Overmixing will not destroy the thixotropy of the resin-asbestos mixture
- Epoxy systems containing Resin-Grade 144 Asbestos have excellent aging characteristics
- Negligible dusting
- Unlike other thixotropes, it is effective with amine hardeners
- Resin-Grade 144 Asbestos is substantially lower in cost than commonly used refined silicas or modified clays
- With the exception of the low-viscosity, cyclo-aliphatic epoxides, no amine salts are necessary for viscosity build-up or thixotropic stabilization

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Calidria

Resin-Grade 144 Asbestos

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- **Effective, low-cost thickening agent and thixotrope for epoxy resin systems**

- **Imparts excellent viscosity control to resin systems (coatings, adhesives, sealants, caulks, mastics)**

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Calidria Resin-Grade 144 Asbestos

. . . a highly purified fiber product that is an effective, low-cost thickening agent and thixotrope for epoxy resin systems. By means of a special refining technique developed by UNION CARBIDE, CALIDRIA Resin-Grade 144 Asbestos is made completely grit-free and non-abrasive—this latter characteristic makes it especially valuable in spray application.

Other desirable features of CALIDRIA Resin-Grade 144 Asbestos include:

- Disperses easily in liquid resin or hardener with a "Cowles" Dissolver or similar mixers
- Overmixing will not destroy the thixotropy of the resin-asbestos mixture
- Epoxy systems containing CALIDRIA Resin-Grade 144 Asbestos have excellent aging characteristics
- Reduced dust
- Unlike other thixotropes, it is effective with amine hardeners
- CALIDRIA Resin-Grade 144 Asbestos is substantially lower in cost than commonly used refined silicas or modified clays
- No amine salts are necessary for viscosity build-up or thixotropic stabilization (with the exception of the low-viscosity, cycloaliphatic epoxides)

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Typical physical properties

Specific Gravity	2.45
Moisture Content, % by wt.	2.0, maximum
Surface Area, sq. meters per gram	60, appr.
Reflectance, G. E. Brightness	72-76
Nature of Surface Charge	Electropositive (cationic)
pH in Water	9.5
Bulking Value, gallons per 100 lb.	4.8
Oil Absorption (DOP), pounds per 100 lb.	120-140
Refractive Index, n_D25° C.	1.54-1.56
Wet Bulk Density in Water, ml.	
as received, 20 g. per liter; 3-hr. settling	700
after dispersion, 2 g. per liter; 1-hr. settling	900-1,000
Dry Bulk Density, lb. per cubic foot	4
Shipping Density, lb. per cubic foot	12-14
Standard Package Weight, lb.	35
% Magnetite	0.6
Screen Size, Typical; % plus 325 mesh	Nil
Fiber Diameter, microns	0.025
Length/Diameter, microns	200 avg. (1000 maximum)

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Typical applications

Figure 1 THICKENING EFFICIENCY IN LIQUID EPOXY RESINS

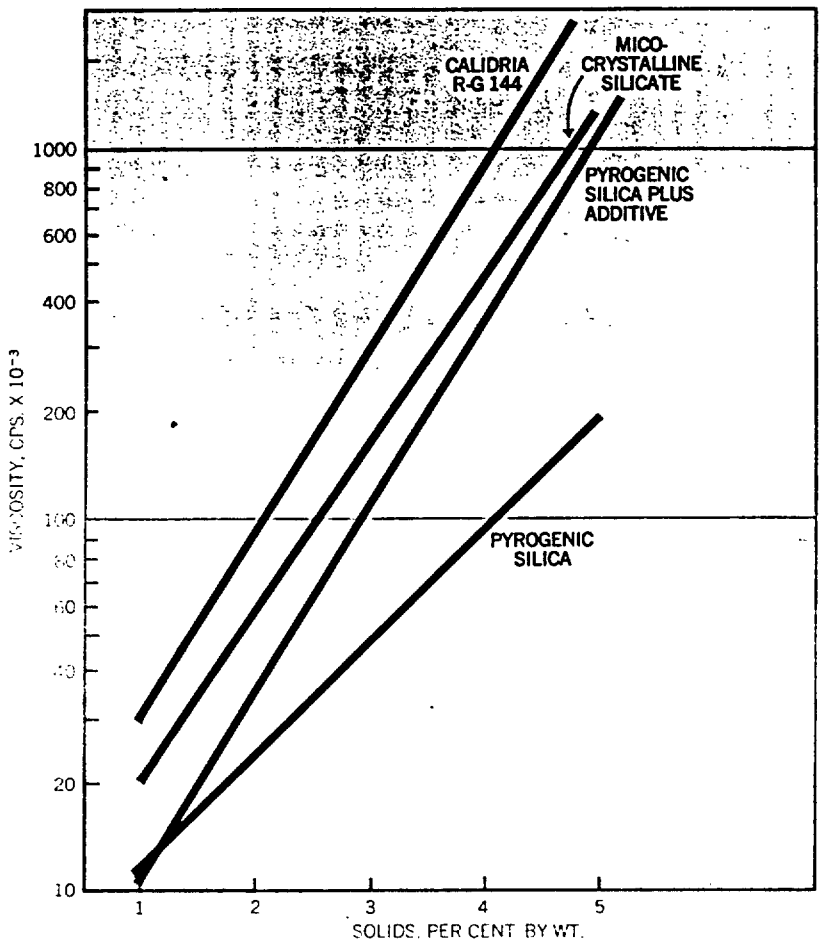
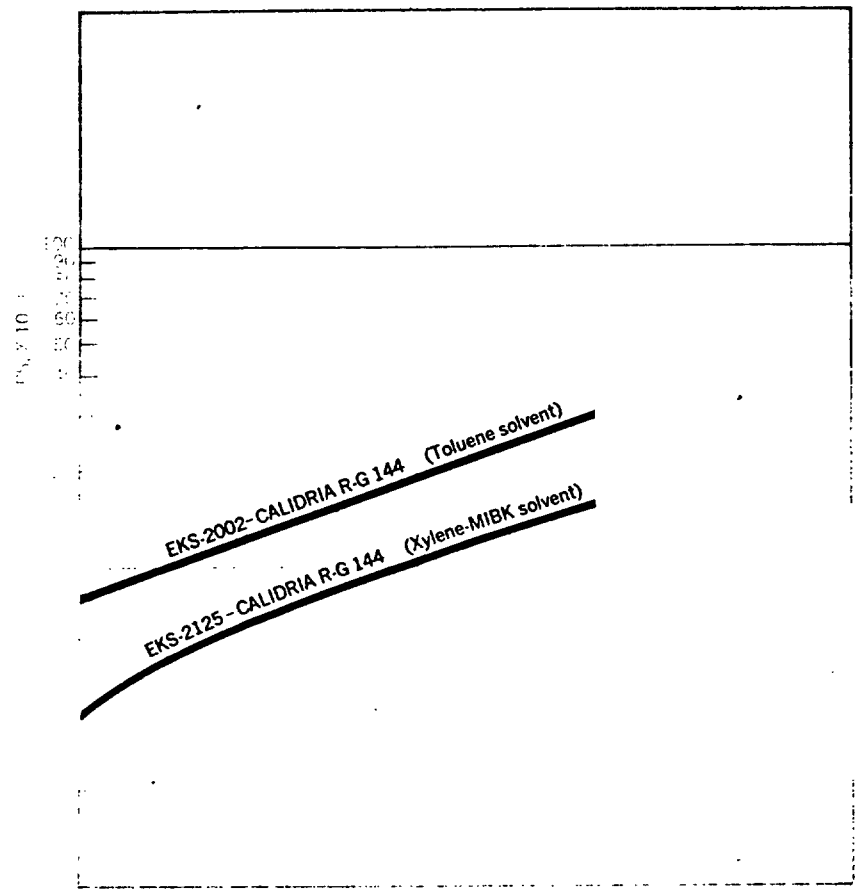


Figure 1 illustrates the effective, low-cost thickening and viscosity control properties of CALIDRIA Resin-Grade 144 Asbestos in epoxy resin systems. It compares relative differences in viscosity of BAKELITE Epoxy Resin ERL-2774 solutions containing equivalent concentrations of CALIDRIA R-G 144 Asbestos, micro-crystalline silicate, and pyrogenic silica.

Figure 2 illustrates the ability of CALIDRIA R-G 144 Asbestos to control viscosity in two different solvent-epoxy systems used in many epoxy coatings and paints.

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Figure 2 VISCOSITY CHARACTERISTICS OF *CALIDRIA* R-G 144 IN BAKELITE® EPOXY SOLUTIONS



resin and amine hardener evaluation

METHOD OF INCORPORATING THE THIXOTROPE:

In preparing the test samples used in determining data for Tables 1, 2 and 3, the thixotrope—CALIDRIA Resin-Grade 144 Asbestos—was added to the liquid resin or hardener at 25°C. and dispersed in a "Cowles" Dissolver at 2400 rpm. for 5 minutes.

VISCOSITY MEASUREMENTS:

Viscosities of the prepared test samples were measured on a Brookfield Model RVF Viscometer at 2 and 20 rpm.

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Table 1 shows performance data of bisphenol based resins, BAKELITE ERL-2774 and ERL-2795, with up to 4 PHR. of CALIDRIA Resin-Grade 144 Asbestos. Vertical draw-down was excellent, and even higher asbestos loading should result in even higher vertical draw-down.

Table 1 THICKENING OF BISPHENOL-BASED RESINS WITH *CALIDRIA* RESIN-GRADE 144 ASBESTOS

Ingredient	Parts by Weight											
BAKELITE ERL-2774	100			100			100			100		
CALIDRIA Resin-Grade 144 Asbestos	1			2			3			4		
Brookfield RVF Viscosity, cps. X 10^{-3}	RPM.		Thixotropic Index (T. I.) (a)	RPM.		Thixotropic Index (T. I.)	RPM.		Thixotropic Index (T. I.)	RPM.		Thixotropic Index (T. I.)
	2	20		2	20		2	20		2	20	
24 hours	34	22	1.5	137	39	3.5	250	53	4.7	464	87	5.3
7 days	32	20	1.6	132	36	3.6	244	54	4.5	430	76	5.7
30 days	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	480	94	5.1
Vertical Drawdown, mil (c)												
Room Temperature	(b)			(b)			(b)			125		
45 days	(b)			(b)			(b)			125		

Ingredient	Parts by Weight											
BAKELITE ERL-2795	100			100			100			100		
CALIDRIA Resin-Grade 144 Asbestos	1			2			3			4		
Brookfield RVF Viscosity, cps. X 10^{-3}	RPM.		Thixotropic Index (T. I.)	RPM.		Thixotropic Index (T. I.)	RPM.		Thixotropic Index (T. I.)	RPM.		Thixotropic Index (T. I.)
	2	20		2	20		2	20		2	20	
24 hours	18	3.8	4.7	38	6.3	6.0	70	11	6.4	91	13	6.9
7 days	16	3.7	4.3	35	6.8	5.1	68	12	5.5	122	22	5.5
30 days	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	125	25	5.0
Vertical Drawdown, mil (c)												
Room Temperature	(b)			(b)			(b)			80		
45 days	(b)			(b)			(b)			70		

(a) Thixotropic Index (T. I.) = $\frac{\text{viscosity at 2 rpm.}}{\text{viscosity at 20 rpm.}}$

(b) Not run.

(c) Vertical Drawdown: A 2-inch wide drawdown was made on a horizontal sandblasted steel panel. The panel was immediately raised to a vertical position and any sag noted. If no sag occurred in 10 minutes, the procedure was repeated and the thickness increased until sagging occurred.

Table 2 presents data that show the effectiveness of CALIDRIA Resin-Grade 144 Asbestos as a thickener of several types of BAKELITE Amine Hardeners. Generally, other thickeners are not effective with amine hardeners.

Table 2 THICKENING OF AMINE HARDENERS WITH *CALIDRIA* RESIN-GRADE 144 ASBESTOS

Formulation	Parts by Wt. BAKELITE ZZL-0814.....100 CALIDRIA Resin-Grade 144 Asbestos.....4			Parts by Wt. BAKELITE ZZL-0820.....100 CALIDRIA Resin-Grade 144 Asbestos.....4			Parts by Wt. BAKELITE ZZL-0854.....100 CALIDRIA Resin-Grade 144 Asbestos.....4		
Brookfield RVF Viscosity, cps. X 10^{-3}	RPM. 2	RPM. 20	Thixotropic Index (T. I.)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)	RPM. 2	RPM. 20	Thixotropic Index (T. I.)
24 hours	187	36	5.3	67	32	2.1	102	23	4.5
7 days	172	34	5.1	66	32	2.1	104	23	4.6
30 days	177	34	5.2	67	35	1.9	104	24	4.4
Vertical Drawdown	**Mil**			**Mil**			**Mil**		
Room Temperature (R. T.)	70			40			40		
50°C.	20			—			—		
80°C.	—			40			40		
30 days at R. T.	70			40			40		
30 days at 80°C.	—			40			40		

Table 3 shows the thickening of a low-viscosity, cycloaliphatic epoxide, BAKELITE ERL-4221, with CALIDRIA Resin-Grade 144 Asbestos and "Armac" C, a long chain aliphatic amine salt. BAKELITE ERL-4221 is the exception that requires an amine salt to be used with CALIDRIA Resin-Grade 144 Asbestos for viscosity build-up or thixotropic stabilization.

Table 3 THICKENING OF A LOW-VISCOSITY, CYCLOALIPHATIC EPOXIDE WITH *CALIDRIA* RESIN-GRADE 144 ASBESTOS AND "Armac" C

Ingredient	Parts by Wt.
BAKELITE ERL-4221	100
CALIDRIA Resin-Grade 144 Asbestos	7
"Armac" C	5

Brookfield RVF Viscosity, cps. X 10^{-3}	RPM. 2	RPM. 20	Thixotropic Index (T.I.)
Initial	262	42	6.3
8 Weeks at 25°C.	268	36	7.4
7 Weeks at 40°C.	243	38	6.4

Systems evaluation

BAKELITE ERL-2774/ZZL-0814

With a CALIDRIA Resin-Grade 144 Asbestos loading of 4 per cent on both resin and hardener, it was possible to hold a 70-mil thickness at room temperature. Higher loadings on the amine should result in much higher vertical drawdown.

BAKELITE ERL-2774/ZZL-0820

A 4-per cent loading of CALIDRIA Resin-Grade 144 Asbestos resulted in a 40-mil thickness that did not sag within 40 minutes at 80°C. The system was gelled at that time.

BAKELITE ERL-2774/ZZL-0854

With a 4-per cent loading of CALIDRIA Resin-Grade 144 Asbestos, it was possible to hold a 40-mil thickness at 80°C. until gelled (65 minutes).

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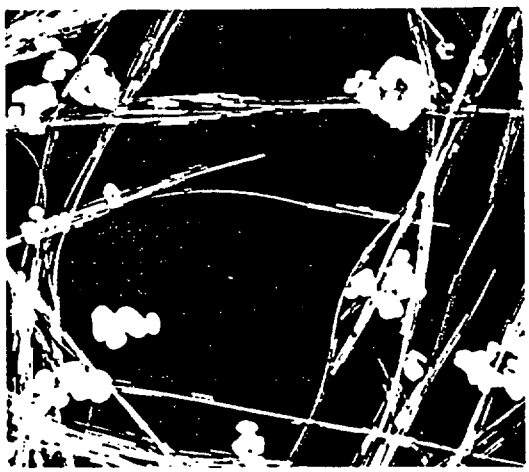
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ASBESTOS T-135 OPACIFYING AGENT

- a highly efficient opacifying agent now in mill use. Excellent performance in both dry and waxed or oiled opacity make it useful in offset, envelope, map, book, glassine, pouch, and saturating papers.

- a unique UNION CARBIDE development, a specially titanated high purity asbestos fiber on which TiO_2 is fixed in finely divided form along the filament. It maximizes the light scattering power of TiO_2 by achieving unusually high retention in the dispersed state without agglomeration. Kubelka-Munk tests show T-135 more than doubles the scattering power of TiO_2 in the sheet over a broad range of addition.



Electron photomicrograph (5,600 X) of Asbestos T-135 showing uniform distribution of TiO_2 on asbestos fiber.

- positively charged, the most highly retained pigment known.

- low cost, less than 70 per cent that of TiO_2 per pound. Direct substitution in quality paper grades can save up to $15 per ton of product paper. Economic amounts can be used to improve opacity/ash ratios in sheet where TiO_2 costs are prohibitive.

- available commercially in carload quantities, in a convenient dust-free pellet form.

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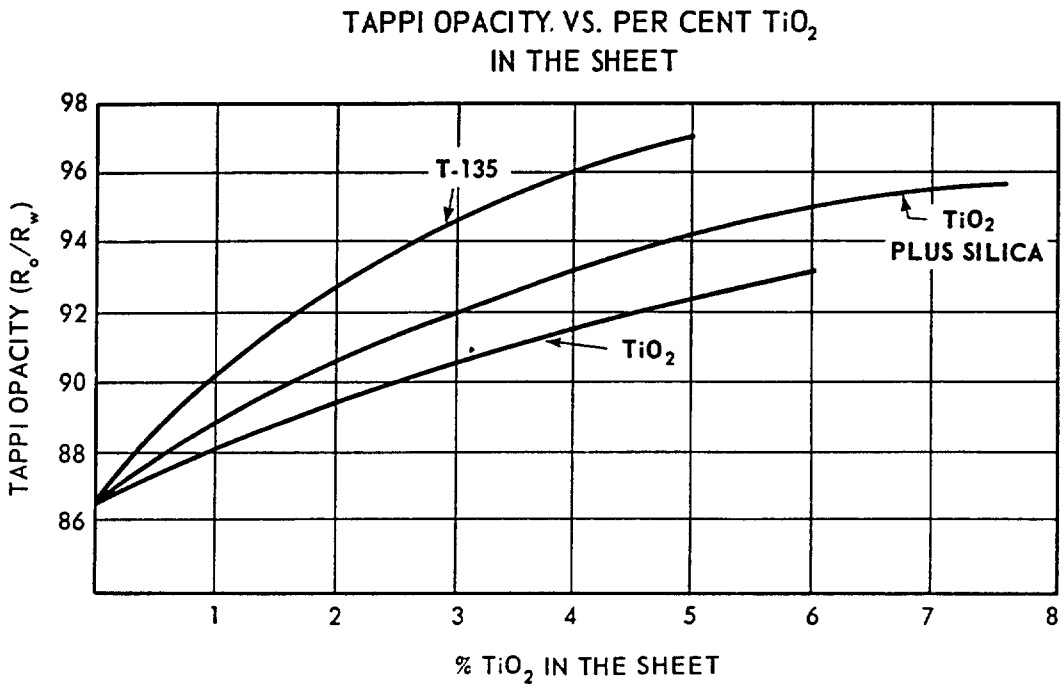
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ASBESTOS T-135 OPACIFYING AGENT



HOW TO USE T-135

- Replace TiO_2 in the furnish pound for pound; frequently 3 pounds of T-135 will replace 4 pounds of TiO_2. Recommended use levels for mill trial evaluation:

Present TiO_2 Addition, Per Cent of Furnish	Per Cent TiO_2 Replacement with T-135
2½ or less	100
2½ – 4	50 to 100
Over 4	50 or less

Under certain conditions, amounts above these recommended levels may affect drainage and strength properties.

- Add T-135 pellets to the beater; the energy requirement to repulp T-135 pellets is less than to defiberize pulp lap.

- Reduce, or preferably eliminate, organic retention aids; T-135 performs this secondary function.

- T-135 can be used in both acid and alkaline systems.

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SOME TYPICAL T-135 MILL PERFORMANCE

T-135 has proved itself in more than 40 mills. Examples of mill data tabulated below, indicate the savings using improved T-135 based pigment-filler systems to produce specification grade paper. In some cases specifications were exceeded, indicating opportunity for further cost optimization.

MILL	PAPER GRADE	ORIGINAL PIGMENT-FILLER		IMPROVED PIGMENT-FILLER		DIRECT SAVINGS
		% Added	Cost Per Ton Paper	% Added	Cost Per Ton Paper	
"A"	50 lb. Opaque Offset	6 TiO_2 2 Clay	$27.80	3 T-135 1.75 TiO_2 2 Clay	$18.28	$9.50 per ton of paper
"B"	25 lb. Book Paper	10.9 TiO_2	$47.80	5 TiO_2 3.8 T-135	$34.13	$13.70 per ton of paper
"C"	50 lb. White Opaque Envelope	10 TiO_2 1.25 Extender	$45.72	5 TiO_2 5 T-135	$38.00	$7.72 per ton of paper
"D"	45 lb. White Opaque Book	1.1 TiO_2 2.8 Extender Clay	$9.43	1.0 T-135 1.7 Extender Clay (Unchanged)	$5.92	$3.50 per ton of paper
"E"	50 lb. Offset	4.7 TiO_2 0.6 Extender 3.1 Clay	$23.35	2.2 T-135 2.4 Clay	$8.00	$15.35 per ton of paper
"F"	70 lb. Vellum Opaque Offset	5.4 TiO_2 8.9 Clay	$27.86	2.2 T-135 3.2 TiO_2 7.8 Clay	$24.56	$3.30 per ton of paper

SECONDARY BENEFITS

In addition to direct savings, fibrous T-135:

- Acts as a retention aid for separately added components such as TiO_2, dyestuffs, fillers, etc.
- Improves sheet formation, smoothness, and printability.
- Often yields wax pick increase for starch-sized sheets.
- Markedly improves solids recoveries in the saveall, reducing loss in mill effluent.

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ASBESTOS T-135 OPACIFYING AGENT

TYPICAL PROPERTIES OF T-135

Ash	90% by wt.
TiO_2	35% by wt.
Moisture (105%)	2.0% by wt.
Mg	16% by wt.
Brightness (Photovolt)	86
Surface Charge	Electropositive
pH of 2% Slurry	~ 9.5

SHIPPING INFORMATION

Pellets, having 53 lb. per cubic foot density.
Packed 50 lb. per bag in 3-ply repulpable bags.
Palletized on 1-net ton pallets; overall dimensions of loaded pallet
46" L x 39" W x 48" H.
Shipment by rail: 60 tons per boxcar, from King City, California.
bulk: 100 tons per covered hopper car from King City, California.
truck: 20 tons, from local warehouses.

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PERFORMANCE DATA

Calidria ASBESTOS

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COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244/POLYESTER RESIN SYSTEMS

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COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244/POLYESTER RESIN SYSTEMS

CALIDRIA Resin-Grade 244 Asbestos, a new, modified asbestos fiber from UNION CARBIDE, developed for maximum thickening efficiency and thixotropy in polyester spray-up and hand lay-up laminating resins, is also an effective thickener for plastisols and organosols used in a broad variety of adhesives, coatings, mastics and sealants. In many systems, CALIDRIA Resin-Grade 244 Asbestos will not contribute color or opacity – a characteristic that makes it particularly attractive in polyester gel coats.

The distinctive characteristics of CALIDRIA Asbestos offer improved viscosity and thixotropic properties to polyester resin systems, superior to other commonly used thixotropic aids, at a considerable cost savings. On a pound-for-pound basis, CALIDRIA Resin-Grade 244 Asbestos has been found to contribute more than twice the viscosity of a typical pyrogenic silica. Savings up to 30 per cent or more are illustrated.

Though CALIDRIA Resin-Grade 244 Asbestos is designed for use in stir-in mixers, optimum efficiency and lowest cost are obtained through use of high-shear mixers such as "Cowles" Dissolvers, sonic dispersers and homogenizers.

Other desirable features of CALIDRIA Resin-Grade 244 Asbestos include:

- Ease of incorporation
- Reduced dust
- Clear, colorless products at low loadings
- Long term shelf life

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COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244/POLYESTER RESIN SYSTEMS

SCOPE

The rheological properties imparted by CALIDRIA R-G 244 Asbestos to polyester resin systems have been determined in a number of commercial laminating resins. Comparative evaluations of CALIDRIA R-G 244 versus pyrogenic silica have also confirmed the performance and economic advantages claimed for CALIDRIA R-G 244 Asbestos.

The following commercial polyester resins were used for these evaluations:

Polyester Resin	Manufacturer
"Hetron" 26869	Durez Div. of Hooker Chemicals Corp.
"Hetron" 17	Durez Div. of Hooker Chemicals Corp.
"Hetron" 130	Durez Div. of Hooker Chemicals Corp.
"Hetron" 19	Durez Div. of Hooker Chemicals Corp.
"Paraplex" 43	Rohm and Haas
"Marco" Resin	Marco Chemical Div. of W. R. Grace Co.
"Koplac" 1000-23	Koppers Company, Inc.
"Dion" DR-315	Diamond Alkali Company, Dion Polymer Prods.
Freeman Resin	Freeman Chemical Corporation

TEST PROCEDURE

To establish a sound and reliable basis for relative test comparisons, viscosities of the base resins were equated by the addition of styrene. CALIDRIA R-G 244 was evaluated in the resins at the 0.5, 1.0, 2.0 and 3.0 parts per 100 parts of resin (PHR). A commercial pyrogenic silica was used for comparative evaluations in several of the resins. Solids were incorporated by one of two procedures:

1. A high-shear laboratory "Homo-Mixer", with a 4-blade, 2-inch diameter impeller.
2. A low-shear "Lightnin' " Mixer, with a 6-paddle, 2-inch diameter impeller.

The degree of shear, implied herein, is in relative terms of impeller rpm. Mixing time was held constant at 3 minutes for all samples.

Viscosity measurements were obtained with a Brookfield Viscometer at 25°C. The samples were hand-stirred prior to measuring the viscosities.

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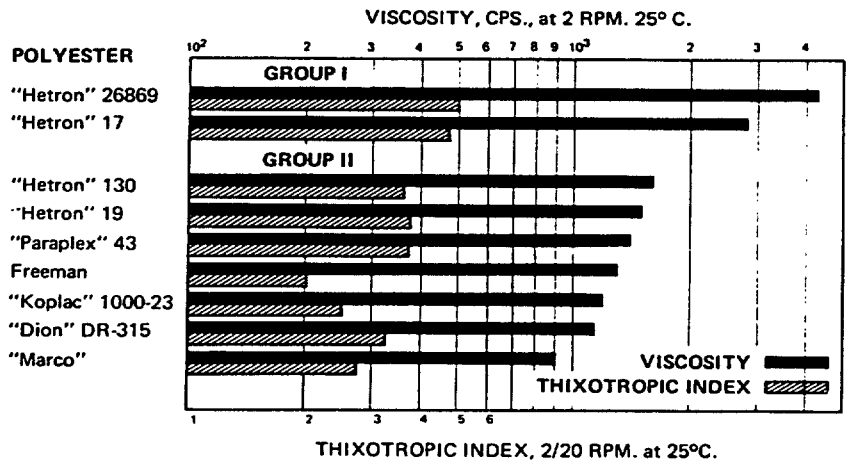
COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244/POLYESTER RESIN SYSTEMS

PERFORMANCE CHARACTERISTICS

The comparative rheological properties of these commercial polyester resins containing CALIDRIA R-G 244 Asbestos are shown in the bar graph, Figure 1. Viscosities are those determined at 2 rpm. Thixotropic Index is based on the 2/20 rpm. viscosities.

FIGURE 1
VISCOSITY AND THIXOTROPIC INDEX DATA

COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244 ASBESTOS IN VARIOUS COMMERCIAL POLYESTER RESINS AT 0.5 PHR ADDITION



Polyester base resins: adjusted to 100 cps. with styrene.

Mixing: "Lightnin'" Mixer, 6-paddle, 2-inch diameter impeller. Mixed for 3 minutes at 1600 rpm.

PROMOTED POLYESTER RESINS

Unlike most other thixotropes, CALIDRIA R-G 244 does not normally require polar additives such as glycol derivatives for viscosity build-up or thixotropic stabilization. However, in some promoted resins, particularly those containing cobalt-type accelerators, nominal additions of ethylene glycol or similar additives will improve the viscosity, thixotropy, and stability of CALIDRIA R-G 244 dispersions significantly. This is illustrated in Table 1.

