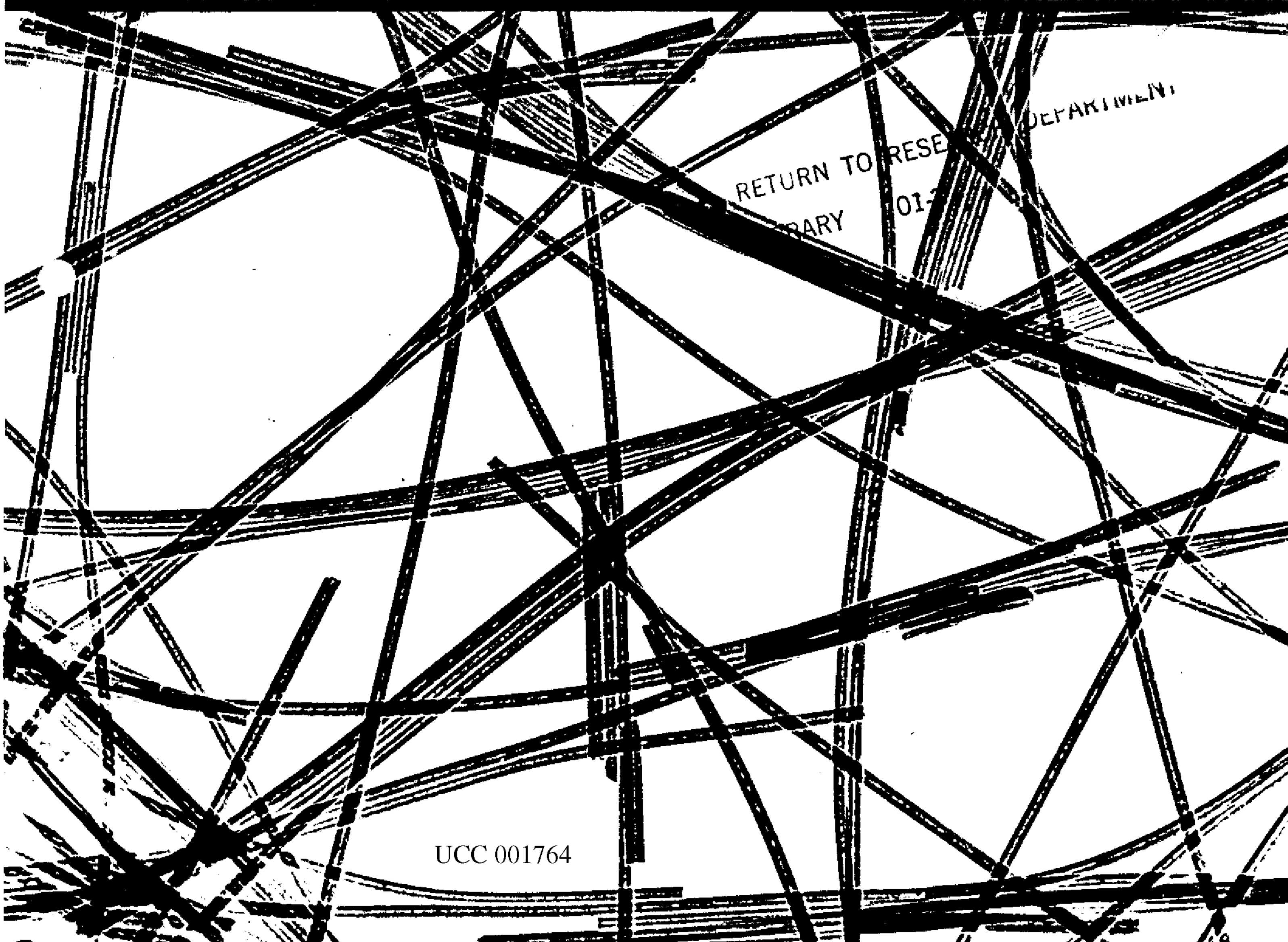
REFINED CHRYSOTILE ASBESTOS

PRODUCT SPECIFICATIONS
DESCRIPTIONS
USES



UNION CARBIDE

UNION CARBIDE CORPORATION
Mining and Metals Division

HIGH-PURITY, GRIT-FREE ASBESTOS AVAILABLE FROM UNION CARBIDE

RESOURCES AND CAPABILITY: Union Carbide owns and mines an extensive deposit of short-fiber (chrysotile) asbestos in the New Idria district of California. Ore mined from this region is processed in Union Carbide's up-to-date mill in King City, California.

NEW PROCESS ASSURES A HIGH-PURITY PRODUCT: Union Carbide's mill incorporates a unique process which results in a short-fiber asbestos product which is purer than any other commercially available. During the processing cycle, each individual chrysotile fibril is fully liberated from the surrounding fibrils and entrapped impurities.

Union Carbide's asbestos is:

- Lower in grit, magnetite, and unrefined fiber bundles.
- Higher in brightness and surface area—uniform in quality.

UNION CARBIDE'S ASBESTOS AVAILABLE IN TWO MAJOR GRADES: Union Carbide's range of HIGH-PURITY grades of asbestos is designed to meet the needs of a number of new uses for chrysotile asbestos. A range of STANDARD grades of asbestos is competitive with the conventionally produced Grade 7 asbestos.

USE:

HIGH-PURITY GRADES

Cellulosic paper: contributes to retention, pitch control, softness, opacity, and printability

Specialty papers

Ceiling tiles

Fresh water treatment: acts as a clarifying agent and decolorizer

Waste water treatment: acts as a flocculant, BOD removal agent and enhances oxidation

Plastic Products: can be used as a reinforcing material and as a filler for non-opaque plastics

STANDARD GRADES

Vinyl-asbestos floor tiles

Asbestos-cement products

Asphalt floor tile

Asphalt road paving

Filled plastics

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Effects of Chrysotile Asbestos Additions to Cellulosic Paper

ROBERT G. WOOLERY

The effects of incorporating a new, highly purified, grit-free chrysotile asbestos fiber in cellulose paper are discussed. Data are presented from both laboratory handsheet tests and paper mill trials on the effect of the fiber on both operational factors and on sheet properties. Effects discussed include retention of cellulose fines and fillers such as TiO_2, freeness, drying rate, pitch control, brightness and opacity, softness, strength, porosity, printability, show-through, and dye retention. Savings possibilities and other economic factors are also discussed. Operational feasibility was maintained while important gains in economics, pollution control, and product properties were obtained with a wide variety of furnished types.

The three principle characteristics of a highly refined chrysotile asbestos product that apply to paper applications are:

1. The surface charge—cationic
2. Particle shape—fibrous
3. Surface characteristics
   (a) Organic adsorption
   (b) Chemical reactivity

These properties differ sufficiently from those of the more conventional paper additives to indicate a promising potential for use in the paper industry. In addition, refined asbestos is a material of low cost and is available in sufficient quantity to supply a consumer as large as the paper industry. Advances in processing techniques have insured a uniform product that can be supplied within quite rigid specifications. With respect to abrasiveness, radiometric determinations have shown that the purified asbestos is considerably less abrasive than ordinary fillers or bleached sulfite pulp. The properties imparted to paper by addition of purified chrysotile asbestos, as well as paper-machine behavior, were determined by experimental work both in the laboratory and in full scale mill trials. These results are discussed in this paper.

LABORATORY DATA

The laboratory results, as reported herein, were obtained in our own laboratories at Tuxedo, N. Y., and through the efforts of Professors L. C. Jenness and A. J. Chase of the University of Maine, who have acted as our consultants during this program. The tests were conducted principally in the laboratory Noble and Wood handsheet machine and, unless otherwise specified, used a bleached sulfite stock beaten to a Canadian Standard freeness of 300 ± 10 ml. Handsheets were made at the standard basis weight of 60 g/sq m and tested, wherever applicable, according to the TAPPI standard procedures.

Effects on Retention

The effects of incorporating a highly defibrillated chrysotile fiber in cellulose paper were found to be unique among inorganic additives. Because of its electropositive surface charge, the self retention of the asbestos fiber is very high when compared with clay or titanium dioxide pigment. As shown in Fig. 1, this improved retention is significant on a single pass retention system or in one where white water recirculation is employed. On the basis of single pass retention, the asbestos showed almost 80% retention compared with only 40% for either clay or titanium dioxide.

It can be postulated that any method of introducing a positively charged material into a paper furnish should tend to improve retention of all components. A summary of the relative surface charges of papermaking constituents (as calculated from laboratory measurements of individual mobilities) is shown in Table I.

Accordingly, the chrysotile asbestos should coflocculate with any and all of the furnish constituents. That this is so is shown when asbestos and TiO_2 pigment are agitated together to form what appears to be a fibrous titanium dioxide pigment. Titanium dioxide dispersed in water produces a milky liquor that tends to remain cloudy for long periods of time. When coflocculation is achieved, the water at the interstices of the flocs is clear. Thus, all of the TiO_2 is being held by the asbestos. Electron micrographs of the combined product (Fig. 2) show that the pigment is still in the dispersed state and is held by the asbestos. Most important is the fact that these flocs are formed without agglomeration of the pigment. This should allow maximum efficiency in obtaining its optical properties.

The advantages of asbestos over conventional flocculants, either inorganic or organic are twofold: (1) retention without agglomeration, and (2) floc stability. Experience has shown that no degradation of the floc occurs even after repeated agitation. Once formed, these flocs are stable even under prolonged high-shear agitation of a Waring blendor. Laboratory studies have shown asbestos to be compatible with all types of organic and polymeric flocculants. In a furnish of high filler content, particularly, the combination of asbestos and coagulant is especially effective. Usually the net effect is greater than can be achieved by either alone.

Table I

	ζ, *mv*	*pH*
Bleached sulfite cellulose	−14	6.4
	−9	5.0
Titanium dioxide (RA-50)	−19	10
	None	6
Talc	−15	6.6
Purified chrysotile asbestos	+38	6.6
	+45	5.0

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Data from laboratory tests run on handsheets to demonstrate the retention properties of chrysotile fiber are shown in Figs. 3 and 4. The control series for this evaluation were made with 4% clay. Where asbestos was employed, it was substituted on a pound-for-pound basis for clay, so that at equivalent retention the ash and opacity values would be comparable. The level of TiO_2 addition was then varied from no TiO_2 to 10% added based on the stock. It is apparent that the retention of the additives is greatly improved with as little as 2% asbestos. Clay retention is also greatly affected. Because these data are based on single pass retention, the values are quite low (Fig. 4). Since this is probably the most difficult retention condition, the effectiveness of the purified fiber is clearly demonstrated.

In another series of tests, run under similar conditions but with high levels of clay, the results were equally encouraging. The ash values for levels of clay additions ranging from 25 to 50% show that the retention of the filler is increased with increasing asbestos additions up to the 6% asbestos (Fig. 5). The effects of white water recirculation on the ash content of the sheet were also determined and are shown in Fig. 6. Whereas the average ash retention only reached about 47% with a one pass circuit, with recirculation the average retention was increased to 70%. There is also evidence that equilibrium was reached in the recirculation system at 3% asbestos whereas it required about 5% for the single pass system.

Effects on Opacity

Inasmuch as chrysotile asbestos has an index of refraction of 1.52–1.55 that is similar to that of kaolin, it could be expected to have equivalent opacifying power. On the basis of the amount added, asbestos-filled sheets showed higher opacities; however, as is shown in Fig. 7, the opacities are essentially identical at corresponding filler weights in the sheet. In the series where asbestos was substituted for 2% clay in a titanium dioxide filled sheet, the resulting opacities associated with the asbestos were invariably higher. In Fig. 8, the average opacity increase is from 2 to 3 points. This is attributed to the increased retention of all components through the cationic charge of the chrysotile asbestos.

Effects on Tear and Tensile

The comparative tear values for the addition of either clay or asbestos are similar. For both minerals, small quantities are beneficial whereas larger quantities prove to be detrimental. Figure 9 shows that small quantities (<5%) of asbestos resulted in better tear factors.

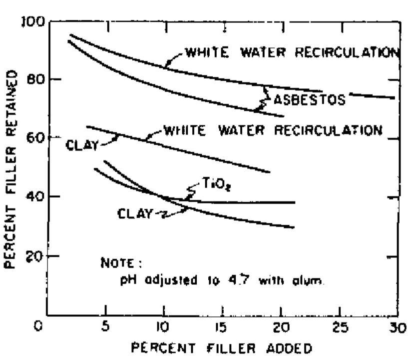

Fig. 1. Filler retention—comparative data

Fig. 2. Co-flocculation of purified chrysotile asbestos and TiO_2 (electron photomicrograph). Magnification = 5600×

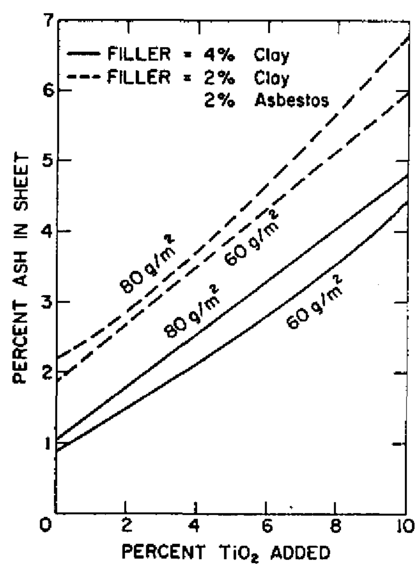

Fig. 3. Ash content versus per cent TiO_2 added—with and without asbestos

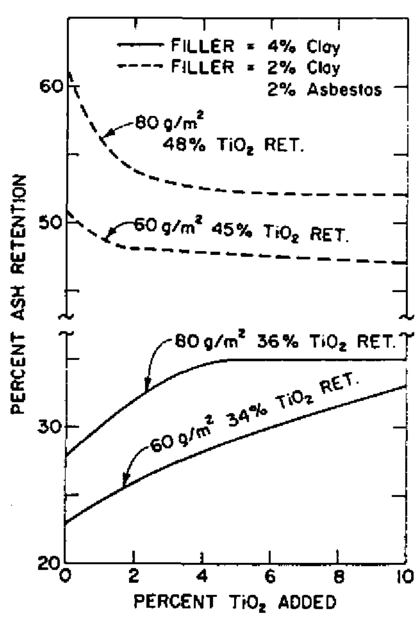

Fig. 4. Effect of basis weight and per cent TiO_2 additions on ash retention—with and without asbestos

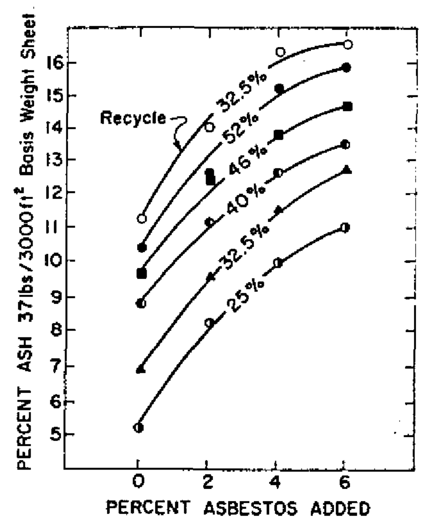

Fig. 5. Effects of asbestos additions on ash content in highly filled handsheets

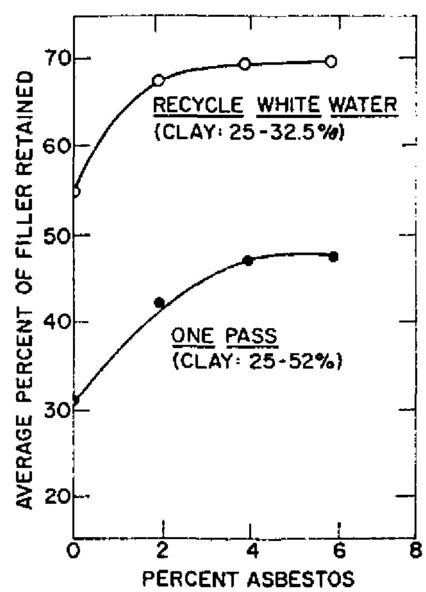

Fig. 6. Average filler retention versus asbestos additions

Above 5% asbestos additions the tear factor decreases below that for clay-filled paper. This effect is probably due to the geometry of the fiber as well as to its smaller particle size. Asbestos is more efficient at disrupting the hydrogen bonding of the cellulose fiber than are nonfibrous minerals. An even better example of the geometry effect can be seen in Fig. 10, where the tensile values are shown for corresponding filler content of the sheet. Once 3% filler in the sheet is exceeded, the effect on tensile strength is influenced considerably more by the asbestos than by either clay or TiO_2.

Effects on Softness

While the strength of the sheet is reduced by asbestos content, a corresponding softening effect is also achieved. This relationship is shown in Fig. 11. In a lightweight tissue sheet a 9% asbestos content resulted in doubling the softness values obtained on a Clark softness-stiffness tester. Various furnishes were investigated and all types appeared to respond in a manner similar to the lightweight sulfite furnish.

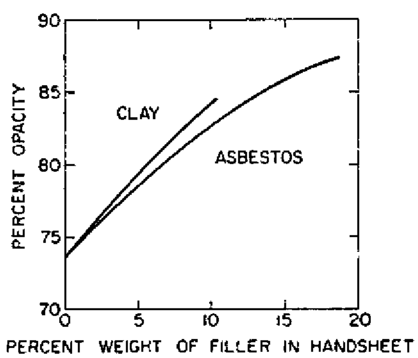

Fig. 7. Handsheet opacity versus filler content

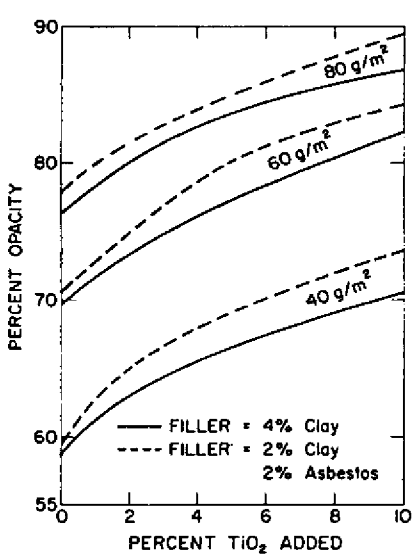

Fig. 8. Opacity gain versus per cent TiO_2 added—with and without asbestos

Effects on Pulp Freeness

As might be expected from the use of a small sized, fibrous filler, the freeness of the furnish is affected. The degree to which the asbestos slows up the furnish drainage appears to be dependent on the original freeness of the stock. For example, the data in Fig. 12 show that the lower the freeness of the stock the less it is affected by asbestos. At the low levels of asbestos addition normally used in paper this has not been a problem in the mill.

Effects on Porosity

With the incorporation of the highly refined asbestos the sheet porosity invariably has a tendency to decrease with increasing asbestos content as shown in Fig. 13. The initial high increase in porosity values obtained by the addition of between zero and 2% asbestos is attributed to the retention of fines. This effect normally accompanies the addition of chrysotile asbestos.

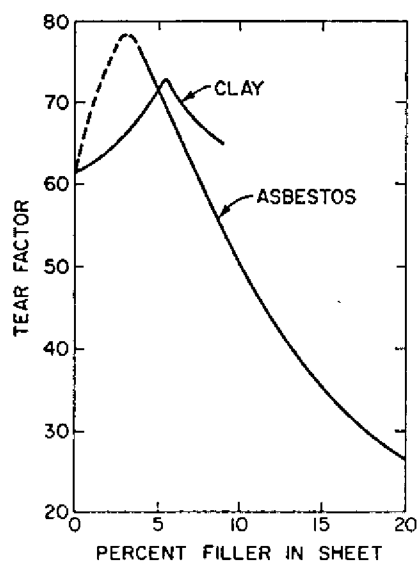

Fig. 9. Tear factor versus filler content

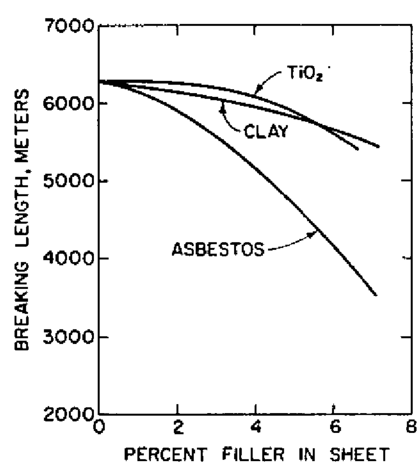

Fig. 10. Handsheet tensile strength versus filler content

Effects on Printability

Normally, any time the porosity of the sheet is reduced and the formation of the sheet is improved, the printability is subsequently benefited. Printing evaluations by the Research Institute for the American Newspaper Publishers' Association of samples obtained from the various mill trials verified these conclusions. Where sheets containing asbestos were compared to the control runs on the same grade, improvements in the following properties were noted:

1. Smoothness
2. Opacity
3. Ink transfer
4. Printability

In most cases, improvements were noted for both the felt and wire sides. Usually the more significant improvements were observed on the wire side thus demonstrating an improvement in two-sidedness.

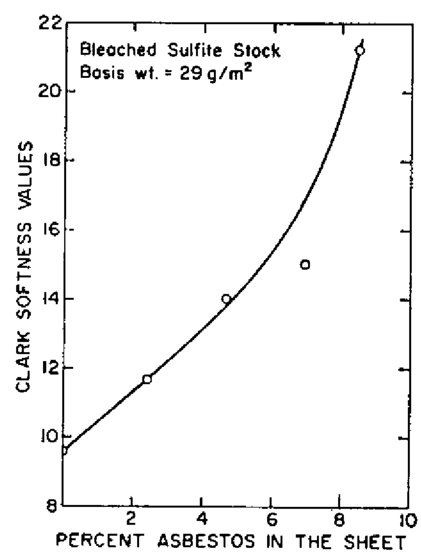

Fig. 11. Handsheet softness versus asbestos content

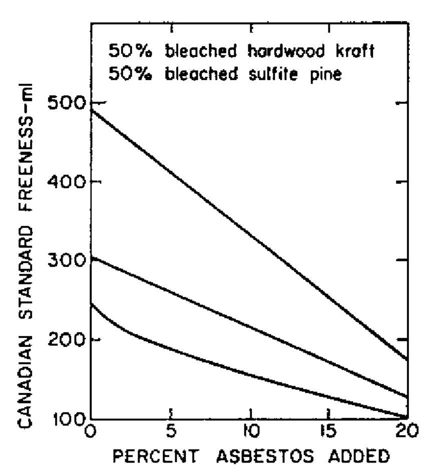

Fig. 12. Furnish freeness versus asbestos content

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Effects of Stock Type

Some data have been obtained on furnishes employing stocks other than a bleached sulfite stock. For the most part the data obtained were consistent with the results reported so far. The most notable exception was in a typical newsprint furnish of 80% groundwood—20% bleached sulfite. Under these conditions, as much as 6% asbestos in the sheet caused no appreciable reduction in the tensile strength. This probably can be attributed in part, to the inherent weakness of the sheet and, in part, to the retention of the groundwood fines which contribute to the sheet strength.

Other Applications

Probably the largest single application for asbestos, in addition to those already described, is as a pitch controlling agent. Laboratory studies have been conducted on a wide variety of pulps, but because of the diversity of pitch problems, no universal data are obtainable. In the majority of the cases, however, asbestos has proved to be more effective than other commercially available products. The total reduction in pitch is generally only slightly lower than competitive products but the amount of asbestos necessary to reach this level is usually significantly less.

