

ASBESTOS

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by

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Research on Asbestos Fibres

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(Jubilee Annual Meeting, Vancouver, B.C.)

(Transactions, Vol. LI, 1948)

INTRODUCTION

VERY little fundamental research has been done on asbestos fibre to take maximum advantage of its properties and to determine in what commercial products it can best be utilized.

For the research chemist who is associated with asbestos development work, a thorough study of mineralogical information on asbestos deposits would furnish reliable information on the rock formations and the mineral impurities closely associated with the asbestos. Furthermore, he must have an intimate knowledge of the uses of the fibre in various products so that he can visualize the importance of the fibre and the role it plays in industry.

Some of the properties of asbestos fibres such as strength, composition, length, harshness or softness, and mineral associates are of considerable importance to the manufacturer because they are responsible for many production difficulties.

FIBRE STRENGTH

It has been known for some time that asbestos filaments have considerable tensile strength. These strengths have been referred to merely as 'weak' to 'very strong'. Not until recently have numerical values been applied to the strengths of asbestos fibres. But today we can take a thin fibre filament and mount it between two holders and apply a gradually increasing load or pull until the fibre breaks. By measuring the cross sectional area of the filament and the amount of load applied, we can calculate the tensile strength of the fibre in terms of pounds per square inch. This type of test is slow and rather difficult, but the fundamental data obtained furnish important basic information that can be applied to mechanical processing equipment and to certain asbestos products.

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During the processes of liberating the fibres from the wall-rock it is necessary to use some type of equipment that will crack the rock and release the fibre. The maximum strength of the fibre is preserved when this type of releasing is gentle and does not produce fractures at right angles to the fibre bundles.

It has been possible to submit crude bundles to processing equipment such as crushers, rolls, fiberizers, etc., and to test the tensile strengths of the fibres before and after processing in order to determine which type of equipment is best suited for opening fibre bundles without destroying the fibre strength. Even the speeds at which some pieces of equipment are operated have a definite effect upon the destruction of fibre strength and a change of several hundred r.p.m. may transform a strong fibre into a weak fibre.

When studying the fibre from a new deposit, it is important to know the strength of the fibre in its natural form, as 'crude', as well as after it has been processed. The basic information gained by this type of test is important when considering the installation of a new mill to process the fibre. If present milling practice is to be used, it may mean that certain pieces of equipment may require by-passing in order to preserve the fibre strength and not destroy the fibre length.

The strength of asbestos fibres is also important in certain commercial products, as for example textiles, papers, and asbestos-cement products. If the strength of the fibre is low, the loss in the textile plant will be high due to drops from the cards and willows. In papers, weak fibres will be ground down by the beater roll. Lifting of the roll may be required, or even reducing the beater cycle, in order to obtain a well formed paper where the fibres retain their maximum strength. In asbestos-cement products, the fibre strength is im-

portant. As the fibre strength is decreased by a processing method, so also is the modulus of rupture of an asbestos-cement board or sheet decreased.

Typical tensile strength values of chrysotile asbestos crudes range from 40,000 to 100,000 pounds per square inch. Sometimes these values are well over 100,000 provided the filaments have not been deformed by wall-rock movement during the period of crystallization.

Other fibres, such as amosite, will have values ranging from 15,000 to 90,000 pounds per square inch, while crocidolite will show strengths from 100,000 to 300,000 pounds per square inch. Some of these values are far greater than the tensile strength of the usual grades of reinforcing steel.

COMPOSITION OF ASBESTOS FIBRES

Commercial asbestos fibre, when carefully separated into various fractions, is found to be made up of a number of component parts: crudy fibres, in which the slender threads or filaments are not separated, but remain in bundles; dust, consisting of extremely fine particles, either fibrous or granular; fairly small size particles of serpentine rock or other minerals closely associated with the fibre deposit; and relatively pure fibres separated into thin threads or filaments. All of these fractions go to make up a commercial fibre and each component part plays a definite role when the fibre mass is used in industry. For example, the crudy bundles improve filtration in wet processes and contribute towards porosity, but they also impart to asbestos papers a rough texture which may be objectionable. Dust acts as a filler which decreases porosity, decreases filtration rates, and increases the density. Rock and other granular material may drop out as a loss during processing or, if it remains with the fibre, it will increase filtration rates, increase

porosity, and give a rough surface textile to papers or pressed products. If the granular material consists in part of magnetite particles, this is considered objectionable from the standpoint of the electrical industry. Therefore, each component of an asbestos mass plays a definite part and it is an extremely difficult task to separate these materials from the fibre mass commercially and to eliminate those that may be objectionable.