TABLE 1
Viscosity of CALIDRIA R-G 244/Promoted Polyester (*) Resin Systems

CALIDRIA R-G 244 (PHR)	Ethylene Glycol (PHR)	Viscosity, cps., at 25°C.		Thixotropic Index at 2 and 20 rpm.
		2 rpm.	20 rpm.	
0.75	— —	800	560	1.4
0.75	0.30	1600	630	2.5

(*)"Silmar Resin" J-3798 — Vistron Corporation
Base viscosity 165 cps.
CALIDRIA R-G 244 incorporated with "Homo-Mixer" at 5000 rpm. for 3 minutes

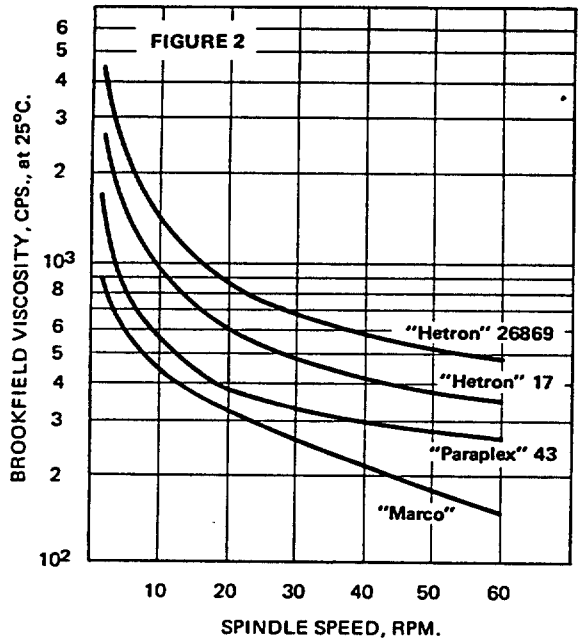
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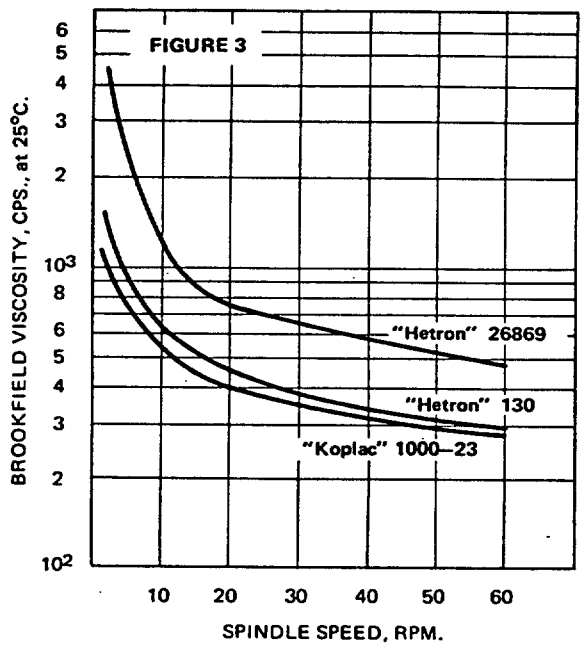
COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244/POLYESTER RESIN SYSTEMS

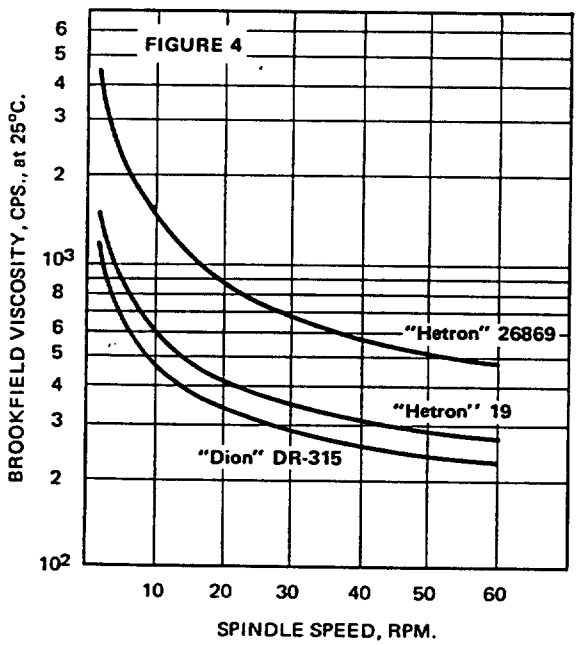
RELATIVE VISCOSITIES

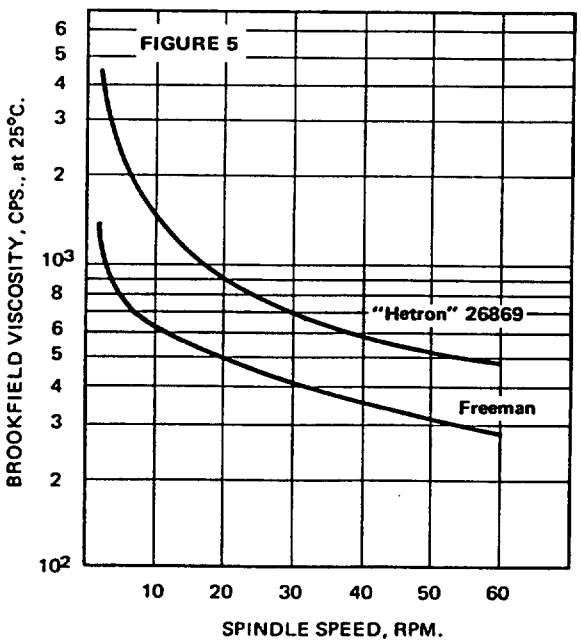
Figures 2 through 5 compare the relative viscosities of the various polyester resins over a range of 2 to 60 rpm.; each containing 0.5 PHR of CALIDRIA R-G 244 Asbestos. "Hetron" 26869 is used as the standard for comparison.

FIGURES 2 THROUGH 5 – COMPARISON OF RELATIVE VISCOSITIES









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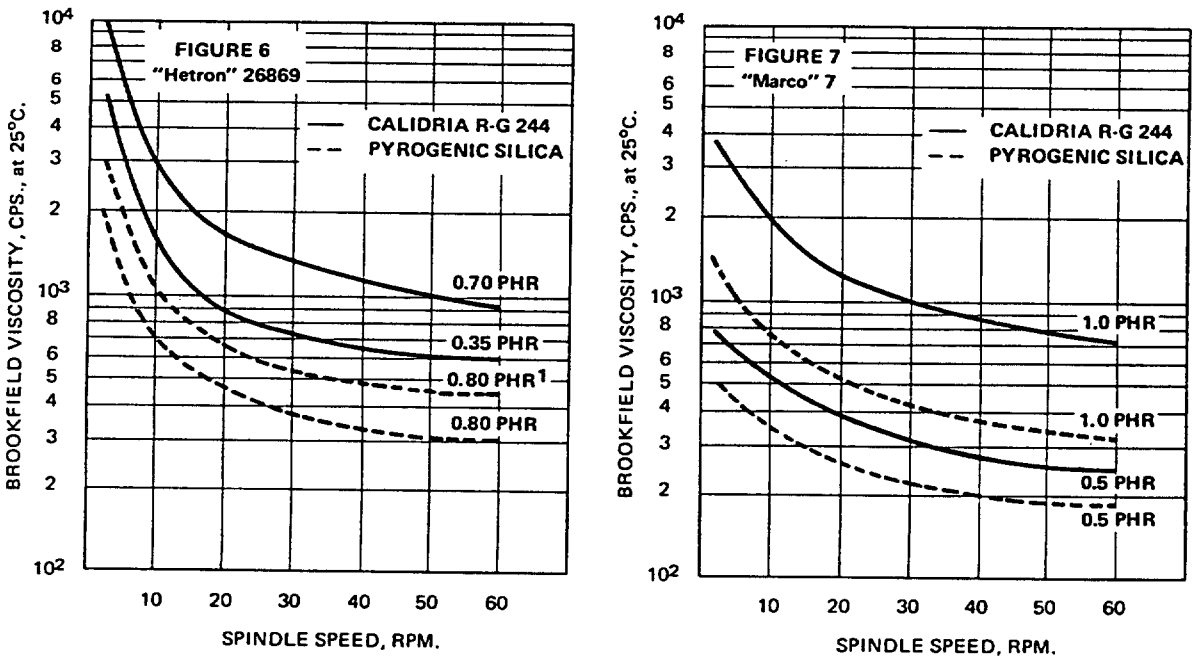
COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244/POLYESTER RESIN SYSTEMS

CALIDRIA R-G 244 ASBESTOS VS. PYROGENIC SILICA

A comparison of the relative performances of CALIDRIA R-G 244 Asbestos and pyrogenic silica is shown in Figures 6 through 9. The thickeners were incorporated with a high shear "Homo-Mixer", for 3 minutes, at 5000 rpm. Four polyester resins, ranging from high to medium low performance (see Figure 1, page 4), were selected for this comparative evaluation. In all resins, the performance of CALIDRIA R-G 244 Asbestos was superior to pyrogenic silica for promoting viscosity and thixotropy. In addition, significant economic advantages became apparent.

FIGURES 6 AND 7

COMPARISON OF RELATIVE PERFORMANCES OF *CALIDRIA* R-G 244 AND PYROGENIC SILICA WITH "Hetron" 26869 AND "Marco" 7



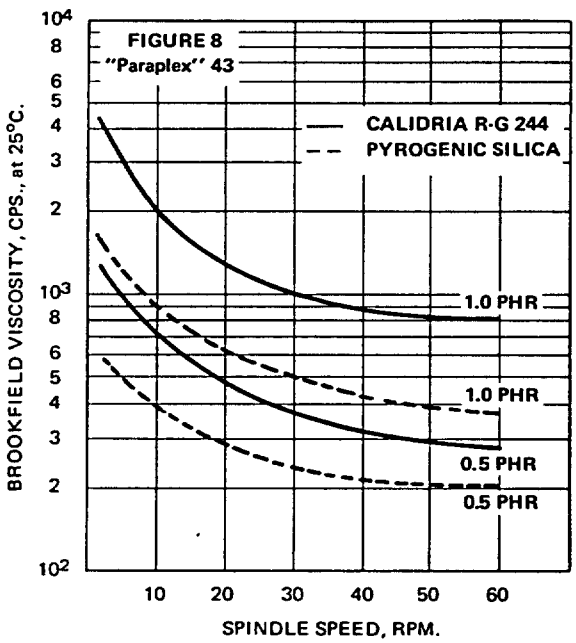
NOTE:
Polyester resins were initially adjusted to a Brookfield viscosity of 100 cps. with styrene.
Mixing: "Homo-Mixer" at 5000 rpm. for 3 minutes.

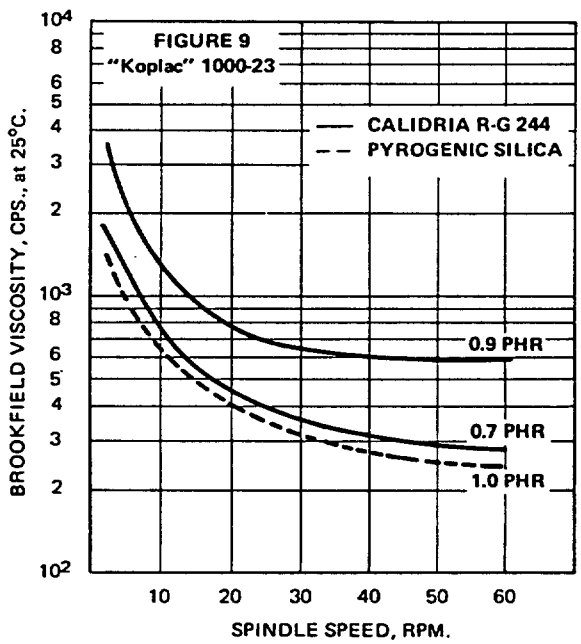
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COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244/POLYESTER RESIN SYSTEMS

FIGURES 8 AND 9

COMPARISON OF RELATIVE PERFORMANCES OF *CALIDRIA* R-G 244 AND PYROGENIC SILICA WITH "Paraplex" 43 AND "Koplac" 1000-23





NOTE:
Polyester resins were initially adjusted to a Brookfield viscosity of 100 cps. with styrene.
Mixing: "Homo-Mixer" at 5000 rpm. for 3 minutes.

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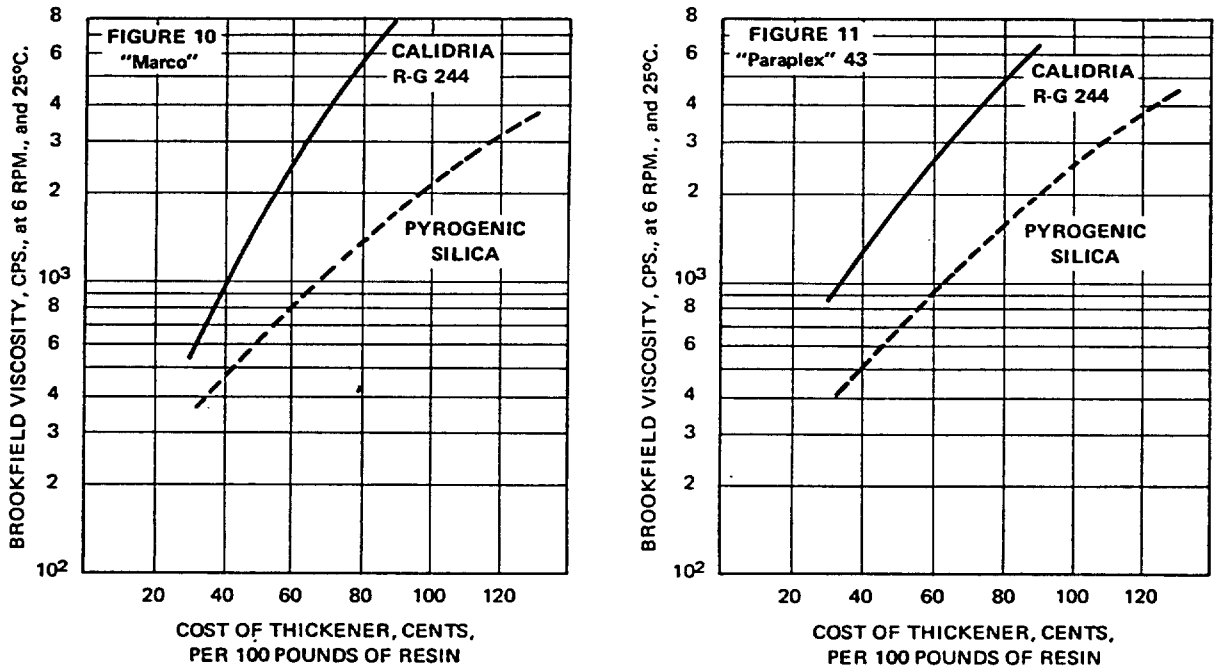
COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244/POLYESTER RESIN SYSTEMS

VISCOSITY VS. COST

Figures 10 and 11 compare the viscosities obtained at 6 rpm., on various additive concentrations vs. the relative cost of the thickeners per 100 pounds of the polyester base resins. From these comparative tests and the relative thixotropic properties shown in Figure 16, page 11, it can be concluded that CALIDRIA Resin-Grade 244 Asbestos will provide, on the average, viscosities equivalent to pyrogenic silica, at approximately one-half the cost.

FIGURES 10 AND 11

COMPARISON OF VISCOSITIES VS. RELATIVE COST OF THICKENERS



SHEAR EFFECTS ON RHEOLOGICAL PROPERTIES

The effects of shear on the rheological properties of CALIDRIA R-G 244 Asbestos and pyrogenic silica in polyesters are shown in Figures 12 to 15. "Paraplex" 43 and "Marco" resins, considered to be typical of most polyester systems, were selected for these tests. Although results obtained with laboratory equipment cannot be assumed to predict optimum conditions for production facilities, these data do indicate that pyrogenic silica is more shear dependent than CALIDRIA R-G 244. On this basis, it can be concluded that pyrogenic silica requires relatively higher levels of energy to develop optimum rheological properties, in polymer suspensions, equivalent to those obtainable with CALIDRIA R-G 244 Asbestos.

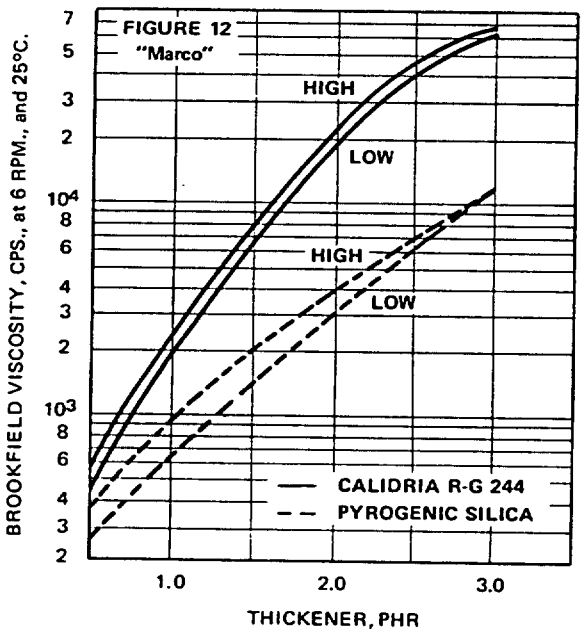
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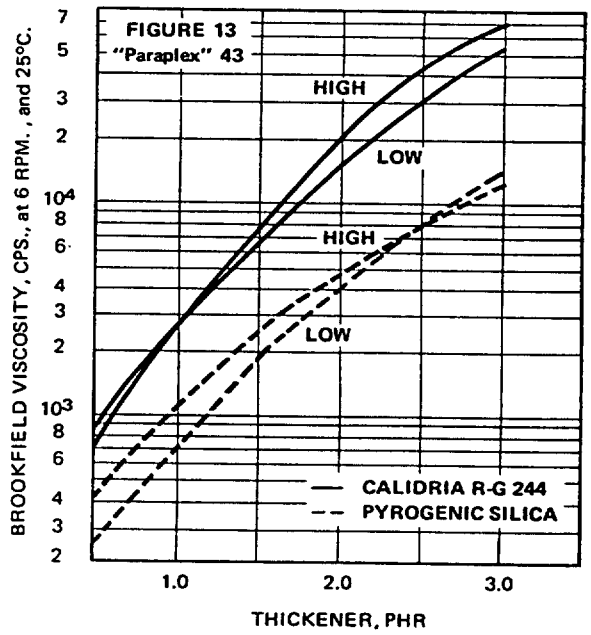
HIGH AND LOW SHEAR MIXING VS. SOLIDS CONTENT

The viscosity vs. solids content experimental results shown in Figures 12 and 13 below were obtained with both high and low shear mixing equipment, using the following standard testing conditions. The initial viscosity of each of the polyester base resins was adjusted to 100 cps. with styrene.

	High-Shear "Homo-Mixer"	Low-Shear "Lightnin' " Mixer
Mixing Time, minutes	3	3
Mixing Blades and Size	4 - 2-inch diameter	6 (paddle) - 2-inch diameter
Mixing Speed, rpm.	5000	1600 (tip speed 800 to 900 rpm.)

FIGURES 12 AND 13
VISCOSITY VS. THICKENER CONCENTRATION
RELATIVE EFFECT OF HIGH AND LOW SHEAR MIXING





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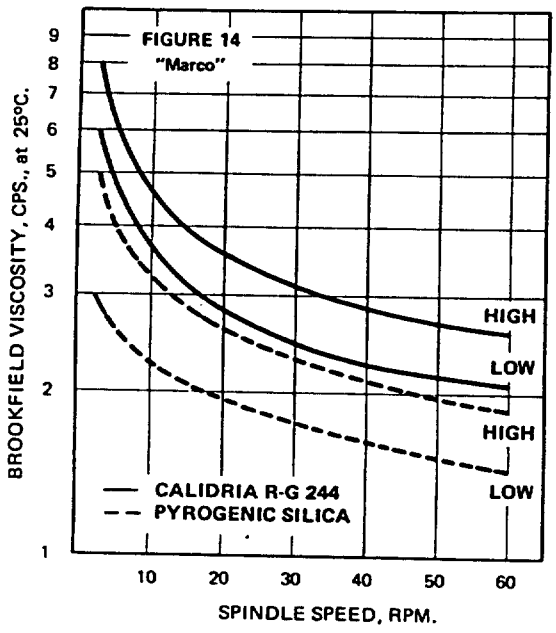
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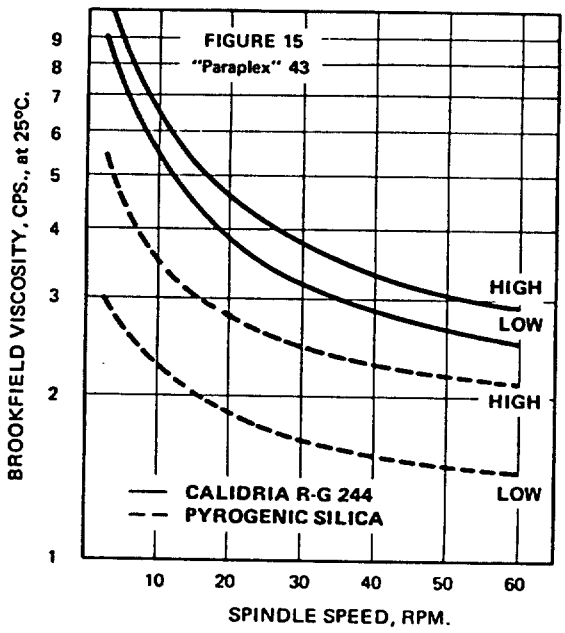
VISCOSITY VS. SHEAR RATE

Viscosities determined at 25°C., over a range of spindle speeds, from 2 to 60 rpm, on "Marco" and "Paraplex" 43 polyesters, containing 0.5 PHR of the thickeners, indicate that CALIDRIA R-G 244 Asbestos, again, maintains a relatively higher degree of thickening efficiency than pyrogenic silica, Figures 14 and 15.

It is evident from these results that pyrogenic silica is more shear dependent than CALIDRIA R-G 244 Asbestos and requires higher levels of energy to develop satisfactory rheological properties for polymer suspensions.

FIGURES 14 AND 15
VISCOSITIES AT VARIOUS SHEAR RATES
VS. EFFECT OF HIGH AND LOW SHEAR MIXING
OF POLYESTERS CONTAINING 0.5 PHR OF THICKENERS



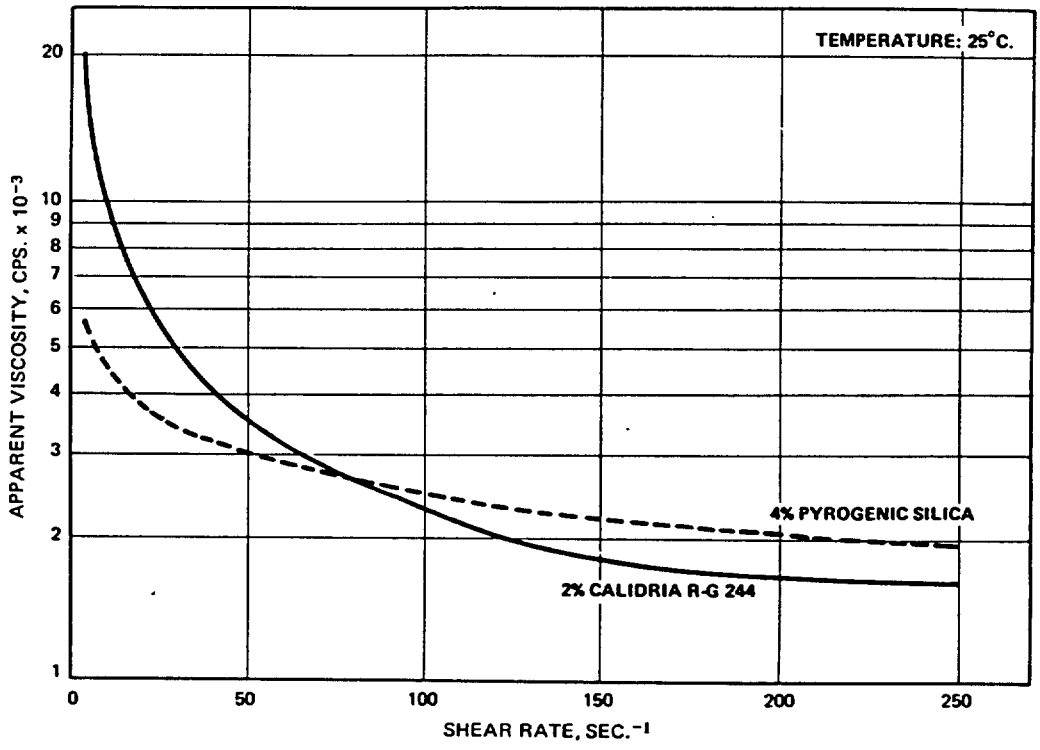


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EFFECT OF SHEAR RATE ON THIXOTROPIC PROPERTIES

CALIDRIA R-G 244 Asbestos provides exceptional rheological characteristics to polyester resins as shown in Figure 16. As indicated, a more fluid system for better spraying and brushing performance is available at one-half the concentration using CALIDRIA R-G 244 as compared to pyrogenic silica, yet sag resistance and viscosity are higher as the shear rate is reduced.

FIGURE 16
COMPARATIVE THIXOTROPIC CHARACTERISTICS
CALIDRIA R-G 244 VS. PYROGENIC SILICA



NOTE:
These data were developed for a "Paraplex" 43 polyester resin (Rohm and Haas) with 10 per cent by weight of styrene added. Instrumentation was with a Haake "Rotovisco", using measuring system SV II.

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POLYESTER PREMIXES— COMPARATIVE COST AND PERFORMANCE DATA

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POLYESTER PREMIXES – COMPARATIVE COST AND PERFORMANCE DATA

CALIDRIA R-G 110 Asbestos, a relatively new product of UNION CARBIDE, has been found to offer the polyester premix market decided product improvements, at reduced costs. Superior properties are obtained with R-G 110 as the sole reinforcing fiber at costs 1/3 to 1/2 those normally associated with Grade 7 chrysotile in similar compounds. In high performance fiber glass premixes, R-G 110 is also superior in providing mechanical properties and processing improvements at lower cost.

A high purity product, CALIDRIA Asbestos has an unusually high fiber content that is converted by a proprietary process to a product that is up to five times as effective, pound for pound, as currently used commercial grades of asbestos, that contain large amounts of ineffective inert materials.

Polyester premix compounds, largely for the electrical, automotive, refrigeration, electronics and industrial equipment fields, usually contain various types of low-cost chrysotile shorts or float-type mineral additives to provide:

- Lower shrinkage during molding.
- Controlled flow.
- Improved heat resistance.
- Uniform distribution of other fibers throughout the molded piece.
- Lower product cost.

The asbestos usually selected are Canadian Grades 7TF and 7RF. Other fibers, such as glass and sisal, are frequently used to provide specific properties. Some formulations also include fillers, pigments, and special additives for mold release.

EVALUATION PROCEDURES

PREMIX PREPARATION

All premix compounds were prepared from Rohm and Haas, "Paraplex" P-43 polyester resin. The resin was mixed with 10 per cent by weight styrene monomer and 1 per cent by weight benzoyl peroxide catalyst. Two types of asbestos were used: Canadian 7TF8 and CALIDRIA R-G 110. The limestone used was sized to permit 98% to pass a 325 mesh screen. Chopped fiber glass strand, 1/8-inch, and sisal fiber, 1/2-inch, were added to the high performance compounds.

MIXING

Sample premix compounds were mixed in a "Baker-Perkins" mixer. The resin system was added to the mixer followed by asbestos, limestone, sisal, and glass, in order, for a total of 30 minutes, but in no case was the compound mixed for more than 5 minutes after the glass fibers were added in order to minimize attrition of fiber length. The premixes were extruded from a "Hobart" mixer fitted with a 3/16-inch plate for further homogenization.

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TEST SAMPLES

Test samples were compression molded from the extruded premix in a 10 x 10 x 1/8-inch plaque mold for 5 minutes at 150°C. with an average 4000 psi. pressure. All specimens for mechanical testing were cut from the 10 x 10-inch plaques.

VISCOSITY SAMPLES

Samples for viscosity determinations were prepared in a "Hobart" mixer. Asbestos and/or limestone was added to the resin system and mixed for 20 minutes. Viscosity measurements were made with a "Burrell-Severs" capillary rheometer.

HIGH PERFORMANCE PREMIX

CALIDRIA R-G 110 Asbestos plus limestone was substituted for 7TF8 asbestos in a high performance premix which contained glass and sisal as primary reinforcement. Both premixes containing CALIDRIA R-G 110, (Table 1 below) exhibit physical properties as good as, or better than, the conventional premix containing 7TF8 asbestos. The overall cost of raw materials is below that of the conventional premix. The relative cost figures used to calculate comparative costs are shown in Table 4, page 5.