Considerable laboratory effort has also gone into the retention of beater-additive latices. Since most of the commercially available latices are anionic, they have proved to be compatible with the cationic chrysotile. It has been found advantageous to blend the asbestos with the cellulose first in order to put the asbestos on the cellulose in a dispersed state. Thus, when the latex is added, it is deposited uniformly throughout the furnish and minimizes the tendency to form the latex agglomerates which are undesirable in the finished sheet. The overall asbestos retention is almost universally improved and the resulting physical properties have been found to be enhanced (particularly wet tensile and fold) to a higher degree than can be attributed to the improved latex retention.

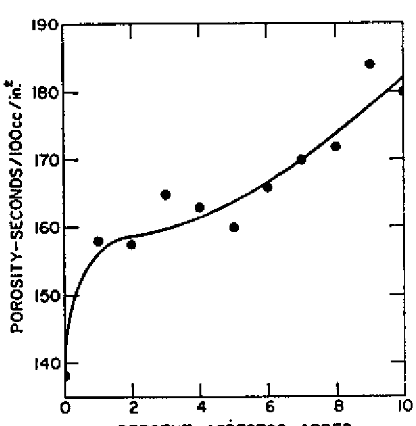

Fig. 13. Handsheet porosity versus asbestos content. Stock, bleached sulfite. Test, Gurley Densometer

Table II

Condition	*Clay, %*	*Asbestos, %*	*TiO_2, %*	*Glue, %*	*Opacity*
1 (control)	4	...	8.25	0.25	89.5
2	1	3	7.0	0.25	92.5
3	1	3	6.0	0.25	91
4	1	3	6.0	...	91

Table III

	Paper analysis			
Condition	*Opacity*	*TiO_2, %*	*Ash, %*	*TiO_2 retention, %*
Pre-trial	82.5	1.64	12.0	65.5
2% asbestos added	83.5	2.20	13.9	88
Post-trial	82.0	1.75	12.2	70

Studies in dye retention have shown that 2% asbestos addition will generally improve the retention and greatly reduce the two-sidedness. This is particularly true with acid and pigment dyes. It has also been possible to predye the asbestos which in turn can be added directly to the furnish and results in a close control of color and shade.

A rather unique application was also discovered in the field of conductive paper. Its function in this area is to improve the sheet formation and to provide a more uniform distribution of the conductive media through coflocculation. Again, the asbestos addition levels required for this application are found to be in the 2–3% range.

MILL TRIAL DATA

Since the beginning of this program, something in excess of 200 mill trials have been conducted. In the majority of these trials the purified asbestos has performed as predicted from the laboratory studies. In addition, on machines where mineral additions are commonplace, no serious problems have developed due to the addition of asbestos. These trials have been conducted on a wide variety of paper grades as well as in paperboard. A review of some of these trials demonstrates the versatility and advantages obtained with the chrysotile fiber.

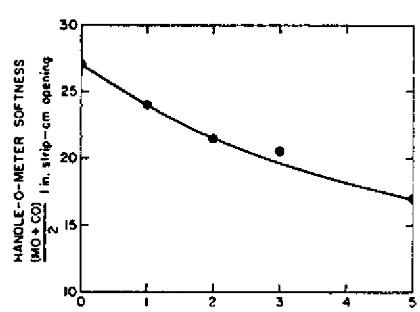

Fig. 14. Towel softness versus asbestos content. Freeness, 600 ml CS

Retention

In a machine trial on a 40 lb opaque printing paper, 3% asbestos substituted for 3% clay resulted in a reduction of the TiO_2 requirement from 165 to 120 lb/ton and eliminated the glue previously used as a retention aid. This was accomplished without departing from the specifications of the sheet and without machine problems. A summary of these results is shown in Table II.

In another trial, on a 37 lb bond paper, 2% asbestos was used for a corresponding amount of clay. Titanium dioxide amounting to 2.5% of the furnish was also going into this sheet for opacity. A summary of these results appears in Table III.

These data show an improvement in TiO_2 retention from about 68 to 88% with a 2% asbestos addition.

In addition, the saveall effluent was monitored during both the control and trial periods. The average solids content during the pretrial and posttrial period was 2.3 lb/1000 gal. During the trial the solids content was reduced to 1.5 lb/1000 gal. Due to the improved efficiency resulting from the asbestos, a 35% reduction in solids loss was realized.

It is not unusual to expect saveall efficiencies improvement during these trials. In one trial, particular attention was paid to the saveall unit since it had been operating under a heavy load with a low efficiency. In this instance both the influent and effluent were monitored. A summary of these data is given in Table IV.

Softness

A natural application for the highly refined chrysotile fiber is in the tissue and towel grades. This mineral is unique as an inorganic softening agent. Numerous mill trials have demonstrated its ability to impart both softness and a velvety handfeel to both tissue and

Table IV

Condition	Saveall, lb solids/1000 gal		
	Influent	Effluent	Saveall efficiency, %
Pre-trial	17.9	4.36	
During trial (2% asbestos), hr			
1.0	14.3	1.15	
2.0	13.2	0.90	
3.0	11.0	0.71	
Post-trial	21.4	6.00	
Average			
Without asbestos	19.64	5.18	74
With asbestos	12.83	0.92	93
Reduction in solids resulting from the use of asbestos, %	35	82	

Table V

Condition	Handle-O-Meter values	
	MD	CD
Control	15[a]	22.5[a]
Trial	9[b]	11.5[b]

[a] Average of 6 reels. [b] Average of 8 reels.

towels. A typical relationship between asbestos content and Handle-O-Meter values on a 40 lb towel is shown in Fig. 14. The levels illustrated, up to 5% asbestos, are typical of the levels used for this purpose. For this grade a 5% asbestos addition reduced the Handle-O-Meter values from a control of 27 to 17.

In a machine trial on a 13.25 lb tissue, 4% asbestos was added to improve softness and handfeel. The furnish consisted of 25% pine, 60% hardwood, and 15% broke. The effects on Handle-O-Meter values are shown in Table V.

Not only was a significant improvement in softness realized but the level of difference between machine direction and cross-machine direction was reduced by nearly 50%. This is probably due to the improved sheet formation. In addition to these improvements the improved drying rate of the asbestos-filled tissue resulted in a lower steam requirement to the Yankee drier.

By virtue of the inherent physical properties of chrysotile asbestos a wide variety of applications to the tissue and towel grades have been explored. Its largest single application at this time is as a tool to achieve quality in a wide variety of furnish components. In mills where the use of coarser and harsher cellulose stocks (or even waste-paper) is limited, the incorporation of asbestos has permitted a higher percentage of these cheaper and coarser pulps without a loss in quality and at a significantly reduced furnish cost. For still another mill, where the drying chain controlled the machine speed, as much as 30–50 fpm increase in machine speed was achieved with a 2% asbestos addition, a situation considerably more economical than the standard furnish at the slower rates.

Pitch Control

The most universal application to date is in pitch control. In mills where this use has been investigated it has been found to be more effective than other commercially available products. Where asbestos is currently being used it has replaced talc, at the ratio of 2 lb of asbestos/3 lb of the competitive product.

CONCLUSION

These studies have shown purified chrysotile asbestos to be unique as an inorganic additive to cellulose paper. Unlike other paper components this material is cationically-charged and, as such, performs as a retention aid to all constituents in the furnish. Its uniformity, small particle size, and fibrous geometry contribute to the softness of the sheet and improve two-sided effects. The high surface area and its adsorption of organics aid in dye adsorption and printability. Its performance on the paper machine has been most satisfactory and, as a rule, has caused no problem in the subsequent processing of the paper. Where care has been used to employ a sufficient quantity of asbestos to be effective, yet not so much that the strength of the paper is degraded beyond reasonable limits, the results have been quite successful.

Because of this versatility we believe that purified chrysotile asbestos will continue to grow in its present application to the paper industry and that new areas will develop where the unique properties of this material will be advantageous.

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I am greatly indebted to Professors L. C. Jenness and A. J. Chase, of the University of Maine, for their collaboration, guidance, and laboratory data throughout all stages of this project. Thanks are also due to Messrs. B. L. Ingalls and G. L. Dickson, of the Union Carbide Corp., Mining and Metals Division Research Center, for their assistance in obtaining the data that have been used in this paper; to Dr. S. Chwastiak for the electrophoretic mobility data; and to the many members of the laboratory staff who have helped through their advice and encouragement.

PROPERTIES OF ASBESTOS SUITABLE FOR USE IN CELLULOSIC PAPER

A. W. Naumann*

ABSTRACT

Chrysotile asbestos is now available in a highly-purified, grit-free form, non-abrasive to Fourdrinier wire and printing plates. Its chemical and physical structure and properties are described relative to the geometry of cellulose pulp fibers. The electrostatic charge properties and surface chemistry of chrysotile in water systems are also discussed in relation to other materials found in paper furnishes.

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Asbestos is a class name for several naturally occurring fibrous minerals. The most common, and the one that is finding increasing use as a paper additive, is chrysotile, $Mg_6(OH)_8Si_4O_{10}$. The purpose of this paper is to compare chrysotile properties with those of other commonly used additives.

CRYSTAL STRUCTURE AND PARTICLE MORPHOLOGY

Chrysotile has a structure like that of the kaolinite minerals (1) in that the structure consists of an alternate series of layers of tetrahedrally coordinated silica and octahedrally coordinated magnesium joined into a composite sheet, with the tips of the silica tetrahedra and one of the surfaces of the octahedral layer lying in a common plane. The silica layer is in an oxide form. The magnesium layer is in a hydroxide form, giving this layer a resemblance to the mineral brucite, [$Mg(OH)_2$]. Figure 1 is a representation of the structure, the "a" dimension having been exaggerated to show the details of the structure.

Pauling (2) predicted, before the layer structure of chrysotile was recognized, that a magnesium analog of the kaolinite minerals would have to exist as curved sheets because of a mismatch in the repeat distances of the individual layers. The normal repeat distance for the silica layers (8.9A), as found in kaolin, is smaller than the corresponding repeat distance of an octahedral magnesia sheet (9.4A), as found in the meneral, brucite (3). Pauling's prediction has been abundantly verified by x-ray diffraction studies and by electron microscopy (1,4,5). The layers of chrysotile curve and close to form cylinders of extreme length-to-diameter ratio. It is partially this filament-like form of chrysotile asbestos that makes it useful as an additive to a paper furnish. An electron micrograph of typical chrysotile fibrils is given in Figure 2.

As is shown by the calibration marks, the individual chrysotile fibrils are extremely small; many thousands being needed to make up the asbestos filaments visible to the naked eye. Fibril lengths vary from a few microns to many tens of microns. Diameters vary much less, and usually are in the range 250 to 350A. As the following data illustrate, this is a size considerably below that of many materials normally considered to be of small dimensions.

Material	Typical Diameter (microns)
Rock Wool	1-20
Synthetic Organic Fibers	10-40
Human Hair	approx. 40
Paper Pulp Fibers	10-30
Kaolin	0.2-10
TiO_2	0.2-2
Chrysotile	0.025-0.035

The usual mode of occurrence of chrysotile is a "cross-fiber" configuration in which filaments of chrysotile (i.e. bundles of fibers) are closely packed together and set at right angles to the walls of cracks and fissures that extend through the host rock of the ore body (6). Liberation of this material is accomplished by repeated crushing and classification operations (6). The resultant products, particularly the less expensive grades, contained up to several percent by weight of rock fragments and other abrasive constituents; and, for this reason, are not well suited to use on the high-speed machinery used in the paper industry.

In 1959, an unusual deposit of chrysotile asbestos, with properties and mode of occurrence that differ from those of cross-fiber material, was discovered in central California (7). The ore of this deposit, instead of occurring in veins, occurs in randomly-oriented, matte-like flakes and agglomerates that are not associated with the hard, consolidated rock masses characteristic of cross-fiber deposits. The ore is of high grade and is therefore amenable to different processing procedures than are usually used with conventional chrysotile ores. Specifically, wet-processing procedures have been developed that give rise to high-purity asbestos products, essentially grit-free and of high brightness.

ABRASIVENESS OF CHRYSOTILE PRODUCTS

The measure of abrasiveness commonly used in the paper industry is the Valley Abrasion Test. Essentially, the method consists of rubbing a section of Fourdrinier wire with a Micarta block in the presence of a slurry of the material under test. The slurry is introduced at the interface between block and wire. It then flows through the wire to a receiving vessel from which it is recirculated to the interface. The results of the test are reported as the "Valley Abrasion Value", corresponding to the weight lost by the wire in milligrams. Unfortunately, the Valley Abrasion Test does not work well with fibrous materials, since fibers are retained on the Fourdrinier wire and do not recirculate freely. A radiometric-tracer method was developed to circumvent this problem. The details of this method have been given elsewhere (8); but, basically, it consists of measuring the amount of radioactivity transferred to the particles of a suspension, from an irradiated Waring-Blendor impeller, during a prescribed blending period.

A comparison of the abrasiveness of wet-processed and conventional dry-processed chrysotile products, along with data for bleached-sulfite paper stock, is given in Figure 3. The data points of this figure, which establish the correlation between the Valley and the radiometric methods, are for a group of nonfibrous samples for which Valley Abrasion Values were available. Count-rate ranges observed for samples of the fibrous materials are superimposed on this correlation curve, and the Valley abrasion values inferred. The actual count-rate ranges for materials of the different types were:

	Count Rate (counts/min)
Wet-Processed Chrysotile Products	500 to 1,500
Bleached Sulfite Paper Stock	2,000 to 2,700
Dry-Processed Chrysotile Products	24,000 to 78,000

The wet-processed materials were clearly much less abrasive than the conventional products, and, in fact, were less abrasive than paper pulp. The wet-processed materials, therefore, would not be expected to cause excessive wear to metal surfaces such as those of Fourdrinier wires, trimming knives, printing plates, etc.

CHEMICAL AND PHYSICAL PROPERTIES

It will be shown in the following paper that chrysotile is an unusually versatile paper additive. The properties that make this possible are:

1. electro-positive surface charge in the pH range where most papermaking circuits operate
2. highly anisodimensional particle shape
3. high surface area

Chrysotile fibrils are of colloidal dimensions by virtue of their small diameters; and, when suspended in water, behave according to the classical electrokinetic rules of hydrophobic colloids. That is, the fibrils develop a surface charge when suspended in aqueous solutions as a result of an adsorption of "potential-determining" ions from the suspending medium. With chrysotile and other oxygen-containing materials (metal silicates, oxides, hydroxides, etc.), the potential-determining ions are H^+ and OH^-. For a given material, adsorption favors hydrogen or hydroxide, depending upon pH. Chrysotile, by virtue of the magnesium hydroxide layer exposed at the surface, has a strong preference for the adsorption of hydrogen ions. Chrysotile surfaces retain hydrogen and display a positive charge up to the range of pH 10 to 12 (9,10). Most materials (including cellulose and the mineral fillers commonly used in the paper industry) carry a negative charge in neutral or acidic solutions. Typical values for the electrophoretic mobility of cellulose and of representative fillers are given in Table I. The significance of the charge of chrysotile fibrils, from the standpoint of the retention of fillers and cellulose fines, is obvious. Having a mutually coagulating system of oppositely charged particles is clearly desirable.

Electrostatic attraction, however, is but one of the factors that influence the effectiveness of chrysotile as a retention aid. The cylindrical shape of chrysotile particles is equally important. Collision and coagulation rate in suspensions of solids follow an expression of the form (11).

$$\frac{dn}{dt} = K\ D\ R\ n^2$$

where D = particle diffusion constant

R = particle radius of influence

n = particle concentration

To a first approximation, R (the collision radius of an anisodimensional particle) varies as the longest dimension of the particle; while D (the diffusion constant) varies as the mean particle dimension (11). The net result, for the rod-like particles of chrysotile, is a large effective collision radius and a large diffusion constant. It has also been established that coagulation in polydisperse systems (i.e., systems containing particles of differing size) proceeds more rapidly than in monodisperse suspensions (11). These factors combine to give a high probability for collisions, not only between chrysotile fibrils, but also between the fibrils and other particulate matter. Thus, in a paper furnish, chrysotile simultaneously acts as an effective "getter" for small particles such as pigments or cellulose fines; and is collected itself, either by the fibers of the paper pulp or as tenuous asbestos flocs. With either mode of collection, macroscopically uniform distribution of chrysotile, and of materials collected by the chrysotile, is obtained. The electron micrographs of Figure 4, which are of surface replicas of handsheets prepared with and without fillers, show the distribution of asbestos and TiO_2 on the surface of a pulp fiber.

The electron micrographs of Figure 4 are of further interest with regard to the mechanical properties of paper. The strength of paper is attributable to the combined effects of four factors: (1) the strength of the pulp fibers, (2) the strength of fiber-to-fiber bonds, (3) the fraction of the fiber areas involved in bonding, and (4) the over-all distribution of bonds as determined by sheet formation (13). The adsorption of chrysotile fibrils onto pulp fiber surfaces will have little influence on the strength of the fibers, but may have considerable influence on the bonding between fibers. It is now generally agreed that bonding in paper is due to the formation of hydrogen bonds at fiber-fiber contacts, and to secondary valence forces of the London-van der Waal's type. Both types of bonding are of short range nature. London-van der Waal's forces decrease as some multiple power of distance. Even for interactions between large particles, where the additivity of forces extend their operative range, the forces fall off rapidly in the first few angstroms and are practically non-existent beyond 100A (14). Typical hydrogen bond distances are 1 to 2A (15). The diameters of chrysotile fibrils (approximately 300A) are long compared to these bond distances. This is not to say that the fibrils act as inert spacers, separating pulp fibers by 300A; for chrysotile fibrils have OH outer surfaces that can enter into hydrogen bonding. Also, pulp fibers are pliable and deformable to a degree, and can expand to fill in the spaces between chrysotile fibrils. But the net effect is to reduce the total attraction between pulp fibers. It has been found, for example, that chrysotile additions to paper result in lower tensile and burst values, and correspondingly improved tear factor and softness. Practical applications of this effect--to improve the softness of tissue and towel products--will be discussed in the paper that follows.

As would be expected from geometric considerations, chrysotile has a relatively high surface area. BET nitrogen values for wet-processed asbestos suitable for the paper industry fall in range 50 to 60 m^2/g. As is evidenced by the rather extensive use of chrysotile as a reinforcing filler for plastic and resin systems, chrysotile surfaces have an affinity for organic materials. Use can be made of this property to adsorb soluble organic matter. Adsorption occurs not only for negatively charged molecules (anionic dyes, organic acids, etc.), where electrostatic attraction can be used to account for adsorption, but under favorable conditions can also occur with cationic species. The adsorption of methylene blue from an aqueous solution is given in Figure 5. Dye concentration in solution was extremely low until surface saturation was reached, indicating an extremely favorable distribution between the surface and solution even though a positive ion and a positive surface were involved. In the paper that follows, examples will be given where the adsorption properties of chrysotile have been used for specific applications such as dye retention, improved printability, and pitch control.

Another property of chrysotile that may be of interest for paper applications is its chemical reactivity. Chrysotile is inherently a basic (alkaline) material because of the brucite-like layers that are exposed at fibril surfaces. It has been shown that the solubility and reactivity of chrysotile suspensions are, to a first approximation, similar to those of magnesium hydroxide slurries (16). It is also known that acid gases in the atmosphere and the acid nature of some of the constituents of paper (alum and chloride residues from bleaching) shorten the useful life of paper. It is reasonable to expect that chrysotile would provide a reserve of alkali which would adsorb and neutralize these acids, and thus would contribute to paper's permanence and durability.

In summary, the shape and composition of chrysotile fibrils give rise to a unique combination of chemical and physical properties that should make chrysotile an unusually versatile paper additive. Non-abrasive chrysotile products are now available in quantity, permitting their evaluation for specific applications.

LITERATURE CITED

(1) Whittaker, E.J.W., Acta Cryst. 9, 855-862 (1956); 10, 149-156 (1957).

(2) Pauling, L., Proc.Nat.Acad.Sci.U.S. 16, 578-582 (1930)

(3) Wyckoff, R.W.G., "Crystal Structures," sections IV c-1 and XII c-5, New York, Interscience, 1960.

(4) Turkevich, J. and Hillier, J., Anal.Chem. 21, 475-485 (1949).

(5) Maser, M., Rice, R.V. and Klug, H.P., Am.Mineralogist 45, 680-688 (1960).

(6) Sinclair, W.E., "Asbestos," chapters 4 and 8, London, Mining Publications, Ltd., 1959.

(7) Munro, R.C. and Reim, K.M., Can.Mining J. 83 (8) 45-50 (1962).

(8) Hampton, W.J., Naumann, A.W. and Wahl, W.H., In "Nuclear Applications to the Wood, Paper, and Pulp Industry, "TID-7704 U.S.A.E.C., April 1964.

(9) Pundsack, F.L., J.Phys.Chem. 59, 892-895 (1955).

(10) Martinez, E. and Zucker, G.L., J.Phys.Chem. 64, 924-926 (1960)

(11) Kruyt, H.R., "Colloid Science," vol. 1, "Irreversible Systems," chapter 7, Amsterdam, Elsevier Publishing Co., 1952.

(12) Riddick, T.M., Chem.Eng. 68 (14) 141-146 (July 10, 1961).

(13) Leech, H.J., TAPPI 37, 343-349 (1954).

(14) Verwey, E.J.W. and Overbeek, J.Th.G., "Theory of the Stability of Lyophobic Colloids," chapter 6, Amsterdam, Elsevier, 1948.

(15) Pauling L., "The Nature of the Chemical Bond and the Structure of Molecules and Crystals," 3rd ed., chapter 12, Ithaca, N.Y., Cornell University Press, 1960.

(16) Pundsack, F.L. and Reimschussel, G., J.Phys.Chem. 60, 1218-1222 (1956).

Presented at the 50th Annual TAPPI Meeting in New York on February 24, 1965.

ACKNOWLEDGMENTS

The author wishes to thank Mr. Wolbert Roettgers for the preparation of the electron micrographs of this communication.