Knowing, then, that commercial grades of fibre contain opened fibres, crudy bundles, fines, and granular materials, it is possible to separate these by a special laboratory technique and express their values in percentages of the original fibre mass.

From our experience, it has been noted that certain grades of fibres require certain combinations of the fibre component parts, and that a change of 10 to 15 per cent in these fractions will make a large and noticeable difference in the manufactured product. Likewise, when we know the type of fibre and the percentages of its component parts needed for a product, we can develop this grade of fibre for this particular product.

Furthermore, when working with asbestos in plastics, the various component parts of a given grade of fibre are extremely important factors. In this case, we are involved in such physical measurements as absorption, wettability, fluidity, impact strength, power factor, bulking, and surface area. This means that the research chemist must know the effects of crudy bundles, fines, and granular materials upon the properties of absorption, wettability, fluidity, etc. After these facts have been established, he must understand the effects of various combinations of the fibre component parts (crudy bundles, rock, etc.) upon these physical properties. With this fundamental information as a background, it is then necessary to make up molding powders, press them in molds, and study the properties of the molded material to see if the objective has been attained.

The results of all these studies place the producer of asbestos in a position to discuss problems understandingly with the plastics manufacturer and to help him with his problems, particularly in the selection of the proper fibre grade.

FIBRE LENGTH

The measurement of the true

staple length of the fibres is probably the most difficult of the asbestos producer's jobs. Asbestos is unlike cotton, rayon, or other organic fibres that can be combed out and the lengths actually measured in inches or fractions of an inch.

The staple lengths of fibres in any given mass vary from those approximating $\frac{1}{8}$ in. and longer to those of microscopic size. Methods that have been successfully applied to organic fibres have failed to give satisfactory results when applied to asbestos. Wet screening methods have given fairly good classifications providing the fibre surfaces are presented horizontally to the screen opening during the test. If the fibres pass lengthwise through the screen opening, the test loses most of its reliability.

A test that can measure the true fibre lengths and can be completed within a few minutes would most certainly be welcomed by the industry. Further effort should be directed by the research chemist to the solution of this problem.

HARSHNESS AND SOFTNESS OF A FIBRE

The terms 'harsh' and 'soft' are often used by the miner and manufacturer in connection with asbestos fibre.

In many cases, the harshness of a fibre is erroneously used to mean crudeness. This point should be clearly defined as the two terms are entirely different. The term 'crudeness' means the presence of many hundreds of fibre filaments in bundles that are unopened and are wider than a thirty-second of an inch. The bundles also tend to appear stiff and will not bend through a 90° arc without fracturing. Of course, these crudy bundles could be soft, silky, or harsh, but, after they are properly opened, they have lost their crudeness as bundles or aggregates and appear as opened or willowed fibres that can be bent at right angles without breaking.

Harsh fibres, on the other hand, are usually weaker than soft fibres and, during a processing method whereby the thin filaments are separated and bent at right angles, they have a tendency to fracture easily, with resultant loss of fibre length. Some investigators have attributed the harshness of a fibre to the presence of mineral impurities which have crystallized close to the fibrils (1, 2, 3). Others believe it to be due to the water of crystallization or water of constitution of the asbestos (3). In any case, the degree

of harshness of a fibre is an important factor in its use in industry.

If a harsh fibre is micro-pulverized and examined under a microscope, it is noticed that the fibres show an abrupt breakage and the pattern resembles a needle structure instead of the wavy pattern shown by a soft, silky asbestos fibre.

The degree of harshness of a given fibre may be estimated by a number of tests such as: (1) opening of the fibre in a standardized piece of equipment and measuring the length loss and increase of fines produced; (2) the tensile strength; and (3) its filtration properties before and after opening. The results of these tests may be expressed as the percent change and the numerical values used for comparison purposes.

It is interesting to note that a harsh fibre always retains a relatively fast filtration characteristic regardless of the type of processing. On the other hand, a so-called soft or silky fibre decreases in porosity at a rate proportional to the degree of opening of the fibre filaments.

It is the fast filtering characteristic of a harsh fibre that makes it attractive to the manufacturer, provided the fibre strength is not too poor. This type of fibre is an excellent material for 'freeing-up' a stock, giving porosity and aiding filtration. However, the manufacturer must be careful in handling harsh fibres or he may destroy the maximum fast filtering properties of the fibre by over processing.

Soft, silky fibres are normally difficult to handle by the manufacturer producing wet machine products. These fibres have a greater surface area than harsh fibres, and are also slower filtering. The degree of softness of a fibre can also be estimated by the same procedure employed for evaluating a harsh fibre and numerical values can be used for comparisons. Usually, it may be said that the softer and silkier the fibre, the greater the difficulty in handling it during the stages of manufacturing. Therefore, it is necessary for the manufacturer to have some knowledge of the workability of soft fibres before he attempts to use them, and it is usually the research man that can determine these properties and supply the necessary information.

