

ASBESTOS TEXTILE INSTITUTE
TECHNICAL COMMITTEE REPORT
COMMODORE HOTEL, NEW YORK
MARCH 8, 1962

Present

E. C. Cutler	- American Asbestos Textile Corporation
W. Maaskant	- American Asbestos Textile Corporation
J. D. McCluer	- H. K. Porter Company, Inc.
D. S. Nichols	- U. S. Rubber Company
M. W. Oliver	- Raybestos-Manhattan, Inc.
D. F. Quealy	- Keasbey & Mattison Company
V. H. Tower	- Asbestos Corporation Service Limited
J. L. Tucker	- Johns-Manville Research Center
Dr. M. C. Shaw	- Asbestos Textile Institute

Subject

Government Specification SS-C-00466C - Recommended Revisions.

3.3.1 Fabrication

Two recommendations were made:

Majority recommended -

- *1. "Cloth shall be woven with single or ply yarns. Cloth may be finished to provide qualities and characteristics such as lint free, brushed, calendered, napped, dry woven or wet woven, providing tensile and construction qualities are maintained as specified."

Minority recommended -

- *2. "Cloth shall be woven with single or ply yarns, with or without glass yarn insert, at buyers option as specified."

3.3.2 Tolerance in Width

- ± 1/2 in. for 40 in. width and less than 40 in. widths.
- ± 3/4 in. for 40 in. to 60 in.
- ± 1 over 60 in.

3.3.3.1 Table I

* Majority recommended reference to yarns used be kept from specifications.

*Minority recommended yarns used be stated in specification.

3.3.3.3 Table II

*Majority recommended 1,40 cloth 24 ends 12 picks be eliminated from specification.

*Minority recommended it be left in specification.

Table III A

*Majority recommended that no reference to yarn count be shown in specification.

*Minority recommended yarns used be shown in specification.

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Table III B

- *Majority recommended that this table be eliminated from specification.
- *Minority recommended this table be a part of specification.

3.3.3.4 Style

- *Majority recommended all reference to yarn cuts including glass yarns be eliminated.
- *Minority recommended inserting statement as is in revised specification.

3.3.6.1 Table I Grade AAA-M

Two cloths mentioned have same weight 2.60. The question asked related to the fact different diameter wire insertions were used for each cloth and whether or not there might be some difference in their weights. This should be checked by all manufacturers of these cloths and comments or recommendations made to Dr. Shaw if there is a difference.

3.5 Form III - Thread, Sewing Without Wire

The breaking strength of four pounds appears to be too low.

Note: Yarn count is mentioned as well as minimum yards per pound required. Should yarn count be eliminated?

3.6.1 The tape shall contain not less than 80 per cent asbestos. The construction shall be 16 ± 2 ends by 8 ± 1 pick.

Reference is made to yarn count. Should yarn count be eliminated?

4.2.1.1 Eliminate the last seven words...."and offered for delivery at one time."

4.2.1.2 Eliminate the last seven words..."And offered for delivery at one time."

4.2.2 Add a last sentence..."Rejected lots may be offered again for inspection provided the contractor has repaired or removed all nonconforming material. The inspector shall again examine samples from resubmitted lots to verify compliance with this specification."

4.3.1 Add a last sentence...same as above 4.2.2.

4.4.1.3 Chemically Combined Water

- *Majority recommended elimination from specification.
- *Minority recommended this be left in specification.

4.4.1.4 Breaking Strength

The breaking strength of the cloth shall be determined by the method 5100 of specification CCC-T-191.

4.4.1.6 Weight

The weight shall be determined in accordance with method 5040 of specification CCC-T-191.

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4.4.3.1 Hygroscopic Moisture

*Majority recommended deletion of all references to chemically combined water.

*Minority recommended specifications as stated be accepted.

5.2.1.2.1.1 Rolls

Substitute details as stated in SS-C-00466b (current specification).