The lower ultimate compound cost can be achieved, because the higher purity and greater asbestos fibril liberation in CALIDRIA R-G 110 permit the use of lesser quantities of CALIDRIA Asbestos and the incorporation of additional quantities of low cost limestone. A comparison of the property characteristics of CALIDRIA R-G 110 and 7TF8 is shown in Table 2 on page 4.

TABLE 1

Comparative Physical Properties and Costs of a Conventional Polyester-Glass Premix Compound vs. CALIDRIA Asbestos-Glass Premix Compounds

	Composition, % by Weight		
	Conventional Premix	CALIDRIA Asbestos Premixes	
Polyester resin system	40	35	40
Fiber glass, 1/8", chopped strand	15	10	7.5
Sisal, 1/2", chopped	10	10	10
Asbestos, Canadian 7TF8	10	–	–
Asbestos, CALIDRIA R-G 110	–	5	7.5
Limestone	25	40	35
Relative Properties & Costs			
Izod, ft.-lb./inch	1.0	1.1	0.9
Flex strength, psi. x 10^{-3}	8.5	8.1	8.7
Flex modulus, psi. x 10^{-6}	1.2	1.3	1.4
Cost, $/lb.	0.151	0.128	0.132

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POLYESTER PREMIXES – COMPARATIVE COST AND PERFORMANCE DATA

LOW COST PREMIX FORMULATIONS

Asbestos fibers yield increased flexural strength, modulus, and heat distortion temperature (HDT) when used as the sole reinforcement in low-cost moldings. CALIDRIA R-G 110 may be substituted for 7TF8 with additional improvements in impact resistance, strength, and HDT.

Table 3 presents data for a series of CALIDRIA R-G 110 reinforced, low-cost premixes showing the variation of properties with changes in composition. These data show that very acceptable properties can be attained with CALIDRIA R-G 110 at a total raw material cost of less than 8¢/lb.

TABLE 2

Typical Asbestos Characteristics

	R-G 110	7TF8
Specific Gravity	2.45	2.50
Reflectance, Photovolt, %	68	65
Surface Area, BET-Nitrogen, $m.^2/g.$	55	15
Magnetite Content, %	1.5	3.5
Oil Adsorption, lb. DOP/100 lb. asbestos	110	50
Particle Size, Wet Screen, Retained on 325M, %	12	11
Dry Bulk, Aerated, $lb./ft.^3$	5	19
Total Available Asbestos, % fiber in package	85	25

TABLE 3

Comparative Physical Properties and Costs of a Conventional Polyester Premix Compound vs. CALIDRIA Asbestos Premix Compounds

	Composition, % by Weight					
	Conventional Premix		CALIDRIA Asbestos Premixes			
Polyester compound	60	60	40	40	30	30
CALIDRIA R-G 110	–	20	15	10	20	10
7TF8 Asbestos	40	–	–	–	–	–
Limestone	–	20	45	50	50	60
Relative Properties & Costs						
Izod, ft. lb./in.	0.2	0.3	0.3	0.3	0.3	0.3
Flex strength, psi. X 10^{-3}	9.1	11.4	11.0	9.4	8.8	8.1
Flex Modulus, psi. X 10^{-6}	1.16	1.0	1.7	1.1	1.3	1.2
HDT, °C.	74.0	76.7	–	77.9	79.7	78.5
Cost, $/lb.	0.132	0.137	0.097	0.093	0.080	0.074

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COST DATA

In order to determine relative compound costs, the following delivered prices were assumed:

TABLE 4

Relative Cost Figures

	$/lb.
1. Polyester system (including styrene monomer and catalyst)	0.20
2. Fiber glass, chopped 1/8" strand	0.30
3. Sisal, chopped 1/2"	0.20
4. 7TF8 Asbestos	0.030
5. CALIDRIA R-G 110 Asbestos	0.075
6. Limestone	0.01

These costs, while not necessarily accurate at any particular location, provide relative data which are useful, as shown below in typical cost comparison calculations.

	Conventional Premix			CALIDRIA R-G 110 Premix		
	% by Wt.	Per Lb. Cost	Premix Cost	% by Wt.	Per Lb. Cost	Premix Cost
Polyester	60 X	0.20	0.12	40 X	0.20	0.08
7TF8 Asbestos	40 X	0.03	0.012	–	–	–
R-G 110 Asbestos	–	–	–	10 X	0.075	0.0075
Limestone	–	–	–	50 X	0.01	0.005
Overall Compound Cost/Lb.			$0.132			0.0925

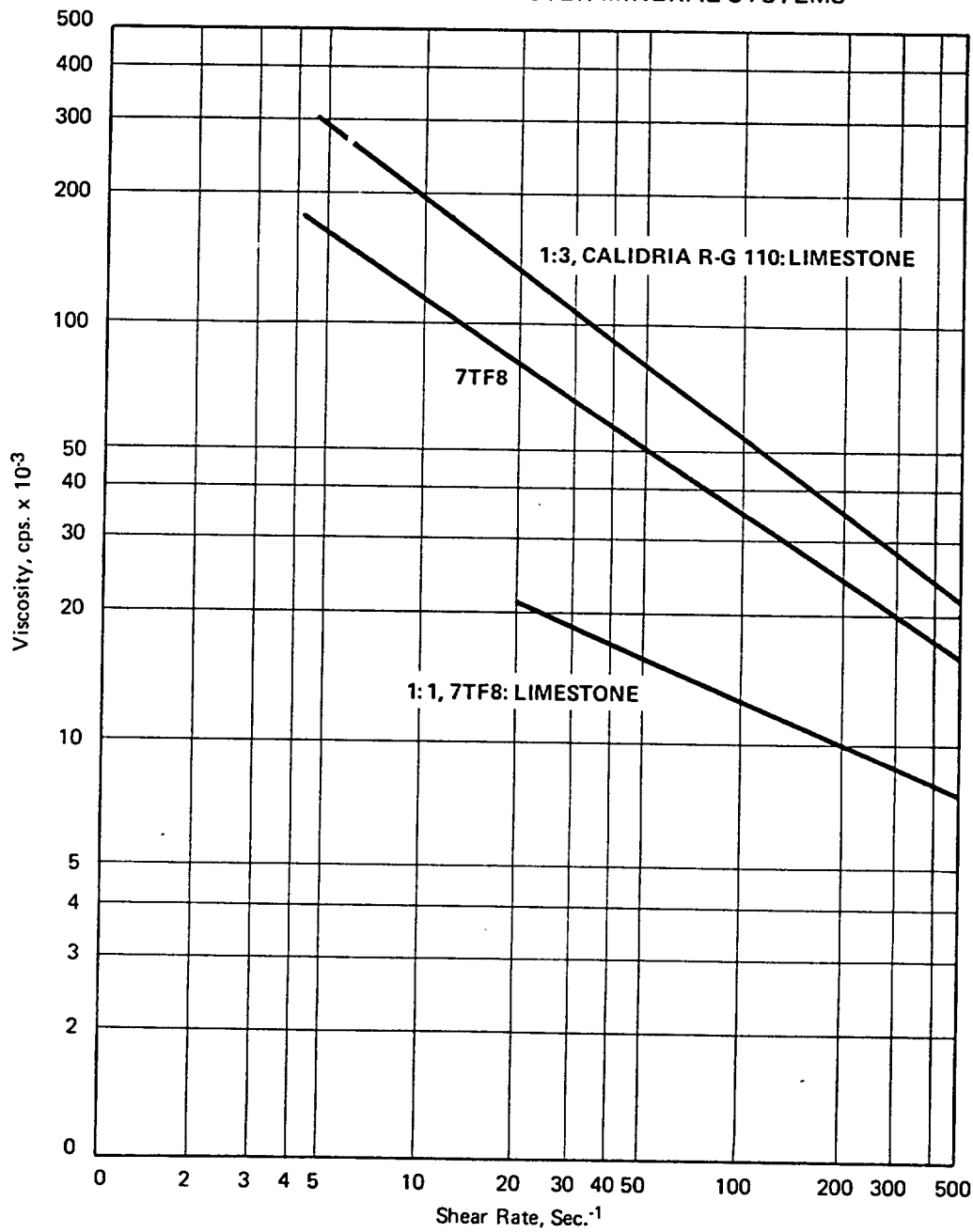
VISCOSITY CONTROL

Samples of polyester resin, asbestos, and limestone containing a total of 30 per cent mineral additive were prepared to demonstrate the viscosity control capabilities of CALIDRIA R-G 110 compared to 7TF8. A comparison of the two is shown in Figure 1, page 6. Higher viscosities are obtained with a 1:3 mixture of CALIDRIA R-G 110 and limestone than with an equal quantity of 7TF8. A curve for a 1:1, 7TF8:limestone mix is included to show that the same performance cannot be obtained. These data illustrate the ability of CALIDRIA R-G 110 to impart flow control characteristics to a polyester premix formulation which surpass the effect achieved with 7TF8.

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FIGURE 1

VISCOSITY PROFILES: POLYESTER-MINERAL SYSTEMS[a]



[a] 30 per cent solids

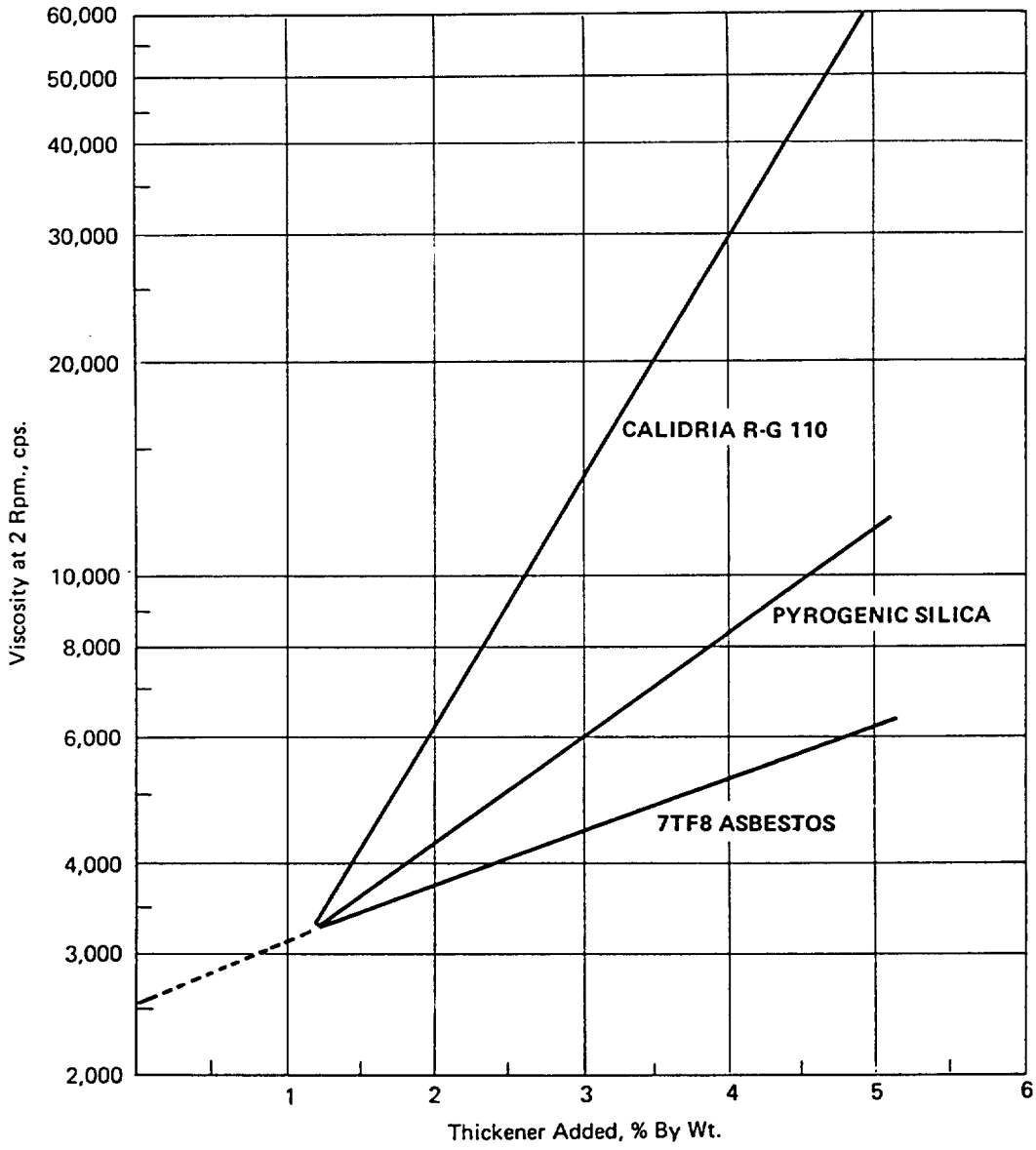
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ASPHALTIC COMPOUND VISCOSITY CONTROL

CALIDRIA R-G 110 Asbestos is also particularly adapted to use in asphaltic and similar compounds where good bodying is required at low concentrations, such as in automotive undercoating and sound deadening applications. Because of its fine particle size, high fiber content and high purity, R-G 110 is essentially non-abrasive and ideally suited to meet the demanding performance of air-less spray applications. Comparative thickening efficiency is shown in Figure 2.

FIGURE 2

COMPARATIVE THICKENING PERFORMANCE
OF VARIOUS MATERIALS IN COAL TAR RESIDUE



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CHEMICALS AND PLASTICS
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PERFORMANCE DATA

Calidria ASBESTOS

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PERFORMANCE OF *CALIDRIA* R-G 144 AND COMPETITIVE THIXOTROPES

In Liquid Epoxy Resin Systems

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PERFORMANCE OF *CALIDRIA* R-G 144 AND COMPETITIVE THIXOTROPES

in Liquid Epoxy Resin Systems

CALIDRIA R-G 144 Asbestos is a highly purified fiber product that is an effective, low-cost thickening agent and thixotrope for epoxy resin systems. Produced by UNION CARBIDE's proprietary process, an unusually high fiber content is obtained, that is both grit-free and non-abrasive.

Comparative evaluations have shown that up to 50 per cent less CALIDRIA R-G 144 Asbestos is required than other commonly used thickeners, to provide equivalent viscosity and thixotropic properties, in liquid epoxy resin systems. Because CALIDRIA Asbestos is much lower in price, its cost-performance is outstanding.

Figures 1 and 2 compare the relative differences in viscosity and thixotropy of BAKELITE Epoxy Resin ERL-2774 solutions containing equivalent concentrations of CALIDRIA R-G 144 Asbestos, micro-crystalline silicate, and pyrogenic silica.

The superiority of CALIDRIA R-G 144 is again indicated, as shown in Figures 1 and 2, in that its use does not require amine-type additives usually recommended with the use of pyrogenic silicas.

Figures 3 and 4 show the superior performance of CALIDRIA R-G 144 Asbestos in BAKELITE Resin Hardener ZZL-0814, in comparison with equivalent mixtures of micro-crystalline silicate and pyrogenic silica.

RESIN AND AMINE HARDENER EVALUATION

In preparing test samples used in determining data for the following graphs, the thixotropes were added to the liquid resin or hardener at 25°C. and dispersed in a "Cowles" Dissolver at 2400 rpm. for 5 minutes.

VISCOSITY MEASUREMENTS

Viscosities of the prepared test samples were measured on a Brookfield Model RVF Viscometer at 2 and 20 rpm.

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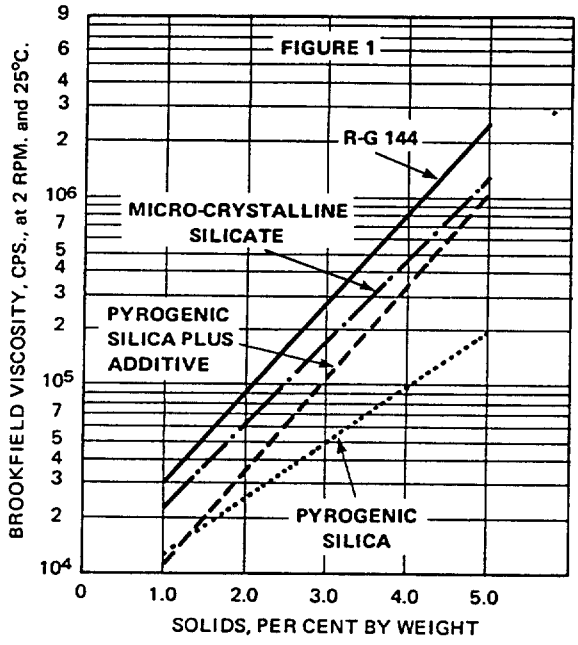
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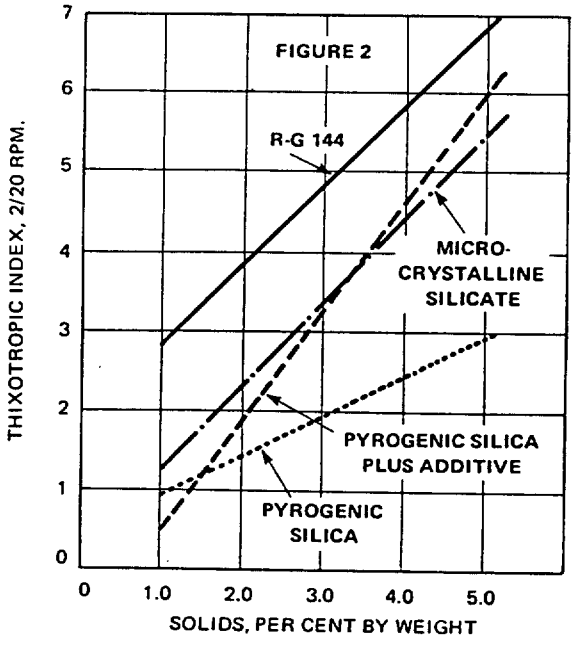
PERFORMANCE OF *CALIDRIA* R-G 144 AND COMPETITIVE THIXOTROPES

in Liquid Epoxy Resin Systems

FIGURES 1 AND 2

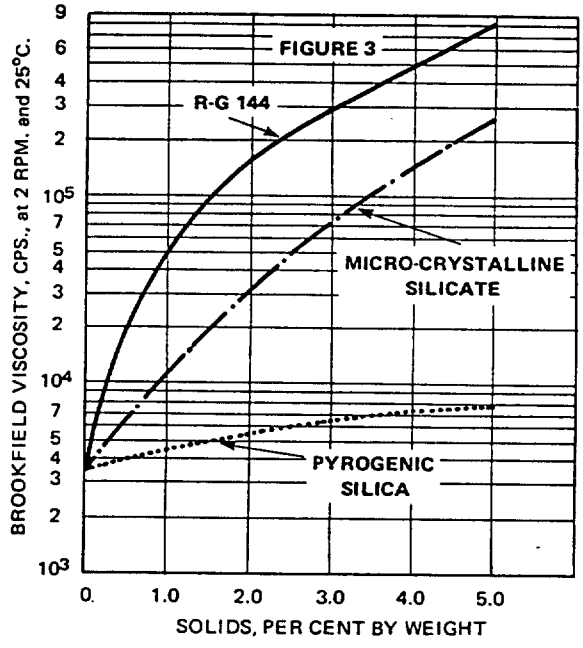
COMPARISON OF VISCOSITY AND THIXOTROPY OF BAKELITE® EPOXY RESIN ERL-2774 SOLUTIONS CONTAINING EQUIVALENT CONCENTRATIONS OF *CALIDRIA* R-G 144 ASBESTOS, MICRO-CRYSTALLINE SILICATE, AND PYROGENIC SILICA

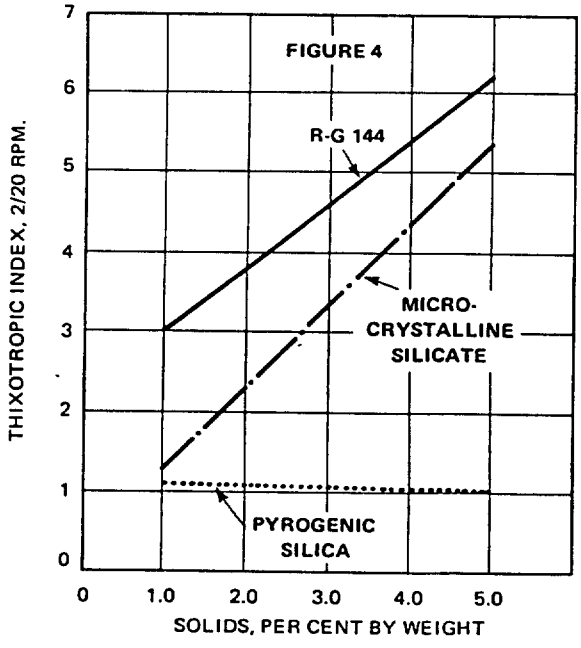




FIGURES 3 AND 4

PERFORMANCE OF *CALIDRIA* R-G 144 ASBESTOS IN BAKELITE® RESIN HARDENER ZZL-0814 COMPARED WITH EQUIVALENT MIXTURES OF MICRO-CRYSTALLINE SILICATE AND PYROGENIC SILICA





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For complete information on properties, applications and prices, or technical assistance in utilizing

Calidria ASBESTOS

contact the nearest UNION CARBIDE Sales Office or CALIDRIA Asbestos Representative:

270 Park Avenue • New York, N. Y. 10017
P. O. Box K • King City, Ca. 93930

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Calidria ASBESTOS

"CALIDRIA" ASBESTOS SG-130 AND SG-210
For Tape Joint Compounds

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Lowers Costs Two Ways

CALIDRIA Asbestos acts as a bodying and secondary thickening agent permitting formulation of lower density, more economical tape joint compounds without the sacrifice of performance. CALIDRIA Asbestos is produced by a proprietary manufacturing process that yields unusually high fiber content and more complete fiber liberation from the natural bundles. As a result, CALIDRIA Asbestos goes up to twice as far, pound for pound, as commercial grades of asbestos containing large amounts of other filler materials that have no specific desirable effects on tape joint compound properties.

Reduces Cracking

The fibers of CALIDRIA Asbestos behave as an active lyophobic colloid in aqueous dispersion; by this mechanism CALIDRIA Asbestos increases tape joint compound liquid cohesive strength during drying. Increased liquid cohesive strength greatly reduces the tendency for cracks over nail holes, in thick sections at the center of the joint, and along the feathered edges.

Enhances Sandability

CALIDRIA Asbestos contains mainly chrysotile fiber and is essentially free from abrasive contaminants, such as magnetite and serpentine rock dust. This composition results in a low density product, free from contaminants that interfere with sanding.

Improves Uniformity

Narrow and well-controlled particle size distribution, low alkalinity and high brightness are characteristic of CALIDRIA Asbestos. These properties are consistent from batch to batch and improve the uniformity of tape joint compounds using CALIDRIA Asbestos.

Suggestions for Use of CALIDRIA Asbestos

CALIDRIA Asbestos can be readily used in your present tape joint compound formulation. Add approximately one-half the proportion of asbestos you now use. Increase the proportion of calcium carbonate or other inert filler to make up for the lower quantity of asbestos. You may also be able to use slightly more water in your ready-mix and maintain your present viscosity level. No other changes in your

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October, 1968
F-42258

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Suggestions for Use of CALIDRIA Asbestos (Continued)

formulation or manufacturing procedure are required.

CALIDRIA Asbestos SG-130 has the coarser particle size; it finds use for bedding compounds or perhaps spackling compound. The SG-210 has the finer particle size and is favored for topping compounds, all-purpose compositions, texture paints, and similar formulas.

A Suggested Ready-Mix Tape Joint Compound For Use With CALIDRIA Asbestos

	Parts by Weight Dry Basis
Fillers:	
Calcium Carbonate, No. 1 White (Thompson Weinman)	61.42
Mica, P80F (Western Mica)	21.00
Clay, ASP-400 (Minerals and Chemicals Philipp Corp.)	4.00
CALIDRIA Asbestos, SG-210 (Union Carbide)	4.58
Binder:	
UCAR Latex 131 (Union Carbide)	6.60*
Workability Control Agent:	
CELLOSIZE Thickener, TJC Grade (Union Carbide)	0.50
Drying Control:	
Ethylene Glycol (Union Carbide)	1.00
Defoamer:	
"Nopco" PD-1 (Nopco Chemical Company)	0.10
Dispersant:	
"Daxad" 30 (Dewey & Almy Chemical Div.)	0.60*
Bacteriastat:	
"Dowicide" A (Dow Chemical Co.)	0.20
	100.00

Total Water: about 56 parts by weight per 100 parts dry solids

*Contained solids basis

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Typical Product Characteristics

	CALIDRIA Asbestos	
	SG-130	SG-210
Reflectance (G.E. Photovolt)	68%	
Contained magnetite	2% max.	
Alkalinity (as % of Na_2O)	0.05 to 0.06	
pH (5% aqueous slurry)	8.5 to 9.5	
Surface area (BET)	50 to 60 m^2/g.	
Oil Adsorption (DOP #/100# asbestos)	90 to 100	110 to 120
Wet Bulk, settled vol. (ml.) 10g/250 ml./1 hr.	200	220
Dry Bulk (#/$ft.^3$)	7 to 8	5 to 6
Water absorption (wt. % in filter cake)	55 to 60	62 to 65
Size distribution (cumulative % retained)		
Wet Screen mesh size		
100	5	Trace
200	17	3
325	28 to 32	10 to 15

Packaging and Shipping Information

Product Form – Opened (finely ground) chrysotile asbestos fiber.

Packaging –

	CALIDRIA Asbestos	
	SG-130	SG-210
One Package	40 lb.	30 lb.
Pallet Weight		
Carload	1,600 lb.	1,050 lb.
Truckload	2,000 lb.	1,500 lb.

Shipping –
Classification – asbestos shorts
Rail point of origin – Welby, California (King City, California)

TOXICOLOGICAL PROPERTIES

It has been known for many years that some persons working in asbestos production were prone to develop a disabling lung disease. In time, this condition became known as asbestosis and was related to exposure to high concentrations of asbestos dust. With further experience, it was found that men could work with asbestos without development of lung disease if dust concentrations were kept below a certain level. It is now generally accepted that a man can work a 40-hour week for a lifetime without developing asbestosis if the asbestos dust particle count is kept at or below 5 million particles per cubic foot of air. This dust concentration of 5 million particles per cubic foot of air is the Threshold Limit Value for asbestos, and no cases

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TOXICOLOGICAL PROPERTIES (Continued)

of asbestosis are believed to have occurred when exposures have been maintained at or below this level, despite large-scale utilization (now approaching one million tons per year in the U.S.A.). This concentration of dust is generally not visible in the average work area unless a beam of light causing a Tyndall effect is present. Usually the dust concentration must be from 8-10 million particles per cubic foot before its presence is visible in average lighting conditions.

Several years ago, it was reported that there was an increase in the incidence of cancerous tumors, especially of the lung, associated with asbestosis. Recently there have been reports of some cancers occurring in individuals exposed to asbestos dust, but who have not developed clinical asbestosis. It is believed by most authorities that these cases have been associated with exposures significantly exceeding the Threshold Limit Value. A major manufacturer of asbestos products who also mines asbestos has not been able to show an increase in cancerous growths in men working where dust concentrations were maintained at the Threshold Limit Value.

Control of asbestos dust exposure is therefore necessary. The control methods are the standard ones applicable to a variety of dusty operations. They include closed flow systems, wet processes where possible, and adequate exhaust ventilation where openings in the system are necessary. Pelletizing is sometimes used to improve the handling characteristics of otherwise dusty materials. Where satisfactory containment to stay within the Threshold Limit Value is impractical or impossible, efficient and reliable respirators are available for the protection of the employee. A program of environmental monitoring in manufacturing operations is highly desirable to determine that Threshold Limit Values are not being exceeded. Employees should wear respirators where dusting occurs in finishing products such as sanding taped joints.