FILTRATION

The filtration characteristic of any fibre mass is an important factor to the manufacturer using wet

methods for the production of asbestos products. For example, the rate of removal of water, either by suction or by pressure, when manufacturing asbestos papers, mill boards, shingles, asbestos-cement sheets, etc., will, to a certain extent, govern the production rates.

Therefore, in order to understand the problems facing the manufacturer, it has been necessary to develop a laboratory filtration test that can evaluate fibres as fibre masses, or as fibres in combinations with other ingredients that are used in commercial products.

The first step in this type of investigation was to determine the effects of all mineral impurities closely associated with commercial asbestos fibres. The next step was to study the filtration properties of asbestos fibres from all parts of the world and also, at the same time, determine the percentage of each mineral impurity.

This was followed by studying the effects of electrolytes, wetting agents, soft or harsh fibres, fibre particle size, weathered fibres, blends containing various types of fibre, crudy fibre bundles, and many others upon a standardized fibre in order to show the advantages or disadvantages as regarding the elimination of water from asbestos slurries. With this type of information available, it has been possible to express the degree of filtration change in percentage and then set up methods of correction so as to obtain the maximum improvement in filtration. Many production problems involving the elimination of water from fibre slurries have been investigated in the laboratory and the information has been successfully applied to the factory processes.

VALUE OF X-RAY STUDIES

Today, X-ray diffraction studies are becoming one of the standard tools of the research chemist. They give the chemist a chance to obtain a preliminary answer to some of his problems within a few hours, whereas a chemical analysis may require weeks of analytical work.

Quite often, the chemical analysis of asbestos fibres shows the presence of small quantities of magnesium, silica, or water in excess of the normal amounts found in an average sample of asbestos. When these data are calculated in terms of minerals, they may indicate small amounts of talc, brucite, chlorite, etc. occluded in, or crystallized between, the fibrils. In such cases, a

careful X-ray investigation shows the typical ring structure of the minerals and the data can then be recalculated showing the percentages of the mineral impurities present in the fibre.

X-ray studies, along with petrographic investigations, have furnished valuable clues to chemical reactions that may take place not only in asbestos fibres themselves, but in finished products.

KNOWLEDGE OF GEOLOGY OF DEPOSIT AS AN AID TO THE MANUFACTURER

If the manufacturer purchases fibre at random, the material he obtains may include asbestos from several different deposits, and the mineral formations of each locality will contribute some important factor to the fibre that may or may not be objectionable to his process.

For example, suppose a certain asbestos-cement manufacturer for a number of years purchased his fibre supply from one mine, where the rocks were very little faulted and hence there was very little fault fibre, and where such minerals as brucite, picrolite, and magnetite were present in only small amount. This manufacturer would have all of his processes well standardized on the fibre from this mine and everything operating in a satisfactory manner. Now suppose that he decided to change his source of fibre supply and the fibre came from a deposit in another locality where there was considerable faulting, and considerable amounts of fault fibre, brucite, picrolite, magnetite, and other minerals. What would happen?

First, if he did any re-processing of the fibre in his factory, such as willowing, he would notice a loss in fibre due to formation of dust or fines caused by the willowing action on the fault fibre, brucite, and minerals present.

Second, the fibre, having a total overall lower strength, would have a tendency to lose length during any processing stage.

Third, the surface area of the processed fibre would be increased and it would have a tendency to require more binding agent.

Fourth, the fibre, when wet, would be slimy and difficult to handle.

Fifth, the porosity of the fibre would decrease and the removal of water by normal filtration means, either by suction or by pressure, would be slowed down, thus resulting in a decreased output of the products.

Sixth, the strength of the final products would probably show a decided decrease in modulus of rupture.

If these changed conditions were suddenly thrust upon the manufacturer, without any forewarning, he would be in a difficult position. Consequently, today, the research chemist studies all of these problems long before the manufacturer needs to make the fibre change. He first consults the geological literature of the locality in which the fibre occurs and becomes familiar with the rock formations. With this information as a background, he obtains large representative samples of the fibre and studies its physical properties in the laboratory. This is followed by pilot-plant tests, where products are made under conditions similar to regular manufacturing procedures. When all of this work is completed he is ready to make a recommendation to the manufacturer as to the value of the fibre and as to whether it can be used successfully, and, if so, what changes in processing will be necessary.

It may be urged that these tests are time consuming and may not be worth the expense, but, if a manufacturer loses production in his factory for any length of time, his financial loss is considerably greater than the cost of the surveys and tests made by the research and development chemist.