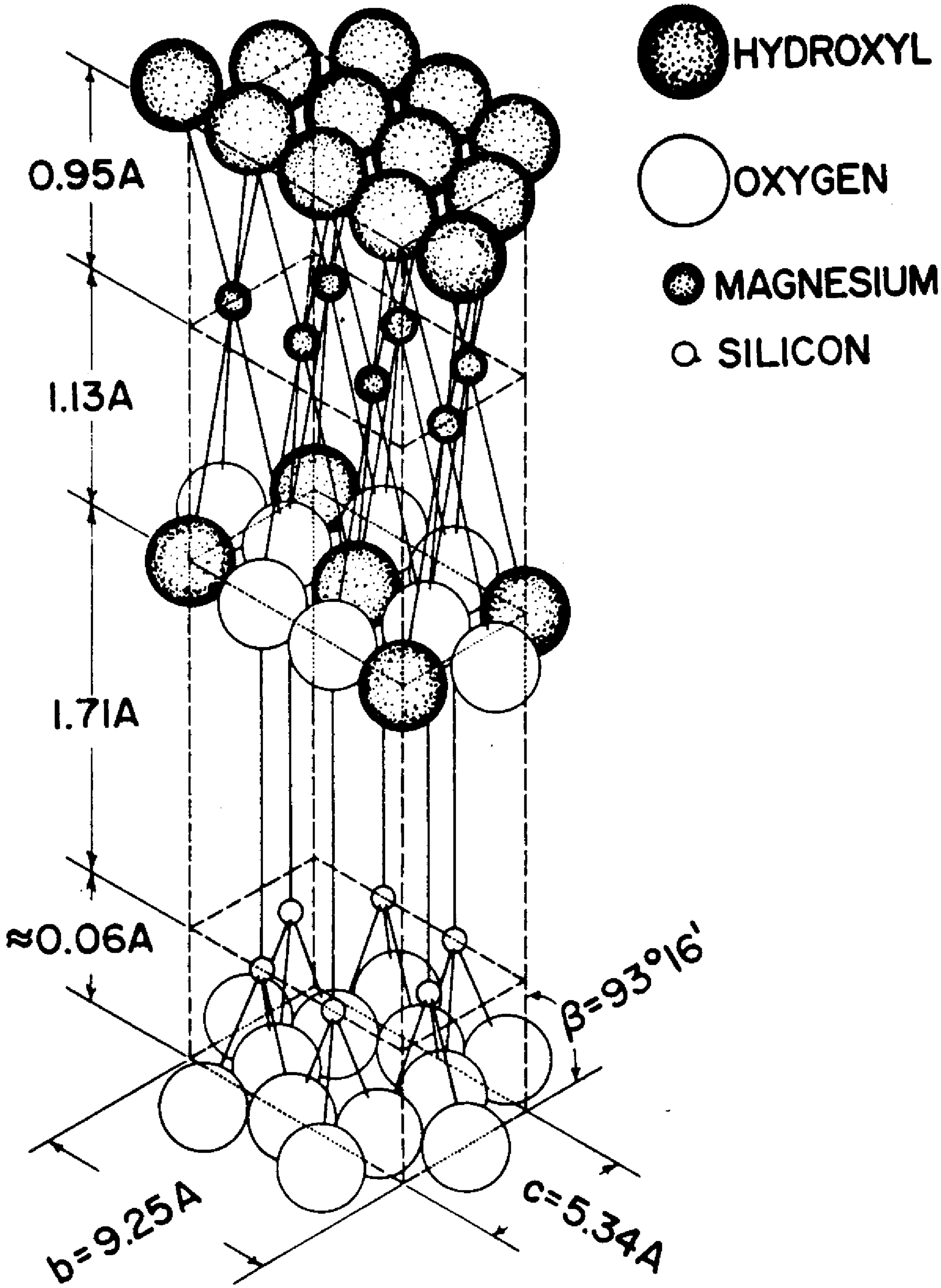


FIGURE I: Chrysotile structure (after Whittaker).

FIGURE 2: Electron micrograph of chrysotile fibrils (15,900X).

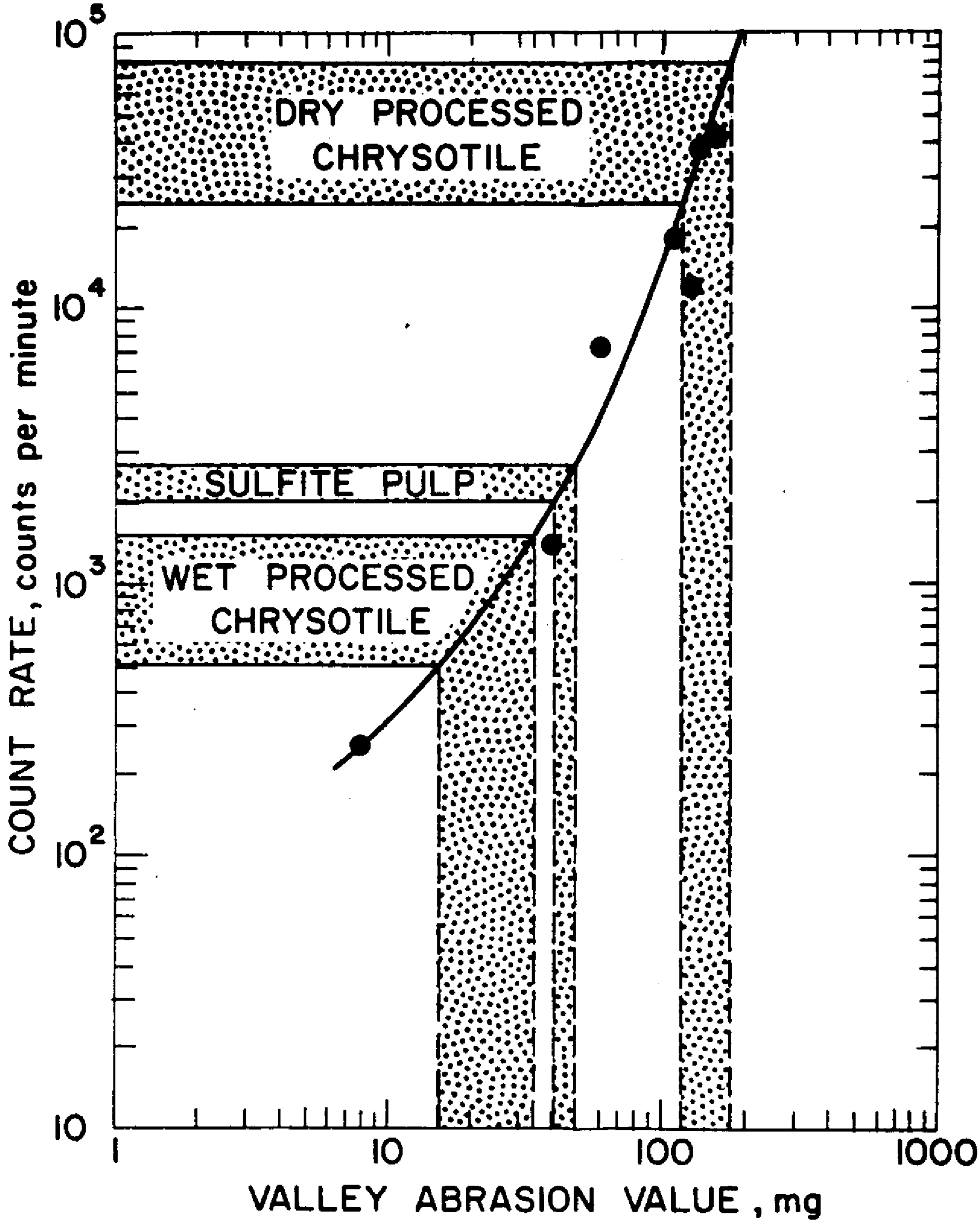
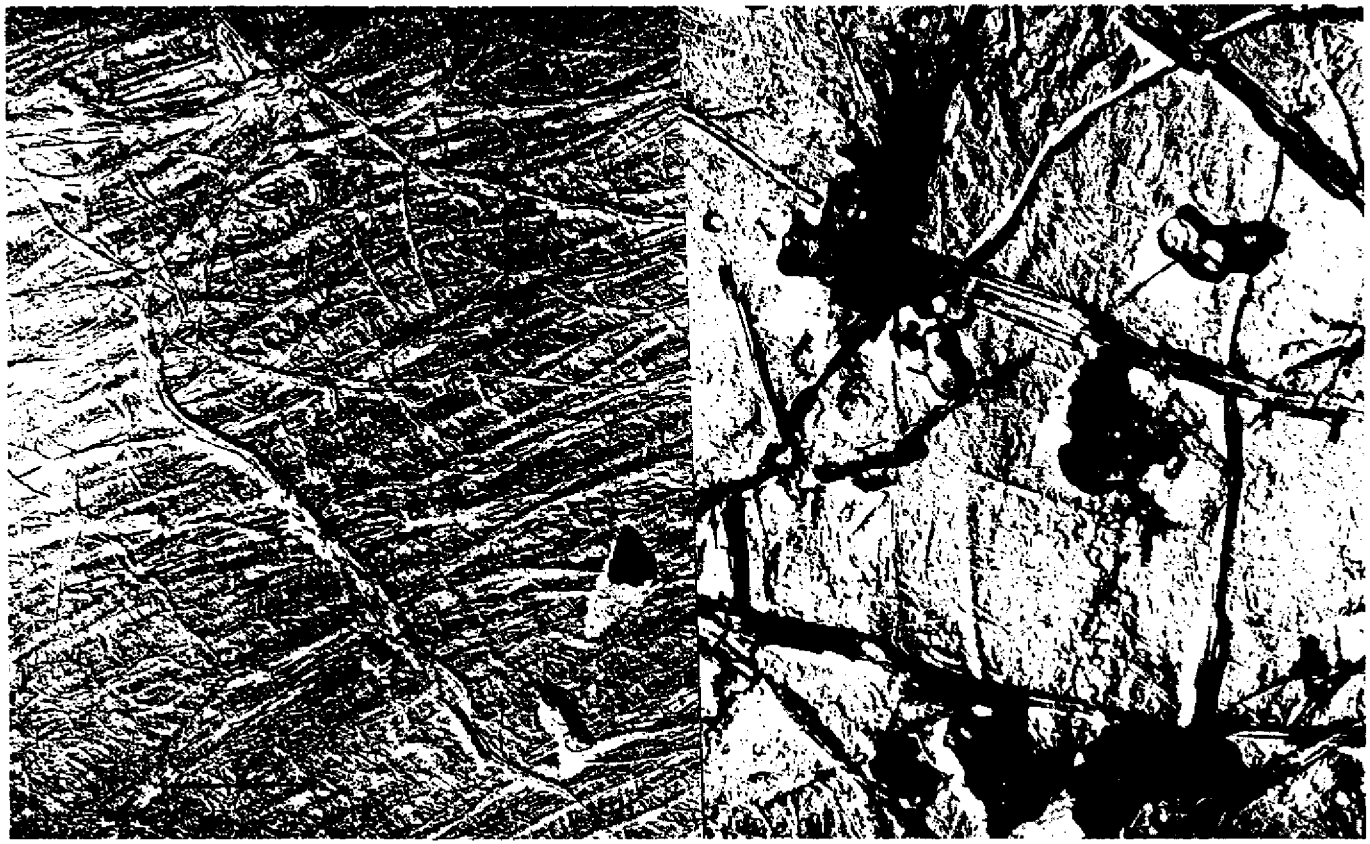


FIGURE 3: Abrasiveness of chrysotile products.



UNFILLED HANDSHEET

FILLED HANDSHEET

FIGURE 4: Electron micrographs (19,950) of surface replicas of handsheets.

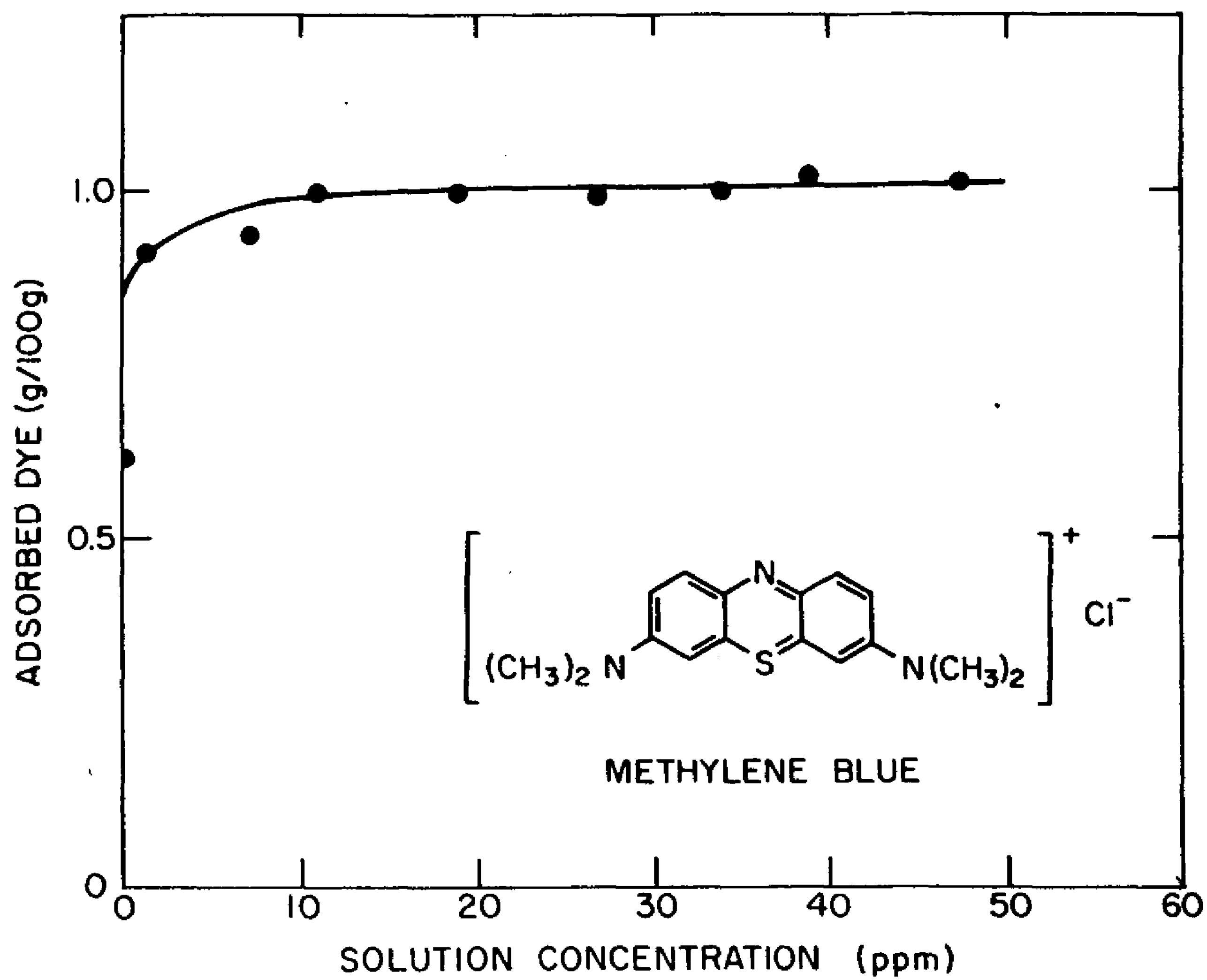


FIGURE 5: Adsorption isotherms of chrysotile with methylene blue.

TABLE I

ELECTROPHORETIC MOBILITY DATA FOR MINERAL FILLERS*

Material	pH	Mobility micron/sec per volt/cm
Kaolin (Hydrite UF)	6.2	-1.4
Talc (Mistron Frost)	6.6	-1.1
Titanium Dioxide (Titanox AWD)	6.1	-1.1
Bleached Sulfite Paper Pulp	6.4	-1.0
Chrysotile	6.2	+3.1

*Data were obtained by the micro-electrophoresis technique described by Riddick (12).

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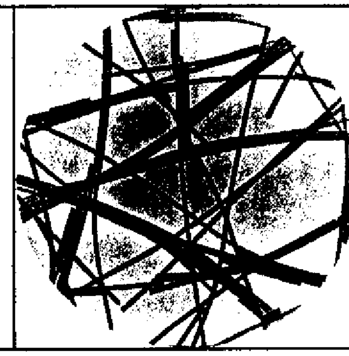

Photomicrograph of Union Carbide's high-purity asbestos fiber

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CALCULATION OF CHRYSOTILE ASBESTOS CONTENT IN CELLULOSE PAPERS AND ASH THEREFROM

(1) Analyze for Mg and report as % Mg of the weight of the paper sheet sample.

(2) If there are no other significant quantities of Mg-containing materials, such as talc, in the paper multiply the % Mg value by 3.9 to get per cent asbestos in the sheet. This factor is based on the formula for chrysotile as $Mg_6(OH)_8Si_4O_{10}$ with a small correction for the manufactured composition.

(3) If it is desired to determine the asbestos residue content in ash from a paper sheet, the 14% loss in water of constitution from asbestos in the ashing process must be taken into account. Starting with a paper sample of known weight, the weight of asbestos contained therein is determined from the per cent asbestos obtained, as in (1) and (2) above. From this weight of asbestos in the original sheet sample to be ashed, 14% of its value is subtracted. The resultant weight is the weight of asbestos residue in the ash. Subtracting it from the total ash weight will, of course, give the weight of non-asbestos residues in the ash.

H.F.R. 6/24/65

DETERMINATION OF MAGNESIUM IN PAPER SAMPLES

The moisture and ash are determined according to the TAPPI standard methods. The ash is then treated with 5 ml of 1-1 sulfuric acid and 2 ml of hydrofluoric acid and the solution is evaporated to dryness. The resulting salts are dissolved by heating with 10.0 ml of 1-1 sulfuric acid. The solution is cooled, transferred to a 100 ml volumetric flask, diluted to 100 ml with water, and thoroughly mixed.

The magnesium in this solution is determined spectrographically using the Rotating Disc procedure similar to that described in ASTM Method No. E-2 SM 7-14. To 20.0 ml of the above solution are added 5.0 ml of five normal sulfuric acid which contains 1250 ppm of molybdenum (made by dissolving a calculated quantity of ammonium molybdate in the sulfuric acid). A spectrum is made of this solution using the Rotating Disc-Spark procedure.

The concentration of the magnesium in the solution is determined by comparing the magnesium/molybdenum intensity ratio with the intensity ratios of solutions of known composition. The spectrographic lines which are used are 2779.834 angstroms for magnesium and 2780.036 angstroms for molybdenum. The magnesium content of the paper may then be calculated from these data.

The spectrographic procedure is described on the following page.

ROTATING DISC METHOD RD-1

Sample Preparation:	Pipette 20.0 ml of the sample and add 5.0 ml of 5N H_2SO_4 containing 1250 ppm Mo. Mix well. Prepare successive dilutions using one part of the sample containing the Mo addition and one part of 1N H_2SO_4 containing 250 ppm Mo. Prepare these dilutions at 1/2, 1/4, 1/8, 1/16 and 1/32 of the original concentration.

Spectrograph:

Slit Width: 25 micron   Slight Height: 1.5 mm
No Prism   No Lens   300 SQF   Order Sorter at 33.5 cm
Grating: 15,000 lines/inch   Mask: 30 mm
Focal dist.: 78 cm   Step Filter: Full plus 3rd
Wavelength: 900   2 SA No. 1

Power Console:

Spark excitation	Primary Resistance	5 ohms
	Inductance	40 microhenrys
	Sec. Resistance	2 ohms
	Capacitance	.0025 microfarads
Powerstat Voltage		130 volts
RF Amperage		7.4 amperes
Oscilloscope Pattern adjusted for		9 breaks

Arc Stand:

Upper electrode: inverted L-4036
Lower electrode: L-4075
Electrode separation: 2 mm (DO NOT adjust)

Sample: Pipette 2 ml of the sample into Teflon cup; place cup on sample table of Rotating Disc Attachment and lift table so that two steel washers will support table. Allow for one complete revolution of disc in solution.

Timing: Give sample a 12-second preburn, during which time all settings must be adjusted to the above given values. The sample burn exposed is 60 seconds.

UNION CARBIDE ASBESTOS

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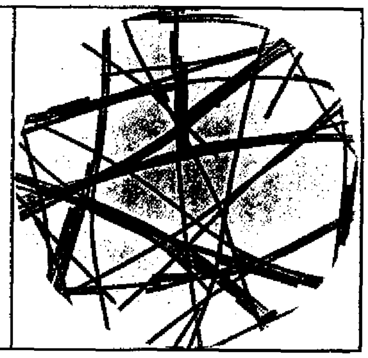
Photomicrograph of Union Carbide's high-purity asbestos fiber



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TECHNICAL SERVICE

The wide range of applications for high-purity asbestos fiber is being examined by Union Carbide's Technical Service staff. Variations in paper manufacturing processes are continuously studied for specific areas of application.

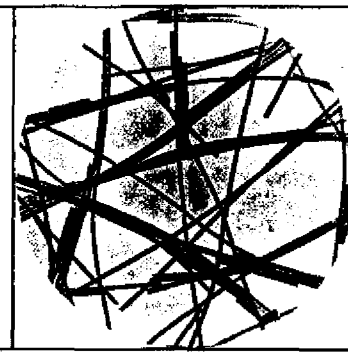
The principal goal of technical services is to provide the assistance to paper companies which will enable them to draw realistic conclusions about the superiority of high-purity asbestos. The staff works closely with the manufacturer in mill trials and other test runs using high-purity asbestos.

Extensive laboratory facilities at Union Carbide's Research Center near Tuxedo, New York provides the Technical Service staff with the necessary research back-up.

UNION CARBIDE ASBESTOS

PRODUCT INFORMATION BULLETIN

Photomicrograph of Union Carbide's high-purity asbestos fiber



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PREPARATION AND METHOD OF ADDITION OF THE HIGH-PURITY ASBESTOS FIBER TO THE FURNISH FOR THE MANUFACTURE OF PAPER

1. Method of Addition

The asbestos fiber is added to the stock preparation system for homogeneous distribution in the same manner as regular wood pulps. Present experience and information on retention properties suggests the following order of addition when using a slurry or opened asbestos fiber:

a. White water

b. Asbestos

c. Normal order of addition for pulps

d. Resin

e. Filler

f. Dye

g. Alum

Suggested practice above is based on the normal makeup. Unusual deviations from the system makeup shown above should be considered as a special case. For example, if bentonite or talc were being used, normally the elimination of this material would be suggested. Asbestos fiber with its superior oil absorbency characteristics, as well as its high specific surface value would be more effective for pitch control properties.

For furnishing Kraft or sulfite specialty grades furnish makeup should be planned for mill trials considering the individual characteristics for each system. As with all stock preparation systems for proper blending of pulps, good agitation to obtain a uniform distribution of the blend of pulp and asbestos fiber is desirable. From experience and the technology developed to date the fibrous asbestos should be treated as a pulp rather than an additive.

2. Points of Addition

A. Batch Type Furnish Makeup Systems

The high-purity asbestos fiber can be blended with the furnish in:

1. Hydropulpers
2. Slushmakers
3. Beaters (when roll is used for blending or beating)
4. Dynopulpers
5. Hi-Lo pulper
6. Pulpmaster
7. Mix tanks with good agitation

B. Continuous Stock Systems

When pulps and chemicals are continuously blended for furnish and chemical makeup, asbestos fiber can be dispersed at 2% solids in Union Carbide's new pellet disintegrator. Good mechanical shear-type agitation is desirable but not absolutely essential. Experience reveals that a mixing tank with a centrifugal pump and recirculation line will provide adequate agitation for opened high-purity asbestos fiber.

C. Specific Retention Applications - Dye Retention Improvement

With critical dye retention problems where the asbestos is to be evaluated strictly for dye efficiency improvement in the manufacture of specialty products, premixing of the asbestos and dye solution should be practiced. With a batch system, this is done as the first step in furnish makeup. With a continuous system a mix tank would have to be used. That is the continuously metered dye solutions and the continuously metered asbestos fibrous slurry would be fed to a small mixing tank which could be gravity-fed to the furnish blending chest.

With all applications for paper quality improvements and material retention improvements, methods of incorporating the asbestos fiber should be used to allow homogeneous distribution and intimate contact. Union Carbide's new pellet disintegrator can be used if there is any doubt.

D. pH Conditions

For best dispersion asbestos fiber should be blended with the furnish in the pH range of 4 to 6 -- 5 is optimum.