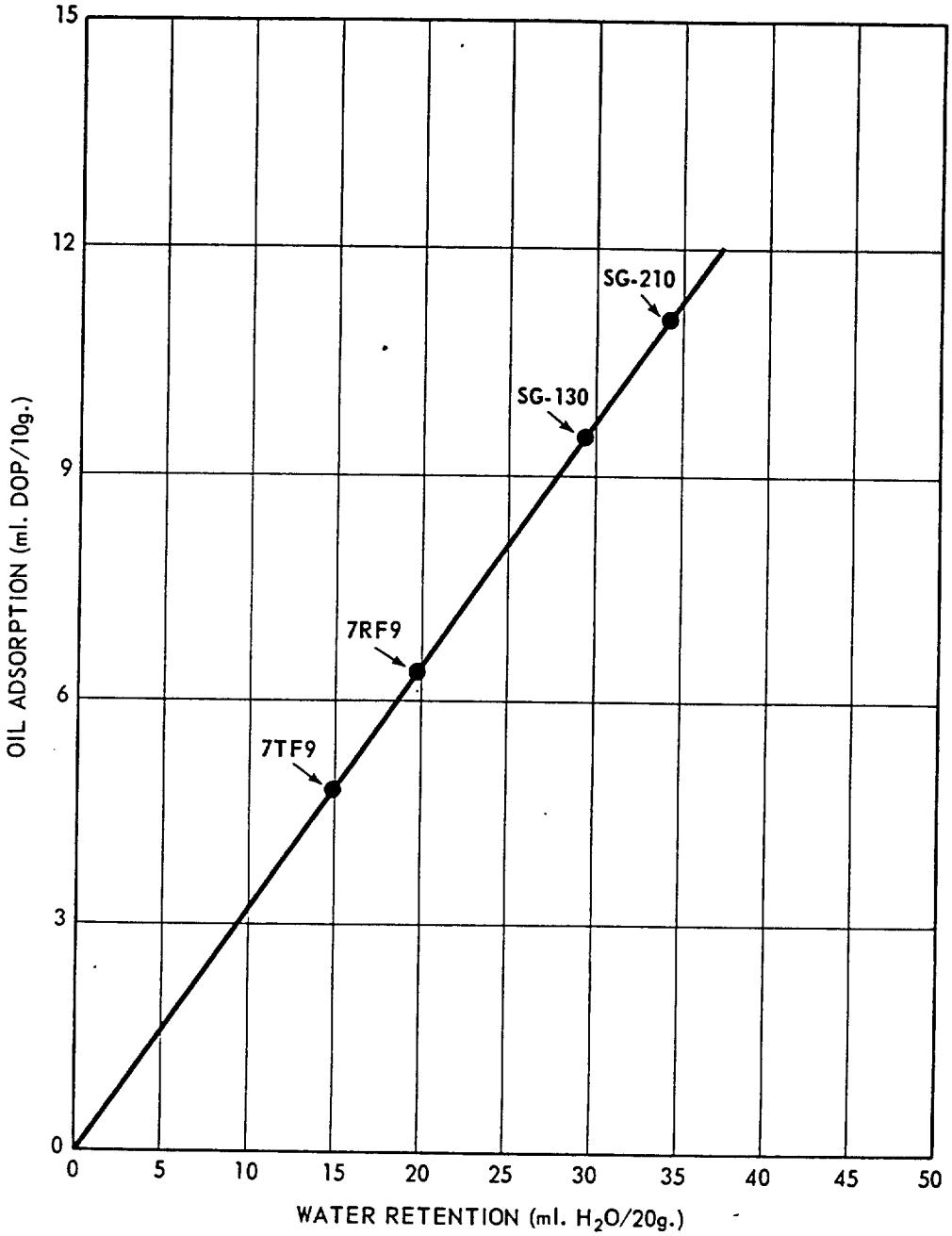
Pre-employment and periodic physical examinations of workers are desirable. These should include chest X-rays to insure that the worker has no chest condition prior to work with asbestos and to determine that no lung changes are resulting from work with asbestos.

In conclusion, while asbestos dust in excess of the Threshold Limit Value is potentially harmful, as are many other dusts encountered in industry, it is as readily controlled as other such dusts and it can be used safely with appropriate precautions.

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"CALIDRIA" ASBESTOS SG-130 AND SG-210

For Tape Joint Compounds



RELATIONSHIP BETWEEN WATER & OIL ADSORPTION CAPACITY OF SOME ASBESTOS PRODUCTS FOR TAPE JOINT ADHESIVE FORMULATIONS

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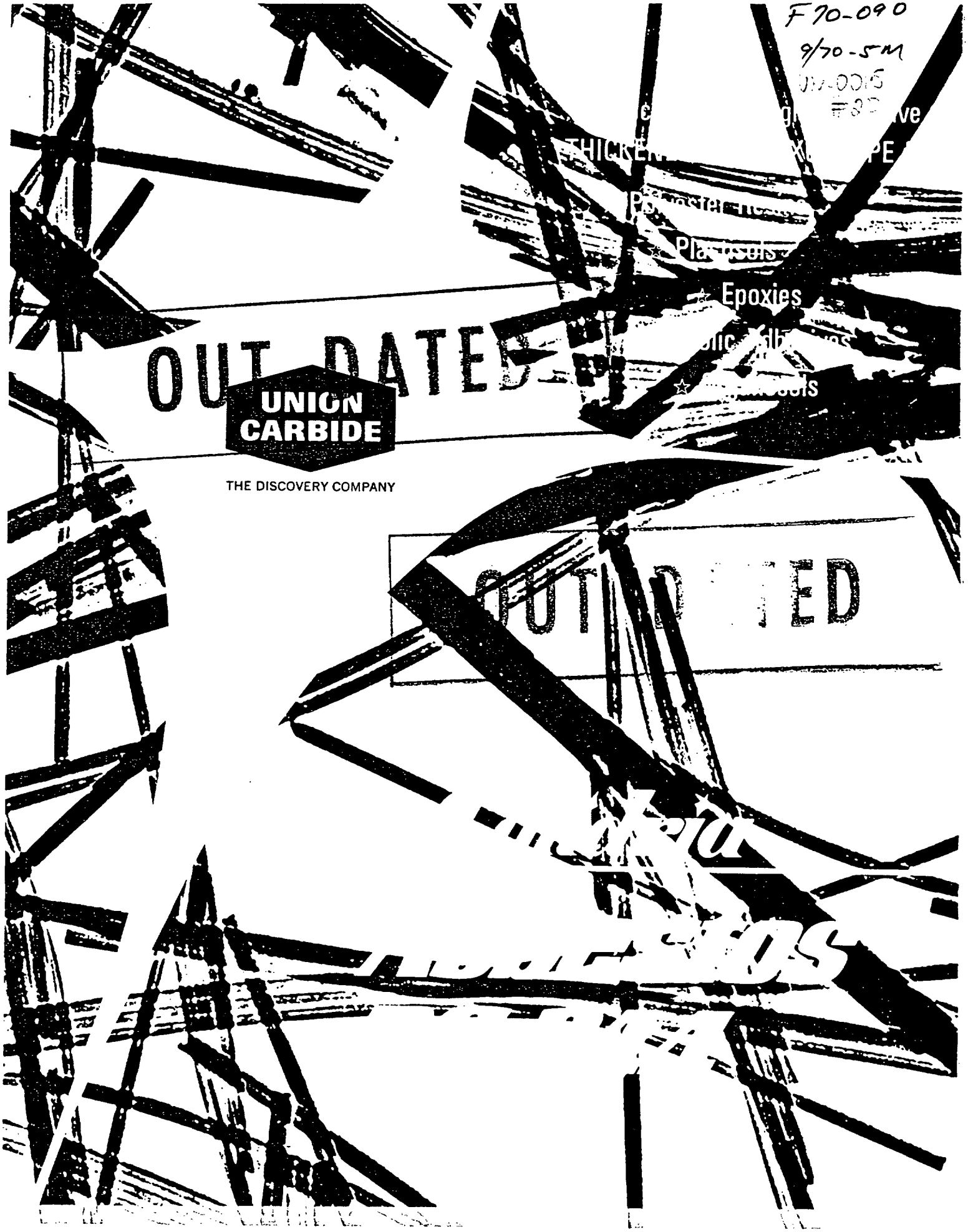
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Calidria ASBESTOS

RG-244

...a chemically modified, highly refined fiber with a mineral coating that gives:

HIGHER VISCOSITY AT LOW LOADINGS—"Calidria" asbestos RG-244 builds more viscosity at a given concentration than pyrogenic silica or other thickeners. Part of this viscosity increase comes from hydrogen bonding between the mineral coating and the resin system—the same way that pyrogenic silica builds viscosity. What makes RG-244 more efficient is that the fibers enhance flow resistance. On a lb.-for-lb. basis, RG-244 builds over twice as much viscosity as pyrogenic silica.

BETTER FLOW AT HIGH SHEAR RATES—"Calidria" RG-244 also improves flow at high shear rates because of its inherent thixotropic characteristics. This property is especially desirable in spray-up applications where less resistance to flow is desired during pumping and spraying.

SAVINGS FROM BETTER PERFORMANCE—By increasing viscosity and thixotropy more efficiently than other materials, "Calidria" asbestos RG-244 allows users to obtain their desired properties with less mineral additive. This reduction lowers costs and reduces any detrimental effect of thickeners on other resin properties.

LOW COSTS TOO—"Calidria" asbestos RG-244 costs less per lb. than similar thickeners. Thus, users save two ways—on unit cost *and* cost performance.

FAST WETTING, EASY DISPERSION—Conventional mixing equipment can be used to disperse "Calidria" RG-244 quickly and easily. In fact, this unique product wets out and disperses considerably faster than most other thixotropes.

BETTER SHELF LIFE, LESS SETTLING—Systems containing "Calidria" asbestos RG-244 can be stored for long periods without any significant change in viscosity or thixotropy. Settling during storage is minimized, and systems containing RG-244 can be remixed easily. In all these respects, RG-244 surpasses most other thickeners.

NO COLOR OR OPACITY—"Calidria" asbestos RG-244 is a highly refined fiber with a clear mineral coating that does not add color to most systems. At the same time, RG-244 has a refractive index that matches many systems, so that it does not add opacity. These features make RG-244 especially well suited for use in clear polyester gel coats.

REDUCED DUSTING—"Calidria" RG-244 is a fibrous material containing a minimum of dust. It therefore reduces dusting during materials handling and additions to resin systems.

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TYPICAL PHYSICAL PROPERTIES

Specific Gravity	2.45	—
Moisture Content	2.0	% max. by weight
Nature of Surface Charge	Neutral	—
Magnetite Content	0.3	% max. by weight
Refractive Index	1.54 to 1.56	n_D 25° C.
Oil (DOP) Absorption	300 to 350	lb. per 100 lb.
Surface Area	>60	sq. m. per g.
Fiber Diameter	0.025	microns
Length/Diameter (Aspect Ratio)	200 avg.	—
Bulking Value	4.9	gal. per 100 lb.
Dry Bulk Density (aerated)	1.0	lb. per cu. ft.

PACKAGING AND AVAILABILITY

Single Package—Weight (3-ply paper bag sealed in polyethylene)	10 lb.
Single Pallet—Weight —Dimensions (full pallets covered by waxed cardboard)	350 lb. approx. 53 in. x 44 in. x 61 in. high
Full Carload (available from King City plant)	52 pallets 18,200 lb.
Full 40-ft. Truckload (available nationwide)	17 pallets 5,950 lb.

"Calidria" asbestos RG-244 is stocked at Union Carbide's shipping locations throughout the United States and is available from several distributors.

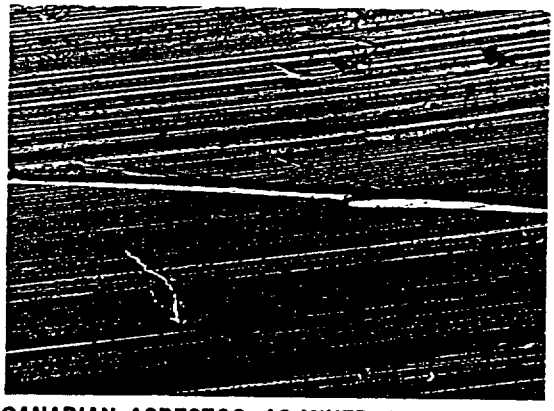
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Why is "Calidria" asbestos different?

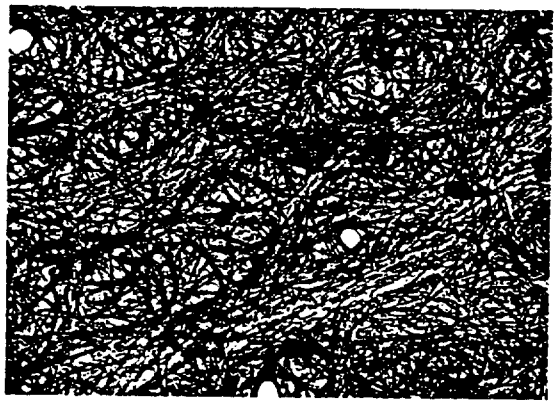
"Calidria" products are made from high-purity, short-fiber chrysotile asbestos obtained from a unique deposit about 160 miles south of San Francisco, California. Unlike conventional deposits that extend through the host rock, this deposit is essentially free of hard, consolidated rock masses. Further, the ore assays up to 60% asbestos fiber compared to conventional deposits which contain from 6 to 10% asbestos.

Special hydraulic beneficiation techniques developed by Union Carbide efficiently break down the fiber bundles and remove the rock and impurities from the asbestos fiber. As a result, all "Calidria" products are over 95% pure asbestos whose fibers are 98% liberated from fiber bundles.

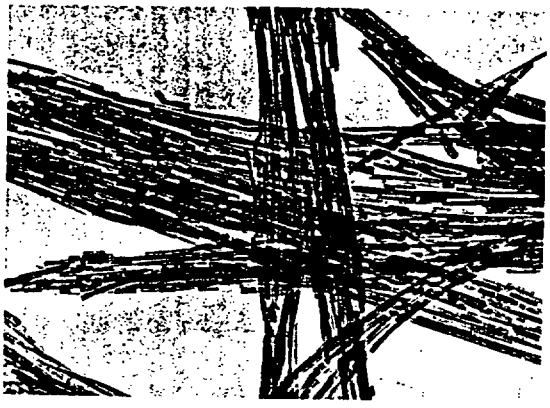
RG-244 is made by additional refining to achieve over 99% purity. The fibers are then chemically coated by a patented process to form this unique, highly efficient thickener and thixotrope.



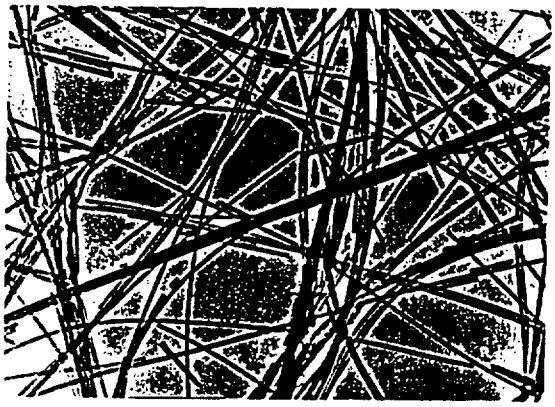
CANADIAN ASBESTOS—AS-MINED—Individual fiber bundles are straight and tightly bonded, surrounded by consolidated rock masses. In this form, the fibers defy separation from each other and from the host rock.



"CALIDRIA" ASBESTOS—AS-MINED—Here the fibers are randomly oriented and essentially free of hard rock masses. Further, the ore assays up to 60% asbestos, considerably more than the Canadian ore.



"CALIDRIA" ASBESTOS—IF DRY-PROCESSED—Even the most exacting dry processes do not completely break down the fiber bundles into individually liberated fibers. Union Carbide technology developed a special wet process to liberate the fibers.



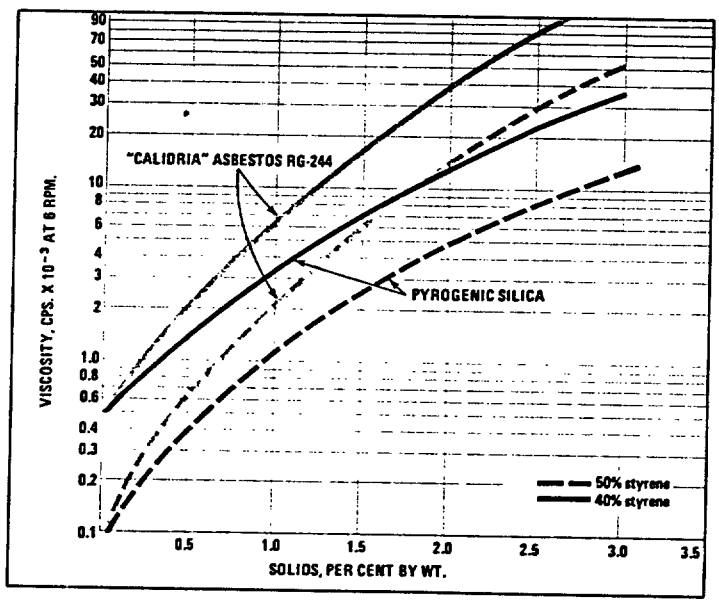
"CALIDRIA" ASBESTOS—UNIQUELY WET-PROCESSED — Union Carbide's process separates 98% of the fibers from the fiber bundles. RG-244 fibers are over 99% pure asbestos and chemically coated to provide an efficient thickener and thixotrope.

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Typical Performance Data/General Purpose UNPROMOTED Polyester Resins

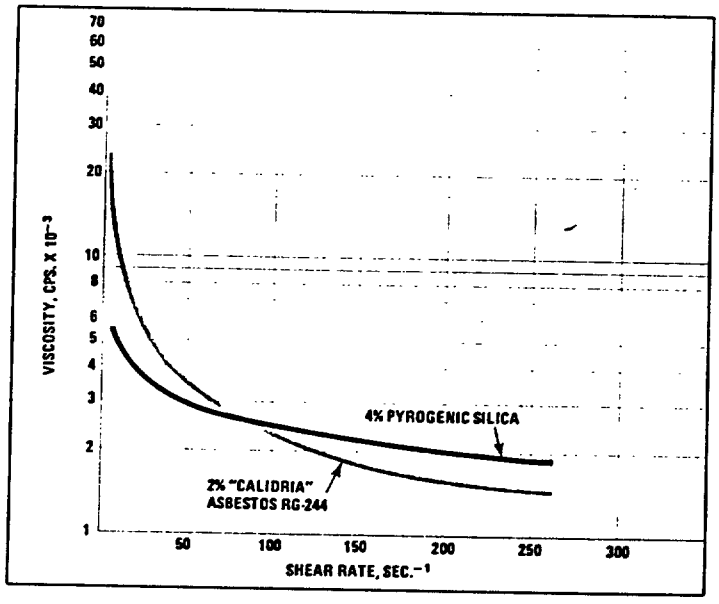
HIGHER VISCOSITY AT GIVEN CONCENTRATION

On a lb.-for-lb. basis, "Calidria" asbestos RG-244 builds substantially more viscosity in these 2 polyester systems than pyrogenic silica. RG-244 builds twice as much viscosity at a 1% concentration and 4 times as much viscosity at 3% concentration. Thus, users can use less RG-244 to obtain their desired viscosity.



HIGHER VISCOSITY AT LOW SHEAR RATES · BETTER FLOW AT HIGH SHEAR RATES

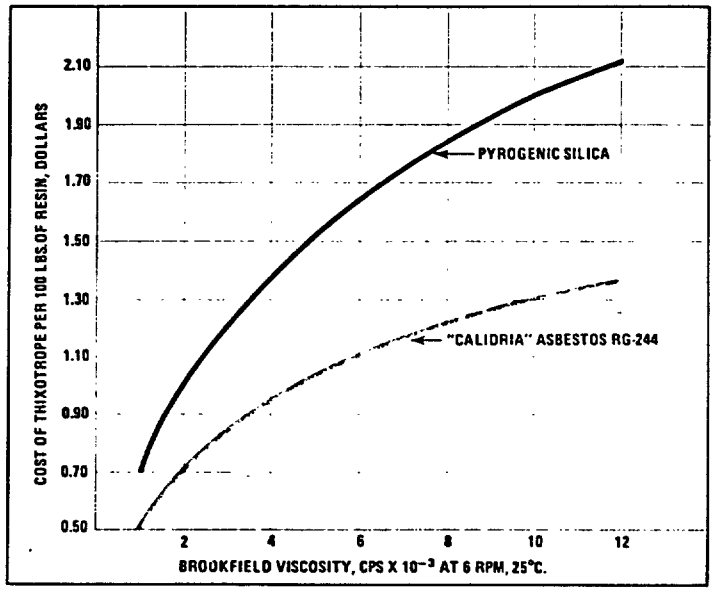
2% "Calidria" asbestos RG-244 gives better thixotropic properties than 4% pyrogenic silica in this unpromoted polyester resin containing about 50% styrene. The RG-244 system has better flow at high shear rates, allowing easier pumping and spray-up. As the shear rate is reduced, the RG-244 resin has better viscosity and sag resistance.



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SAVINGS USING "CALIDRIA" ASBESTOS RG-244 · UNPROMOTED Polyester Resins

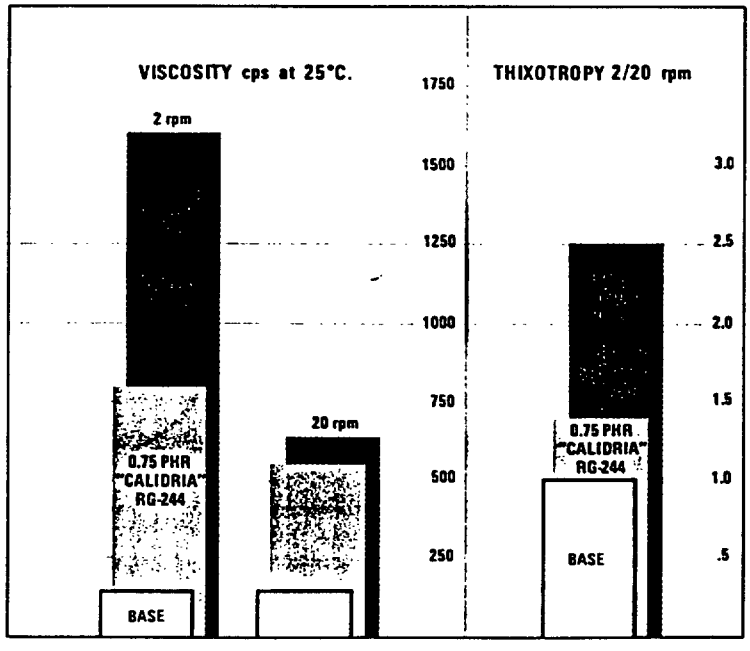
The better performance and lower cost of "Calidria" asbestos RG-244 allow substantial savings. In the typical unpromoted polyester resin system shown at the right, "Calidria" RG-244 builds a given viscosity for about one-half the cost of pyrogenic silica.



Typical Performance Data / General Purpose PROMOTED Polyester Resins

IMPROVES BOTH VISCOSITY AND THIXOTROPY

"Calidria" asbestos RG-244 also effectively improves the viscosity and thixotropy of promoted polyester resins. In many cases, the improved viscosity and thixotropy provided by RG-244 will be sufficient to meet user needs. Should higher values be required, a small addition of ethylene glycol or a similar additive will improve the viscosity, thixotropy, and stability of the RG-244 dispersion. At the right is an example of these improvements in a typical polyester resin containing a cobalt-type accelerator.



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Typical Performance Data/Heat-Curable VINYL PLASTISOL Sealants

"Calidria" asbestos RG-244 improves the viscosity of heat-curable vinyl plastisols without reducing their inherently good adhesion properties. In fact, RG-244 provides excellent anti-sag properties at both low (275 to 375 deg. F.) and high (above 350 deg. F.) fusion temperatures. An example of how RG-244 improves the viscosity of a high-fusion temperature structural sealant without detracting from adhesion is shown below:

FORMULATION FOR HIGH-FUSION TEMPERATURE STRUCTURAL SEALANT

INGREDIENT	PARTS BY WEIGHT
BAKELITE QYOH-2 Resin	100
FLEXOL Plasticizer 10-10	60
FLEXOL Plasticizer 10A	40
EX-1 Extender Plasticizer	10
Barium-Cadmium Stabilizer	2
UNION CARBIDE Silane Y-5162 Adhesion Promoter	0.25
Calcium Carbonate	130
CALIDRIA Asbestos RG-244	5

TEST DATA

Butt tensile adhesion to cold-rolled steel after 45 minutes cure at 350° F.	440 psi
Severs type flow properties Binks orifice (1/8 inch) Time of test: 150 seconds	
Aged 24 hr. at room temperature	63 g. at 40 psi
Aged 72 hr. at 130° F	76 g. at 40 psi
Aged 45 days at room temperature	73 g. at 40 psi
Shore hardness, A scale after 24 hr. at room temperature	76

Dispersion of "Calidria" Asbestos RG-244

ULTRASONIC

Good dispersion of "Calidria" asbestos RG-244 in polyester laminating resins can be obtained with an "Econosonic" disperser operating at 300 psi pressure. Pressures above 300 psi tend to reduce viscosities. In general, "Calidria" asbestos RG-244 requires less energy for adequate dispersion than comparable concentrations of pyrogenic silica.

"COWLES" DISSOLVER

A "Cowles" dissolver can disperse "Calidria" asbestos RG-244 in 5 to 10 minutes at 3500 rpm, using a 3-in. impeller in a 3-quart container. Under these conditions a 1% loading can be mixed for 1 hour while a 2% loading can be stirred for 30 minutes without degrading. Large volumes of RG-244 can be dispersed easily by scaling up the equipment.

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Any of our offices below will be glad to give you complete information on properties, applications, and prices of "Calidria" asbestos.

Calidria ASBESTOS

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Plant

King City, California 93930	P. O. Box K	408-385-5961

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Seattle, Washington 96118	4726 Rainier Ave., South	206-723-8660

UNION CARBIDE

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MINING AND METALS DIVISION
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THE DISCOVERY COMPANY

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PERFORMANCE OF *CALIDRIA* R-G 144 AND COMPETITIVE THIXOTROPES

in Liquid Epoxy Resin Systems

CALIDRIA R-G 144 Asbestos is a highly purified fiber product that is an effective, low-cost thickening agent and thixotrope for epoxy resin systems. Produced by UNION CARBIDE's proprietary process, an unusually high fiber content is obtained, that is both grit-free and non-abrasive.

Comparative evaluations have shown that up to 50 per cent less CALIDRIA R-G 144 Asbestos is required than other commonly used thickeners, to provide equivalent viscosity and thixotropic properties, in liquid epoxy resin systems. Because CALIDRIA Asbestos is much lower in price, its cost-performance is outstanding.

Figures 1 and 2 compare the relative differences in viscosity and thixotropy of BAKELITE Epoxy Resin ERL-2774 solutions containing equivalent concentrations of CALIDRIA R-G 144 Asbestos, micro-crystalline silicate, and pyrogenic silica.

The superiority of CALIDRIA R-G 144 is again indicated, as shown in Figures 1 and 2, in that its use does not require amine-type additives usually recommended with the use of pyrogenic silicas.

Figures 3 and 4 show the superior performance of CALIDRIA R-G 144 Asbestos in BAKELITE Resin Hardener ZZL-0814, in comparison with equivalent mixtures of micro-crystalline silicate and pyrogenic silica.

RESIN AND AMINE HARDENER EVALUATION

In preparing test samples used in determining data for the following graphs, the thixotropes were added to the liquid resin or hardener at 25°C. and dispersed in a "Cowles" Dissolver at 2400 rpm. for 5 minutes.

VISCOSITY MEASUREMENTS

Viscosities of the prepared test samples were measured on a Brookfield Model RVF Viscometer at 2 and 20 rpm.