FUTURE OF THE ASBESTOS INDUSTRY

The asbestos industry appears to have reached a stage where considerable expansion of output of fibre is necessary. In making this statement it is, of course, assumed that there will be no displacement of asbestos by other materials in the products for which it has been used in the past and also that the many new developments now in progress will materialize commercially in the near future.

The demand for asbestos today far exceeds the supply, and it has been necessary for many producers of asbestos products to curtail production because of the shortage of fibre.

The situation has been relieved somewhat as a result of many refinements in extraction at the mills which have made it possible to increase recoveries and throw away less fibre in the tailing product.

Developments in the plastics industry in Canada and the United States during the past few years open up an estimated potential

may reach 400 to 11,000 tons per year.

The asbestos-cement products industry in the United States and Canada, which uses flat sheets, corrugated sheets, shingles, etc., may, it is estimated, consume 200,000 tons of asbestos per year.

The asphalt tile industry, which uses short asbestos fibre, has shown considerable expansion during the past few years, and this consumption may be estimated at 120,000 tons of asbestos per year.

There is also an increasing production of asbestos papers, mill boards, brake linings, clutch facings, pipe coverings, roofings, black line, etc., that require asbestos fibres of various grades. The total amount of fibre used in these products in Canada and the United States might be estimated at 180,000 tons per year.

Therefore, it may be said that the potential volume of asbestos that could be consumed in Canada and the United States might reach a total of 450,000 to 500,000 tons per year for the next few years provided the fibre is available and the asbestos products manufactur-

ing process is uninterrupted by labour conditions or shortage of materials, to expand the present factory equipment.

CONCLUSIONS

In concluding, the writer wishes to point out that, in our work on asbestos fibres in the Research Center, we have set up a procedure to be followed during our fundamental and development investigations. This plan of investigation includes the following types of approach:

- (1) Obtain the complete history of the source of the fibre.
- (2) Study its physical and chemical properties.
- (3) Improve the physical or chemical properties of the fibre so that it will be better suited for its specific use.
- (4) Study the processing technique and develop the best method in the pilot plant for handling the fibre and then recommend the procedure to be followed in the factory.
- (5) After the preliminary investigations are completed, the processed fibres are submitted

to other pilot-plant operations in the Research Center, where regular products are made on a semi-commercial scale.

If the problem involves very large tonnages of asbestos fibre, the work is transferred to the large-scale pilot plant at the mines at Asbestos, Que., where large size production milling equipment is used.

In this manner, we are able to follow the fibre from the earliest stages in the crude or mill rock throughout all its investigations in the laboratory and pilot plants, and during the time when the fibre is incorporated into the final product. This procedure gives the research man full responsibility for the research and development work until the factory accepts the material and takes over the production job.

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Filterability of Asbestos Fibres Used in Wet Processes

By M. S. BADOLLET*

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INTRODUCTION

THE manufacture of some asbestos products involves the use of asbestos in combination with water, cement, and granular fillers. This type of production is often called the wet or semi-wet process and requires the use of either pressure or vacuum to eliminate the excess water in the fibrous blend so that the product may develop the proper strength during the curing stage.

Asbestos-cement products available today are numerous and are a valuable contribution to the building industry. Their production in quantity depends upon the type of equipment employed, the speed at which it can be operated, and the factors involving the blending of asbestos cement, water, and fillers.

Assuming that all mechanical troubles at a plant have been eliminated or are under control, it is still advisable to study the basic properties of the raw materials used in the asbestos-cement products.

The type of cement used is an important factor, but usually the manufacturer of the cement is willing to work with the asbestos development engineer and recommend the proper type to be used for the product.

The source of the water should not be overlooked as a general factor involved in the production cycle. Waters containing a high percentage of contamination such as silts, humus, or soluble salts may adversely affect the setting of the cement or cause a slowing down of the production rate in the factory.

Asbestos in combination with cement is an ideal material for building products. It is inorganic, will not deteriorate, and can be handled

by mechanical equipment with a minimum reduction of fibre length.

The many physical properties peculiar to asbestos fibres (1) should be well understood by the manufacturer. They may be briefly enumerated as follows: fibre strength, fibre composition, slimmness, length, harshness, softness, and filterability or porosity. This last named property is important and it is the purpose of this paper to present some basic studies on filtration as applied to production problems.

FILTRATION STUDIES

The term filtration is used here to designate the removal of water from a slurry or wet matte of asbestos fibre by applying pressure or vacuum.