UNION CARBIDE ASBESTOS

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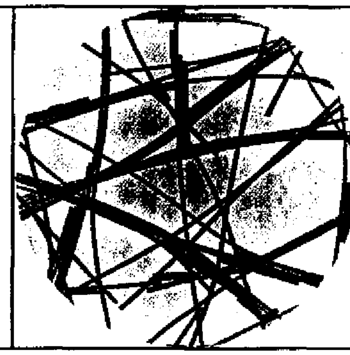
Photomicrograph of Union Carbide's high-purity asbestos fiber



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THE USES OF HIGH-PURITY ASBESTOS IN PAPER

How various paper companies have benefited by using high-purity asbestos:

Softness and Surface Feel Improvement:

1. Superior handfeel and softness qualities not obtainable before the use of high-purity asbestos.
2. Elimination of expensive synthetic fibers used for softening.
3. Improved drying and release properties at the creping dryer.
4. More waste paper and less expensive chemical pulps could be used.
5. Elimination of expensive softer pulps.
6. High quality tissue could be made with Southern Kraft pulps.
7. Formation improvement as well as softening -- two factors that are diametrically opposed in normal papermaking.

Pitch Control:

1. Less rejections for holes due to pitch deposits.
2. Cleaner system and more efficient operation.
3. Cleaner felts and wires.
4. Fewer machine breaks and lost time.

Retention of TiO_2:

1. Substantial cost savings and reduced pollution.

Newsprint Opacity Improvement and Printing Gains.

Board Coverage and Printing Gains:

1. Less expensive furnish required for the top liner.
2. Reduced TiO_2 requirements for the top liner.

3. Improved uniformity of formation.

4. Improved top liner smoothness.

5. Indications of improved printability.

Improved Saveall Efficiency:

Typical case histories illustrating improved efficiency in saveall.

Company "A"

Condition	Effluent (lbs. solids/1000 gal)
Before Asbestos Addition	2.2
During Trial (1-2% Asbestos)	1.5
After Trial	2.4

Reduction in Solids Losses = 35%

Company "B"

Condition	Effluent (lbs. solids/1000 gal)
Before Asbestos Addition	3.25
During Trial (2.5% Asbestos)	0.55

Reduction in Solids Losses = 83%

Note: Separan used before and during trial.

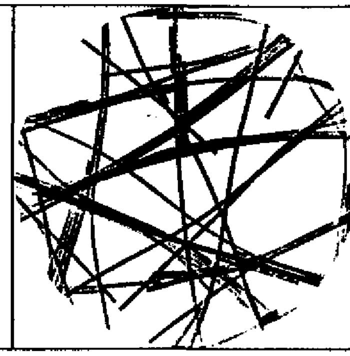
Company "C"

Condition	Saveall - (lbs. solids/1000 gals)		
	Influent	Effluent	
Before Asbestos Addition	17.9	4.36	
During Trial (2% Asbestos)			
1.0 hr.	14.3	1.15	
2.0 hr.	13.2	0.90	
3.0 hr.	11.0	0.71	
After Trial	21.4	6.00	
Average:			
Without Asbestos	19.65	5.18	74%*
With Asbestos	12.83	0.92	93%*
Reduction in Solids due to Asbestos =	35%	82%	

*Recovery of solids to the Saveall.

ASBESTOS

PRODUCT INFORMATION BULLETIN



UNION CARBIDE HIGH-PURITY ASBESTOS

A NEW WHITE FIBROUS FILLER FOR PITCH CONTROL IN PAPER AND BOARD

PROVIDES

HIGH CAPACITY

FOR

REDUCING

DEPOSITABLE

PITCH

PLUS

Opacity
Retention of Pigments and Fines
Better Sheet Formation

SEE ATTACHED MILL TRIAL DATA

APPLICATION

PITCH CONTROL WITH ASBESTOS

Absorbing and Dispersing the Wood Resins or Pitch Contained in Paper Furnishes Containing Sulfite Pulps, Groundwood and Semi-Chemical Groundwood

INTRODUCTION:

When pitch is not absorbed and dispersed uniformly in the furnish, fourdrinier wires are plugged, the pitch deposits on the paper machine felts and the paper produced contains blemishes such as scars or holes depending upon the thickness and basis weight of the paper.

Whether or not an agent or material has the potential for being effective should be evaluated by the mill interested since pulps and wood species vary considerably in pitch content. Several paper companies have evaluated our material —High Purity Asbestos—for pitch control as compared to the effectiveness of talc which they normally use. The results have been:

% Asbestos	Conclusion
2%	Twice as effective as talc.
3%	Completely eliminated the pitch. (No matter how much talc was used, the pitch was not completely eliminated with the talc.)

Statistics on typical requirements:

Paper Machine	*No. 2*	*No. 6*
Daily Prod. (Tons)	80	400
Present Talc use	3,000 lbs./day	9,000 lbs./day
Asbestos usage	1,000 lbs./day	5,200 lbs./day
Grade Produced	Bag Stock	Liner Board or Asphalt Laminate

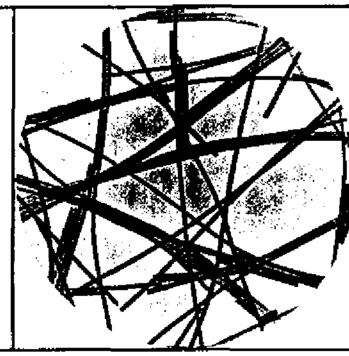
RESULTS OF THIS WORK:

Carload quantities of asbestos are now being used for pitch control.

UNION CARBIDE ASBESTOS

PRODUCT INFORMATION BULLETIN

Photomicrograph of Union Carbide's high-purity asbestos fiber



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UNION CARBIDE HIGH-PURITY ASBESTOS

A NEW FIBROUS FILLER AND RETENTION AID

FOR PAPERBOARD

PROVIDES

IN TOP LINER—

- Opacity
- Pigment Retention
- Improved Formation
- Reduced Underliner Show-Through
- Cost Savings

PLUS

Improved Printability

Surface Flexibility and Toughness

For Improved Folding

SEE ATTACHED MILL TRIAL DATA

APPLICATION—BOARD MILL EVALUATION

TOP LINER OF 22 PT. FOLDING BOXBOARD

Purpose of Trial:

1. Improve Titanium Dioxide Retention
2. Reduce stream pollution
3. Improve surface coverage or reduce underliner show-through.

Type of Paper Machine: An 8-cylinder Board Machine with 120" of effective trim.
Production Rate: 165 tons per day Machine Speed: 270 ft./min.
Basis Weight: 85 lbs./1000 Ft.^{2} or 255 lbs./3000 Ft.^{2}

Top Liner Furnish: (All waste papers)	Top Liner Furnish with Asbestos:
50% Blank (unprinted Newsprint) News	no change
29% Hard White Envelope Clippings	no change
21% Bleached Sulfate Cuttings	no change

Chemical and Color Additives:	Chemical and Color Additives:
1% TiO_2 (25¢/lb.)	1% TiO_2*
1% Mer-Size	no change
1% Natural Gum	no change
0.5% Sodium Aluminate	no change
pH 5.8 with Alum.	no change
6% Luster Clay (3¢/lb.) (reduced 3% with 3% asbestos added)	3% Asbestos added
3 oz. Paper Blue R.	no change

* Not needed with asbestos; see comments below.

Material Savings and quality gains associated with the use of asbestos:

I. Improved Brightness:

% Asbestos	0	2	3
Top Liner Brightness	65	66	67
Basis Weight (Lbs./1000 Ft.^{2})	85.5	85.1	85.4

II. Surface coverage improvement and reduced underliner show through was apparent to the Technical Superintendent and stated to be a very important quality gain.

III. The customer stated that shade was much better with the asbestos; getting away from their characteristic "tattle-tale" grey appearance.

IV. The brightness levels obtained with improved retention due to asbestos would, without question according to the Technical Superintendent, allow the elimination of the 1% TiO_2. The top liner represents 2500 lbs. per hour or 25 lbs./hr. of TiO_2. At 25¢/lb., 600 lbs. of TiO_2 per day would yield $150/day savings. Since 3¢/lb. luster clay was replaced pound for pound with asbestos, the actual cost of the asbestos use would be about 2¢/lb. or $36/day leaving this Paper Mill a daily savings of $114 or with the 22 pt. Folding Box Board being produced on this one machine 100 days per year *annual savings would be $11,400 per year.*

V. Top liner vat overflow to the sewer was reduced to coincide with the use of 3% asbestos yielding an estimated savings of $310 per day of *$31,000 annually.*

VI. These savings are significant. They are enhanced by improvement in the bending characteristics of heavier board brought about by the flexibility effects of asbestos.

APPLICATION

IMPROVING BOARD TOP LINER

TYPE BOARD: 33 pt. — 120 lb./1000 Ft.^{2} WHITE VAT LINED CHIP

Purpose of Application:

1. Improve top liner appearance and reduce show-through
2. Improve top liner brightness
3. Improve smoothness
4. Improve printing characteristics

Type of Paper Machine: 5 cylinder machine producing 40 tons per day. These results would apply to many high tonnage machines producing the same grade of board.

Asbestos Used: High Purity at the 1% addition level

Furnish for Top Liner:	Tabulating Stock	42%
	Kraft	52%
	Clay	5%
	Size (Rosin)	0.3%
	Alum	0.7%

System pH 4.5

RESULTS OBTAINED FROM THIS APPLICATION OF HIGH PURITY ASBESTOS

I. *SHOW-THROUGH REDUCTION OR TOP LINER FORMATION IMPROVEMENT* was visually apparent. Using the top liner brightness divided by the bottom liner brightness as an indication of reduced show-through indicated a 20% improvement.

II. Brightness of the top liner was improved 4 points (62.5 increased to 66.5 with the asbestos present).

III. Smoothness (Sheffield) of the top liner was improved 16%.

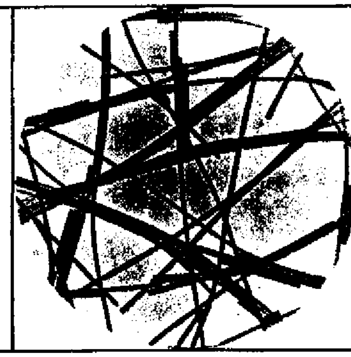
IV. The board samples containing the asbestos gave improved Vanceometer readings indicating better printability. Better printability should also be expected with the improved brightness, smoothness, reduced show-through and improved uniformity.

This manufacturer continues to use High Purity Asbestos as a result of this work. Substantial quality gain permits the producer to reduce the weight of top liner with accompanying savings.

UNION CARBIDE ASBESTOS

PRODUCT INFORMATION BULLETIN

Photomicrograph of Union Carbide's high-purity asbestos fiber



UNION CARBIDE CORPORATION · MINING AND METALS DIVISION · 270 PARK AVENUE, NEW YORK, NEW YORK 10017

UNION CARBIDE HIGH-PURITY ASBESTOS

A UNIQUE FIBROUS SOFTENING AGENT AND RETENTION AID

FOR TISSUE AND TOWELS

PROVIDES

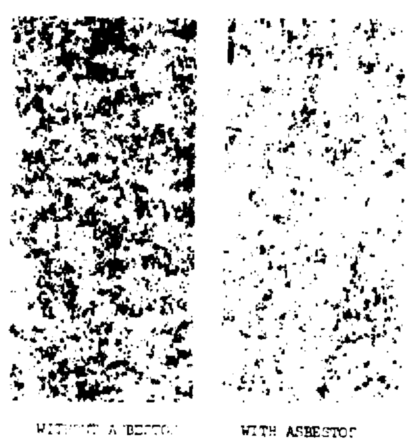
FEXIBILITY; DRAPE; VELVET SURFACE FEEL

CLARK SOFTNESS VALUES :

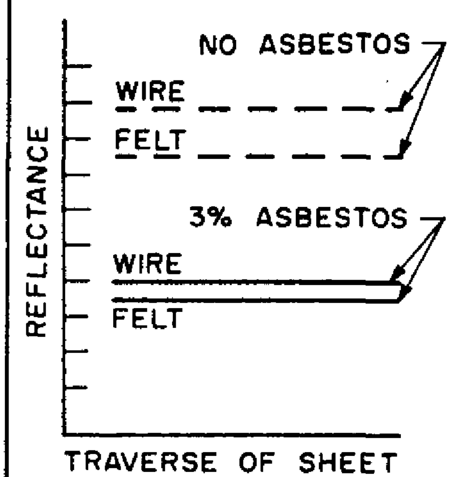
BLEACHED SULFITE UNFILLED ——— 9.5

SAME WITH 5% ASBESTOS — 14.1

IMPROVED SHEET FORMATION



INCREASE DYE RETENTION



PLUS

IMPROVED RETENTION OF CELLULOSE FINES AND FILLERS

SEE ATTACHED GRAPHS AND MILL TRIAL DATA

APPLICATION SOFTNESS FOR FACIAL TISSUE

Purpose of Trial: Improve overall softness and reduce raw material costs.

Type of Paper Machine: Yankee — 120" Trim with 75/58 mesh wire
Machine Speed: 1000 ft./min. with 10% Crepe
Production Rate: 20 tons/day

Furnish (in use):	Furnish Possible Using 4% High Purity Asbestos:
10% Kraft Bleached Hardwood ($90 per ton)	29% Kraft Bleached Hardwood ($90 per ton)
66% Spruce Sulfite ($150 per ton)	43% Kraft Bleached Pine ($110 per ton)
24% Broke ($130 per ton)	24% Broke ($102 per ton)
	4% Asbestos ($150/ton)
Furnish Cost . . . $139 per ton paper	$110 per ton paper

Savings to paper company per year (300 days) $174,000

Economic Gain and Quality Improvement:

This trial indicated that this paper company can save $174,000 per year in their facial operation alone. High Purity Asbestos was evaluated at the 2%, 4%, and 6% level. A panel of people experienced in evaluating facial tissue handfeel judged the 4 and 6% asbestos content paper the best they had felt for handfeel. A side benefit was noted by the paper company people—that the asbestos contributed to more uniform formation.

Physical Characteristics of the Facial Tissue:

Percent Asbestos:	0%	2%	4%	4-6%
Basis Weight (Lbs./3000 ft.^{2})	11.53	10.96	10.66	10.94
Bulk or Caliper (Std. Test)	32	31	30.9	31.2
Machine Direction Tensile (oz./15 mm strip)	9.3	8.6	7.1	5.1
Cross Direction Tensile (oz./15 mm strip)	4.8	3.8	3.4	2.6
Tensile Ratio (M.D./C.D.)	2.0	2.2	2.1	2.0
Absorption (seconds/.01 ml)	5	5	5	5

RESULT OF THIS WORK WITH THIS PAPER COMPANY:

This company now uses asbestos in all products: tissue, towels, and facial tissue.

SOFTNESS AND FORMATION

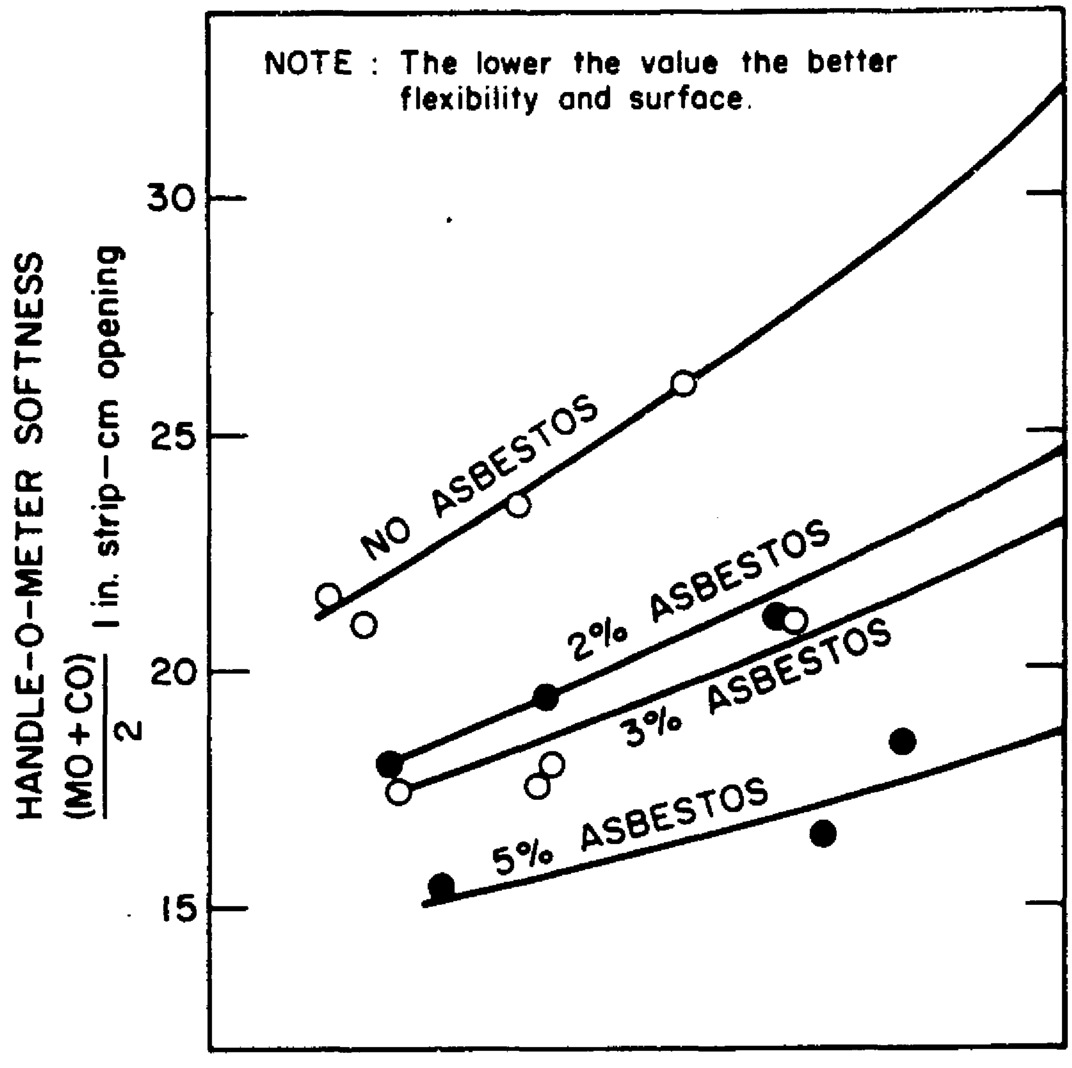
Another example of paper properties experienced with High Purity Asbestos additions is illustrated in Table 1. High Purity Asbestos was added to a 30 lb. wet creped towel and softness was found to improve over 20%. Additional benefits included improvements in wet tear. % stretch, and an obvious reduction of solids in the clarified water at the effluent of the saveall.

TABLE I

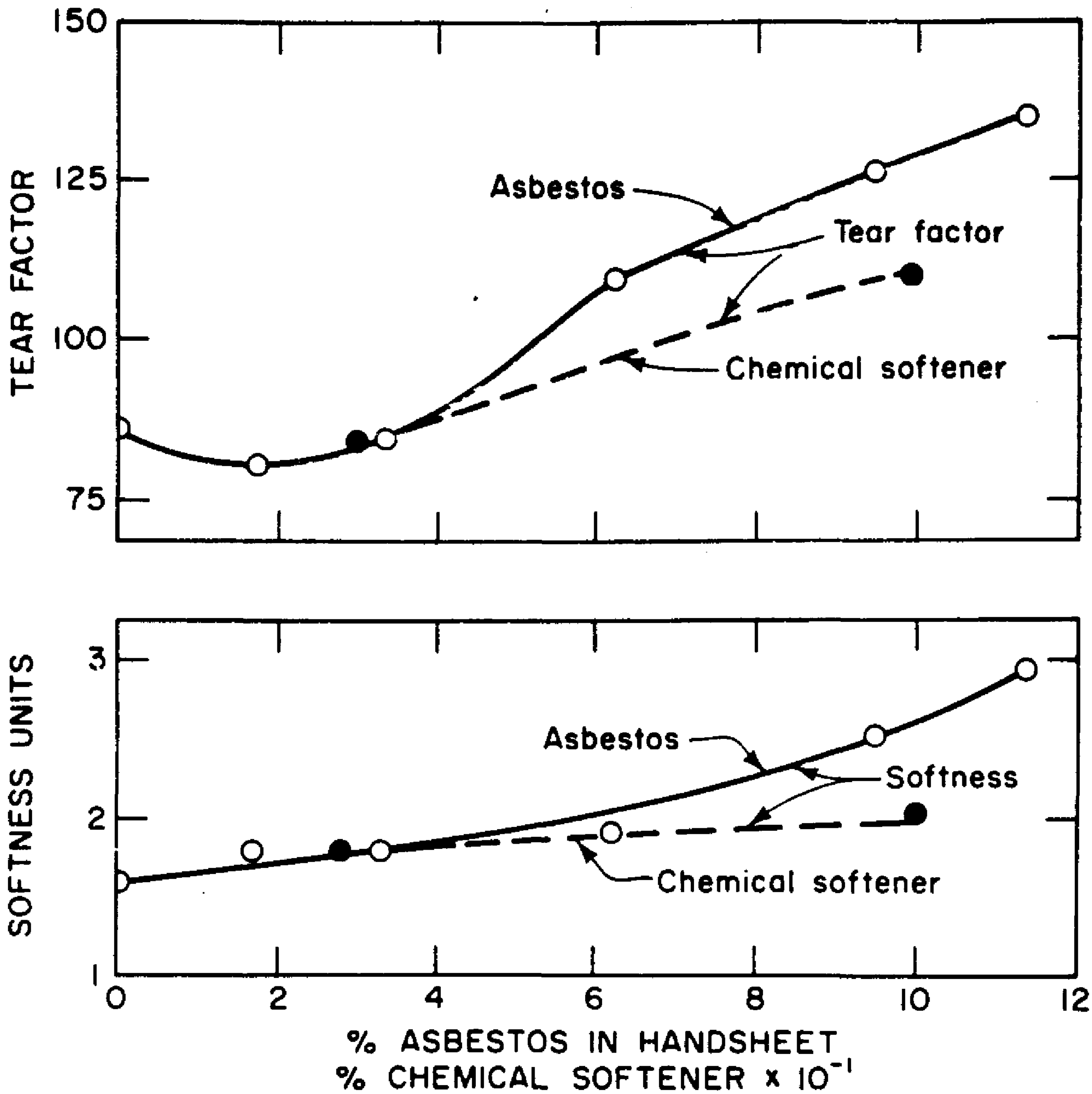
TRIAL DATA

	No Asbestos	With Asbestos in Paper 2%	3%	4%
Basis Weight (lbs./24"x36"x48")	30.0	30.1	29.8	30.4
Softness (Crush Test)	2200	1700	1680	1680
Bulk (4 ply cap.)	0.267	0.268	0.266	0.274
% Stretch	6.5	7.4	7.2	7.1
Wet Tensile Aged (one inch strip aged in oven at 108°C for 10 min.)				
Machine Direction	2.7	—	2.8	2.7
Cross Direction	1.7	—	1.5	1.6
Dry Tensile (one inch 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
Absorbency (1/10cc) Seconds	35	—	33	35

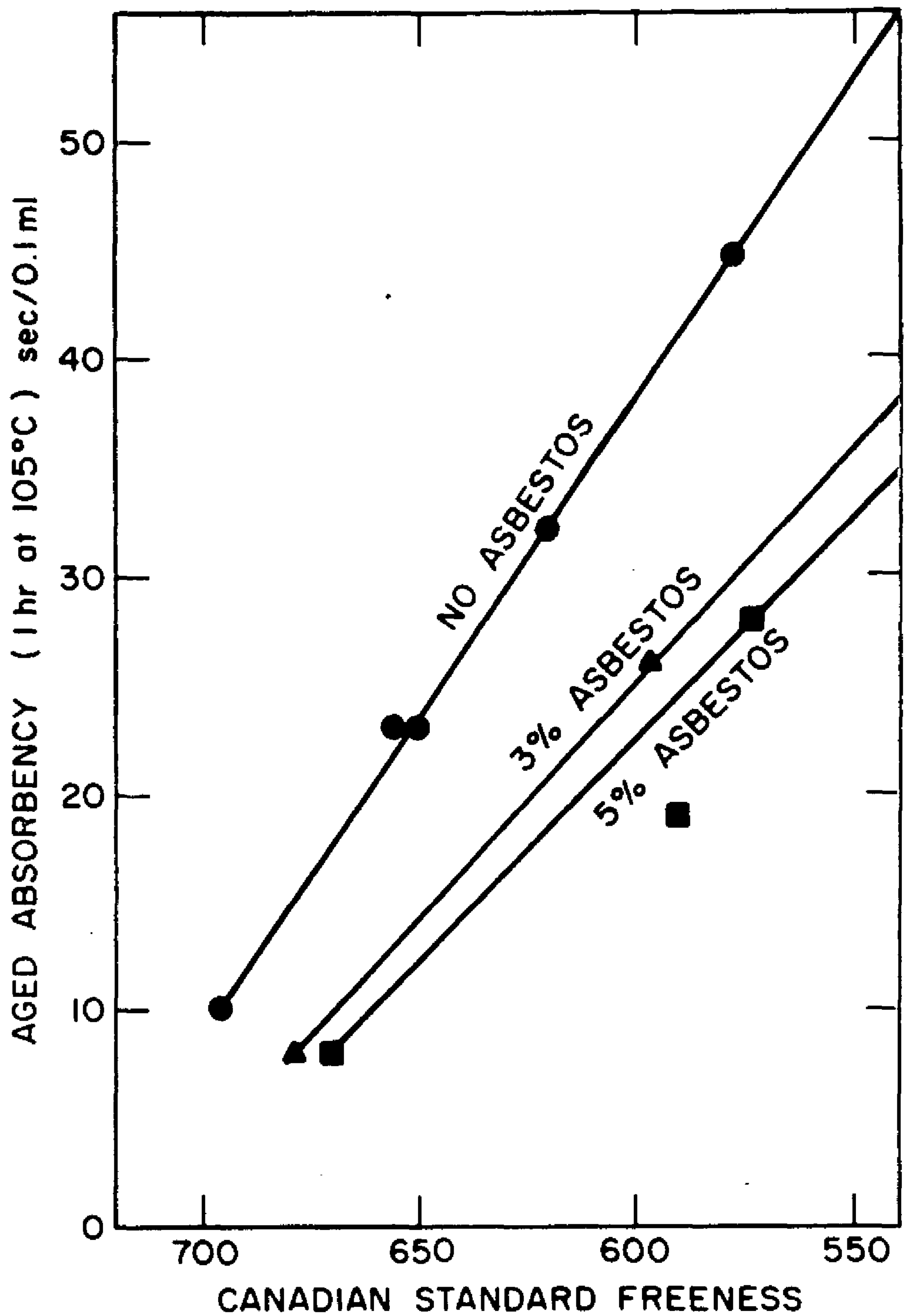
Formation improvements are often dramatic with High Purity Asbestos addition.