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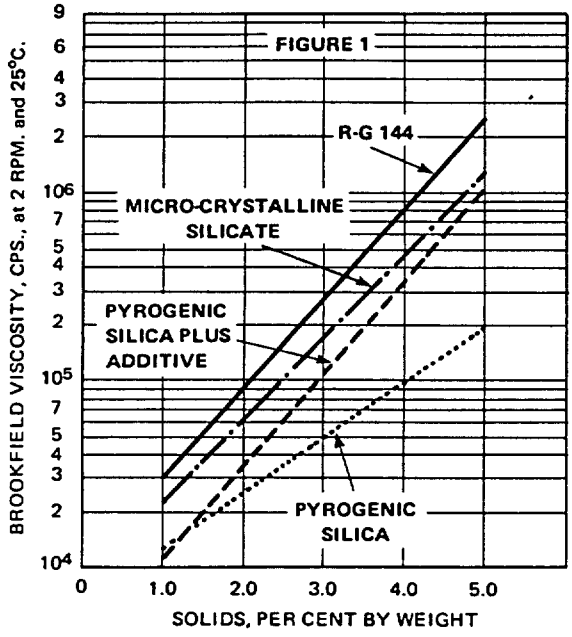
Union Carbide trial exhibit UC-780: Union Carbide Calidria Asbestos Product Literature: Resin-Grade 244, Resin... Published by AsbestosClaims.Law
ACL Doc 16004 · Page 66 of 96 asbestosclaims.law/library/16004/66

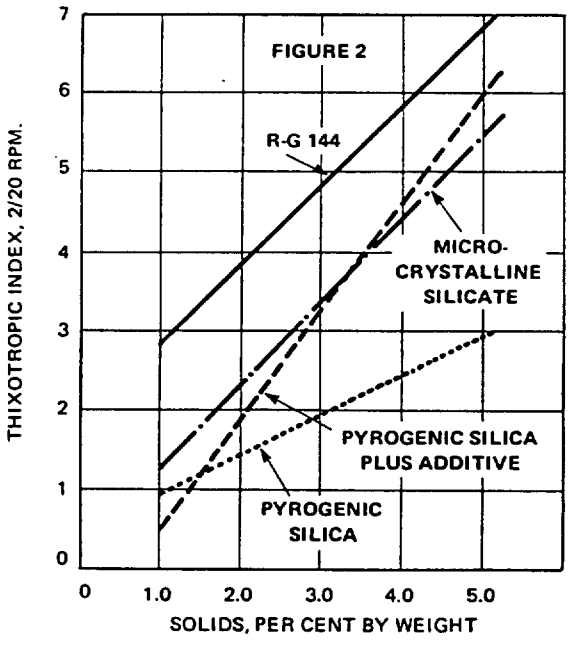
PERFORMANCE OF *CALIDRIA* R-G 144 AND COMPETITIVE THIXOTROPES

in Liquid Epoxy Resin Systems

FIGURES 1 AND 2

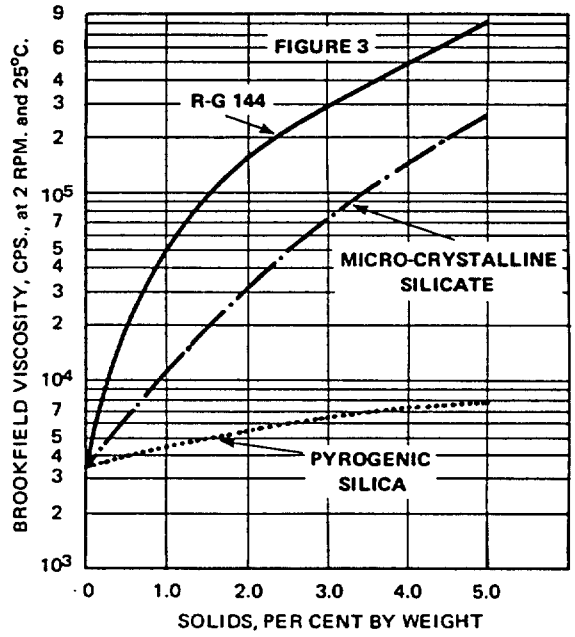
COMPARISON OF VISCOSITY AND THIXOTROPY OF BAKELITE® EPOXY RESIN ERL-2774 SOLUTIONS CONTAINING EQUIVALENT CONCENTRATIONS OF *CALIDRIA* R-G 144 ASBESTOS, MICRO-CRYSTALLINE SILICATE, AND PYROGENIC SILICA

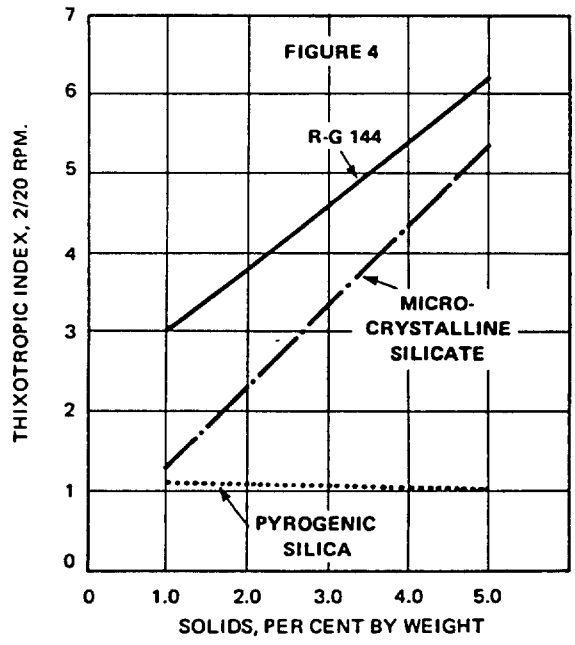




FIGURES 3 AND 4

PERFORMANCE OF *CALIDRIA* R-G 144 ASBESTOS IN BAKELITE® RESIN HARDENER ZZL-0814 COMPARED WITH EQUIVALENT MIXTURES OF MICRO-CRYSTALLINE SILICATE AND PYROGENIC SILICA





Union Carbide trial exhibit UC-780: Union Carbide Calidria Asbestos Product Literature: Resin-Grade 244, Resin... Published by AsbestosClaims.Law
ACL Doc 16004 · Page 67 of 96 asbestosclaims.law/library/16004/67

Any of our offices below will be glad to give you complete information on properties, applications, and prices of "Calidria" asbestos.

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Plant

King City, California 93930	P. O. Box K	408-385-5961

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MINING AND METALS DIVISION
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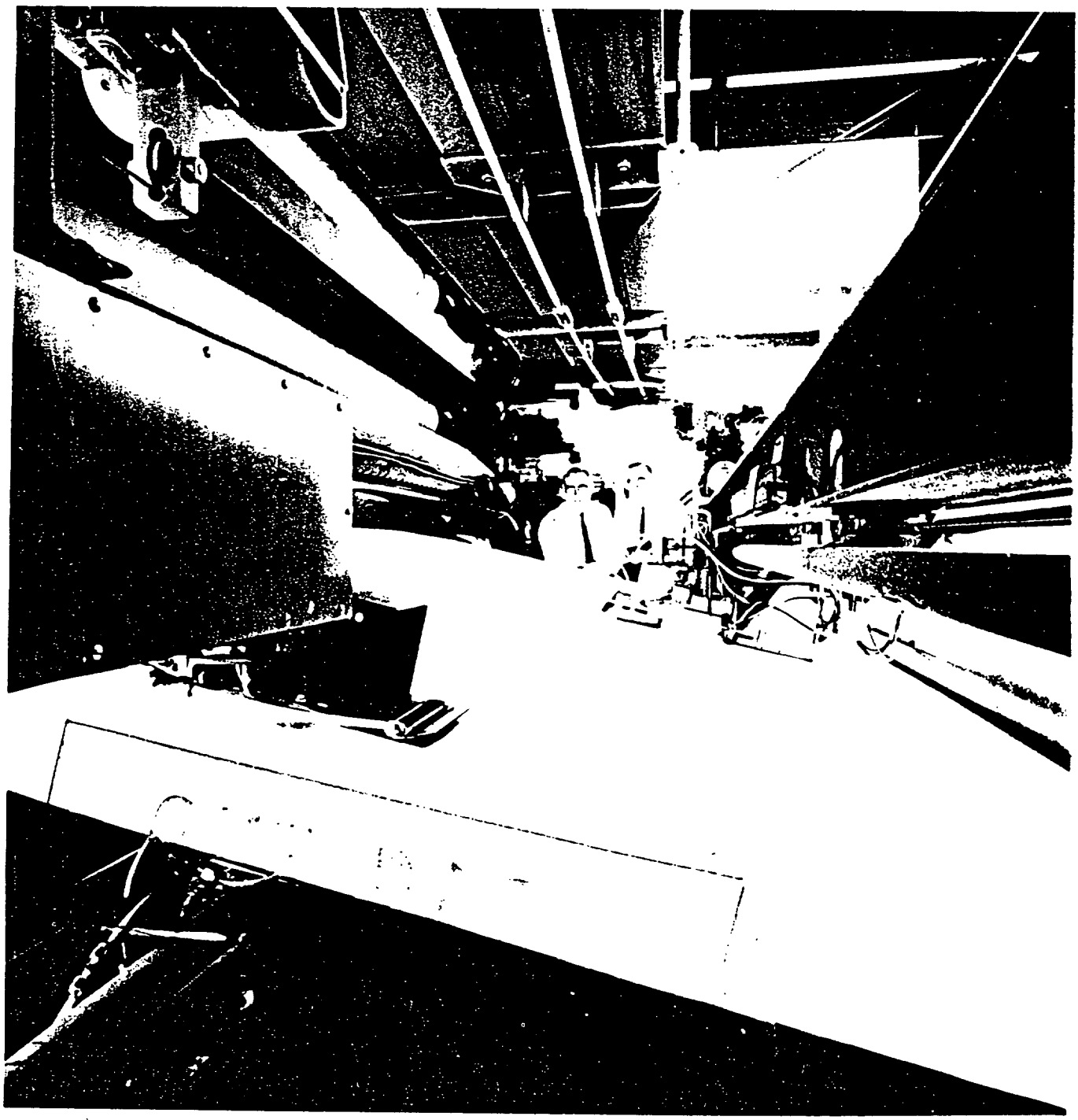
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Chemical 26

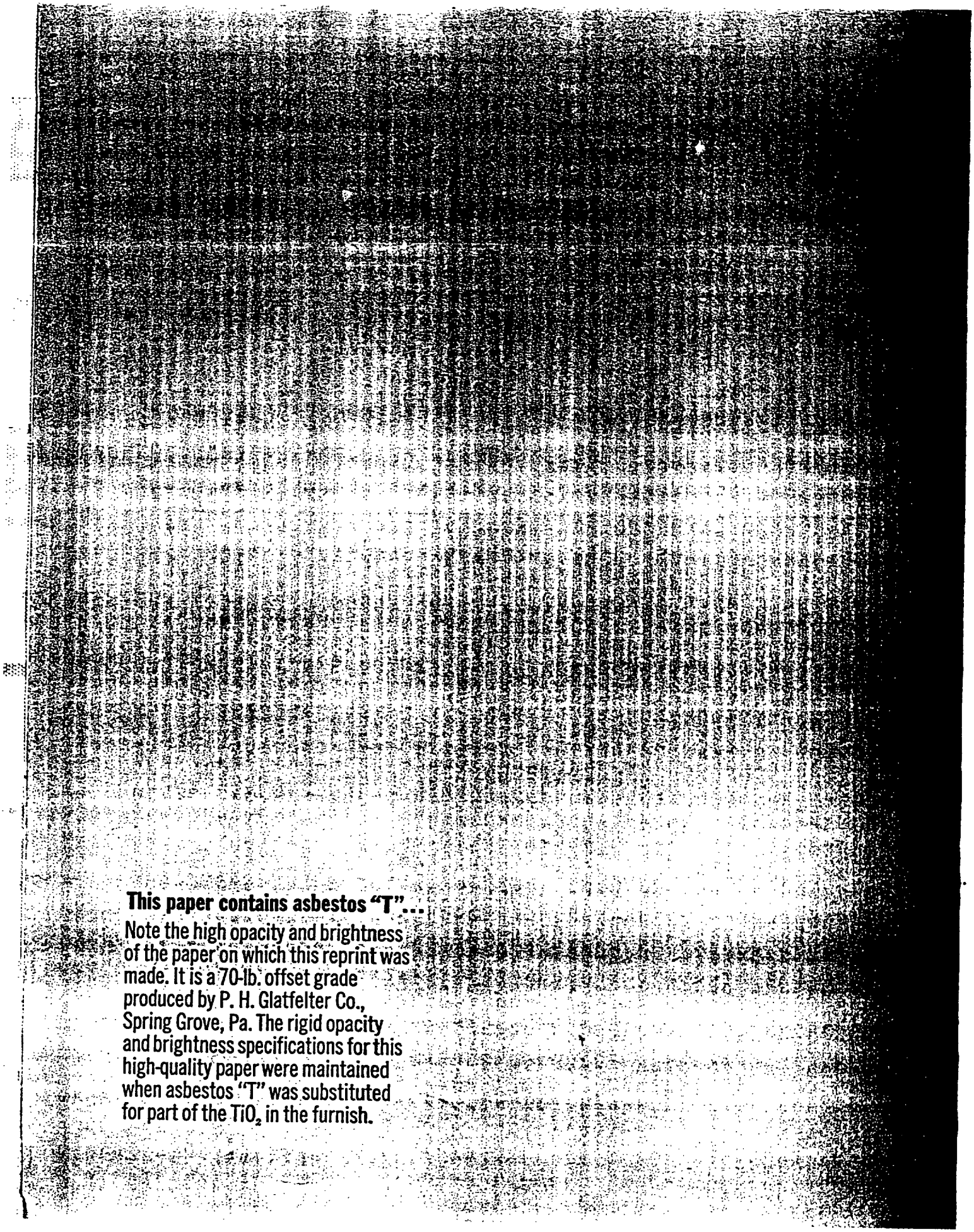
The Process Magazine of the Pulp and Paper Industry



CHECKING OPACITY — AND WHAT A NEW ASBESTOS-TITANIA RETENTION AID CAN DO

JULY 1966

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asbestosclaims.law/library/16004/69



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a high-purity pairing: asbestos-titania

■ There are all the appearances of a solid future for asbestos in papermaking.

So Union Carbide Corp's Mining and Metals Div. (New York) thinks. For proof, the division points to over 200 mills that have used the fiber for retention, pitch control, saveall recoveries and softness. Now the company, confident about its markets, has brought out a modification of the original high-purity asbestos — what it calls asbestos "T", with the fiber intimately bonded to titanium dioxide. This bonding, says Carbide, means that TiO_2 retention is at the same level as that of asbestos, said to be the highest of all furnish fillers.

There are two other features also important to asbestos "T." The titania in the new product is dispersed uniformly throughout the fiber and does not agglomerate in use, yielding maximum optical efficiency. And at the same time, asbestos "T" improves the retention of separately added TiO_2, clay, cellulose fines and dyestuffs in the furnish.

OPPOSITES ATTRACT

The reason asbestos acts this way lies with its electrostatic charge. At most pH's, the positively charged asbestos has a strong attraction for negatively charged TiO_2. This pull is great enough to hold the titania contained in the product and still attract particles of separately added TiO_2 that come in contact with the asbestos in the furnish — and the bond holds up under severe agitation.

This effect is also responsible for the ability of asbestos to optimize the optical efficiency of TiO_2. Without asbestos in the system, the TiO_2 particles tend to agglomerate, reducing their optical efficiency. But the strong opposite charge between asbestos and TiO_2 helps keep titania scattered uniformly throughout the sheet, and this uniform distribution retains the optimum surface area and size for optical efficiency. Result: mills have found less TiO_2 is needed in the sheet to obtain a given opacity.

Mill experience has shown that asbestos "T" improves the retention and optical properties of TiO_2

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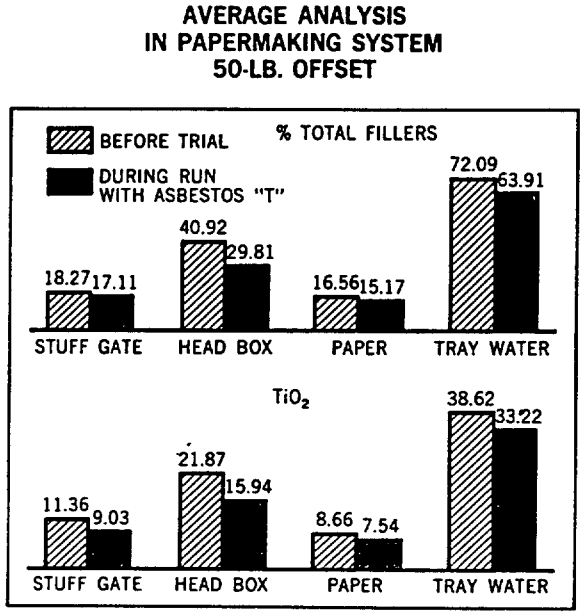
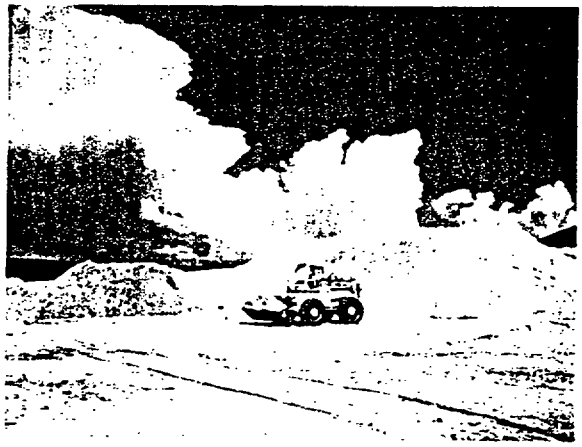


Figure 1. During this production trial, 50 lbs. of Union Carbide's asbestos "T" (4.3%) replaced the equivalent amount of titanium dioxide in preparation of the furnish.



Carbide's California mine supplies high-purity asbestos.

to such an extent that in many furnishes, 1 lb. of asbestos "T" can replace 1 lb. of TiO_2 without sacrificing opacity or brightness. Carbide now figures that since asbestos "T" costs about two-thirds as much as TiO_2, the substitution can yield significant savings. By making a complete or partial replacement, says Carbide, mills have cut papermaking costs by $3-8/ton. And they can achieve these savings by using the compound in much the same manner as the company's high-purity asbestos. How the product's handled: the "T" pellets (used for compactness in shipping) are added to the pulper or beater, where they open up into short fibers that mix with the furnish components. (Carbide recommends that asbestos "T" at first replace up to 50% of TiO_2 content, but not exceed a 5% addition, based on cellulose content. With experience mills can replace more than 50% of TiO_2.)

Once in the system, asbestos "T" provides improved retention by reducing solids losses to the tray water and the subsequent buildup of solids in the head box — and it improves solids recoveries in the save-all, thereby reducing their loss in the mill effluent. The end-product, says Carbide, could be a paper with such pluses as better sheet formation, smoothness and printability. Such benefits from asbestos "T" have often resulted from mills which first started with the high-purity grade and then graduated to the new formulation. What follows, then, are detailed results from several mills with experience in both these retention aids.

ON TO OFFSET

One of the first production runs using asbestos "T" was at an operation making 50-lb. offset paper. Mill goal: to replace part of the TiO_2 in the furnish with asbestos "T" on a pound-for-pound basis. Thus, during this production run, 50 lbs. of asbestos "T" (4.3%) replaced 50 lbs. of TiO_2 added to the beater, and specifications for the paper were maintained. Trial run results showed the presence of asbestos "T" improved the retention of separately added TiO_2 by 18% while retention of all fillers improved by 16%. And the single-pass retention of asbestos "T" (including both the asbestos and TiO_2 in the product) was 57.1% — higher than the other components. *(Figure 1 shows the total filler and TiO_2 percentages at various points in the papermaking system before and during asbestos usage; single-pass retention figures determined from these numbers are indicated in figure 2.)*

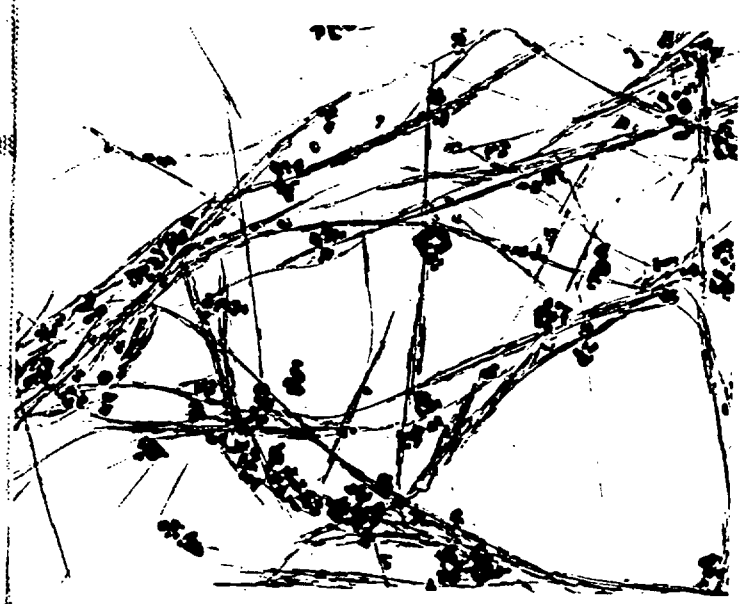
For the overall system, asbestos "T" improved the retention of separately added TiO_2 by 9.6% — from 76.2% to 83.5% — with asbestos "T" retention (both components) at 79%. Mill analysis shows that 75 min. after additions of the retention aid were stopped, the head box contained 4.5% asbestos "T" and the sheet, 2.6%. On the basis of this information, Carbide says, the asbestos remaining in the recycle system continued to work effectively long after it was removed as an additive.

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The improved retention provided by the asbestos reduced the loading of inorganic solids in the head box and buildup in the tray water. At the same time, the presence of asbestos "T" in the saveall improved recovery there. At the head box, the total filler content was reduced from 41% to 30%. As for the solids content in the tray water and saveall:

Total solids, lbs./1000 gallons	No asbestos	With asbestos
Tray water	26.54	17.14
Saveall influent	18.08	13.60
Saveall effluent	0.34	0.11

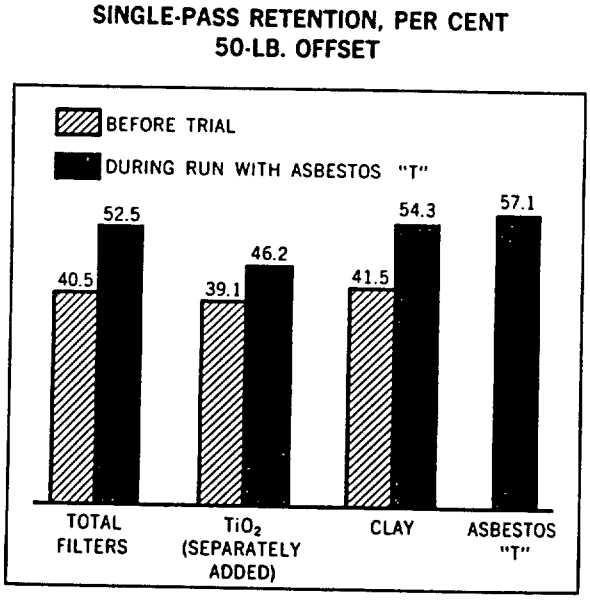
Thus the solids in the tray water were reduced by 34%, while the saveall influent and effluent were reduced by 25% and 68%, respectively. Overall recoveries in this flotation saveall increased from 98.1% to 99.2% in the presence of asbestos.



This mill, says Carbide, was most concerned with the maintenance of its opacity and brightness specifications. However, all quality specifications were met — opacity was kept at 91.0% vs. a prior 90.7% and brightness averaged 85.3% compared to 85.5% before. Moreover, claims Carbide, high values were maintained despite a drop in the TiO_2 content of the sheet from 8.66% to 7.34 % when asbestos "T" was substituted for part of the titanium dioxide in the furnish. Supplier and customer conclusion: data confirm the ability of asbestos "T" to optimize the light-scattering efficiency of TiO_2, yielding improved opacity and brightness at lower filler levels.

IT'S A GIFT

Asbestos "T" has yielded similar results in other production runs. For example, a mill producing 25-lb. white gift wrap used 30 lbs. of asbestos "T" to replace the same amount (or 50%) of the TiO_2 going into the furnish. According to mill information *(see figure 3)*, the new asbestos formulation improved across-the-wire retention of ash by 28% and separately-added TiO_2 by 6%. Retention improvements for the entire system were 50% and 15%, respectively. Retention of the asbestos "T" (both the asbestos and the TiO_2 in the product) was much higher than the other components — 41% across the wire and 76% overall, mill personnel reported.



Electron micrograph (left) shows the dispersed particles of titanium dioxide clinging to the asbestos fibers. Asbestos "T" itself (figure 2, above) improved the single-pass retention of fillers and titanium dioxide.

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These results reduced solids in the tray water from 7.8 lbs./1000 gallons to 6.4 lbs./1000 gallons and saveall effluent content from 0.79 lbs./1,000 gallons to 0.53 lbs./1,000 gallons. The brightness of the paper increased 3.5% with the addition of asbestos "T" — rising from 79.3% to 82.8%, making it possible for the mill to replace even more TiO_2 while maintaining the original 79% level. Opacity with asbestos, however, was down slightly. This was due in part to a 2-lb. higher basis weight when no retention aid was present in the system.

GOVERNMENT ISSUE

Meanwhile, Union Carbide's regular high-purity asbestos has been proving itself as another means for reducing clay and TiO_2 input. Some mills, says the company, take advantage of the improved retention to obtain quality improvements without adding additional fillers — and Carbide claims either objective can be accomplished with considerable savings in furnish costs by the use of asbestos.

One mill which obtained such improvements used asbestos in the production of 40-lb. government offset. An average of 2.20% asbestos was fed into the machine, replacing an equivalent amount of clay, and TiO_2 additions came to 3%. Results: asbestos improved ash retention from 23.4% to 25.6% across the wire and from 40% to 51.5% overall. *(The total ash content at various points in the papermaking system over a three-day period is shown in figure 4.)*

Because of this improved retention, the TiO_2 content of the reel was increased from 1.16% to 1.40%. This meant an increase in opacity from 89.3% to 91.2%, while brightness remained the same and all other sheet specifications were met.

This mill also obtained a substantial reduction in traywater and saveall losses:

Total solids, lbs./1000 gallons	No asbestos	With asbestos
Tray water	149.9	113.7
Cloudy effluent	28.0	13.0
Clear effluent	17.7	6.2

The addition of asbestos led to a 20% reduction of tray-water solids (TiO_2, clay, cellulose fines). And at the same time, the solids in the cloudy and clear saveall effluents were cut back by 55% and 65%, respectively.

TAKING OUT TITANIA

Another mill producing 40-lb. white opaque paper used the improved retention obtained from asbestos to reduce TiO_2 addition. Initially, 3% high-purity as-

AVERAGE RETENTION, PER CENT
25-LB. WHITE GIFT WRAP

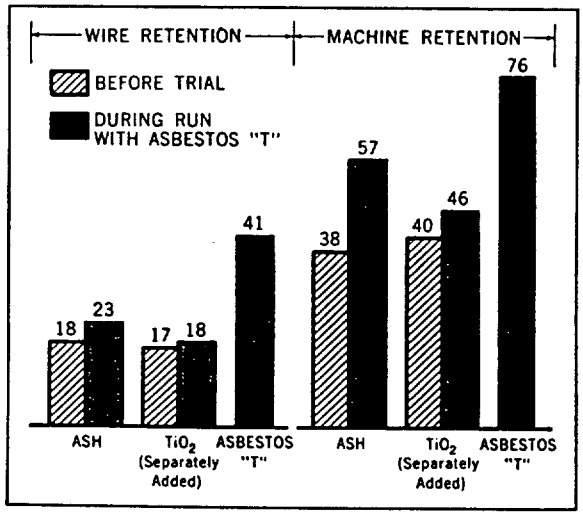
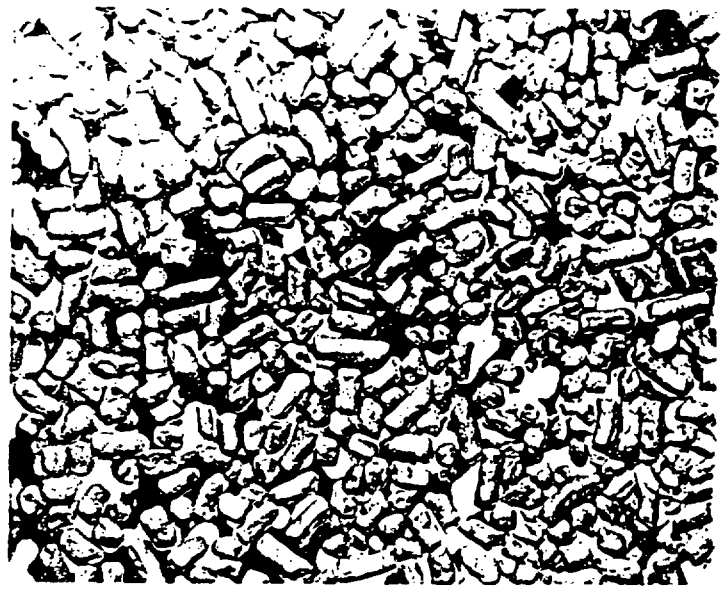


Figure 3. Asbestos "T" (which comes in the rod-shaped pellets shown on the right) at this mill boosted the retention of ash and titanium dioxide across the wire.