A simple laboratory procedure has been devised for accurately

measuring the filterability of asbestos in water, or of asbestos in combination with water and cement. The apparatus (Figure 1) consists of a vertical bomb or cylindrical iron pipe threaded at each end so that it may be capped. The bottom cap is fitted with a screen and outlet so that the filtration proceeds on this disc of a definite area. The water or filtrate which passes through the filter matte is passed up vertically through a rotometer which accurately measures the rate of flow. Pressure is applied gradually by the use of a pressure regulator so that a constant rate of flow is maintained throughout the filter cycle. Slight agitation is maintained within the bomb by allowing the entering air to percolate

(1) See BADOLLET, M.S., *Research on Asbestos Fibres*; C.I.M., Trans., Vol. LI, 1948, pp. 131-134.

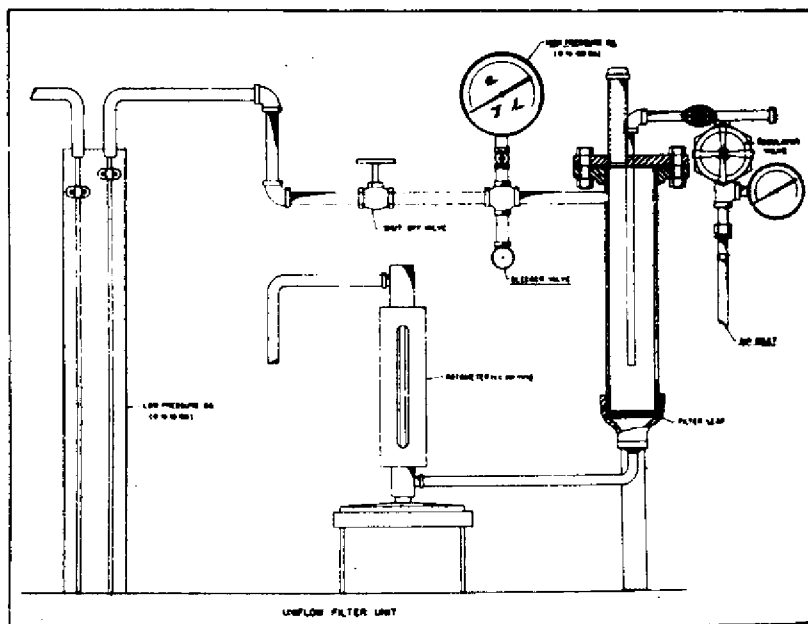


Figure 1.—Apparatus for measuring the filterability of asbestos.

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upward from a point or several points above the filter disc. This prevents settling of the slurry and allows a gradual deposition of the fibre upon the filter disc.

The data obtained by such filter tests are plotted on co-ordinate paper and the areas under the curves are measured in square inches so that the values can be compared directly with each other.

Procedure is as follows: The top of the filter unit is removed and a small sample of the fibre under study, made up as a slurry in water, is poured into the bomb and the cap replaced. A low pressure is applied and the entire amount of fibre in the bomb is allowed to deposit on the filter disc or leaf to form a thin pre-coat. A larger sample of the fibre is now made up as a slurry and placed in the bomb for the actual test. By means of a pressure regulator, the float in the rotometer is maintained at a standard rate of flow (in terms of c.c. per minute). The pressure is continually applied so that the flow rate is kept constant. Pressure readings are recorded every 30 seconds and the pressure values are plotted against time in order to present the data graphically.

Effect of Asbestic Fines

A quantity of commercial asbestos fibre was first cleaned to remove all dust, rock, and asbestic fines. This clean fibre was then set aside for the filtration studies.

The asbestic fines or dusts used in these studies were obtained from an asbestos-mill dust house. A microscopic examination of the dust showed that the particles ranged in size from 0 to 40 microns and were of irregular shape with practically no fibrous structure.

Blends of these fines with the clean fibre were made up, containing, respectively, 10, 20, 30 and 40 per cent fines.

Filtration studies were made on each of these blends and also on the clean fibre. The results of the tests are given in Table I and are shown graphically in Figure 2.

The data, when plotted graphically (Figure 2), give typical filtration curves and from these we are able to measure the area under each curve and calculate the effect of the fines upon filtration.

It will be quite evident from inspection of Figure 2 that the pres-

TABLE I.—EFFECT OF ASBESTIC FINES

AREA DESIGNATION (See Figure 2)	PERCENTAGE OF FINES IN SAMPLE	AREA UNDER CURVE AT 6 MIN.	PERCENT DECREASE IN POROSITY DUE TO PRESENCE OF FINES
E.....	0%	10.326 sq. in.	—
D.....	10%	12.148 sq. in.	17.64%
C + D.....	20%	15.989 sq. in.	54.84%
B + C + D.....	30%	22.655 sq. in.	119.40%
A + B + C + D.....	40%	27.373 sq. in.	165.10%

$$\text{CALCULATION (example): } \frac{12.148 - 10.326 \times 100}{10.326} = 17.64\%$$

ence of asbestic fines is objectionable since they adversely affect the filtration characteristics of an asbestos fibre. The manufacturer objects to the presence of asbestic fines because they slow down the wet process machines and also increase his overall fibre losses by

as slow filtering, poor saturation, and increased density, and, finally, will give a brittle product.