Asbestos softening of a 40-lb. towel.



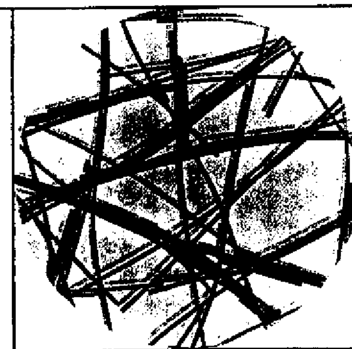
Effects of asbestos on paper softness and tear (kraft pulp, standard weight).



Asbestos improving aged towel absorbency.

ASBESTOS

PRODUCT INFORMATION BULLETIN



Photomicrograph of Union Carbide's high-purity asbestos fiber

UNION CARBIDE CORPORATION • MINING AND METALS DIVISION • 270 PARK AVENUE NEW YORK, NEW YORK 10017

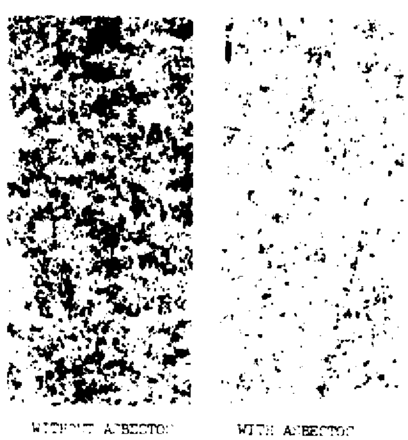
UNION CARBIDE HIGH-PURITY ASBESTOS

A NEW WHITE FIBROUS FILLER AND RETENTION AID

FOR PRINTING PAPERS

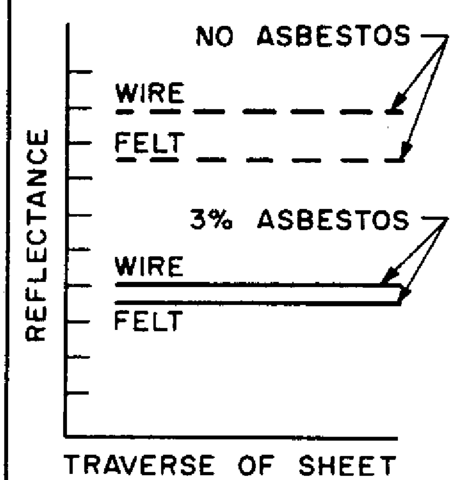
IT PROVIDES:

IMPROVED SHEET FORMATION



IMPROVED TiO_2 RETENTION

INCREASE DYE RETENTION



PLUS

- Opacity
- Brightness
- Reduced Show-Through
- Cellulose Fines Retention
- Printability Improvements
- Reduced Static Electricity Buildup

SEE ATTACHED MILL TRIAL DATA

RETENTION OF TITANIUM DIOXIDE IN BOND PAPER

Purpose of Trial: Improve Titanium Dioxide Retention to effect either material cost savings or improve the opacity of 37 lb. Bond produced by this paper company.

Type of Paper Machine: Open Fourdrinier — 126″ Trim — machine speed 700 ft./min.

Production rate: 70 tons per day.

Furnish (in use):	Furnish Change During Trial:
18% Hardwood-Sulfite	no change
26% Softwood-Sulfite	no change
56% Softwood-Kraft	no change
Additives*	2.4% Asbestos
1.6% Talc	no change
13.0% Clay	to 10.6% Clay
0.4% Emulsified Wax	no change
3.0% Titanium Dioxide	to 2.4% (Post trial retention data indicated that 1% TiO_2 could have been removed without a loss in opacity).

Savings Resulting From Improved TiO_2 Retention:

Reduction of TiO_2: 1% of 70 tons of paper per day = $350/day savings.

Cost of 2.4% asbestos (3¢/lb. due to 2¢/lb. clay reduction) $100/day

Net savings per day due to asbestos retention of TiO_2 .... $250 or $3.60/ton paper

Annual Savings $37,800

These savings are for this one grade being produced 150 days per year.
Actually this company has other grades where the same results may be obtained.

Other Gains associated with this mill evaluation:

1. Saveall Effluent was improved in clarity. This unit was handling an estimated one million gallons of excess white water per day and the use of 2.4% asbestos allowed a 35% reduction of solids passing to the sewer. This amounts to reduced stream polution and more tons of paper per 100 tons of stock.
2. Closure or more uniform formation was indicated by porosity readings.
3. Opacity values increased during the use of asbestos even though clay and TiO_2 quantities were reduced as shown above.
4. Smoothness values were improved.

Physical Characteristics of the Bond Paper produced:

Percentage Asbestos:	0%	1%	2.4%
Basis Weight (lbs./300 Ft²)	38.3	37.0	38.0
Machine Direction Tensile	12.6	13.0	13.8
Cross Direction Tensile	8.3	8.0	6.5
Mullen	20.6	20.8	22.0
Tear	32/33	30/33	34/36
Smoothness (Gain)	53	32	31
Opacity (Gain)	82.5	83	84-84.5
Brightness	83	82-83	82
Wax Pick	18/16	18/18	18/18
Caliper	3.23	3.09	3.10
% Ash in the Bond Paper (gain)	10.2	11.3	12.4

*Based on 5050 lb. batch of cellulose fiber

APPLICATION

RETENTION AID IN PAPER MILL SAVEALL OPERATION

OBJECT: REDUCE SOLIDS LOSSES AND REDUCE RIVER POLLUTION

TYPE OF SAVEALL: OLIVER DRUM TYPE FILTER WITH STAINLESS 60/40 MESH WIRE USING FRESH CELLULOSE PULP AS A FILTER AID.

MATERIAL TO BE RECLAIMED FROM EXCESS WHITE WATER RETURNED FROM THE PAPER MACHINE

1. Titanium Dioxide
2. Clay
3. Cellulose fines
4. Starch
5. Dye particles

Data for the operation:

Production rate of Paper Machine: 60 tons/day

Machine Speed: 800 fpm Wire mesh — 75x58

Total Filler Content: 6.25% (1.25% TiO_2; 2.5% clay; 2.5% starch)

Furnish: 50% Magnifite Hardwood
30% Softwood Draft-Spruce
20% Broke

pH 5.0 with Alum

REDUCTION OF SOLIDS LOSSES USING HIGH PURITY ASBESTOS:

% Asbestos	0	2½
Flow Rate (GPH)	1,000,000	1,000,000
Average Solids in lbs./1000 gals.	3.25	0.55
Number of days/year for this particular condition	200	200
Value of Material $/ton	100	100

ANNUAL SAVINGS RESULTING FROM THE USE OF ASBESTOS: $27,000

APPLICATION—RETENTION OF FILLERS

Novel Paper No. 22 for Color Books

Purpose: Improving Retention of Fillers for Improved Opacity, and for Material Savings.

Type Paper Machine: Open-Fourdrinier | Machine Trim: 132"

Production Rate: 150 tons per day | Machine Speed: 804 F.P.M.

Systems pH: 4.5 - 5.0

Basis Weight: 32 lb./1000 ft.^{2}

Furnish:

	Prior to use of Asbestos	with 2% Asbestos
80%	Groundwood	80%
20%	Unbleached sulfite	20%
5%	Georgia clay	5%
0.3%	Tetrasodium Polyphosphate	0.3%
0.4%	Zinc Hydrosulfite	0.4%
0.3%	Alum	0.3%
2.8%	Zeolex	0%
0%	Asbestos	2.2% — added

Other additives to the headbox: Kymene 557 — 1.7%.

Retention Results:

% Asbestos	0	2.2%	
% Clay	24	39	
% Total ash	30	43	
% Increase due to asbestos (clay retention)		62%	52.5% ave.
% Increase due to asbestos (total ash)		43	

Paper Tests with and without Asbestos:

	0% Asbestos	2.2% Asbestos
Basis Weight (lbs./3000 ft.^{2})	32	32
% Ash	4.4	6.5
% Opacity	92.9	93.6
Two-sidedness	1 pt.	0 - 0.5 pts.

Economic Gain and Quality Improvements:

1. High Purity Asbestos (2.2%) replaced 2.8% Zeolex with an immediate cost advantage. With a production rate of 140 ton/day, Zeolex was being used at a cost of $548/day while its replacement, High-Purity Asbestos, cost $308/day, yielding a savings of $240/day. The asbestos also caused an increase in clay retention; a 0.7 pt. opacity gain was achieved allowing either improved quality, or an additional estimated savings of $390/day if normal specifications are held. Final result was a total daily savings of $680/day.

2. Reduced two-sidedness during the use of High-Purity Asbestos also gave an improved paper product.

SALES OFFICES
FOR UNION CARBIDE
ASBESTOS

Northeastern Region
270 Park Avenue
New York, N. Y. 10017
212 551-4420

Southern Region
1371 Peachtree St. N. E.
Atlanta, Ga. 30309
404 873-4966

Midwest region
1300 Lakeside Avenue
Cleveland, Ohio 44114
216 621-4202

Western Region
22 Battery Street
San Francisco, Calif. 94106
415 982-1360, Ext. 16

UNION CARBIDE

UNION CARBIDE CORPORATION
MINING AND METALS DIVISION
270 Park Avenue
New York, N. Y. 10017

NEW TO THE PAPER INDUSTRY

UNION CARBIDE

HIGH PURITY ASBESTOS

INCREASES

* Softness
* Retention
* Opacity
* Pitch Control
* Sheet Formation
* Printability

AT LOWER COST

IMPROVE QUALITY...CUT COSTS
WITH UNION CARBIDE'S HIGH-PURITY ASBESTOS

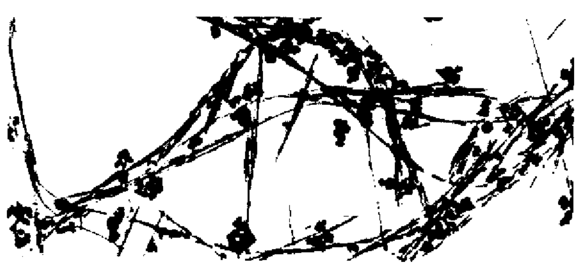
UNION CARBIDE **ASBESTOS**

IS:

* Grit free
* Higher in brightness and surface area
* Instantly dispersible

HERE'S WHAT IT CAN DO FOR YOUR PAPER

* Superior TiO_2 Retention



Greatly improved by the high surface charge of the fiber as shown in the photomicrograph.

* Positive Pitch Control—because of the high-surface area and absorptivity of Union Carbide's fiber.
* Opacity, Printability, and Sheet Formation—all improved by greater retention and more uniform dispersion of all fines.
* Softness—Union Carbide's high-purity asbestos softens tower and tissue stock by simple addition of fiber—gives excellent hand feel.

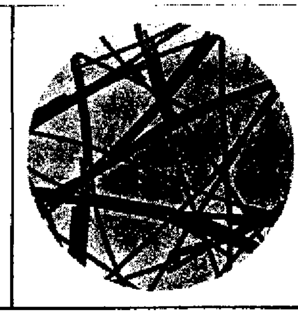
AND IT'S AVAILABLE:

Union Carbide owns and mines an extensive deposit of short fiber (chrysotiie) asbestos in the New Idria district of California. A modern mill, incorporating a unique process, produces a short-fiber asbestos product which is purer than any other commercially available. During the processing cycle, each individual chrysotile fibril is fully liberated from the surrounding fibrils and entrapped impurities.

UNION CARBIDE ASBESTOS

PRODUCT INFORMATION

Photomicrograph of Union Carbide's High-purity asbestos fiber



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A THREE-MINUTE STORY ON UNION CARBIDE ASBESTOS

High purity, non-abrasive, high brightness -- these unusual properties make Union Carbide asbestos different from all other asbestos products. The reason for the difference is that Union Carbide asbestos comes from an unusual high-grade ore deposit that is essentially free of hard, consolidated rock masses. A patented wet process then breaks down the fiber bundles and removes the rock and other foreign material, leaving a product that is essentially pure asbestos. When added to paper, this product offers many money-saving advantages, including improved furnished retention, saveall efficiency, optical efficiency, pitch control, and softness.

A positive surface charge is responsible for the improved retention obtained from Union Carbide asbestos in paper. Asbestos, with a Zeta potential of +40 millivolts, attracts TiO_2 and cellulose whose Zeta potential is -2 and -13 millivolts respectively. (These charges occur at a pH of 6.) This strong opposite charge reduces the loss of solids to the tray water.

Thousands of tiny fibrils are contained in every pellet of Union Carbide asbestos. Each fibril is only a few microns in length and has a length-to-diameter ratio of between 200 and 300 to one. These fibrils are so tiny that if all the fibrils in 1 gram of asbestos were put end to end, they would circle the earth at the equator 40 times. The large surface area provided by these fibrils helps the asbestos improve retention and pitch control.

An abrasion test has been made to measure the relative abrasiveness of Union Carbide asbestos and bleached sulfite paper stock. Wet-processed asbestos was found to be less abrasive than pulp, indicating minimum wear on fourdrinier wires, trimming knives, printing plates, etc.

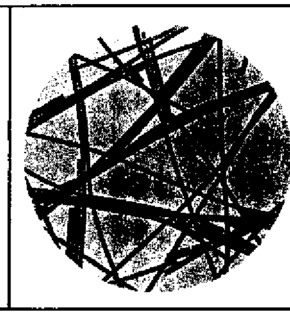
Asbestos is a group of minerals. Union Carbide asbestos is a chrysotile asbestos, the most abundantly produced of 6 species of asbestos found in the world. Its formula, in case anyone is interested, is $Mg_6(OH)_8Si_4O_{10}$.

One of the world's largest asbestos deposits is the source of Union Carbide's high-purity asbestos product. Located near King City, Calif., about 150 miles south of San Francisco, this deposit has millions of tons of known reserves, assuring users of a continuing supply.

For more information about this unusual asbestos, write or phone one of these offices:

270 Park Ave., New York, N. Y.	212-LL1-4420
1371 Peachtree St. N.E., Atlanta, Ga.	404-876-3331
6855 W. 65th St., Chicago, Ill.	312-581-5000
22 Battery St., San Francisco, Calif.	415-982-1360

UNION CARBIDE ASBESTOS



Photomicrograph of Union Carbide's High-purity asbestos fiber

PRODUCT INFORMATION

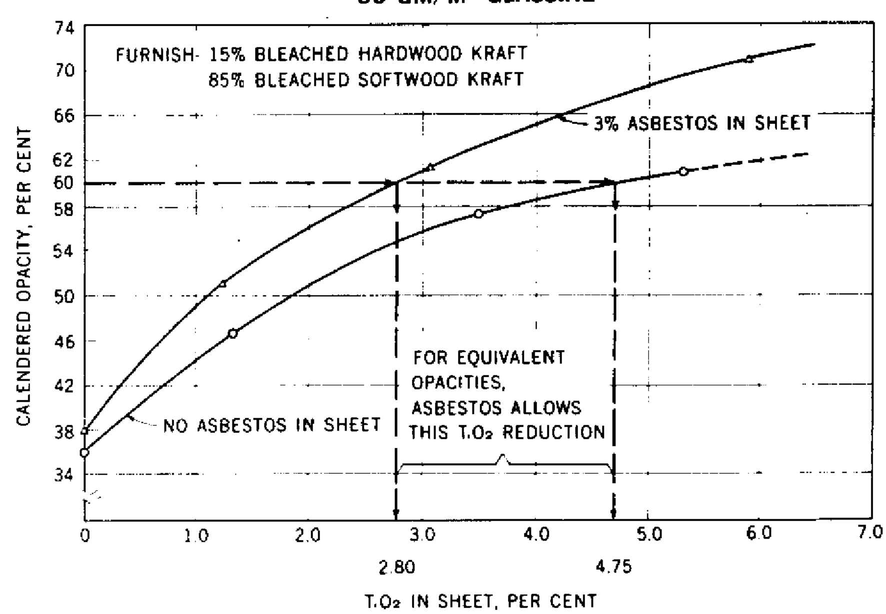
UNION CARBIDE CORPORATION • MINING AND METALS DIVISION • 270 PARK AVENUE, NEW YORK, N.Y. 10017

UNIVERSITY OF MAINE FINDS THAT ASBESTOS IMPROVES OPTICAL EFFICIENCY OF TiO_2 IN GLASSINES; TiO_2 ADDITIONS AND COSTS REDUCED

Many mills have reduced TiO_2 additions to glassine and pouch papers by using asbestos in the furnish. The reason: asbestos improves the optical efficiency of TiO_2, so that less TiO_2 is needed in paper to obtain a given opacity level. This practice allows substantial reductions in furnish costs.

This effect was recently measured by the University of Maine. Using hand-sheet studies, the university's paper laboratory measured the calendered opacity of 30 gm/m2 glassine containing 0 and 3 per cent asbestos. The graph at the right shows the opacity obtained at different TiO_2 levels.

EFFECT OF ASBESTOS ON OPTICAL EFFICIENCY OF TiO_2
30 GM/M² GLASSINE



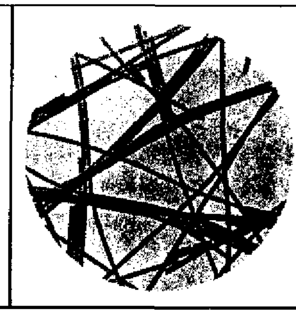
These results show that the presence of asbestos in the glassine sharply reduces the TiO_2 needed to obtain a given opacity. As an example, consider a glassine calling for an opacity of 60 per cent. Without asbestos, 4.75 per cent TiO_2 would be needed in the sheet. When the paper contains 3 per cent asbestos, however, only 2.8 per cent TiO_2 is needed.

This reduction of almost 2 per cent TiO_2 in the sheet can lead to substantial savings in pigment costs. The total TiO_2 cost of the sheet without asbestos would be about $23.75 per ton. In comparison, the cost of the TiO_2 and asbestos in the asbestos-bearing sheet would be about $18.40 per ton. Thus, a saving of at least $5.35 per ton is possible using asbestos in this practice, not counting the differences in retention between the two practices.

The curves above show that even greater TiO_2 savings are possible by using asbestos in glassines requiring more than 60 per cent opacity.

UNION CARBIDE ASBESTOS

Photomicrograph of Union Carbide's High-purity asbestos fiber



PRODUCT INFORMATION

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ASBESTOS "T"

. . . replaces TiO_2 on lb.-for-lb. basis, reducing furnish costs; opacity and brightness maintained

Asbestos "T" is a special combination of asbestos and TiO_2 -- a titanated high-purity asbestos. The product gives unusually high retention -- not only of its own components but also of separately added TiO_2 and fillers. This is because positively charged asbestos strongly attracts negatively charged pigments and fillers ... and holds them even under severe agitation.

Asbestos "T" also improves opacity by optimizing the optical efficiency of TiO_2. Thus, higher opacity can be obtained at lower TiO_2 levels in the sheet. The reason: the finely divided TiO_2 particles in asbestos "T" are distributed uniformly throughout the asbestos fibers. The strong attraction between asbestos and TiO_2 then keeps the titania scattered uniformly during use, assuring optimum optical efficiency.

These two pluses -- improved retention and improved optical efficiency -- allow asbestos "T" to replace TiO_2 on a lb.-for-lb. basis in many furnishes without sacrificing opacity or brightness. Since asbestos "T" costs about 60 per cent as much as TiO_2, substantial savings can be made.