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bestos was used to replace a similar amount of clay. Then the TiO_2 additions were reduced from 8% to 6.8%. This resulted in an ash retention increase during the production run from 38.4% to 40.6% across the wire and from 68.1% to 71.8% overall. *(Data on this analysis throughout an 11-hour period are shown in figure 5.)*

But despite the reduction in TiO_2, the ash and titania contents of the paper at the couch remained about the same as before the trial. The TiO_2 content averaged 6.26% with asbestos compared to 6.12% before, and opacity and brightness were therefore kept at 92% and 81.5%, respectively.

As at the other mills, tray-water and saveall effluent solids were markedly reduced:

Total solids, lbs./1000 gallons	No asbestos	With asbestos
Tray-water	30.3	25.5
Saveall influent	22.0	19.2
Saveall effluent	11.7	8.9

From the figures, the mill estimates that tray-water solids were reduced by over 15% while losses from the saveall were slashed by 24%. Saveall recoveries improved from 47.0% to 53.7% with asbestos in the system.

Asbestos' contributions apparently have not been limited to paper. Board producers also report significant improvements in retention by using the high-purity variety. One mill producing 28-35 pt. white vat-lined chipboard increased the retention of pigments in both the topliner and underliner, as measured by the decrease in solids in the white water.

In the topliner system, 1.9% asbestos was added to the furnish without any other change in the furnish components. White-water solids were sharply reduced from 20.5 lbs./1000 gallons to 3.8 lbs./1000 gallons. As for the underliner, a 1.4% asbestos addition meant a reduction in white-water solids from 17.7 lbs./1000 gallons to 4.9 lbs./1000 gallons. Clay addition was then cut from 3.8% to 2.5%, further reducing white-water solids to 4.1 lbs./1000 gallons. Besides obtaining an improvement in pigment retention, mill personnel reported better smoothness with asbestos present in the liner — an improvement that could lead to better printability.

What all this data point up, Carbide hopes, is something the company has claimed over the past few years — that asbestos isn't as foreign an aid to papermaking as its industrial history would seem to imply. ●

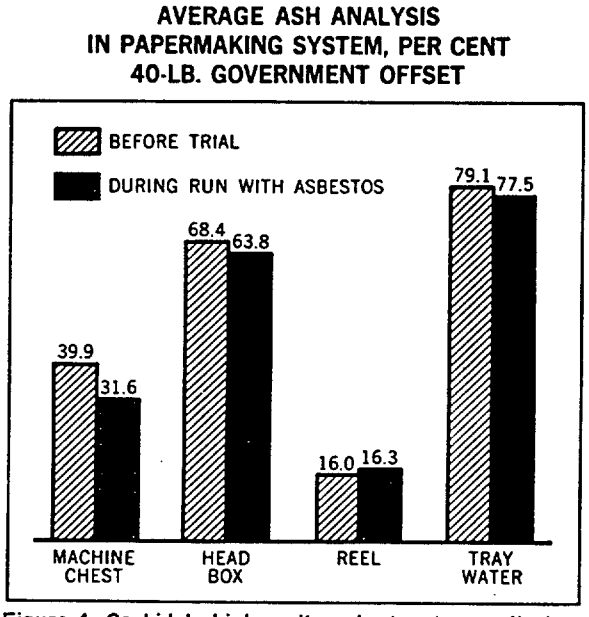


Figure 4. Carbide's high-purity asbestos does well also. This furnish held 2.2% of the fiber, enough to raise ash retention by 10% across the wire and 30% overall.

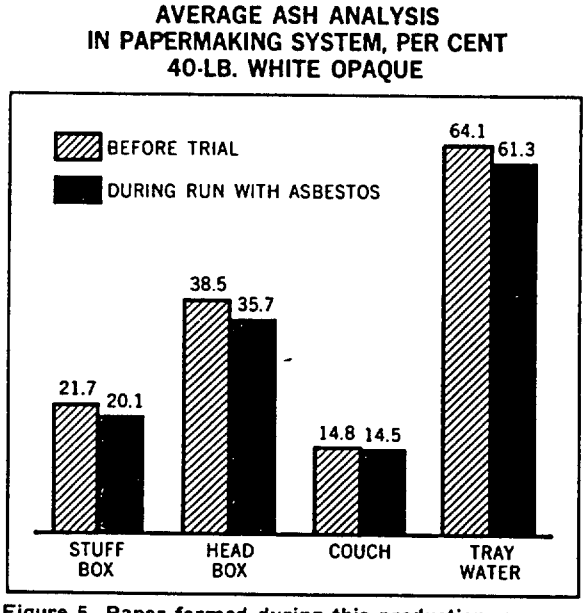
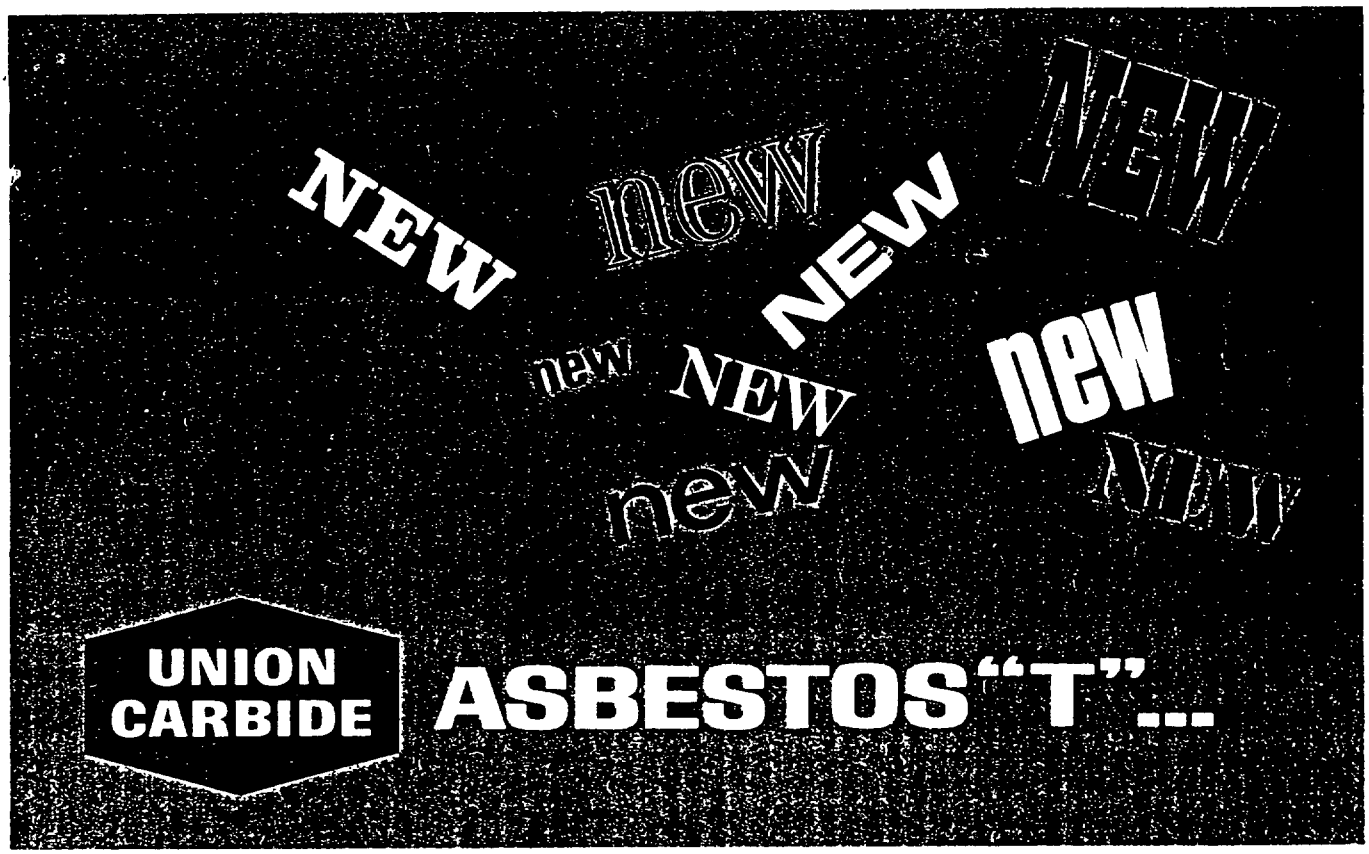


Figure 5. Paper formed during this production run contained 3% high-purity asbestos and maintained its ash content despite a reduction in TiO_2 and clay additions.

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reduces furnish costs

LOW-COST WET-END ADDITIVE

Asbestos "T" is a special combination of asbestos and TiO_2. The product gives unusually high retention—not only of its own components but also of separately added TiO_2 and fillers. Thus, 1 lb. of asbestos "T" can often replace 1 lb. of TiO_2 without sacrificing opacity or brightness. Since asbestos "T" costs about 60 per cent as much as TiO_2, substantial savings can be made.

IMPROVED RETENTION OF FURNISH

Positively charged asbestos "T" strongly attracts negatively charged pigments and fillers. A typical mill improved overall retention of separately added TiO_2 from 76 to 84%. Retention of asbestos "T" was highest of all fillers.

EFFECTIVE TiO_2 EXTENDER

Asbestos "T" improves opacity by optimizing the light-scattering efficiency of TiO_2. Thus, higher opacity can be obtained at lower TiO_2 levels, reducing TiO_2 costs. A typical mill reduced the TiO_2 content of its sheet from 8.7 to 7.3% without any loss of opacity.

BETTER SAVEALL EFFICIENCY

With asbestos "T" in the papermaking system, mills have improved their recoveries of TiO_2 and other solids in the saveall. Improvements have been made in flotation, filtration, and sedimentation savealls. One mill reduced losses of solids in the saveall effluent by 68%. By discharging a clearer effluent, it also reduced river pollution.

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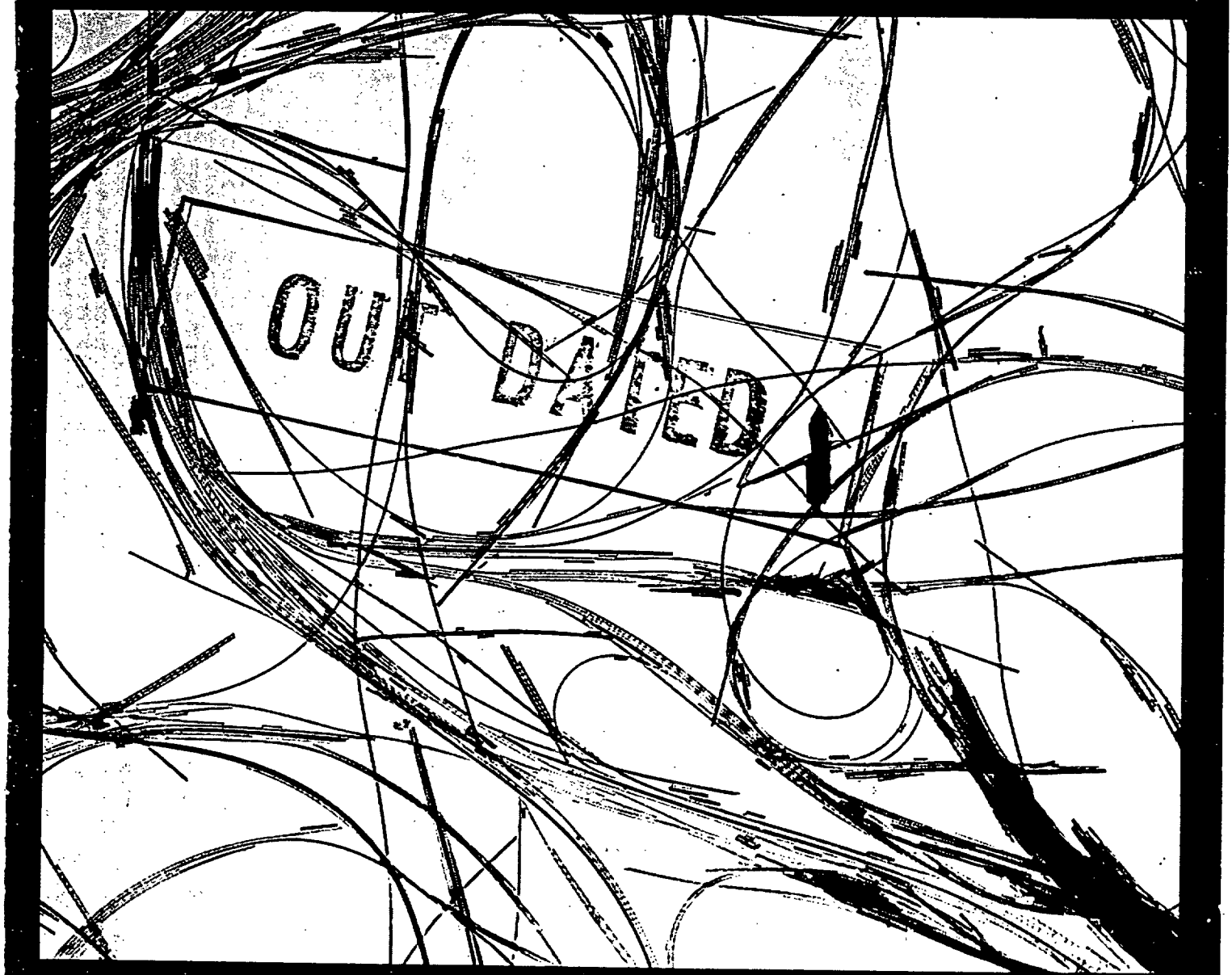
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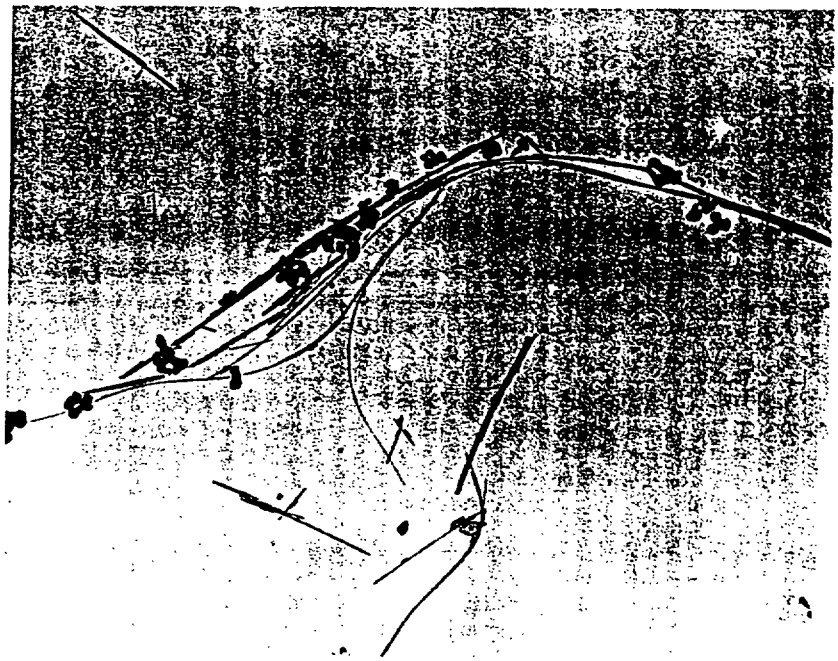
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January 10, 1966



Asbestos-cellulose combinations offer dramatic possibilities

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Electrostatic attraction between high purity asbestos fibers and titanium dioxide pigment in papermaking water systems. Electron micrograph magnification 10,000x.

Asbestos-cellulose blends offer dramatic possibilities

This highly-retained fiber does not replace other products, is being used as a retention aid, gives high optical efficiency, aids in pitch control and acts as a modifier.

By R. G. Woolery

Chrysotile asbestos has found its way into the cellulosic paper industry only recently. This has been brought about by the introduction of a new high-purity, short-fibered grade made acceptable for all paper grades by a novel processing technique developed by Union Carbide. Since its introduction, its use has been growing steadily. The uniqueness of this highly-retained fiber is that in most applications it does not replace any available product. Being fibrous, colloidal and cationically charged, it is set apart from all other wet end additives, and its function is quite unlike any of the other mineral fillers. Because of these properties, new applications are constantly being developed, and the proven areas of use expanded.

Mr. Woolery is group manager, asbestos development, Union Carbide Corp., Mining and Metals Div.

Filler and pigment retention

In the application of asbestos as a retention aid, it is important that its function is not confused with that of a polymeric coagulant. Laboratory tests have shown each to have its own special functions in this area. These conclusions were arrived at through tests designed to study the coagulation or co-flocculation in simple systems. A series of tests were conducted on the ability of asbestos and organic coagulants to produce flocs and to clarify clay slurries of various consistencies. The tests were run following American Cyanamid's standard flocculent testing procedure employing a 1.0 liter graduated cylinder. The clay slurry is made up to the desired concentration, the coagulants added, and agitated with a specially designed plunger. An agitation period of 1.0 minute and a settling period of 20 minutes were used. The clear supernatant was decanted, sampled, and a light transmittance determined at 650 mμ. The asbestos used was a specially prepared grade containing a minimum of interfering ions. The organic coagulant used was Union Carbide's C-149, a cationic polymeric flocculent.

One series of tests has been conducted on slurries of 1,000 ppm kaolin. As is usual with the polymeric flocculents, some optimum level of addition is reached (in this case, about 30 ppm), and thereafter any further addition proved detrimental. With the asbestos, however, at no level does the trend ever reverse itself. There is a point, nonetheless, at which it is no longer economical to

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increase the asbestos addition as the advantages gained do not warrant the additional asbestos. Under these conditions, that point would appear to be between 50 and 75 ppm asbestos. The most effective approach is a combination of asbestos plus polymer. Asbestos with 1.0 ppm C-149 is superior to asbestos with 2.0 ppm C-149. Both combinations, however, are superior to either the asbestos or the C-149 alone. It would be equally easy to show that the combination has economic advantages over either product alone.

In terms of the conditions on a paper machine, this would be equivalent to a heavily loaded sheet. If we take a typical case of 0.50 per cent (5,000 ppm) headbox fiber consistency, this would amount to a 33 per cent (based on stock) filler loading, a not too uncommon occurrence in a highly-filled sheet. The 50-75 ppm of asbestos would be equivalent to 1.5 per cent of the cellulose stock. The combined furnish consistency would be 0.76 per cent.

In a similar series of laboratory tests conducted on clay slurries of 100 ppm kaolin, the results were quite different. Coagulation with either the polymer or alum was only slight. Asbestos at 25 ppm, on the other hand, showed a remarkable ability to clarify the supernate at these low levels of solids. Under such conditions, it was found that it was not necessary to use a combination of asbestos and organic flocculent as the advantages to be gained by this technique were slight and uneconomical. The ability of the asbestos to supply the nuclei for the floc enables it to clarify effectively even at low levels of solids.

If we again use a typical headbox fiber consistency of 0.50 per cent (5,000 ppm), a level of 100 ppm of clay is equivalent to about two per cent filler based on the stock and an asbestos level of 0.5 per cent. Thus, these laboratory data would indicate that on highly-filled sheets a combination of ½ per cent asbestos plus an organic coagulant or two per cent asbestos alone would be optimum, whereas on low levels of filler, only 0.5 per cent asbestos would be required.

To expect a direct relationship between the laboratory results and machine operation would be an oversimplification since a great many other variables enter into the papermaking system. One of these factors is the type of organic flocculent used. For this reason, a wide variety of these products was investigated and in all cases the results were essentially the same. At high levels of kaolin (1,000 ppm), it was found that the more effective the polymer, the more effective was the combination. The selection of C-149 was made because it was typical and showed a better than average ability to coagulate clays.

Probably the principal overriding factor in the paper machine conditions is the presence of the cellulose fibers themselves. By virtue of the large diameter of the average cellulose fiber, it is not to be expected that an asbestos fiber (d = 270 A) would cause flocculation except perhaps of the very finest fraction. It is known, however, that in the presence of an anionic wood fiber, the cationic asbestos is attracted and becomes attached. Thus, when adding the mineral fillers, the asbestos acts as a coupling agent whereby the filler particles are attracted to the asbestos fibers that are already attached to the cellulose fiber. In the act of attaching itself to an anionic wood fiber, some of the cationic surface charge is lost, thus reducing its capacity to attract and hold filler (or TiO_2) particles. This accounts for the fact that in over 400 mill trials it was found that more asbestos is required for retention than would be indicated in the laboratory tests. Mill trial experience has shown that for filler retention purposes at least one per cent asbestos is required and, preferably, a level of two per cent is desired. Where heavy loading is necessary, and here is used a figure of > 10 per cent ash in the sheet, not less than 2½ per cent and, in some cases, as much as 3 to 3½ per cent asbestos is recommended.

Laboratory tests have also shown the effects that can be attributed to the presence of various ions. As has been shown elsewhere, the pH is important. The surface charge of the asbestos is enhanced greatly by lowering the pH with an optimum level in the range of pH 4 to pH 5. Sulfate ions have been found to be detrimental, while the trivalent anions, particularly Al, enhance the surface charge. Thus, the very nature of the water in the machine may influence greatly the ability and efficiency of the asbestos.

Mill trial data

The effect of asbestos on the Fourdrinier machine is often quite dramatic. In one trial, the asbestos was added "on top" of the furnish of a 22.5 classified grade. During the trial period, reel samples were taken and analyzed for filler content. The results of these data are shown in Figure 1. As is common in many mill trials, only one per cent asbestos was added until it was evident there would be no machine problems. After



Mr. Woolery is a graduate from the University of California, holding a BS degree in mining engineering. A member of TAPPI, AIME and ASTM, his experience includes 11 years with Union Carbide in both mineral engineering and asbestos application development.

one hour and twenty minutes, this was raised to the recommended two per cent level. It was apparent that the machine was just reaching equilibrium at the end of the trial. By this time, the clay content of the sheet had risen from 8.86 to 10.44 per cent although no additional clay was added to the system. The asbestos level during this period averaged 1.6 per cent for approximately an 80 per cent retention. Even three hours and twenty minutes after the asbestos addition was stopped, the sheet still contained 0.36 per cent asbestos. The increased retention of fillers was also reflected in the opacity gains noted during the trial. In addition, several side benefits were observed. These included a more closed sheet (a decrease in porosity), slight benefits in smoothness, better printability, and significant gains in show-through.

In certain instances, the entire circuit was sampled to study the effects of the asbestos on the furnish components. In one typical case, we were able to obtain these data on a 39-lb. (50-lb. coated) magazine stock. The sampling points were (1) stuff box, (2) headbox, (3) white water, (4) reel, (5) saveall influent, and (6) saveall effluent. In Figure 2, the analyses of the headbox, stuff box and reel are presented. At the beginning of the trial 2.5 per cent asbestos was added and the clay to the stuff box cut from 24 per cent to 17 per cent. This resulted in a reduction of the clay content in the headbox from 42 to 27 per cent. The clay content in the sheet dropped from 16.5 to 13 per cent, which was augmented by a 1.8 per cent asbestos content for a total sheet content of 14.8 per cent filler. In spite of the filler reduction, the machine retention of clay in-

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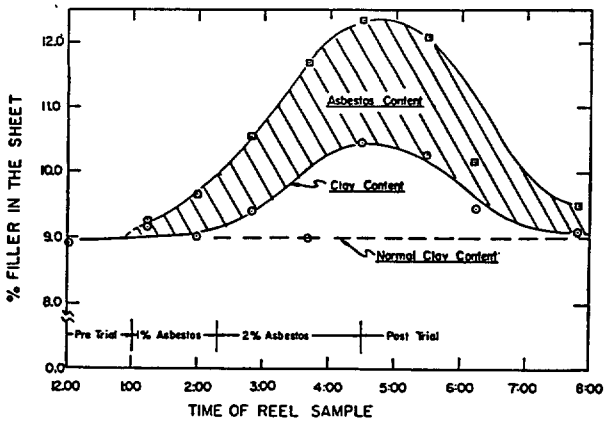


Figure 1. Effects of asbestos additions to a 22.5 lb. classified grade.

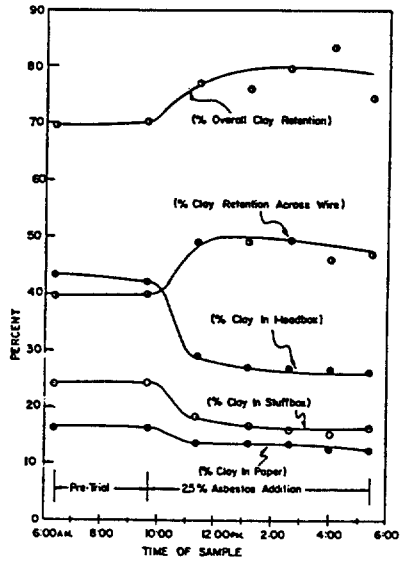


Figure 2. Clay analysis of machine run on a 39 lb. magazine grade.

creased from 70 per cent to 80 per cent, and the one pass (or wire retention) went from 39 per cent during the control period to 47 per cent during the trial.

A simple check on retention, particularly wire retention, is the solids level in the tray water. As shown in Figure 3, during the control period the total solids were running 59 lb./1,000 gallons. Of this, the clay fraction accounted for 35½ lb./1,000 gallons. During the trial period, the total solids were reduced to 35 lb./1,000 gallons and the clay to 19¾ lb./1,000 gallons. Thus, the cellulose content remained relatively constant, while the clay losses were reduced by 45 per cent. The asbestos content of the tray water amounted to an average of 1 lb./1,000 gallons.

The other important circuit is the saveall unit (disc-type filtration) for the machine. This circuit was thoroughly monitored during the trial. As would be expected with the improved retention, the solids to the saveall influent were reduced significantly from a pretrial average of 61 lb. total solids per 1,000 gallons to 47 lb./1,000 gallons during the trial period. The clay portion of the influent for these periods was 37 and 20 lb./1,000 gallons, respectively. This amounts to a 23 per cent reduction in total solids, a 46 per cent reduction in clay and a reduction of 11 per cent in cellulose.

The samples of the effects on the saveall effluent were too small for complete analyses; however, the reduction in saveall solids losses is appreciable. The cloudy effluent was cut from 8½ lb./1,000 gallons to 4½ lb./1,000 gallons and the clear effluent reduced from 5¾ lb./1,000 gallons to 2½ lb./1,000 gallons during the asbestos trial. This represents a 47 per cent improvement in the cloudy effluent and a 55 per cent improvement in the clear effluent. This was due, in part, to the reduced load to the saveall and in part to the improved efficiency of the saveall with asbestos present. The saveall efficiency rose in the cloudy and clear effluents from 86½ per cent to 91 per cent and from 92 per cent to 95 per cent, respectively.

This example of a paper machine operation probably best explains the role of asbestos. Unlike the polymers, it does not break down (i.e., lose molecular weight) and continues to be effective in all phases of the papermaking circuit. Furthermore, it contributes to the basis weight in a manner similar to other fillers. Finally, it contributes to improved sheet properties.

Optical efficiency

In addition to the improved filler and pigment retention gained through the use of asbestos, there is evidence that the type of coflocculation achieved gives a high optical efficiency. This can be illustrated by the effect on waxed opacity obtained in a series of laboratory tests conducted on a "typical" saturating furnish of bleached alpha pulp. The handsheets (basis weight 120 g./M²) were made in a laboratory Noble & Wood handsheet machine. The asbestos and titania were blended with the pulp in a Herman Standard Disintegrator and the pH adjusted to 5.0 with alum. Waxed opacity results were obtained by measuring the opacity of a specimen which had been dipped in molten paraffin sealing wax. Results have been compared with the waxed opacity obtained on handsheets containing only TiO_2.

These data show that the incorporation of the asbestos is contributing significantly to the waxed opacity of the sheet. In the sheets containing asbestos it was possible to achieve a waxed opacity of about 90 per cent with a TiO_2 content of eight per cent; without the asbestos, it required a TiO_2 content of approximately 11 per cent. The handsheets incorporating asbestos varied in asbestos content from 2.3 to 5.5 per cent; however, little or no benefit was derived at the higher asbestos levels. These results indicate that the asbestos, per se, contributes little or nothing to waxed opacity which agrees with the results obtained in other studies. The improved waxed opacity is, therefore, attributed to the high optical efficiency of the TiO_2 obtained by coflocculation rather than agglomeration.

Economically, it is most advantageous to use the lower level of asbestos as the savings in furnish cost under these conditions would be on the order of $12.00 per ton of product.