Effect of Temperature of Water

In many wet processes, the water temperature is an important factor and production rates can be increased by taking advantage of this fact.

A series of four tests were conducted at temperatures (F.) of

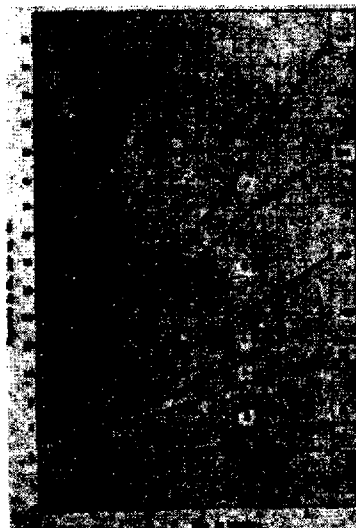


Figure 2.—Effect of fines on filterability of asbestos.

passing through the equipment screens into the waste water.

It is known that commercial fibres contain various amounts of admixed asbestic fines and that, if these form a high percentage of the total fibre mass, they will cause serious manufacturing troubles such



Figure 3.—Effect of water temperature on filterability of asbestos.

50°, 72.5°, 86° and 122°. In each case the same fibre was used, so that the only variable was the temperature of the water.

The results of the tests are presented in Table II and, graphically, in Figure 3.

TABLE II.—EFFECT OF WATER TEMPERATURE

TEMPERATURE °F.	AREA UNDER CURVE AT 6 MIN.	INCREASE IN FILTRA- TION RATE
59°.....	25.918 sq. in.	—
72.5°.....	21.629 sq. in.	16.6%
86°.....	18.481 sq. in.	28.9%
122°.....	13.295 sq. in.	48.7%

$$\text{CALCULATION (example): } \frac{25.918 - 21.629 \times 100}{25.918} = 16.6\%$$

These tests show that, by increasing the water temperature, it is possible to remove the water from an asbestos fibre slurry in a shorter time and thereby give the manufacturer an opportunity to increase his production rate. In some plants, warm water is used so as to gain this added advantage.

Effect of Serpentine Rock of Different Sizes

Serpentine rock relatively free from asbestos was ground in a ball-mill and screened for size by sieving on a rotap apparatus. A constant weight of each screen fraction was then added to a constant weight of asbestos in order to determine which size is the most effective in improving filtration. The assumption was made that the rock particles were perfect spheres and that the average diameter of each particle was the average of the screen openings. Although it is realized that this involves a certain amount of error, the method does give a rough comparison of the specific surface area in terms of cm^2 per gram.

It was found that, of the several screen sizes of serpentine rock used in the tests, the most effective in improving the filtration characteristics of the asbestos fibre was the -20+35 mesh material. The larger sizes apparently do not give as good a porous structure to the fibre, and with the smaller sizes, also, the filtration rate is lower, due to decrease in the porosity of the fibre mass (see Table III and Figure 4).

Although the presence of some suitably sized serpentine rock is beneficial in improving the filterability of asbestos fibres, care must be taken not to use an excessive amount, which would adversely affect the physical structure of the asbestos-cement products. If the percentage of grit or serpentine rock exceeds that normally present in commercial grades of asbestos, then the asbestos-cement products will have lower strengths and increased densities.

Effect of Crudy Bundles or Pencils

Milled fibres as sold to customers frequently contain crudy bundles that are not properly fiberized. The presence of these bundles, if not further opened by re-processing, will have certain adverse effects

TABLE III.—EFFECT OF SERPENTINE ROCK

SCREEN SIZE OF ROCK	CALC. SPECIFIC SURFACE AREA	AREA UNDER CURVE AT 6 MIN.	IMPROVEMENT IN FILTRATION
0.....	—	28.9 sq. in.	—
- 8 + 10 mesh.....	11.8 cm^2/gm .	14.8 sq. in.	48.8%
- 10 + 14 mesh.....	16.8 cm^2/gm .	11.8 sq. in.	59.2%
- 20 + 35 mesh.....	37.4 cm^2/gm .	9.0 sq. in.	68.8%
- 65 + 100 mesh.....	154.0 cm^2/gm .	16.1 sq. in.	44.3%
- 150 + 200 mesh.....	294.0 cm^2/gm .	17.6 sq. in.	39.1%

$$\text{CALCULATION (example): } \frac{28.9 - 14.8 \times 100}{28.9} = 48.8\%$$

upon filtration and upon the quality of the manufactured products.