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

Here, as examples, are three mill experiences using asbestos "T" as a partial replacement for TiO_2:

MILL DATA #1
50-lb. offset

Asbestos "T" added	50-lb. (4.3%)
Reduction in TiO_2	from 125 to 75 lb.
Wire retention of:	
separately added TiO_2	improved from 39 to 46%
asbestos "T"	57.1%--highest of all fillers
Overall retention of:	
separately added TiO_2	improved from 76 to 84%
Opacity	91.0%--vs. 90.7% before
Brightness	85.3%--vs. 85.5% before
Saveall-effluent solids	reduced by 68%
SAVINGS	$8.00 per ton of paper

MILL DATA #2
25-lb. white gift wrap

Asbestos "T" added	30 lb.
Reduction in TiO_2	from 60 to 30 lb.
Wire retention of:	
separately added TiO_2	improved from 17 to 18.3%
asbestos "T"	41.3%--highest of all fillers
Brightness	improved from 79.3 to 82.8%
Saveall-effluent solids	reduced by 33%
SAVINGS	$2.70 per ton of paper

Future plans: Further reduction in TiO_2, increasing savings

MILL DATA #3
25 lb. book paper

Asbestos "T" added	100-lb. (2.5%) per 4000 lb. fiber
Reduction in TiO_2	from 400 to 275 lb.
Reduction in TiO_2 extender	from 100 to 50 lb.
Wire retention of:	
separately added TiO_2	22% in both practices
asbestos "T"	48%--highest of all fillers
Overall retention of:	
separately added TiO_2	improved from 45 to 47%
asbestos "T"	81%
Opacity	91.4%--vs. 90.6% before
SAVINGS	$8.60 per ton of paper

PROPERTIES OF ASBESTOS "T"

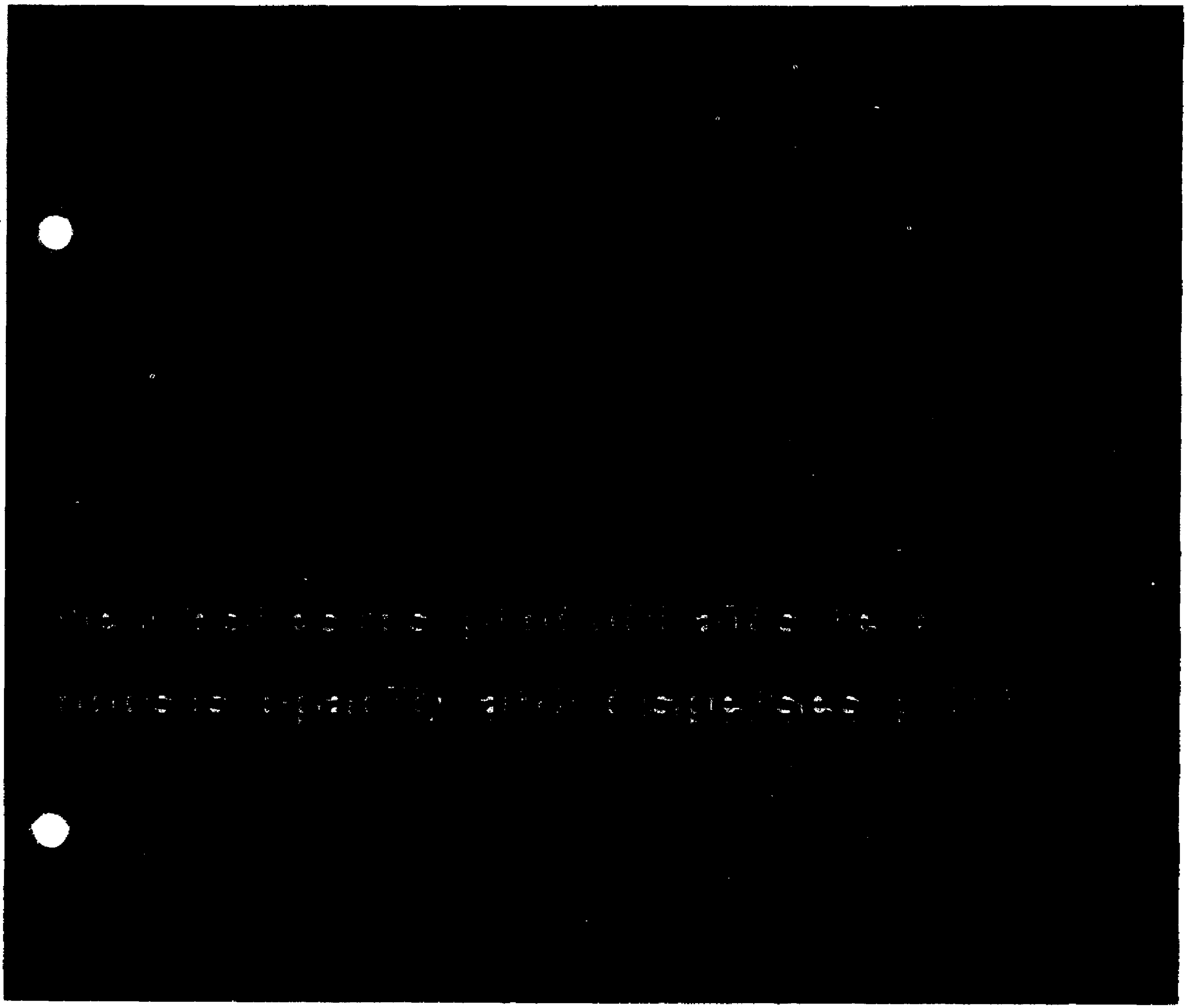
Reflectance	86 to 88% (photovolt reflectometer)
Magnetite	0.35% max.
Moisture	3% max.
Density of Pellets	51 lb./cu. ft.
Loss on Ignition at 100°C	10%
Ash 1 Hr. at 800°C	90%

Availability -- Asbestos "T" is supplied as convenient pellets (about 3/8 in. x 5/8 in.) for compactness in shipping. These pellets are readily repulpable in water and allow convenient bulk handling and compact storage.

Packaging and Shipment -- Asbestos "T" pellets are packed in 50-lb. bags and shipped in carload lots.

PAPER TRADE JOURNAL

FEBRUARY 14, 1966



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 saveall. 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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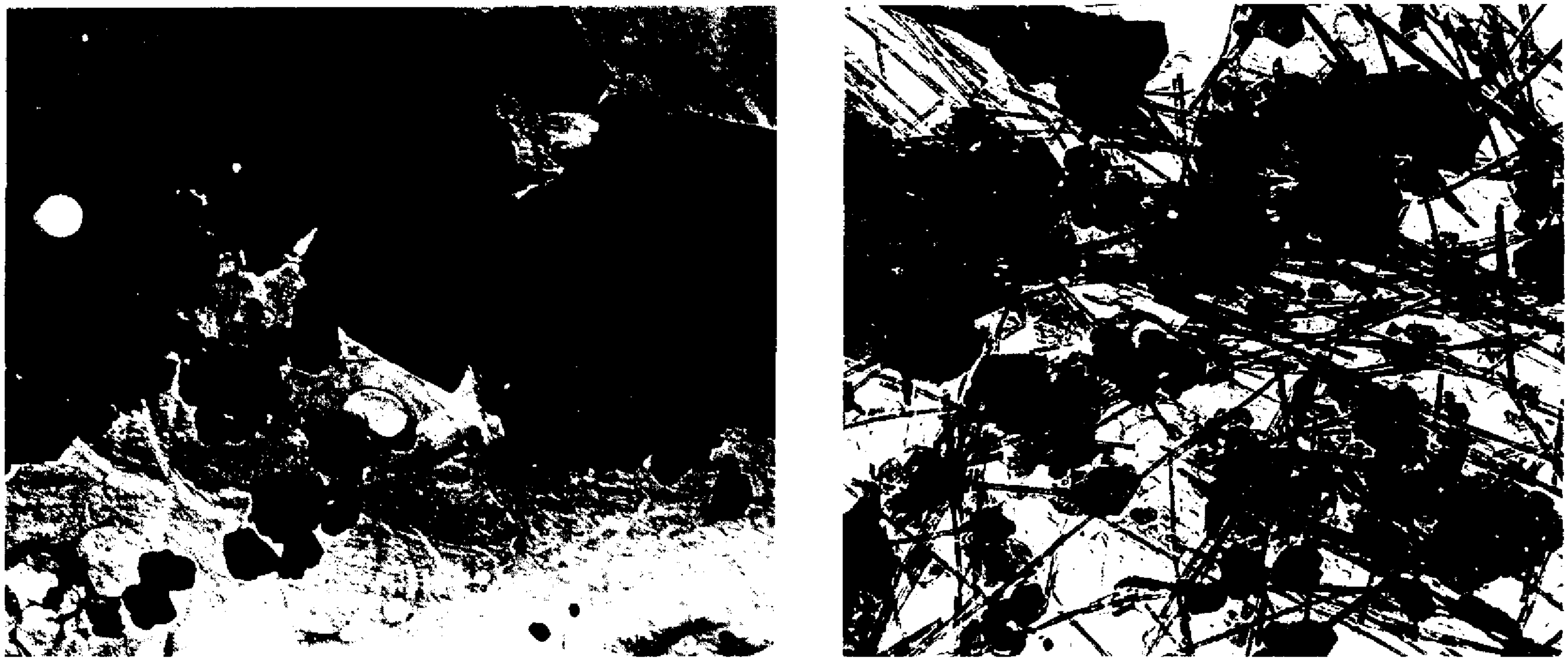

FIGURE 1—Electron micrographs (x24,000) of commercial 50 lb. offset containing 1.68 per cent TiO_2 and 22.5 per cent clay. Sheet at left does not contain asbestos and has densely packed agglomerates of TiO_2 (black) and clay (gray, angular) with large surrounding voids. Sheet at right contains 1.5 per 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-

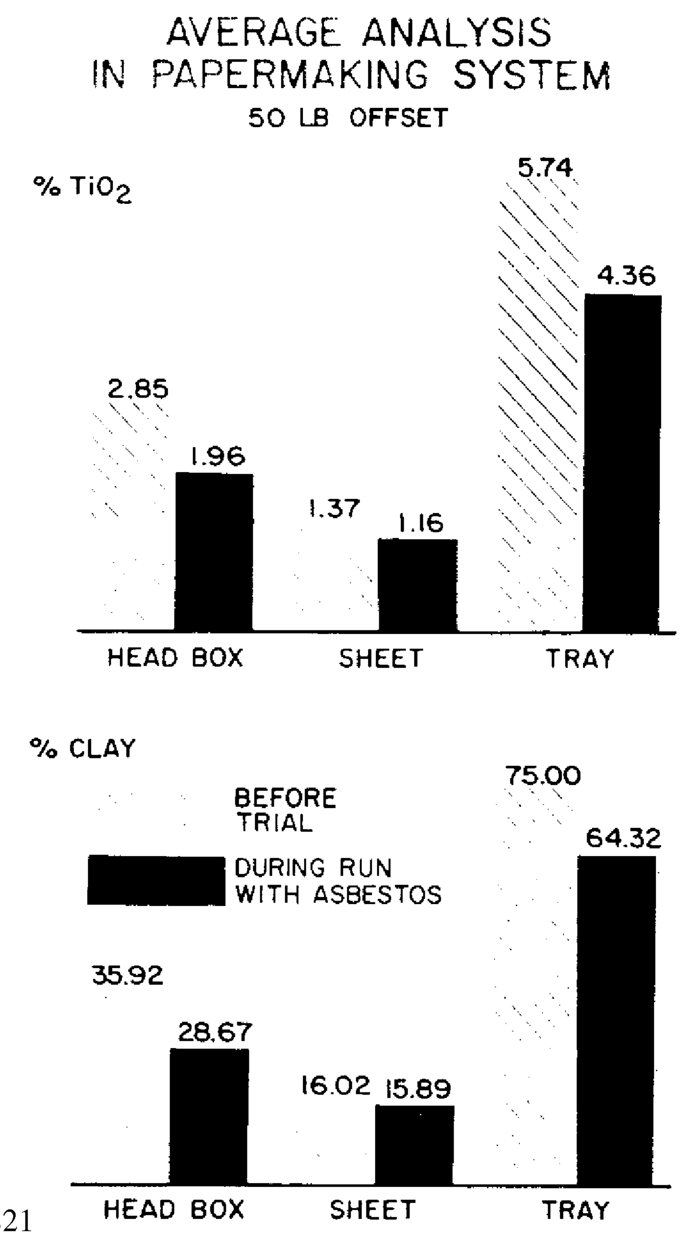

FIGURE 2—Average analyses in papermaking system producing 50 lb. offset. During the 7 hours that 1.7 per cent asbestos was added to the system, TiO_2 retention increased from 48 to 62 per cent while clay retention increased from 45 to 57 per cent across the wire.

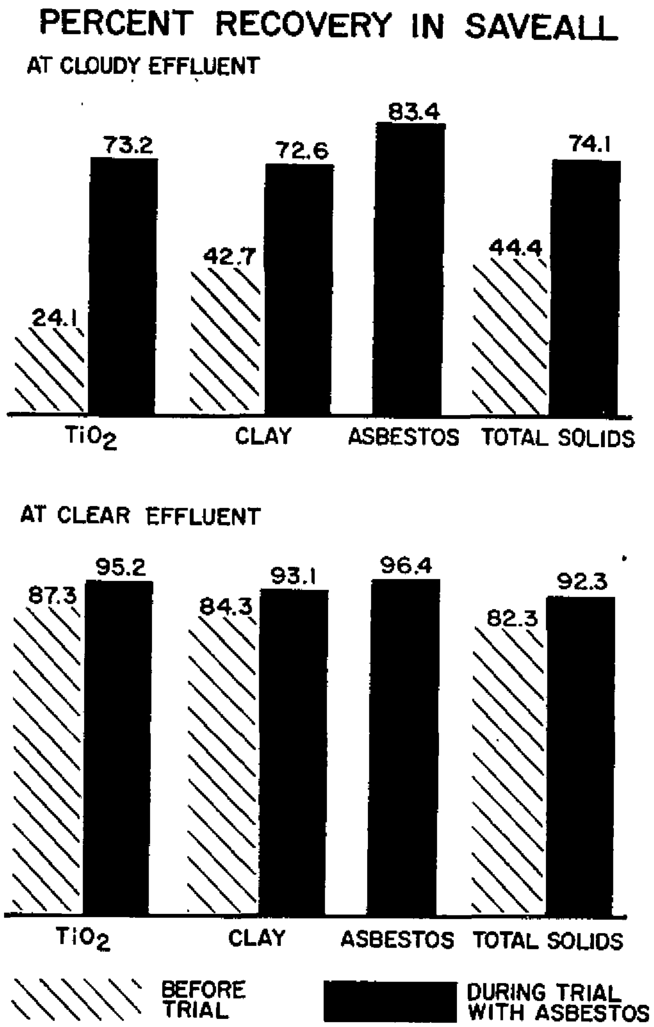

FIGURE 3—The presence of asbestos in this drum-filter saveall increased solids recoveries from 44.4 to 74.1 per cent at the cloudy effluent and from 82.3 to 92.3 per cent at the clear effluent.

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

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.

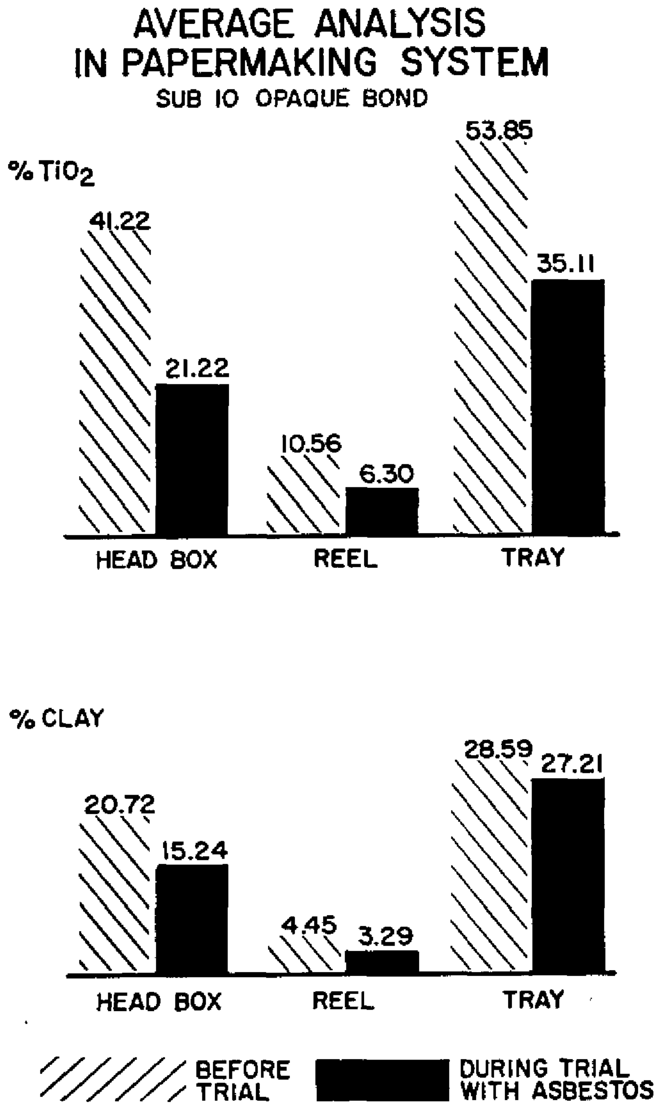

FIGURE 4—Average analyses in papermaking system producing sub. 10 opaque register bond. During this 8 - hour production run, a 1.2 per cent asbestos addition increased TiO_2 retention by 15 per cent.

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.

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

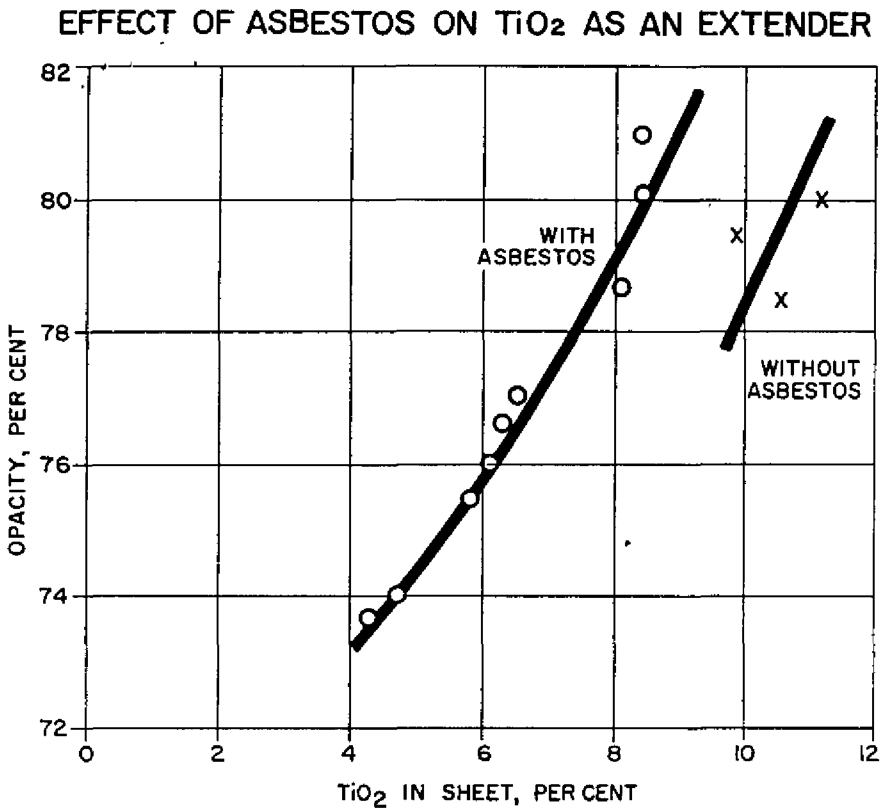

FIGURE 5—Sub. 10 opaque register bond containing 1.13 per cent asbestos met opacity specifications at lower TiO_2 levels than paper containing no asbestos. Thus, asbestos improved the light-scattering efficiency of TiO_2.

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.

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

SAVEALL

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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UNION CARBIDE ASBESTOS

Pulp & Paper

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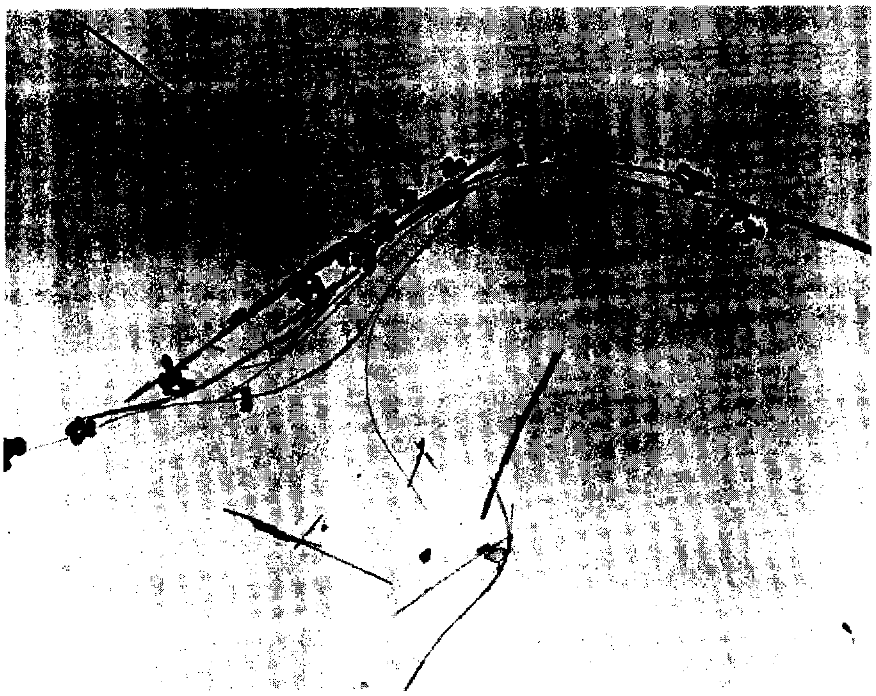
January 10, 1966

Asbestos-cellulose combinations offer dramatic possibilities



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 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.

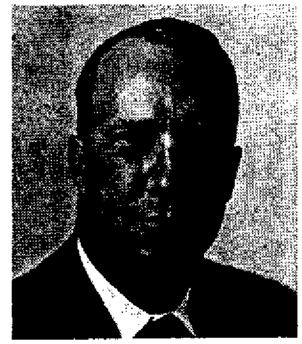
To expect a direct relationship between the laboratory results and machine operation would be an oversimplification since a great many other variables enter into the papermaking system. One of these factors is the type of organic flocculent used. For this reason, a wide variety of these products was 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-

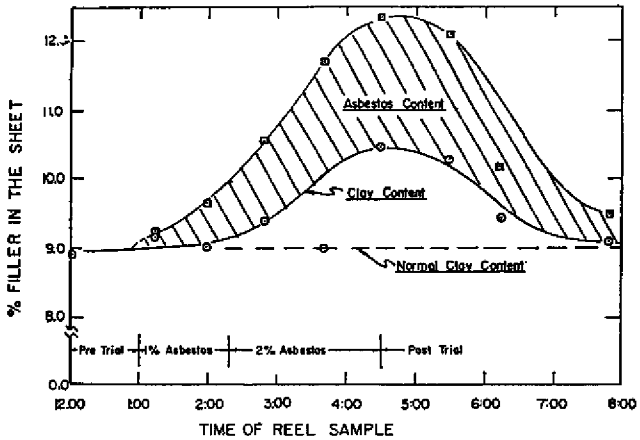


Figure 1. Effects of asbestos additions to a 22.5 lb. classified grade.

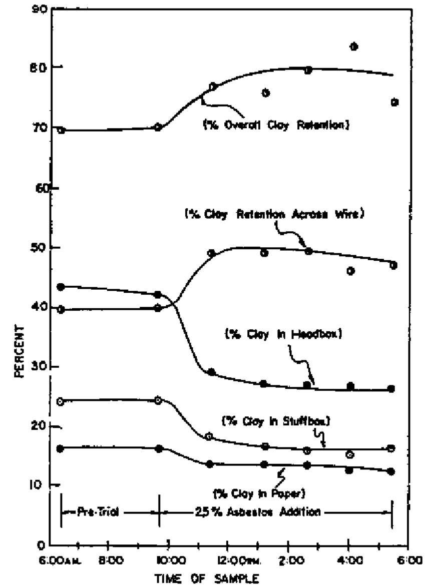


Figure 2. Clay analysis of machine run on a 39 lb. magazine grade.