Pitch control

At the present time, no single product has really solved the problem of pitch. The most frequently used mineral for this application is a form of talc. The mineral itself tends to be hydrophobic and, therefore, may be classed as oleophyllic, at least in comparison with the common fillers used in paper. It is probably this property of talc that makes it somewhat successful as a pitch controlling agent.

Asbestos, on the other hand, is readily wettable by water and would, therefore, be considered hydrophyllic. When compared in various mill trials,

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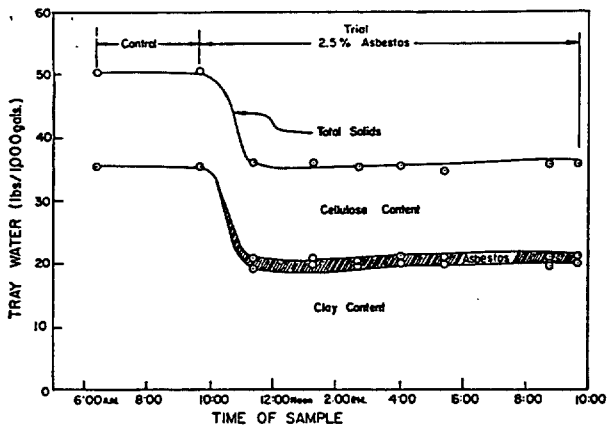


Figure 3. Tray water analysis on 39 lb. magazine grade.

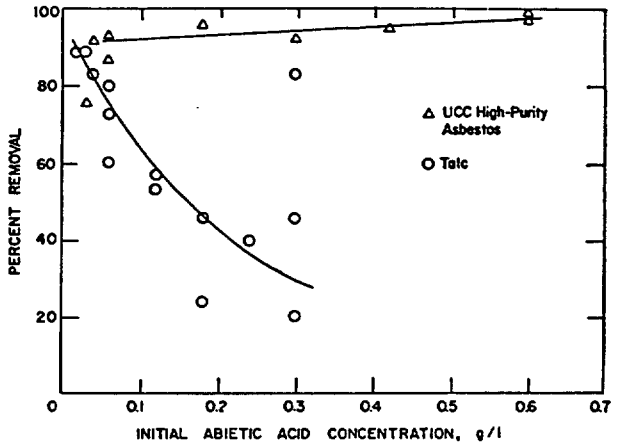


Figure 4. Effect of asbestos and talc on abietic acid removal from water solutions.

it has frequently proved to be significantly more effective than talc. This would indicate that some other property is also important. Tentatively, this has been attributed, in part, to the high surface area and, in part, to the cationic surface charge of asbestos.

Laboratory tests have been made in an attempt to compare the relative effectiveness of asbestos and talc in removing pitch. Since abietic acid is the most common of the resin acids, it was used to simulate pitch in the laboratory study. The abietic acid solution was adjusted to a pH of 4.0 ± 0.2, the level where many papermaking circuits operate. Because abietic acid is quite insoluble in acid solutions, a visible precipitate could be seen.

Additions of four grams per liter of high-purity asbestos and talc were then made to different solutions. The suspensions were allowed to stand until a supernate free of asbestos or talc flocs could be withdrawn. The floc-free solutions were then analyzed with spectrophotometer at a wavelength of 250 mμ to determine the abietic acid concentration.

As shown in Figure 4, asbestos removed abietic acid effectively at all concentrations. Talc was effective at low levels but became less effective and gave more erratic results as the abietic acid concentration increased. Thus, to the extent that the abietic acid simulates pitch, the effectiveness of asbestos for pitch control is largely due to its ability to flocculate and remove suspended solids and to a lesser degree by adsorption of dissolved matter.

As yet, no one has developed a satisfactory method of analyzing for pitch and, therefore, in the mill the only criterion has been performance. In most of the mills now employing asbestos it has been used because their problem has been sufficiently severe that no other product has worked satisfactorily. In many instances, the asbestos is performing a dual role. In addition to controlling pitch, it has contributed to improved filler retention, sheet formation and printability.

Because of its success in pitch control, its use has been extended to areas such as control of organic matter in waste pulps. Only recently, it was tried in a board mill that had been experiencing problems of asphalt agglomerates in the final product. It was reasoned that the same properties that make asbestos effective in pitch control should be applicable to the problems encountered in asphalt dispersion and control.

It was first tried at 1.25 per cent asbestos level in a 21-lb./1000 ft.^{2} chip board consisting of printed news and corrugated boxes. Little or no improvement was observed during the first 8-10 hours; however, after it had been on the machine for 18 hours, marked improvements were noted both in the number and size of the asphalt agglomerates. This type of response would indicate that the asbestos can do little once the agglomerates have formed, and its function is one of adsorption or coflocculation of dispersed asphalt before it has an opportunity to coagulate. As is customary with retention and pitch control applications, the asbestos was added with the pulp at the hydropulpers. As of the time of this writing, the asbestos is still being used in this grade and doing a satisfactory job.

In a subsequent trial on a lightweight kraft grade, 1.25 per cent asbestos was employed for pitch control. This particular grade was also plagued with a polyethylene problem. Agglomerates would form in the sheet, which resulted in breaks on the rewind. It was observed in this grade that the asbestos not only improved the asphalt condition but reduced the problem attributed to the polyethylene.

Modified asbestos products

The very fact that chrysotile asbestos has a positive surface charge as well as a somewhat reactive surface makes it a prime candidate for modification. With high-purity asbestos as a base product, it is relatively simple to affect the physical properties by either physical or chemical means. For some uses, it has been advantageous to use a combination of treatments.

The most successful modified asbestos product is currently marketed under the name asbestos "T." During the cource of refining the asbestos, a highly-dispersed stream of titanium dioxide is blended with the purified asbestos and manufactured in such a way that the TiO_2 becomes an intimate part of the product. Once this has been accomplished, the material resembles a fibrous titania. The result is a single product that combines the properties of both constituents. The retention capabilities of the "T" are comparable to the natural product, and its opacifying power is greatly enhanced by the titania. In the mill trials completed, it has been used to replace titanium dioxide on a pound-for-pound basis in quantities up to five per cent of the total furnish. This is possible due to the high optical efficiency achieved and to the improved retention of the furnish components.

In one mill trial asbestos "T" was substituted on a pound-for-pound basis for titanium dioxide in a 50-lb.

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offset. At the beginning of the trial, 50 lb. of "T" were used to replace 50 lb. of titania. Eventually, 100 lb. of "T" per ton of stock were added to the beater in place of 100 lb. of TiO_2 without affecting the properties of the final sheet. Thorough sampling was possible throughout the circuit.

Asbestos "T" has the ability to improve wire retention. In one trial, the one-pass retention went from a pretrial value of 40 per cent to an average trial value of 49 per cent. As the trial progressed, the total filler in the sheet remained constant, while the headbox loading was reduced from 41 per cent to near 26 per cent of the total furnish. The wire retention of the "T" during this period was calculated to be 60 per cent.

Any improvement in the wire retention must, of course, result in less solids passing through the wire. The analyses of the tray water support the calculated wire retention improvements. The total solids in the tray went from 27 lb./1,000 gallons to 17 lb./1,000 gallons. More significantly, the clay and TiO_2 content were both reduced by 50 per cent during the period. The Asbestos "T" portion seemed to level off at about 2 lb./1,000 gallons.

As with the regular asbestos product, the "T" material proved to be effective in the flotation type saveall. The solids content of the influent correlates well with the tray water and shows a 31 per cent reduction in solids to the saveall. The load to this unit was decreased from 19 lb./1,000 gallons to 13 lb./1,000 gallons while both the clay and the TiO_2 contents were halved.

The saveall effluent was also monitored during this trial and the total solids content determined. The samples were too small for complete analyses; however, the amount of total solids reporting to the effluent was reduced by 76 per cent. Thus, the "T" material acts as a co-flocculating agent in the furnish while contributing substantially to the sheet opacity. For the most part, it is not recommended that levels exceeding five per cent "T" be used. Its cost, however, is only about ⅔ that of titanium dioxide which makes this product economically attractive in many grades of high-quality paper.

A number of other types of modified products are currently under evaluation in the laboratory and, in some cases, under experimental continuous machine study. In some instances, our research is aimed at solving specific problems. Two such programs now under way are "strike in" improvement for newsprint and a bulking agent for paper and board.

An alternate approach has been to modify the asbestos, determine its physical properties, and then look for areas of application. One of these categories is an asbestos product of varying degrees of hydrophobicity. By controlling the chemical alteration any degree of water repellency can be given to the fiber up to and including a product that is 100 per cent hydrophobic.

Certainly, with such a versatile material, and by virtue of its amenability to modification, a wide variety of end use oriented asbestos products will continue to be developed. ■

Acknowledgments

Thanks are due to Messrs. B. L. Ingalls and G. L. Dickson for their assistance in obtaining the data presented and to Dr. A. W. Naumann for his contribution of the Abietic Acid Study.

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Have you used these PELLETS as a wet-end additive?



These pellets of Union Carbide high-purity asbestos burst into short, non-abrasive fibers when added to a pulper or beater. The fibers disperse uniformly throughout the pulp and give these improvements and cost savings:

over 100 Mills have ...

IMPROVED PITCH CONTROL

Union Carbide asbestos effectively prevents pitch buildup. In this way, it helps keep cleaner felts and fourdrinier wires, reduces machine breaks and down time, and reduces rejections for paper blemishes. Several mills with severe pitch problems have found that 1% asbestos keeps pitch harmlessly dispersed throughout the sheet.

EFFECTIVE TiO_2 EXTENDER

Asbestos improves opacity by optimizing the light-scattering efficiency of TiO_2. Thus, higher opacity can be obtained at lower TiO_2 levels, reducing TiO_2 costs. A typical mill reduced TiO_2 content of its sheet from 10.6 to 6.3% without any loss of opacity.

IMPROVED RETENTION OF FURNISH

Positively charged asbestos strongly attracts negatively charged pigments and fillers. A typical mill improved TiO_2 retention from 65.5 to 88% with 2% asbestos and saved $3.60 per ton. Another improved single-pass retention of all fillers by 21% with 3% asbestos. Also, the large surface area of asbestos readily absorbs dyes, improving retention and reducing two-sidedness.

INCREASED SOFTNESS

Tissues and towels containing Union Carbide asbestos have improved softness. One mill increased softness of towels by 20% with 3% asbestos. It also improved wet tear and per cent stretch. Another mill used asbestos to replace hardwood with stronger softwood without sacrificing quality. The change also netted significant savings in furnish costs.

BETTER SAVEALL EFFICIENCY

With asbestos in the saveall, mills have improved their recoveries of solids. Improvements have been made in flotation, filtration, and sedimentation types of savealls. One mill increased saveall recoveries from 74 to 93%, saving $27,000 per year. By discharging a clearer effluent, it also reduced river pollution.

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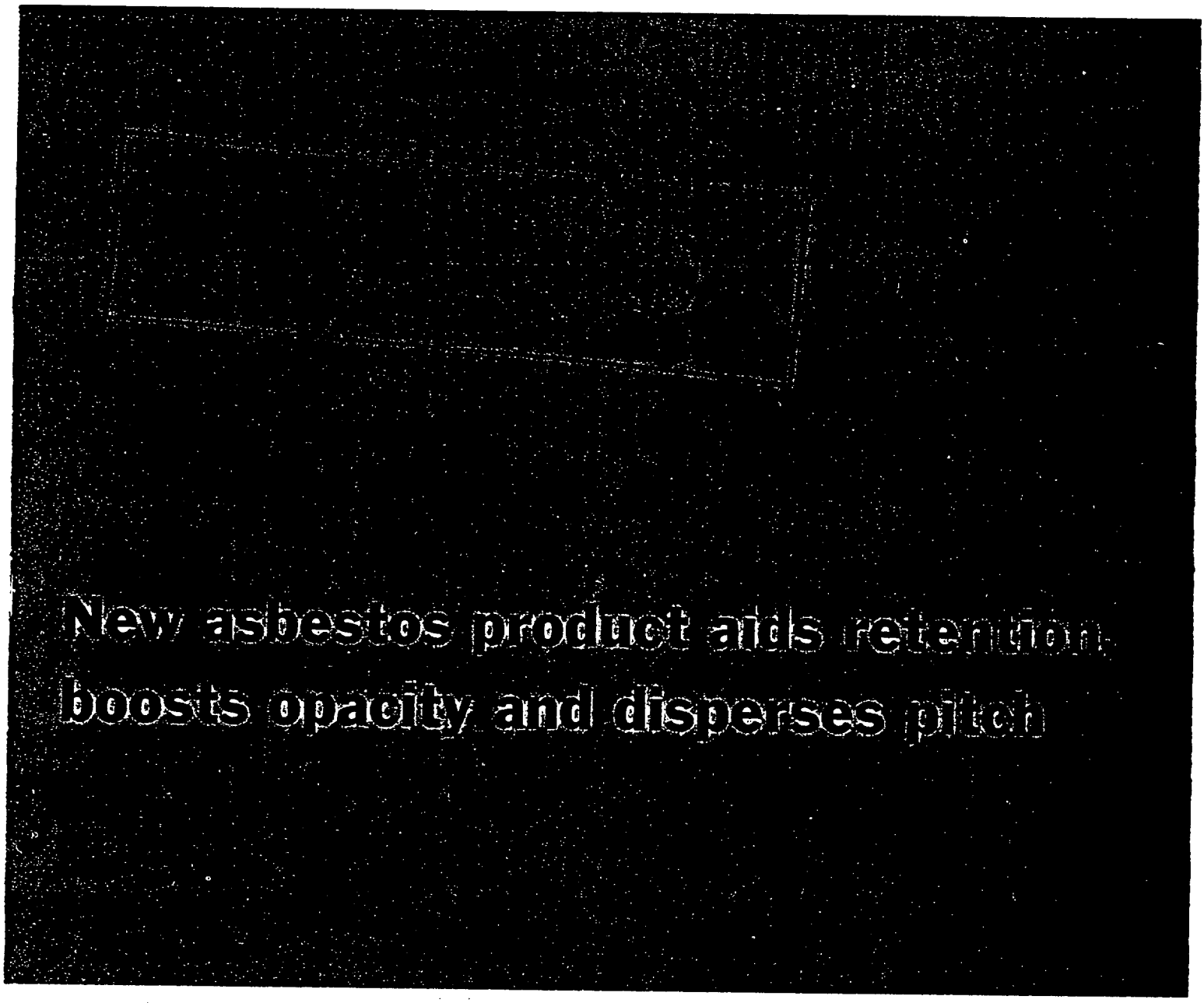
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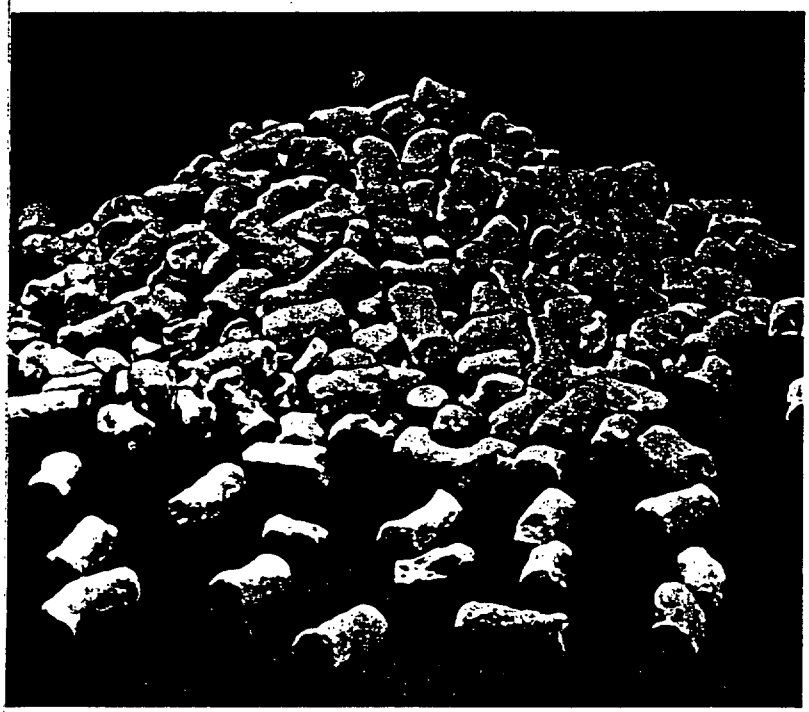
PAPER TRADE JOURNAL

FEBRUARY 14, 1966



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New type of asbestos shows advantages in papermaking



Blair L. Ingalls,
Tech. Service Rep., Mining and Metals Division, Union Carbide Corp.
and
Charles P. Klass,
Associate Editor, Paper Trade Journal

Unique product, when used as ingredient in furnish, has increased filler retention and save-all recovery, improved opacity, enhanced softness and helped to disperse pitch.

In 1958, Union Carbide began work on an unusual deposit of chrysotile asbestos 160 miles south of San Francisco, Cal. Unlike conventional deposits that extend through the host rock, this deposit was not associated with hard, consolidated rock masses. Wet processing techniques were then developed to produce a high-purity asbestos product—grit-free and of such high brightness that it could be used in paper. In fact, radiometric determinations have shown that this asbestos is considerably less abrasive than ordinary fillers or bleached sulphite pulp.

When added to the pulper or beater, this high-purity asbestos behaves in an unusual manner. The pellets of asbestos (pellets are used for compactness in shipping) open up and disperse into short fibers that mix thoroughly with the furnish components. Being positively charged, the fibers then attract negatively charged furnish components, including cellulose and fines, titanium dioxide, clay, and dyestuffs. Asbestos thus improves the retention of these components on the wire, substantially reducing the loss of solids to the white water.

The presence of asbestos in the papermaking system also allows improved recoveries of solids in the save-all. Asbestos attracts fines in the same manner as on the machine, thereby reducing the loss of solids in the mill effluent.

Mills adding asbestos for retention generally use about 2½ per cent, replacing a similar amount of clay. The improved retention provided by the asbestos also allows reductions in pigment additions such as titanium dioxide and clay. Since the mining and metals division of Union Carbide sells this asbestos in the price range of many cellulose pulps, savings in pig-

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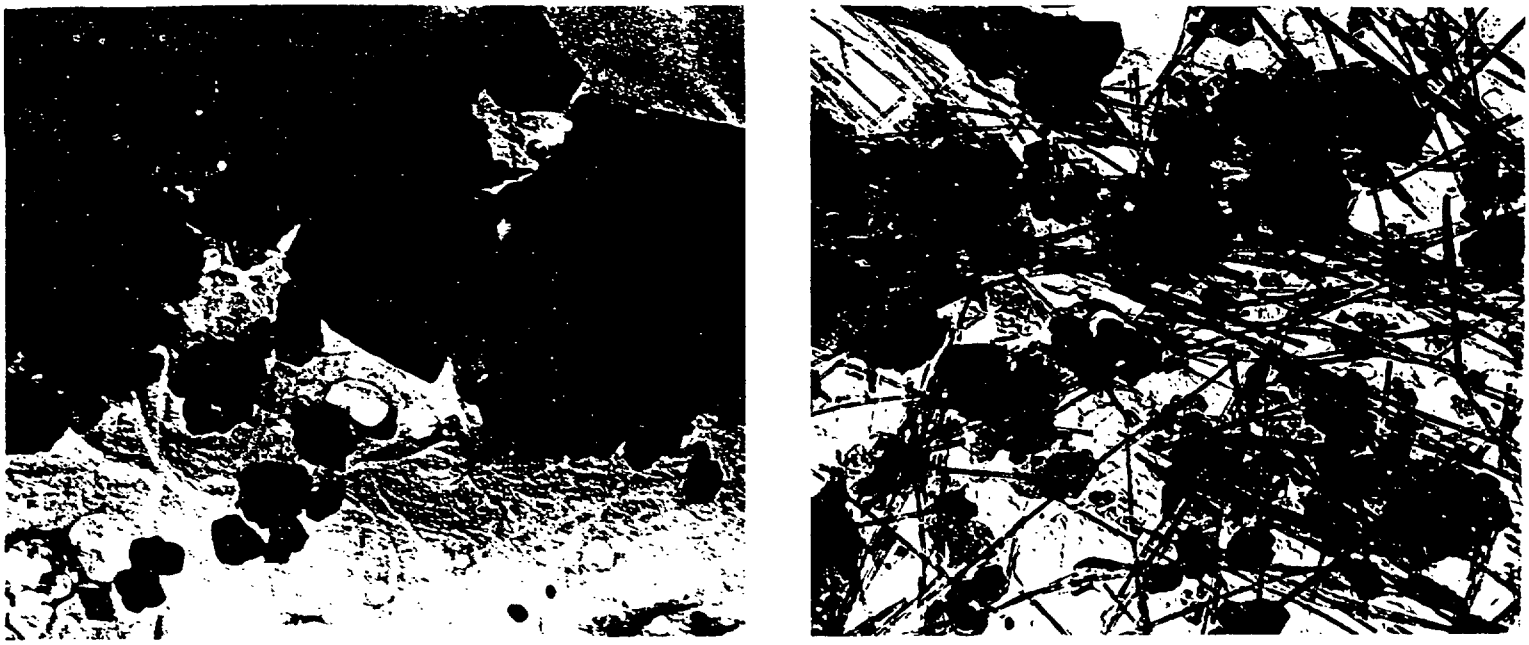


FIGURE 1—Electron micrographs (x24,000) of commercial 50 lb. offset containing 1.68 per cent TiO_2 and 22.5 per cent clay. Sheet at left does not contain asbestos and has densely packed agglomerates of TiO_2 (black) and clay (gray, angular) with large surrounding voids. Sheet at right contains 1.5 per cent asbestos and has a more uniform distribution of TiO_2 and clay. Thus, latter structure provides better light-scattering efficiency.

ment costs are significant. To these savings can be added the reduction in solids losses at the save-all.

Effective TiO_2 extender

An additional benefit obtained from having asbestos in the furnish is its ability to improve opacity by optimizing the light-scattering efficiency of titanium dioxide. Thus, less titanium dioxide is needed in the sheet to obtain a given opacity, lowering costs.

This effect is illustrated by the electron micrographs of commercial sheets shown in Figure 1. Ideally, the particles of titanium dioxide should be scattered uniformly throughout the sheet so that the optimum surface area and size for light scattering can be retained. Without asbestos, however, the particles tend to agglomerate, reducing the light-scattering efficiency. By having an opposite charge, asbestos fibers attract titanium dioxide and help keep the particles distributed more uniformly than previously.

Other benefits

Some mills are using asbestos to prevent pitch buildup. In this way, asbestos helps keep cleaner felts and fourdrinier wires, reducing machine breaks and down time, and reduces rejections for paper blemishes. From 0.6 to 2 per cent asbestos, depending on mill conditions, has been found to prevent pitch agglomeration and keep it dispersed in a finely divided form throughout the pulp. Mills using asbestos for pitch control also have ob-

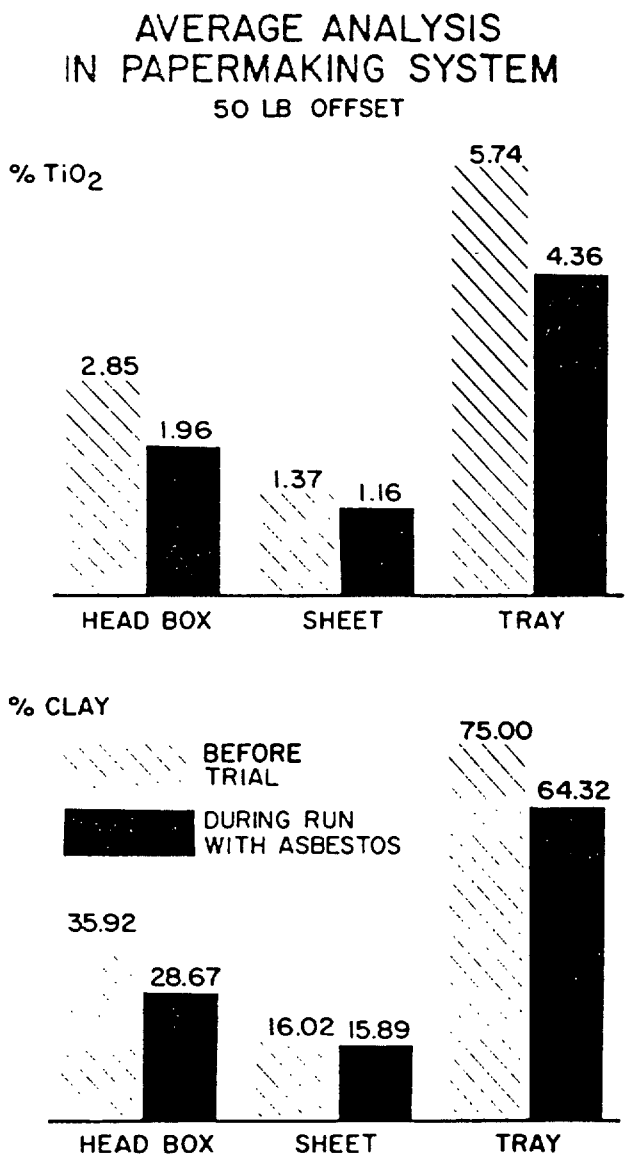


FIGURE 2—Average analyses in papermaking system producing 50 lb. offset. During the 7 hours that 1.7 per cent asbestos was added to the system, TiO_2 retention increased from 48 to 62 per cent while clay retention increased from 45 to 57 per cent across the wire.

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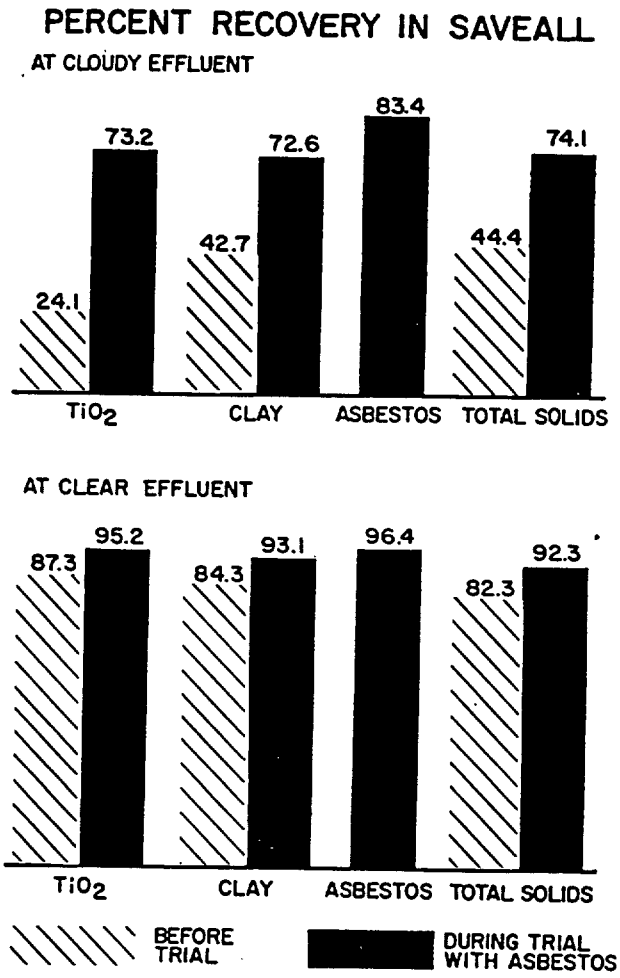


FIGURE 3—The presence of asbestos in this drum-filter saveall increased solids recoveries from 44.4 to 74.1 per cent at the cloudy effluent and from 82.3 to 92.3 per cent at the clear effluent.

tained improved retention of fillers.

In addition, mills making tissues and towels have added asbestos to improve softness. A two to four per cent asbestos content in the sheet gives improved hand feel, and its effect on sheet softness is readily measurable on Handle-o-meter and other softness measuring devices. Where economically attractive, asbestos allows mills to replace hardwood with stronger softwood without sacrificing softness.

To date, over 100 mills have evaluated asbestos and many are using it on a regular basis. Some of the results of this mill experience are given below.

Retention improved 28%

In one production run on 50-pound offset paper, asbestos was used to improve the retention of the furnish components. The trial run lasted for seven hours, during which 1.7 per cent asbestos was added to the pulper, replacing 3.4 per cent clay.

Figure 2 shows the titanium dioxide and clay analyses at various points in the papermaking system before and during asbestos usage. Retention calculations from these figures indicate that titanium dioxide and clay retention across the wire improved about 28 per cent during the asbestos trial. Average titanium dioxide retention increased from 48 to 62 per cent. Clay retention improved from 45 to 57 per cent. The average retention for asbestos during the trial was 69 per cent on the wire and 86 per cent for the overall system.