A quantity of crudy fibre was selected and fractions of various screen sizes were separated on a rotap apparatus so that a constant weight of these bundles could be added to a constant weight of fibre.

greatest effect upon speeding up the filtration properties of an asbestos fibre (see Table IV and Figure 5). As the surface area of the bundles increased, the tendency was for filtration to be slowed down, thus indicating that, if all the bundles were completely opened,



Figure 4.—Effect of rock particles on filterability of asbestos.

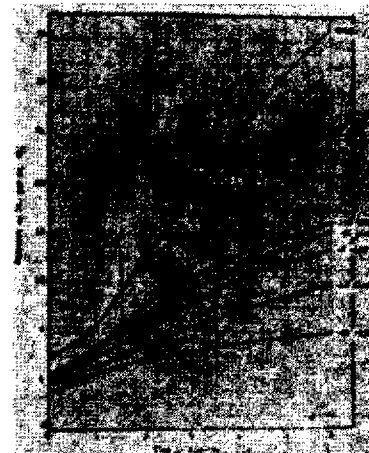


Figure 5.—Effect of crudy fibre bundles on filterability of asbestos.

In this case it was necessary to make the assumption that the fibre bundles were perfect cylinders. The lengths and diameters of these bundles were measured under the microscope and then averaged for each screen fraction.

The crudy bundles with the smallest specific surface area had the

the filtration rate of the fibre would approach that of a normal fibre and would be classed as slow.

Screening of the crudy bundles on the 10 mesh screen indicated that the grading for size was not accurate, as the specific surface area of these bundles should have been between 102 and 127 cm^2 per gram.

TABLE IV.—EFFECT OF CRUDY FIBRE BUNDLES

SCREEN SIZE	CALC. SPECIFIC SURFACE AREA	AREA UNDER CURVE AT 6 MIN.	IMPROVEMENT IN FILTRATION
Original.....	0	28.9 sq. in.	—
- 4 + 8 mesh.....	102.0 cm^2/gm .	7.1 sq. in.	75.5%
- 10 + 14 mesh.....	168.0 cm^2/gm .	9.4 sq. in.	67.5%
- 14 + 28 mesh.....	127.0 cm^2/gm .	11.6 sq. in.	59.8%
- 28 + 35 mesh.....	164.0 cm^2/gm .	13.2 sq. in.	54.3%

$$\text{CALCULATION (example): } \frac{28.9 - 7.1 \times 100}{28.9} = 75.5\%$$

calculations seem to agree with the general trend and indicate a decrease in the fibre bundle cross-section.

As shown graphically in Figure 5, the 4-1-2 bundles increased the filtration rate more than did the 22-1-22 mesh bundles.

From the viewpoint of the manufacturer, the presence of the crudy fibre bundles would be considered satisfactory — particularly if he did any reprocessing — as he would have more effective fibre present in his product. It might even enable him to reduce the quantity of fibre used and make a superior product at a reduced fibre cost. However, the presence of crudy fibre bundles has a detrimental effect in some products because they impart a rough surface, and any subsequent sanding or polishing would result in the product having an uneven texture.

Fibres From Different Deposits

For these tests, samples of asbestos crudes from a number of sources were carefully processed so as to avoid contamination with particles of the wall-rock, and, after a preliminary opening by hand, were passed through a laboratory-type micro-pulverizer so as to obtain fibres of approximately the same size. The pulverized fibres were measured under the microscope and were then tested for filterability.

The cross-section measurements indicated that, for each prepared sample, the widths ranged from 1 to 5 microns and the lengths from 10 to 200 microns.

Figure 6 shows graphically the results of filtration tests. The slowest filtering fibre tested is the Arizona soft fibre (curve A). The prepared Canadian soft fibre (curve C) is faster filtering than the Arizona soft fibre. The Italian slip chrysotile (curve D) is faster filtering than the Canadian soft fibre.

The Cyprus chrysotile (curve F), which has a semi-harsh feel to the hand, would be considered fairly fast filtering in comparison with the other soft fibres. Curve E represents a typical Canadian semi-harsh fibre and it would be considered fast filtering. Curve D was obtained for a very harsh fibre from Arizona; this is extremely fast filtering.