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 19½ 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 5½ 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./M^2) 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,

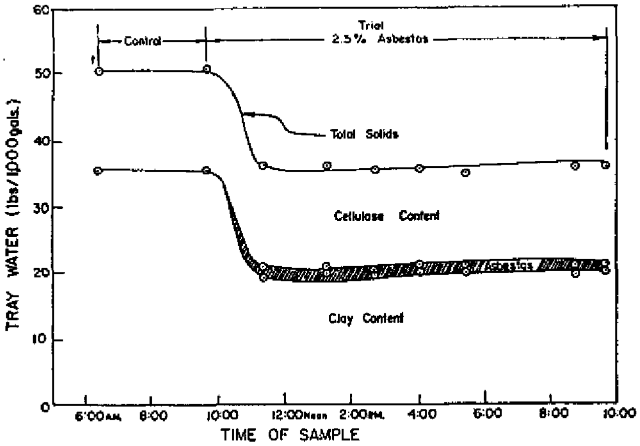


Figure 3. Tray water analysis on 39 lb. magazine grade.

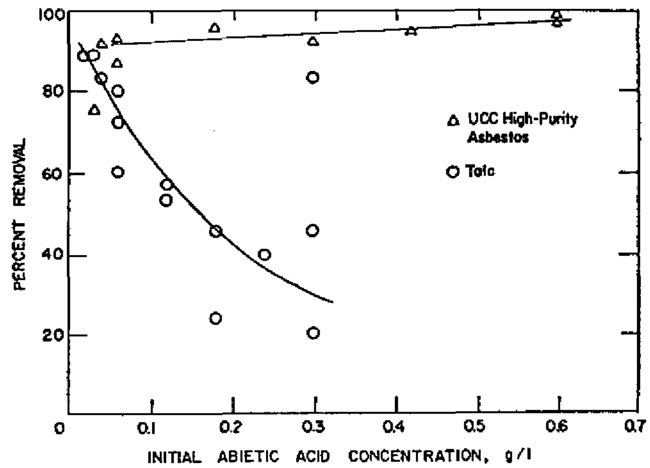


Figure 4. Effect of asbestos and talc on abietic acid removal from water solutions.

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.

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 pre-trial 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. ■

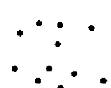
Acknowledgments

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.

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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MINING AND METALS DIVISION

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UNION CARBIDE ASBESTOS

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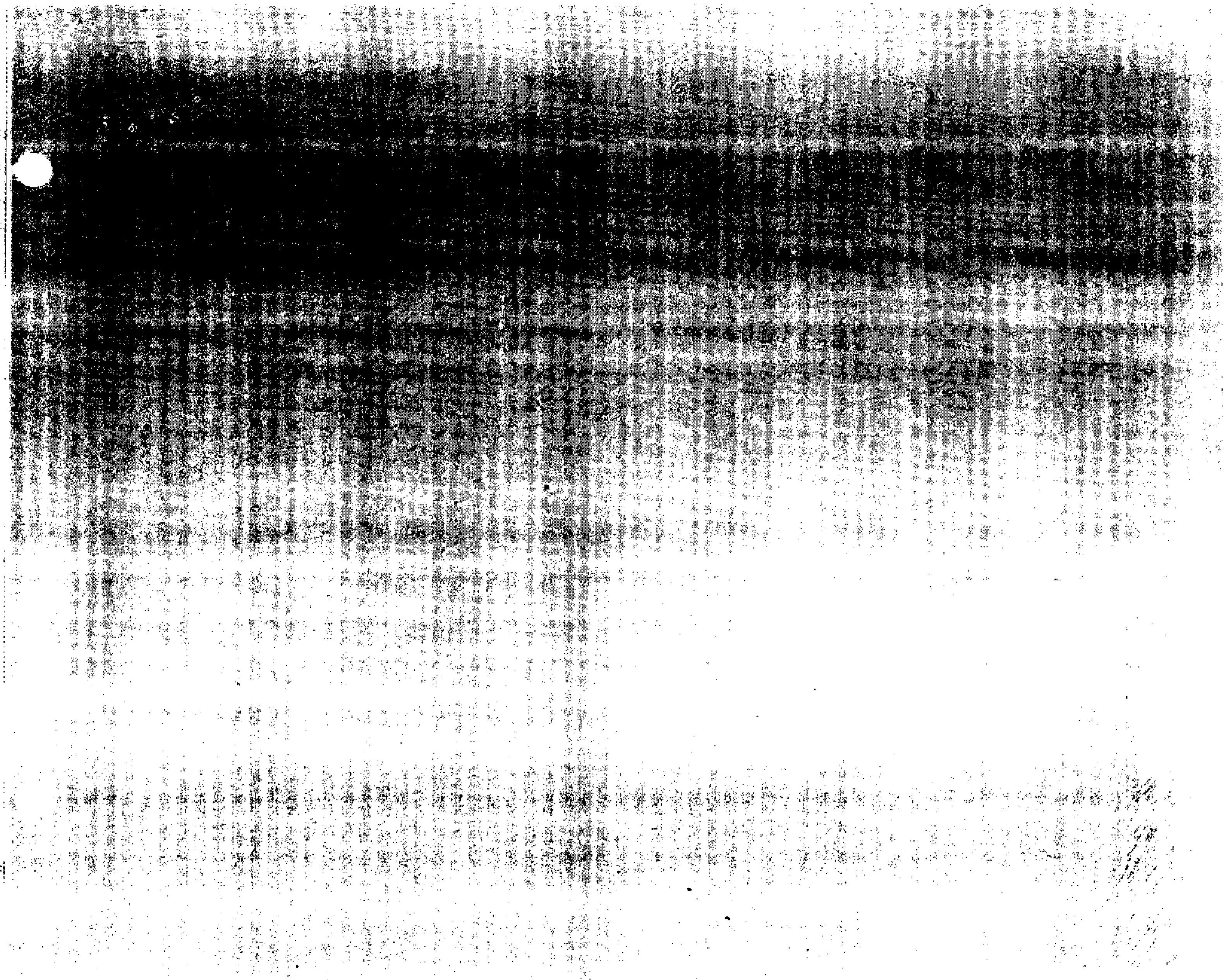
Chemical 26

The Process Magazine of the Pulp and Paper Industry

JULY 1966

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



This paper contains asbestos "T"...

Note the high opacity and brightness of the paper on which this reprint was made. It is a 70-lb. offset grade produced by P. H. Glatfelter Co., Spring Grove, Pa. 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.

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

AVERAGE ANALYSIS
IN PAPERMAKING SYSTEM
50-LB. OFFSET

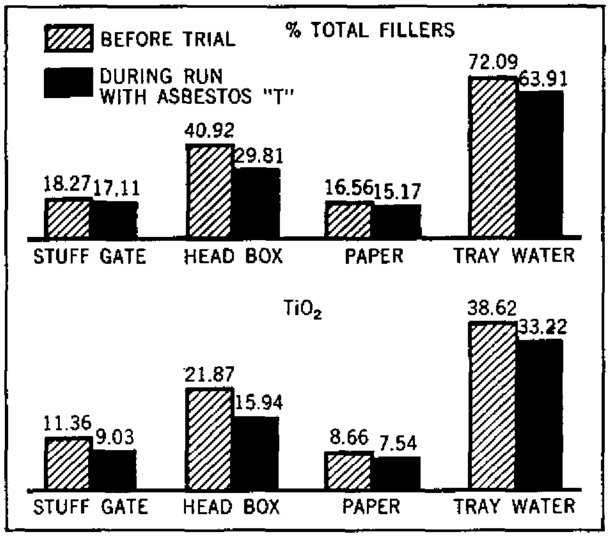
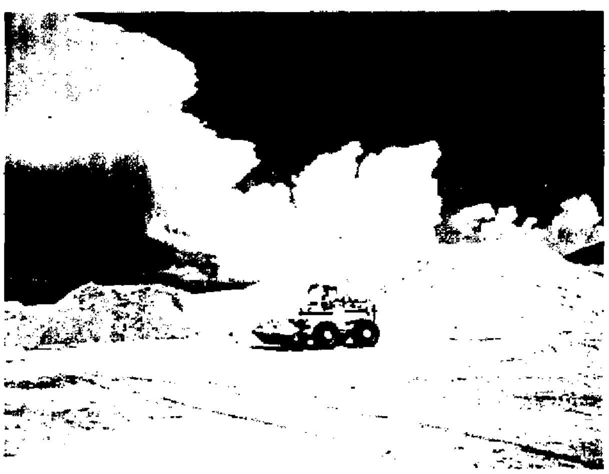


Figure 1. During this production trial, 50 lbs. of Union Carbide's asbestos "T" (4.3%) replaced the equivalent amount of titanium dioxide in preparation of the furnish.



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.)*

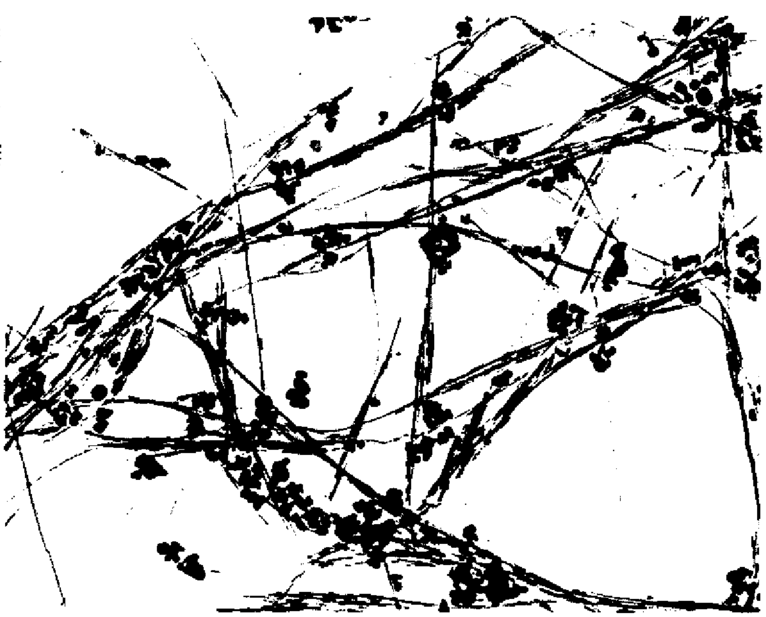
For the overall system, asbestos "T" improved the retention of separately added TiO_2 by 9.6% — from 76.2% to 83.5% — with asbestos "T" retention (both components) at 79%. Mill analysis shows that 75 min. after additions of the retention aid were stopped, the head box contained 4.5% asbestos "T" and 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.

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 re-



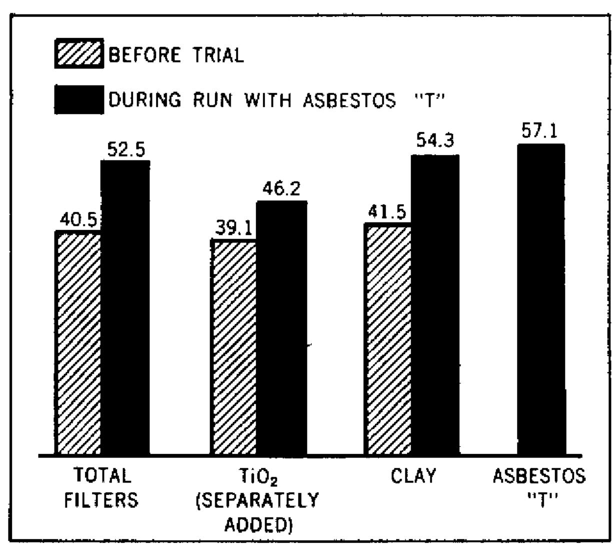
coveries in this flotation saveall increased from 98.1% to 99.2% in the presence of asbestos.

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.

SINGLE-PASS RETENTION, PER CENT
50-LB. OFFSET



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:

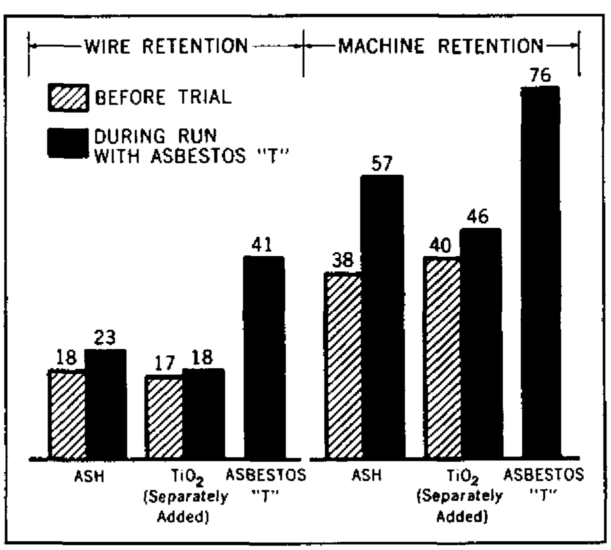
Total solids, lbs./1000 gallons	No asbestos	With asbestos
Tray water	149.9	113.7
Cloudy effluent	28.0	13.0
Clear effluent	17.7	6.2

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



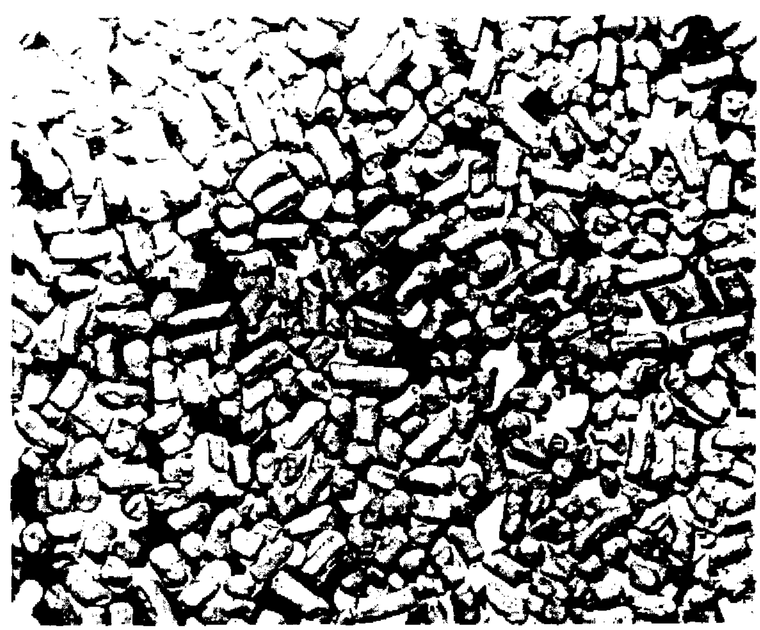


Figure 3. Asbestos "T" (which comes in the rod-shaped pellets shown on the right) at this mill boosted the retention of ash and titanium dioxide across the wire.

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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. ●

**AVERAGE ASH ANALYSIS
IN PAPERMAKING SYSTEM, PER CENT
40-LB. GOVERNMENT OFFSET**

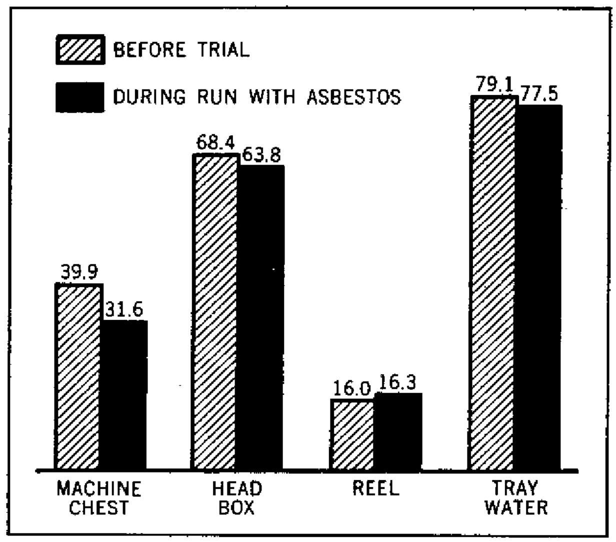


Figure 4. Carbide's high-purity asbestos does well also. This furnish held 2.2% of the fiber, enough to raise ash retention by 10% across the wire and 30% overall.

**AVERAGE ASH ANALYSIS
IN PAPERMAKING SYSTEM, PER CENT
40-LB. WHITE OPAQUE**

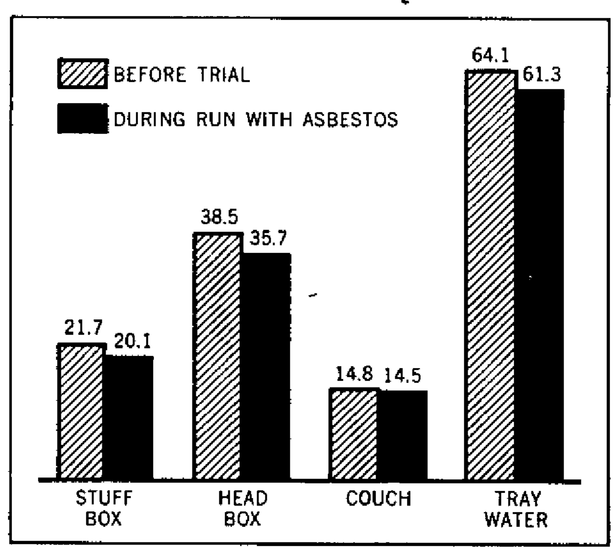
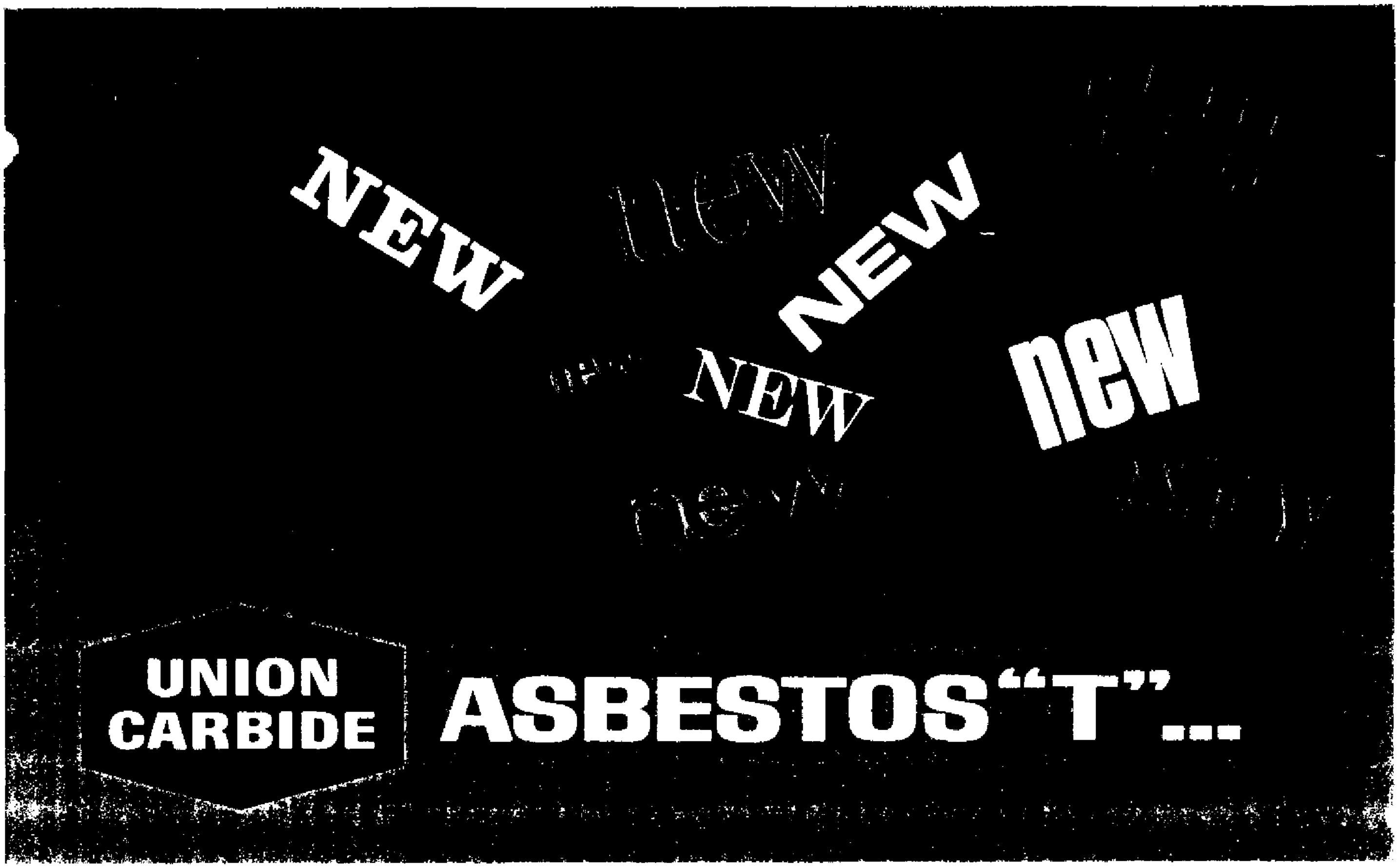


Figure 5. Paper formed during this production run contained 3% high-purity asbestos and maintained its ash content despite a reduction in TiO_2 and clay additions.



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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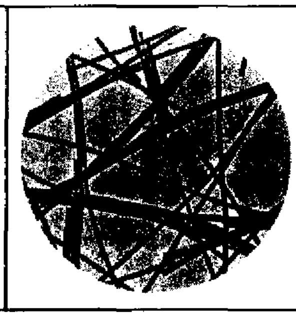
UNION CARBIDE ASBESTOS

Photomicrograph of Union Carbide's High-purity asbestos fiber



PRODUCT INFORMATION

UNION CARBIDE CORPORATION • MINING AND METALS DIVISION • 270 PARK AVENUE, NEW YORK, N.Y. 10017

RESIN-GRADE ASBESTOS

Union Carbide's Resin-Grade Asbestos is an effective, low cost thickening agent and thixotrope for vinyl plastisols and gels, polyesters, epoxy cements, mastics and sealants.

Resin-Grade is a highly purified, white chrysotile asbestos. Fibers are of essentially uniform diameter - averaging 250 angstroms or .025 microns. Lengths vary from a few microns to tens of microns.

By means of a special refining technique, Resin-Grade Asbestos is made completely grit free and non-abrasive. This latter characteristic makes it especially valuable in spray application. Moisture content is controlled at a low level for maximum reproducibility.

TYPICAL CHARACTERISTICS

Specific Gravity		2.45 g/cc
Moisture Content		2.0% max.
Surface Area		60 M^2/gm approx.
Reflectance (G.E. Brightness)		72-76
Nature of Surface Charge		Electropositive(cationic)
pH in Water		9.5
Bulking Value		4.8 gals./100 lbs.
Oil Absorption (DOP)		120 lb./100 lbs.
Refractive Index		1.54 - 1.56
Wet Bulk Density (in water):		
as received, 20 g/liter	(3 hrs. settling)	700 ml.
after dispersion, 2 g/liter	(1 hr. settling)	900-1,000 ml.
Dry Bulk Density		4 lbs./cu. ft.
Shipping Density		12-14 lbs./cu. ft.
Standard Package Wt.		35 lbs.