This improved retention substantially reduced the buildup of solids in the head box and in the tray water. At the head box, titanium dioxide and clay levels were reduced by about one-third and one-fifth respectively. In the tray water, solids were reduced by 36 per cent during the trial with asbestos. Tray-water reductions for titanium dioxide and clay were 49 and 43 per cent respectively.

The presence of asbestos in the papermaking system also substantially improved the recovery of solids in the save-all. The solids content, per cent ash, and per cent titanium dioxide of the influent and effluent are shown below:

	No Asbestos	With Asbestos
Save-all Influent		
Solids, lb./1000 gal.	19.1	15.0
% Ash	45.6	38.7
% TiO_2	2.42	1.41
Save-all Effluent		
Solids, lb./1000 gal.	4.16	2.24
% Ash	75.2	76.1
% TiO_2	4.45	3.57

Based on these figures, save-all recoveries improved from 78 to 85 per cent with the use of asbestos. Solids losses at the effluent were reduced 46 per cent. Of even greater economic significance, losses of titanium dioxide in the effluent were reduced by 58 per cent.

Retention save-all recoveries gain

Similar results were obtained by a mill making 50-pound offset printing paper. In a four-hour trial, 2.4 per cent asbestos was added to the pulper. Clay was reduced in two steps from 27.4 to 18.0 per cent while titanium dioxide was reduced from 8.40 to 7.12 per cent. Despite these reductions, the titanium dioxide content of the reel averaged the same as before (at 5.2 per cent), indicating an increase in titanium dioxide retention from 63 to 73 per cent. The clay content of the reel decreased slightly; however, over-

TABLE I—Production Run on 30-pound Towel

	Per Cent Asbestos in Paper			
	0	2	3	4
Basis Weight (lb./24 in. x 36 in.—480)	30.0	30.1	29.8	30.4
Softness (Crush Test)	2200	1700	1680	1680
% Stretch	6.5	7.4	7.2	7.1
Wet Tensile Aged				
Machine Direction	2.7	—	2.8	2.7
Cross Direction	1.7	—	1.5	1.6
Dry Tensile (1-in. strip)				
Machine Direction	9.6	—	9.3	8.6
Cross Direction	5.7	—	5.5	5.5
Wet Tear				
Machine Direction	30	—	36	42
Cross Direction	34	—	42	52

Union Carbide trial exhibit UC-780: Union Carbide Calidria Asbestos Product Literature: Resin-Grade 244, Resin...
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all clay retention increased from 49 to 56 per cent, Opacity averaged 94 per cent while brightness averaged 85 per cent, the same as before the trial.

A detailed analysis at the drum-filter save-all showed that asbestos also substantially improved recoveries at both the cloudy and clear effluents. As shown in Figure 3, asbestos improved recoveries at the cloudy effluent from 44.4 to 74.1 per cent. At the same time, recoveries at the clear effluent were improved from 82.3 to 92.3 per cent. In terms of losses, asbestos reduced solids in the cloudy effluent from 0.85 to 0.38 lb./1000 gal. At the clear effluent, asbestos reduced solids from 0.27 to only 0.11 lb./1000 gal.

Opacity Improved

Another mill tried asbestos in hopes of improving titanium dioxide retention and meeting opacity specifications at lower titanium dioxide levels. The grade of paper used in the trial was substance 10 opaque register bond. During this eight-hour production run, 1.2 per cent asbestos was added to the pulper, replacing three per cent clay. This addition was less than the 2.5 per cent asbestos addition that the mill had planned on making. Nevertheless, impressive results were obtained.

The titanium dioxide and clay analyses before and during the trial are shown in Figure 4. Single-pass retention calculations showed that titanium dioxide retention increased by 15 per cent during the use of asbestos. The average asbestos retention across the wire was 54 per cent. At the same time, tray-water and save-all effluent solids decreased markedly. Solids in the tray water declined from 35.7 to 15.5 lbs./1000 gal. while the solids in the save-all effluent dropped from 0.84 to 0.17 lbs./1000 gal.

Of major significance to this mill was its ability to meet its minimum opacity specification of 74 per cent at lower titanium dioxide levels. The titanium dioxide content of the sheet was reduced from 10.56 per cent before the trial to 6.30 per cent with asbestos. Despite this severe drop, opacity specifications were met with 1.13 per cent asbestos in the sheet, as shown in Figure 5. Although data on opacity before the trial are limited, the curves indicate that the asbestos-bearing sheet needed 20 per cent less titanium dioxide to obtain the same opacity as the sheet without asbestos. Thus, asbestos improved the light-scattering efficiency of the titanium dioxide.

Similar results were obtained in a six-hour trial by a mill making thirty-pound pouch paper (82 G.E. brightness). A two per cent asbestos addition was made to the beater, replacing a similar amount of clay. The titanium dioxide addition was cut by 16.7 per cent in hopes of obtaining equivalent opacity values at reduced titanium dioxide levels. Retention of titanium dioxide increased from 60 to 84 per cent with the asbestos addition. Average opacity during the run with asbestos was 62.6 per cent, a slight improvement over the 61.9 per cent average before the trial. Average brightness was 85.1 per cent, up slightly from 84.6 per cent before the use of asbestos.

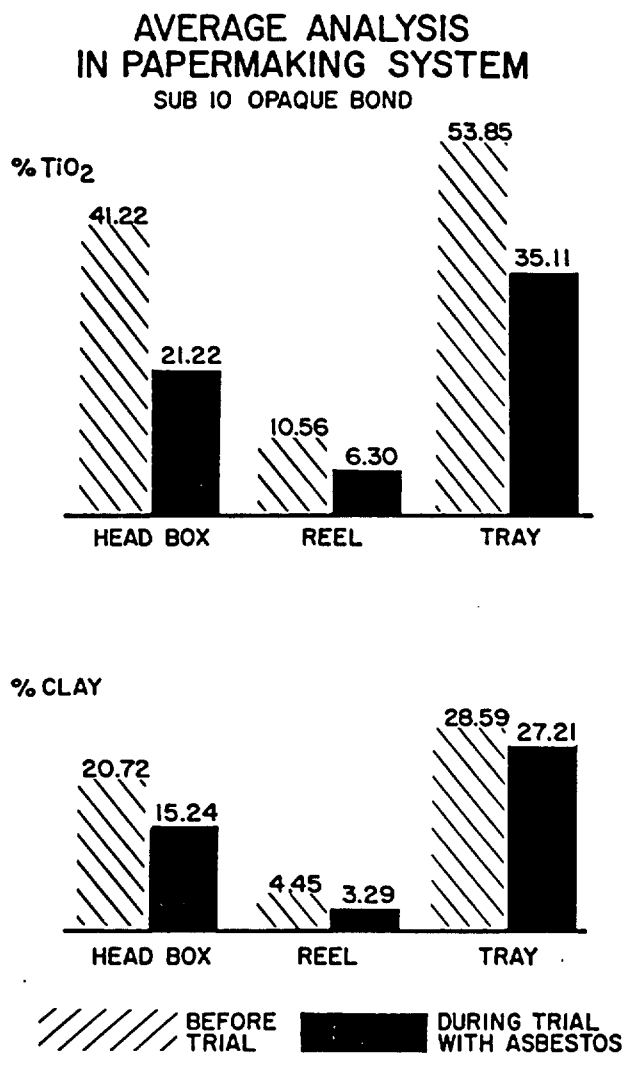


FIGURE 4—Average analyses in papermaking system producing sub. 10 opaque register bond. During this 8 - hour production run, a 1.2 per cent asbestos addition increased TiO_2 retention by 15 per cent.

TABLE II—Production Run on 13.5-pound Toilet Tissue

	FURNISH				PROPERTIES				
					Softness (Handle-o-Meter)			Tensile (lb./5" x 5½")	
TIME	Pine and Broke		Hard-wood	Asbes-tos	Machine Direc-tion	Cross Direc-tion	% Stretch	Machine Direc-tion	Cross Direc-tion
1:25	20% Pine		80%	0	4.0	13.0	37.5	2.7	1.8
1:45	80% Pine		20%	3%	—	—	—	—	—
2:50	60% Pine	15% Broke	15%	3%	6.3	14.5	32.5	5.0	1.5
3:30	60% Pine	20% Broke	20%	3%	6.8	9.0	19.3	4.7	1.6
4:45	40% Pine	20% Broke	40%	3%	6.5	11.5	22.5	4.0	1.5
5:55	40% Pine	20% Broke	40%	3%	6.0	10.0	24.4	3.3	1.5

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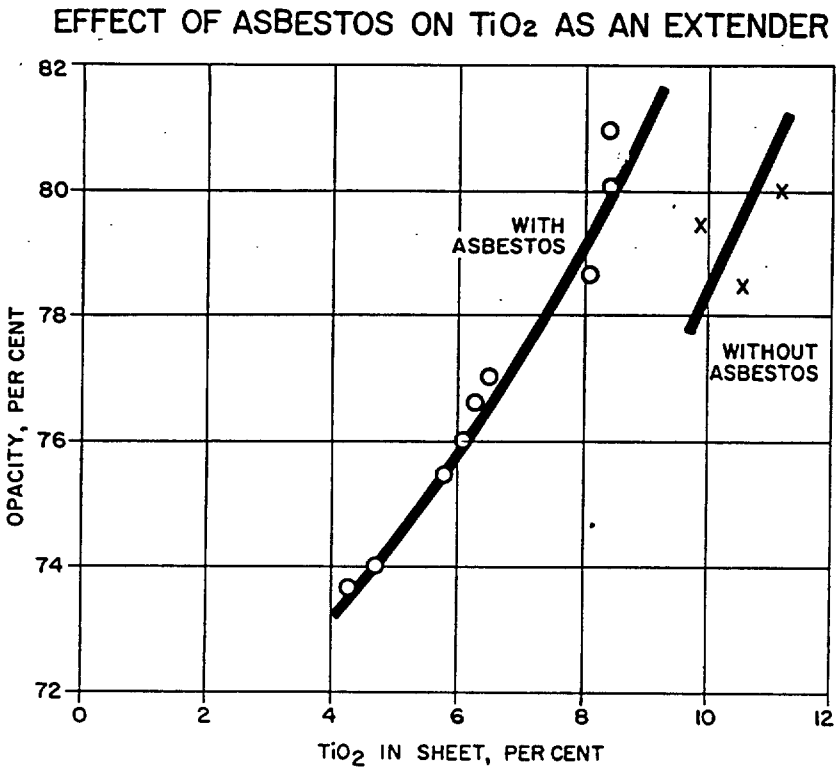


FIGURE 5—Sub. 10 opaque register bond containing 1.13 per cent asbestos met opacity specifications at lower TiO_2 levels than paper containing no asbestos. Thus, asbestos improved the light-scattering efficiency of TiO_2.

Softness improved 20%

In this trial run at another mill, enough asbestos was added to the pulper to obtain two, three and four per cent asbestos in 30-pound toweling. The object of the trial was to determine if asbestos would improve softness of the stock. The results are shown in Table I. Using the crush test as the measure of softness, the mill found that softness improved from 2200 without asbestos to 1680 with four per cent asbestos. (Lower values indicate improved softness.) Thus, an improvement of over 20 per cent was achieved.

At the same time, per cent stretch increased from 6.5 to 7.1, and wet tear strength was improved 40 per cent in the machine direction and over 50 per cent in the cross direction. There was no significant change in either the wet tensile aged or dry tensile strength with the addition of asbestos.

Another mill took advantage of the improved softness provided by asbestos by increasing its use of pine in the furnish. This mill normally used an 80 per cent hardwood, 20 per cent pine furnish, because it needed at least 80 per cent of the short-fibered hardwood to meet softness specifications of its 13.5 pound toilet tissue.

As shown in Table II, a three per cent asbestos addition was used during the four-hour production run while the mill made various adjustments in its furnish. For the first three hours, pine and broke were increased to 80 per cent of the furnish. Then, for the last hour, a 60 per cent pine-broke furnish was used.

The properties of the tissue are also shown in Table II. With the 80 per cent pine-broke furnish, softness declined somewhat according to Handle-o-meter readings. (Higher values indicate reduced softness.) When the pine and broke in the furnish were reduced to 60 per cent, softness values began to return to pre-trial conditions in the machine direction and were better than before the trial in the cross direction.

Per cent stretch and tensile values went through similar cycles. Based on this trial and subsequent tests, mill management concluded that the increased softness provided by asbestos would allow them more flexibility in their choice of furnish components and still produce equal or better quality tissue.

These typical examples from mill experience show that asbestos can be an effective retention agent, extender, and softening material. Proper use can lead to extensive savings and improvements in the papermaking process.

This paper contains asbestos too...

The paper on which this reprint was printed contains Union Carbide's high-purity asbestos "T." The rigid opacity and brightness specifications for this high-quality paper were maintained when asbestos "T" was substituted for part of the TiO_2 in the furnish. This substitution allowed substantial savings in furnish costs.

Union Carbide trial exhibit UC-780: Union Carbide Calidria Asbestos Product Literature: Resin-Grade 244, Resin... Published by AsbestosClaims.Law
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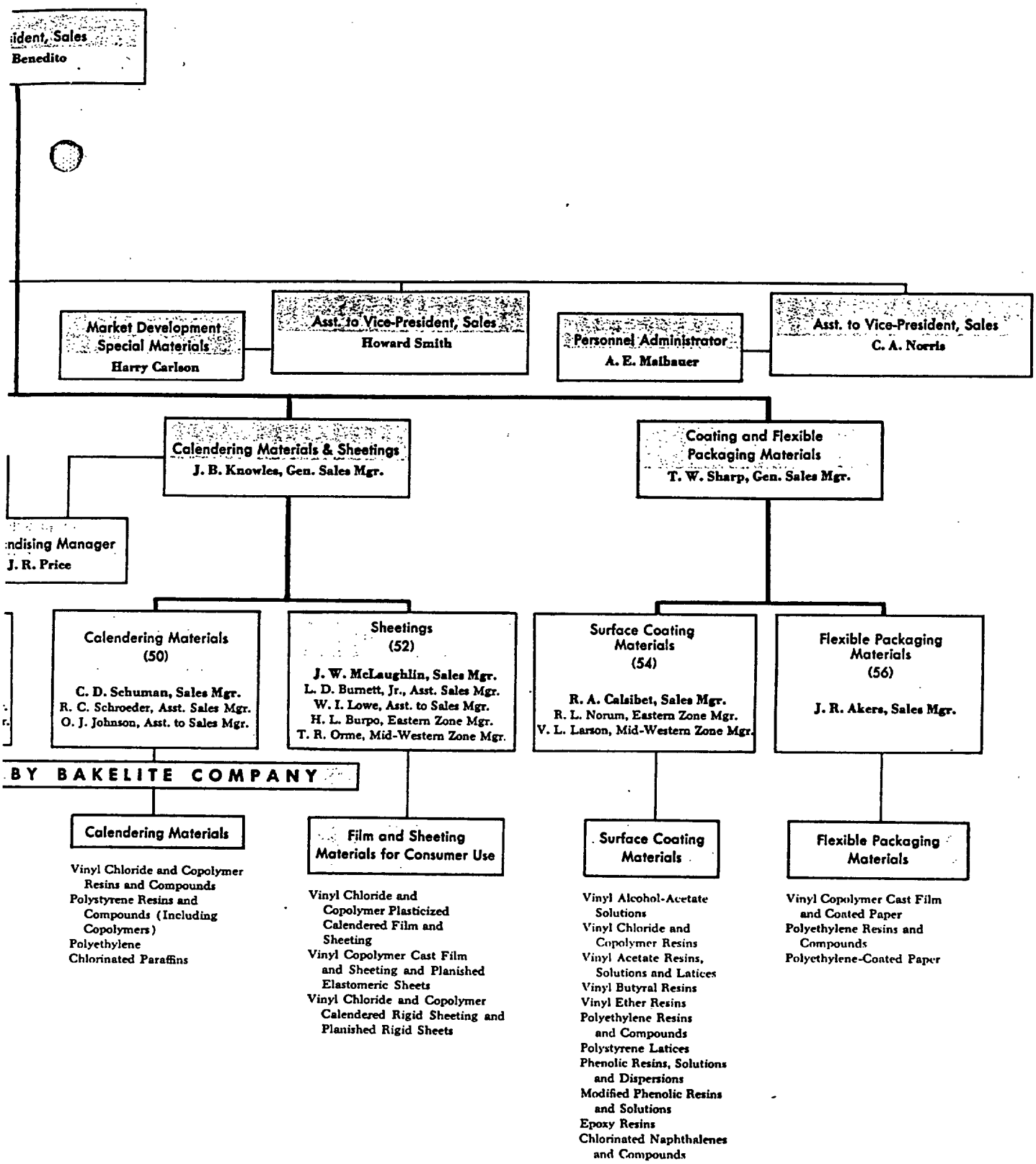
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Sales Organization Chart

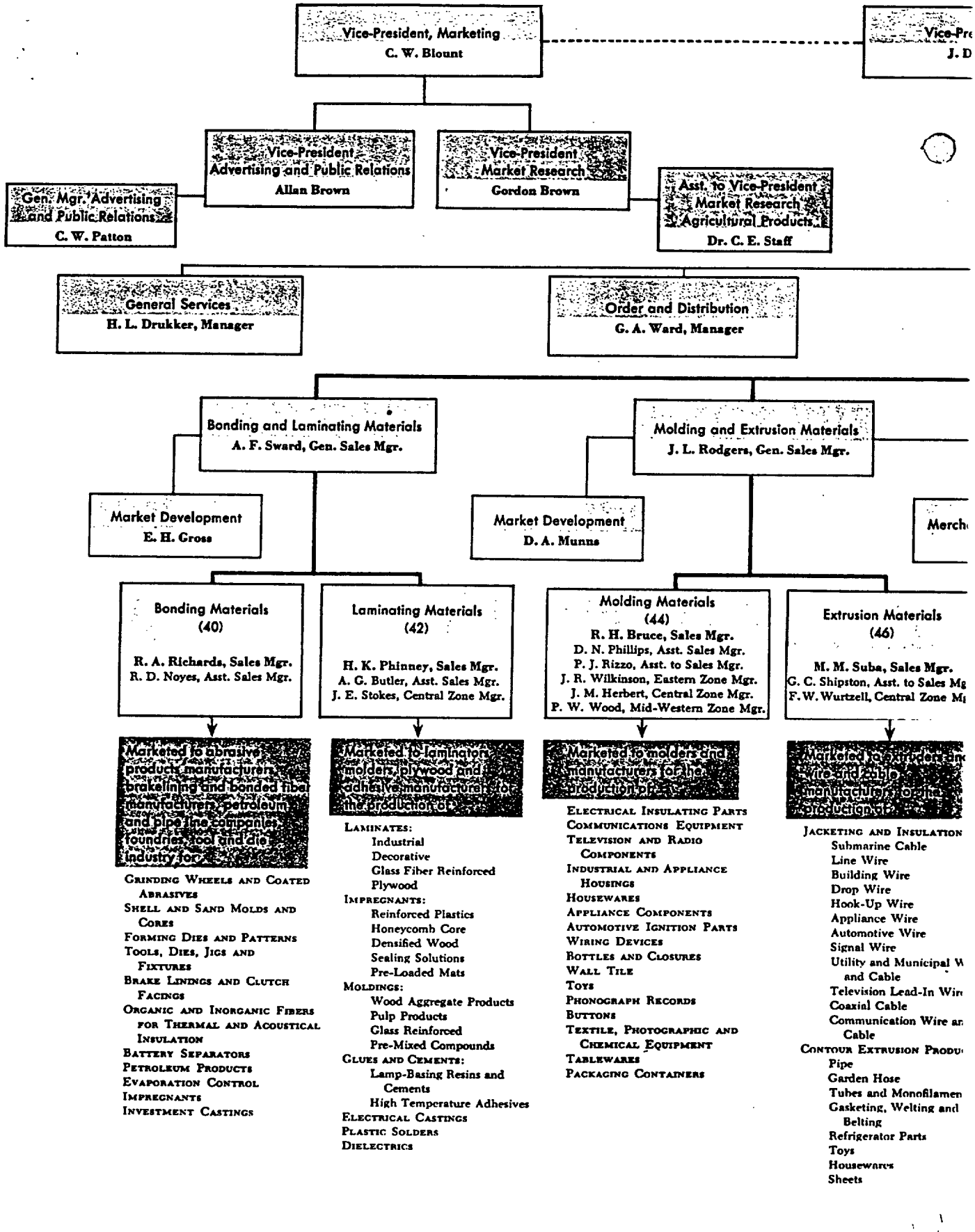
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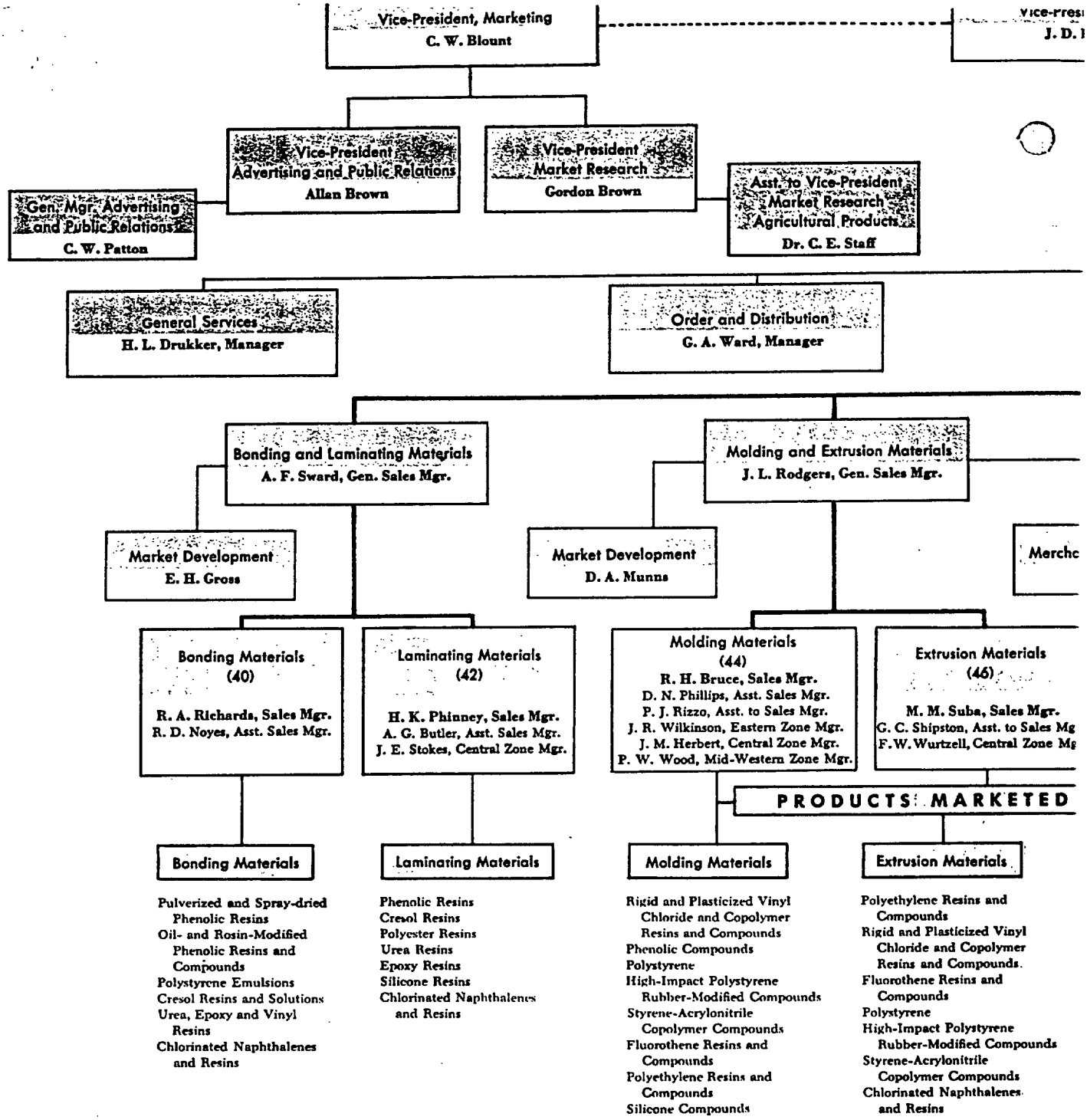


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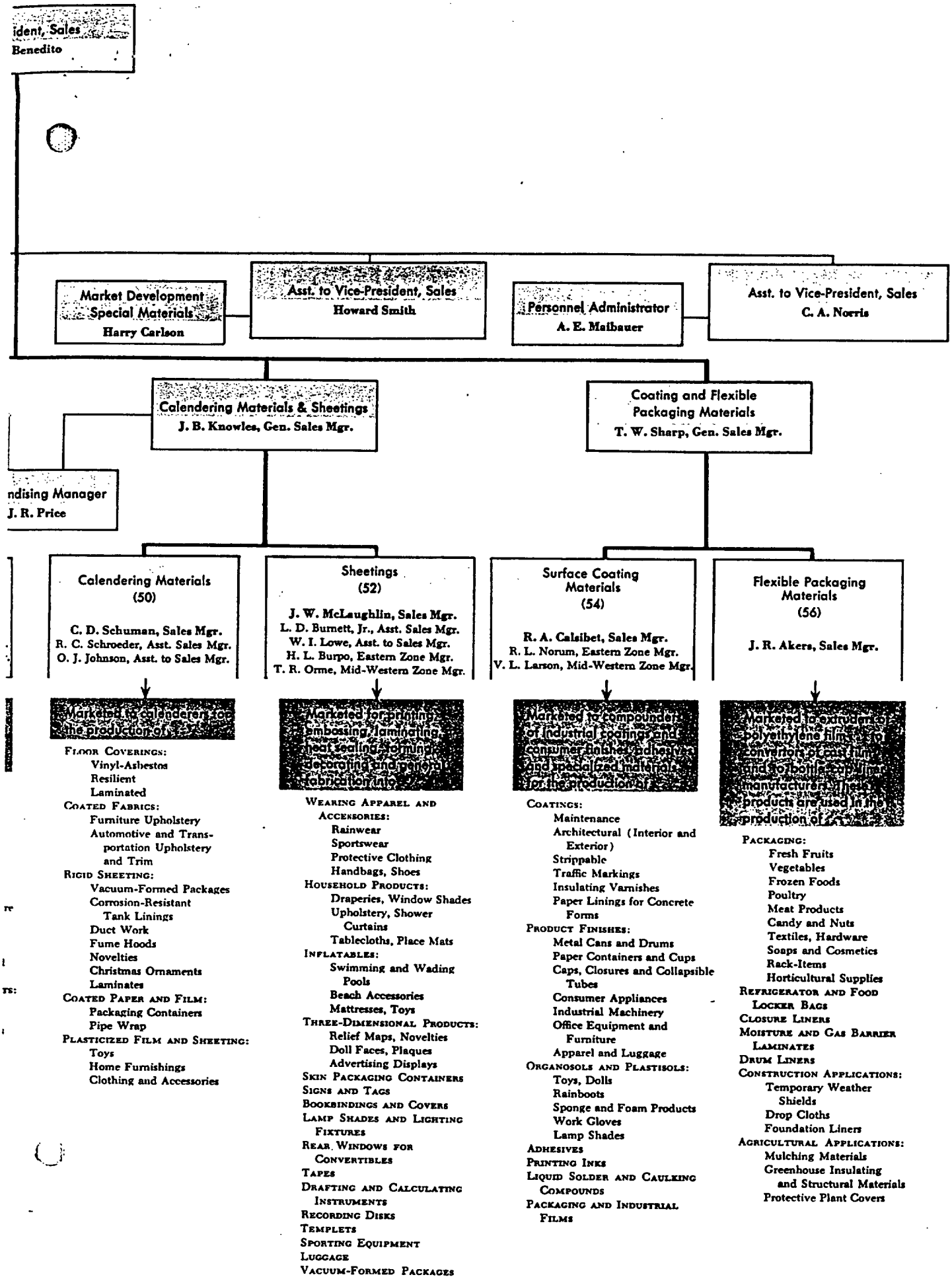


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LARCHMONT, N. Y.	1877 Palmer Avenue			o	o		o	o	o
LOS ANGELES 58, CALIF.	2770 Leonis Boulevard	o	o	o	o	o	o	o	o
NEW YORK 17, N. Y.	30 East 42nd Street	o	o	o	o	o	o	o	o
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August, 1957
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