The area measurements of each curve are given in Table V. In order

TABLE V. Filtration Characteristics of Chrysotile Fibres
(Fibre width, 1-5 microns; fibre length, 10-200 microns)

IDENTIFICATION	CURVE (Figure 6)	AREA UNDER CURVE AT 4 MIN.	FILTER-ABILITY (Can. soft = 100%)
Arizona soft.....	A	13.89 sq. in.	37.6%
Canadian soft.....	C	8.50 sq. in.	100.0%
Italian slip.....	D	6.40 sq. in.	124.7%
Cyprus.....	F	3.30 sq. in.	161.2%
Canadian semi-harsh.....	E	1.78 sq. in.	179.0%
Arizona harsh.....	B	0.24 sq. in.	197.2%

to compare the curves we have taken the Canadian soft fibre as the standard. By this method we are able to express the filterability of each fibre as a percentage, with Canadian soft fibre taken as 100 per cent. Since the Arizona soft fibre was so slow filtering it was impossible to measure the area of its curve at the end of six minutes. As a consequence, the area measurements in these tests were all made at the end

harshness, the fibre will filter faster.

Application of Technological Information to Manufacturing Processes

The importance of the filtration characteristics of asbestos fibres should not be overlooked by the manufacturer of asbestos products which are made by wet or semi-wet methods. In the manufacture of paper, millboard, shingles, pressed sheets, or pipe, the ease of the removal of the water will to a certain extent affect the production rate. If a fibre is difficult to de-water, then the manufacturer either changes his process mechanically, changes his grade of fibre, or uses some fibre blend that will allow him to maintain the production rate.

By adding a fast filtering fibre to a slow filtering fibre it is possible to step up production rates, but the manufacturer must be careful not to overdo this mixing for fear of losing strength in the product.

It is usually considered that fibres ranging from semi-harsh to harsh are fast filtering and likewise that the fibre strength decreases with its degree of harshness. Therefore the manufacturer must exercise care in selecting his fibre, or the ratio of soft to harsh fibre in his fibre blend must be well planned, in order to obtain the best fibre for his particular process.

At the present time, United States manufacturers of asbestos products who employ the wet or semi-wet process consume approximately 340,000 tons of asbestos per year. This includes approximately 11,000 tons of fibres from countries other than Canada and the United States. This immediately raises the question as to why these foreign fibres are used. Would they be used if Canada could supply the total tonnage required? The answer to this ques-

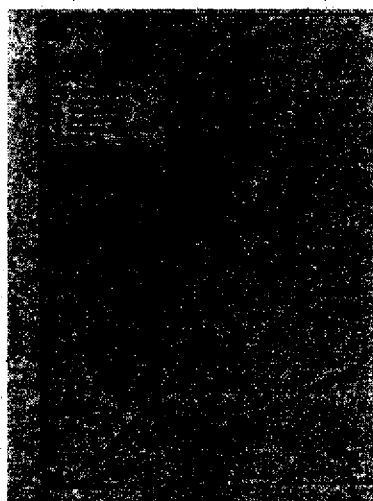


Figure 6.—Filtration characteristics of chrysotile fibre from various localities.

of four minutes instead of six minutes.

On this basis of comparison, the Arizona soft fibre (curve A) is 82.4 per cent slower filtering, and the Italian slip fibre (curve D) is 24.7 per cent faster filtering, than the Canadian soft fibre (curve C). For the Cyprus, Canadian semi-harsh, and Arizona harsh fibres, the filtration rate is faster than for the soft chrysotiles.

A physical examination of each of these fibres would show that the softer and silkier a fibre, the more difficult it is to filter. As the softness of texture decreases and the fibre assumes a certain degree of

tion is not so much concerned with the availability of the fibre as with the particular physical properties of the foreign fibres that give the manufacturer the effects desired in his operations. These foreign fibres have the required free filtering properties and at the same time have strength. They also give the manufacturer sufficient latitude for blending, so that he can sweeten his slow filtering fibres with strong fibres that are fast filtering.

CONCLUSIONS

(1) The presence of asbestic fines or shorts decreases the filterability of a fibre mass in proportion to the

quantity of fines or shorts present in the mixture.

(2) By increasing the water temperature it is possible to increase the filterability of a fibre mass and thus improve the operation of the process.

(3) The presence of serpentine rock will increase the filterability of a fibre mass provided the rock is not too small in particle size. In the tests made, —20+35 mesh material gave the maximum improvement in filtration; with smaller sizes, the filtration rate began to decrease, due to decreasing porosity of the mixture.

(4) Crudy fibre bundles will improve filtration. As the cross-section

of the bundles is decreased, the filtration rate is slowed down. The presence of large quantities of crudy bundles may also affect the surface texture of the product, a factor which must be taken into consideration.

(5) Fibres from different deposits show considerable diversity in filtration characteristics. Soft, silky fibres are difficult to filter; semi-harsh to harsh fibres filter easily.

(6) By knowing the filtration characteristics of different fibres it is possible to select those that filter rapidly or to blend fibres to obtain the desired filtration results to fit the manufacturing process concerned.