RESIN-GRADE ASBESTOS IS NON-ABRASIVE

	Relative Abrasiveness
Resin-Grade Asbestos	1.0
Bentonite	39
Diatomite	25

The attached graphs present typical data on the use of Resin-Grade Asbestos as a thixotrope in "Flexol" Plasticizer EPO; the performance may be enhanced, if desired, by the addition of small percentages (0.1%) of ethylene glycol or other polyols.

High shear mixers are recommended for optimum efficiency and dispersion stability. A mixing procedure for Cowles dissolvers is attached. Sonic dispersers, homogenizers and similar equipment are also satisfactory.

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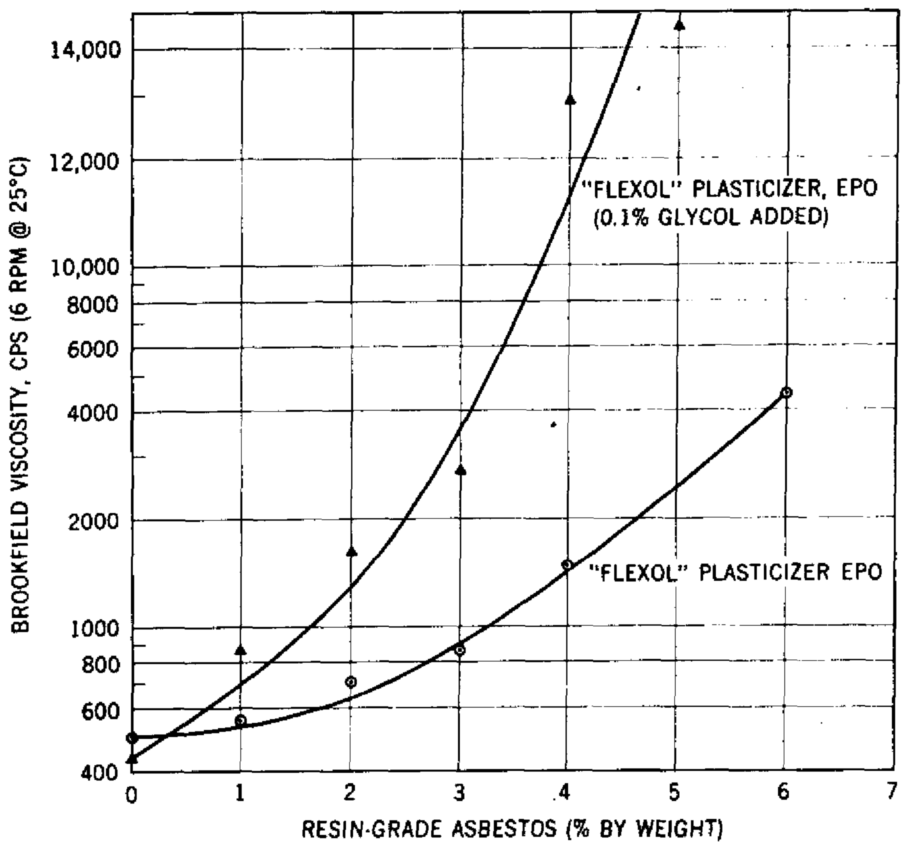
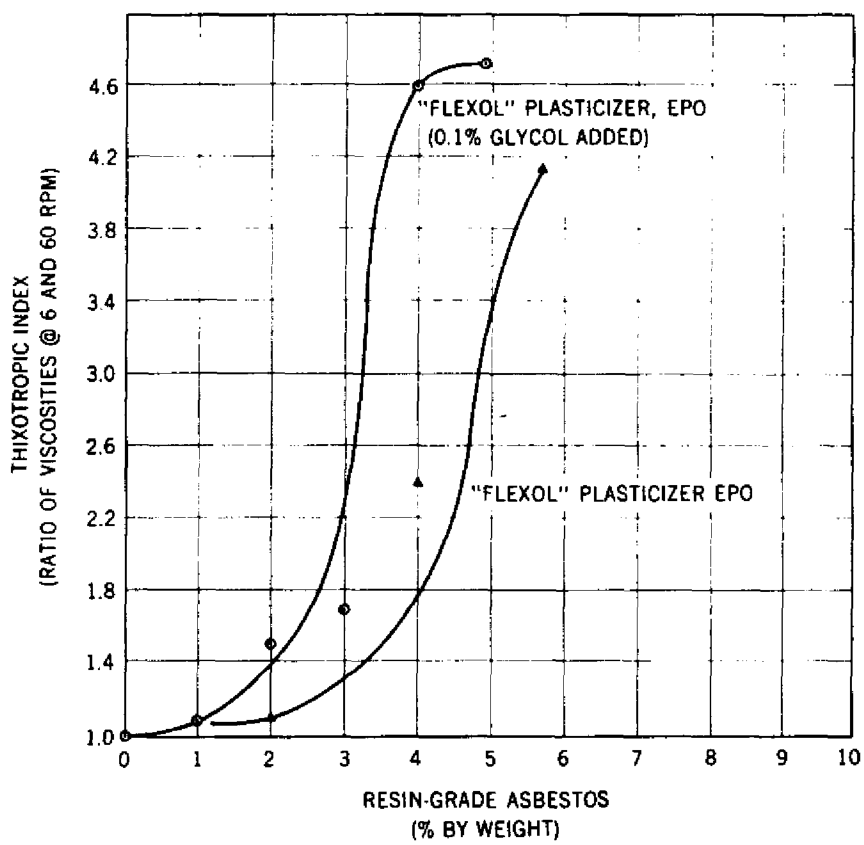
	6855 West 65th Street, Chicago, Ill.	312-581-5000
	22 Battery Street, San Francisco, Calif.	415-982-1360

THICKENING EFFECT OF RESIN-GRADE ASBESTOS IN "FLEXOL" PLASTICIZER, EPO



THIXOTROPIC INDICES OF RESIN-GRADE ASBESTOS IN "FLEXOL" PLASTICIZER, EPO



Dispersing of Union Carbide's Resin-Grade Asbestos in Di-Octyl Phthalate using the Cowles Dissolver

The subject matter serves as a means of introducing Resin-Grade Asbestos with vinyls in plastisol compositions.

The following composition was dispersed using a 1-VG Cowles Dissolver with a B-1503 (3") impeller in a 4-1/8" diameter vessel.

80% Di-Octyl Phthalate (DOP)
20% Resin-Grade Asbestos
100

Log of operation:

Start with all the DOP and at 1800 RPM charge in one-half the Resin-Grade Asbestos into the vortex of the mixture. Raise the RPM to 5000 and run for 2 minutes. Temperature reached 120°F. Lower speed to 1800 RPM. Charge in 1/2 of remaining asbestos and raise RPM to 3000 and run for 2 minutes. Lower speed again to 1800 RPM and add balance of asbestos. Then operate equipment as follows:

Min.	Temp.	RPM	Observation
0	130°F.	3000	Maintain lower speed to prevent surge.
5	150°F.	4000	Rolling flow without showing a vortex.
10	175°F.	5000	RPM raised to maximum permitted by condition of mix. Rolling flow without a vortex. Slight occasional surge only, diminishing as temperature increases.
15	210°F.	5000	
20	235°F.	5000	Batch secured.

Concentrations greater than 20% asbestos do not seem practical because of the surging nature of the flow pattern due to viscosity increase. With DOP as the vehicle, there seems to be no channeling (cutting a hole) about the impeller. Examination under the microscope for uniform break-up of the clusters of asbestos seems to be the best method for evaluating the dispersion method. The agglomerates of asbestos seem to be uniformly attrited to the ultimate fiber lengths within 10 minutes.

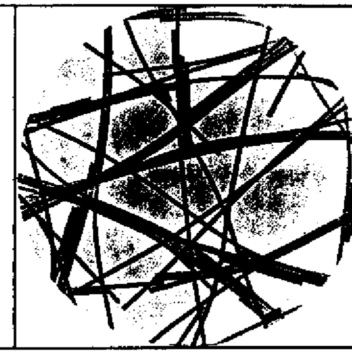
It takes about a minimum of 20 minutes for complete dispersion because of the inability to reach maximum speed sooner than 10 minutes. Concentrations of 10-12% can be dispersed in 10 minutes at 5000 RPM.

Suggested use in: Coatings, Plastisols, Mastics, Polyesters.

UNION CARBIDE ASBESTOS

PRODUCT INFORMATION BULLETIN

Photomicrograph of Union Carbide's high-purity asbestos fiber



UNION CARBIDE CORPORATION · MINING AND METALS DIVISION · 270 PARK AVENUE, NEW YORK, NEW YORK 10017

UNION CARBIDE STANDARD GRADE ASBESTOS

FOR USE IN VINYL AND ASPHALT TILE

ADVANTAGES

1. Standard Grade Asbestos is available in both pellet and opened fiber form. The high density of the pellet form lowers transportation costs. It is particularly suitable for bulk handling.

2. Pelletized Asbestos may be added directly to Banbury mixers. This method simplifies handling and permits larger batch sizes.

3. Union Carbide Asbestos contains less gangue. This means there is more fiber available for re-inforcement. Substantial savings are possible in reducing the % asbestos in tile formulation.

4. Union Carbide Asbestos is brighter and cleaner. It serves as an extender for TiO_2.

ASBESTOS FIBER ANALYSIS

	Union Carbide Tile Grade Opened Fiber	Union Carbide Tile Grade Pellets	Typical Canadian Grades
Oil Absorption (ml. D.O.P./10 gms)	8 - 9	-	3.5
Wet Bulk (ml./10 gms)	95 - 110	-	45 - 200
Dry Bulk (lbs./ft.3)	7 - 11	44	12 - 23
% Reflectance at 450 M	68 - 72	-	57 - 69
B.E.T. Surface Area (M^2/gm)	56 - 58	-	12 - 28
% Magnetite	1.0 - 2.0	-	4.5

Rotap

Mesh	% On	% On
+10	0.02	0.02
-10+20	1.23	4.82
-20+40	13.08	41.80
-40+100	48.58	27.20
-100+200	12.51	7.99
-200+325	8.14	18.00
325XD	16.43	.20

TYPICAL TILE FORMULATION AND PROCESSING-CONDITIONS

Formulation:

Copolymer	15.56%
Primary Plasticizer	4.66%
Epoxy Plasticizer	.78%
Lubricant	.20%
Stabilizer *	.75%
UNION CARBIDE ASBESTOS	12.00%
Limestone	63.05%
TiO_2	3.0%

Processing:

Preblend	15 minutes
275° Sigma Mixer	6 minutes 230°-240°F Drop Temp.
Differential Mill	Rolls at 285° and 195°F
Calender	Rolls at 170° and 180°F

Tile Analysis:

	Union Carbide Pellet Grade	Union Carbide Opened Fiber
1. McBurney Indent:		
a. 1 Min., 72°F	7.7	7.5
b. 10 Min., 72°F	10.0	10.9
c. 30 Sec., 115°F	27.8	19.9
2. Reflectance at 450 mu of finished tile %	65	64

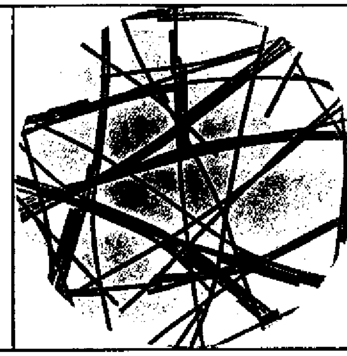
* Suggested Stabilizers and Manufacturers:

1. Advastab CZ-45	Advance Division Carlisle Chemical Works
2. Vanstay PX-126	R.T. Vanderbilt Company
3. Mestap MGH	Nopco Chemical Company
4. Ferro 5109	Ferro Chemical Company
5. Metasap MEG-3	Nopco Chemical Company

UNION CARBIDE ASBESTOS

PRODUCT INFORMATION BULLETIN

Photomicrograph of Union Carbide's high-purity asbestos fiber



UNION CARBIDE CORPORATION • MINING AND METALS DIVISION • 270 PARK AVENUE, NEW YORK, NEW YORK 10017

UNION CARBIDE'S HIGH PURITY ASBESTOS -- AN EFFECTIVE LOW-COST FIRE RETARDANT

aff II

Union Carbide's unique High Purity Asbestos has specific qualities that make it useful for the preparation of "Viscous Water" for fire control. It produces thick water slurries which adhere even to vertical combustible surfaces while allowing controlled penetration of water into the depth of the combustible material.

Union Carbide High-Purity Asbestos Characteristics

1. The asbestos is a noncombustible mineral in the natural form of a short fiber measuring one-millionth of an inch in diameter.

2. The fibers are completely separated from each other during the refining process, thus maximum absorbency, dispersibility, and thickening effects in water are obtained.

3. Rock, slimes, and magnetite have been removed by a special process to form a pure asbestos product of extremely low abrasiveness to pumps or other fluid handling equipment.

Slurry Characteristics

Small concentrations (3% or 25 lb. per 100 gal.) of high-purity liberated asbestos mixed with water forms a slurry that is essentially an inorganic "gelatin". The slurry is thixotropic; static viscosity is that of a gel. It will adhere to vertical surfaces. High-purity asbestos slurry retains 70% to 80% of the water as a thick, adhesive blanket on the fuel surface. The 30% free water drains slowly from the slurry to penetrate into the depth of the fuel.

A small quantity of "wetting agent" can be added to the slurry to increase the depth penetration rate of free water. A unique, dual function slurry results, having a valuable combination of "viscous" water and "thin" water characteristics.

Foam generating chemicals* can be added to the slurry and the mixture applied through a foam nozzle. The asbestos foams have a very high strength and persistence.

Asbestos Forms

High Purity Asbestos is shipped in 20 and 40 pound bags as a dry, opened material. There is no necessity to protect the material from freezing or from getting wet. Outside storage under a tarpaulin is adequate. It is also available in the form of high-density pellets in 50 pound bags. The pellets require the application of mechanical attrition energy to open the fiber and must be repulped in a "beater" type apparatus instead of the simple recirculation or line mixer used for the opened asbestos.

Slurry Preparation

Asbestos-water slurry is usually prepared from dry, opened fiber. A moderate degree of hydraulic shear is necessary to fully re-liberate the fiber. Recirculation through a pump or discharging the mixture through an orifice or throttling valve is sufficient to produce a viscous slurry. Slurries are permanently stable at solids concentrations as low as 0.5%, allowing for advance batch preparations.

Asbestos slurry is slightly basic (pH of 9.0). Corrosion effects are no different from that of water. The salt content and pH of the water have minimal effects on the slurry viscosity.

Asbestos slurry is compatible with the long term retardants, wetting agents, and foam* chemicals.

(Wetting agents and foam chemicals should be added after the asbestos has been mixed to prevent the formation of foam in the mixing tank).

Batch and line mixers have been used to prepare slurries of 2% to 6% by weight asbestos. A typical formulation consists of 3% weight of asbestos (25 lb. per 100 gal.) and 0.07% by volume (8 oz. per 100 gal.) wetting agent for depth penetration of the fuel by the 30% free water.

Slurry Application

Asbestos slurry can be applied with standard apparatus. The small, colloidal-like size of the fibers produce a mixture which flows and is handled in the same manner as water through pumps, hose and nozzles. Because magnetite, rock, and slimes have been removed, abrasion is extremely low. Wear on brass parts is negligible. Being thixotropic, it is highly viscous when static or at moderate shear rates, but it exhibits a decreasing viscosity with increasing shear rate. The following table shows the flow rates that can be obtained with a slurry containing 3% asbestos through 100 feet of one-inch hose.

* Foam generating chemicals of the non-ionic or cationic types (protein base) produce an extremely effective foam for use on Class B fires. The anionic types cannot be used with asbestos on Class B fires.

Asbestos - 3% by Weight

Hose - 100 Foot Length, 1 Inch I.D.

Flow Gal/Min.	Pressure Psig
10	24
20	30
30	34
35	36) Same as Water
40	47)

Typical Uses

Asbestos slurry has been used in tanker trucks, slip-on units and back pack tanks. The long term stability of the slurry is ideal for advance preparation in tankers so that the greater knock down and flash back effects of viscous water are always available for the first water applied to the fire.

Example of Use in 500 Gallon Tank - 3% Weight of Asbestos

1. Load 450 gallons of water into tank.

2. Start pump with high recirculation rate of water. Adjust recirculation valve for pressure drop of 50-100 psig.

3. Add 125 pounds of High Purity Asbestos to the recirculating water.

4. Top off tank to 500 gallon and continue recirculation for 1 to 2 minutes.

5. If wetting agent is normally added during storage it can be put in during the last few seconds of recirculation. Otherwise add the wetting agent as in normal operation.

Costs

At 3% consistency, 25 pounds of asbestos are required per 100 gallons, giving a total cost of 2.0 cents per gallon. With 8 oz. of wetting agent for 100 gallons, the total cost is 2.2 cents per gallon ($2.20 per 100 gallons). These costs are based on the delivered price of the asbestos on the East Coast; West Coast prices are lower.

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UNION CARBIDE ASBESTOS

PRODUCT INFORMATION BULLETIN

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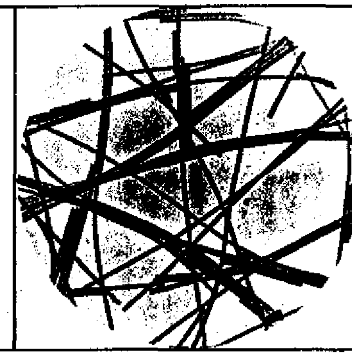

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UNION CARBIDE'S HIGH-PURITY ASBESTOS --

ADVANTAGES FOR USE AS A FOREST FIRE RETARDANT

aff - I

Research and study by Federal and State agencies have defined the necessary characteristics of forest fire retardants and supressants[1, 2]. High-Purity Asbestos meets these requirements to a far greater degree than other mineral and organic thickeners for "viscous" water. These characteristics are as follows:

1. Low cost of asbestos plus low quantities required at 2% to 6% (17 to 50 lb. per 100 gal.) provide viscous water at 1.8¢ to 4.4¢ per gallon.

2. Readily available in pound or tonnage quantities.

3. Non-toxic to plant or animal life - Asbestos is an insoluble, non-reactive mineral.

4. Adheres to Forest Fuels as well as impermeable vertical surfaces such as steel siding.

5. Prevents or reduces rekindling, especially at the higher concentration of 6%.

6. Does not act as a desiccant on vegetation.

7. Requires a small amount, less than other mineral thickeners.

8. Mixes easily with no special requirements for either rate of addition or dispersion during mixing.

9. Unaffected by temperature changes.

10. Nonabrasive, noncorrosive and nonerosive.

11. Stores well, does not require protection from freezing or moisture.

12. Conveniently packaged in 40-pound bags.

13. Not sensitive to pH or mineral content of water.

14. Will not deteriorate from biological or chemical action.

15. Insensitive to minute contamination; neither wetting agents nor chemical retardants affect "gel" qualities.

16. "Gelatin" characteristics obtained with low shear energy.

17. Pre-mixed batches permanently stable, no settling of the asbestos slurry.

18. Mixing and Handling readily developed by trained fire control personnel.

19. Flows through fire hoses and nozzles without serious friction loss, yet sets up and holds once it is applied.

20. Slipperiness not a serious problem, spills and dried slurry residue removed by hose flushing.

21. Not degraded by shear stresses in pump and fittings.

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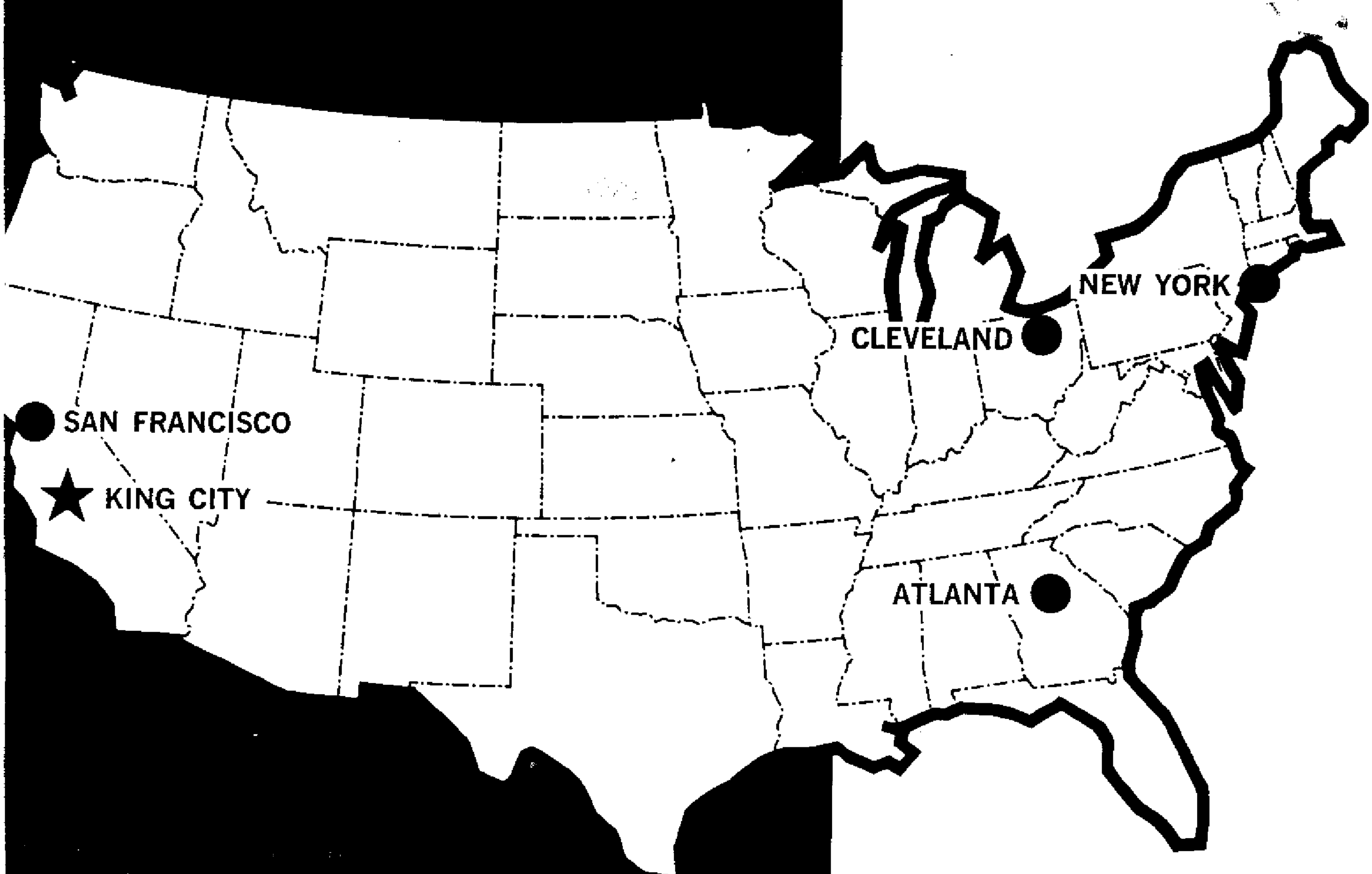
(1) California Air Attack Coordinating Committee, 1958 "Performance standards and test procedures for new chemical fire retardants".

(2) Hardy, C.E., Rothermel, R.C. and Davis, J.B., 1962 "Evaluation of forest fire retardants: A test of chemicals on laboratory fires." Research paper 64, 33 pp., illus. U.S. Forest Serv., Intermountain Forest and Range Expt. Sta.



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