5.2.1.2.1.2 Thread and Tape

Substitute 5.2.1, Level A, SS-C-00466b.

5.2.1.2.2 Level B

5.2.1.2.2.1 - Substitute 5.2.2, Level B, SS-C-00466b.
5.2.1.2.2.2

Request use of domestic type fiberboard box according to PPP-B-636 for level B.

Insert Level C from 5.2.3 SS-C-00466b.

6.1.1 Form I - Grade UG Cloth and Form IV Tape

This cloth and tape are intended for use as the jacketing material over thermal insulation, etc.

6.3 Eliminate.6.4 Commercial Sizes and Variation in Quantity.6.4.1 Cloth

Asbestos cloth is normally available in widths of 36 in., 40 in., and 60 in. These cloths are commonly supplied in rolls of 50 yards $\pm$ 5 yards. Form I Style 3 cloth is commonly supplied in rolls of 100 yards $\pm$ 10 yards. Ten per cent of the total rolls may contain two pieces.

6.4.1.1 Variation in Quantity

A permissible variation of $\pm$ 2 per cent shall be allowed. Such increase or decrease shall apply to the total quantity of each item or sub-items to be delivered to each of the destinations listed herein.

Note: *These subjects were not unanimously approved; hence are listed on other sheets that will be forwarded to ATI members for final comments. As soon as you receive them, approve or disapprove each subject and return the sheets immediately to Dr. M. C. Shaw with your comments.

Where there is no * revisions were unanimously approved.

J. L. Tucker

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FELLOWSHIP REPORT

MYRIL C. SHAW

RESEARCH FELLOW

ASBESTOS TEXTILE INSTITUTE

PHILADELPHIA TEXTILE INSTITUTE

PHILADELPHIA, PA.

REPORT #58

June 8, 1962

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MT-004326

Introduction

During the past quarter the attentions of the Fellow have been directed toward 1) the revision of specification SS-C-00466b, 2) considerations regarding revision of MIL-I-3053c, 3) the evaluation of cloth tensile strength as it is influenced by adhesive and cementing agents, and 4) the improvement in the equipment and the accuracy of the Mapes Magnetic Analyzer in the A.T.I. Fellowship laboratory.

We have endeavored to confine our activities to those within the limits of the projects contained in Group A of the recently drafted project list. Within this area we have, through inquiry on the part of the Bureau of Ships, initiated another review of specification MIL-I-3053c, Insulation, Electrical, Asbestos-Fiber, Treated and Untreated. This latter consideration having for its apparent primary purpose the desire to more clearly define the dielectric strength properties of the materials included.

In addition to the regular programs of study as outlined, investigations have been conducted for member companies, including magnetic rating evaluations and heat aging studies on cloths.

Revision of Specification SS-C-00466b.

Specification SS-C-00466b in the form which contains those recommendations of the majority of our membership is now being reviewed by the Bureau of Ships. The recommended specification continues to contain most of the cloths that were included in the last issue of the subject specification with only the following constructions having been eliminated: (1) Style 2, 1.40#, 24x12 construction, Grade U.G., (2) Style 3, 0.90#, 15x14 construction, Grade U.G., (3) Style 5, 1.10#, 14x8 construction, Grade U.G.

It was however, recommended that the wire inserted, Grade AAA-M cloth, having one strand of 0.008 nickel-copper alloy be noted to weigh 2.75# rather than 2.60# per square yard as heretofore.

Specific exceptions were taken to those portions of the original proposal by the Bureau of Ships wherein revisions were suggested covering Packing.. The provisions proposed by the Bureau of Ships specified that the cloth should be packed in fiber drums. Exception has been taken to this proposal since, if it were to become effective, problems of warehousing and stocking the drums would pose serious problems and the over-all effect would be to increase the delivered costs of those materials so packed.

Further, in considering these specifications, Mr. J. H. Chilcote has inquired as to whether or not the Grade AAA-M, wire inserted cloth might be used as the inside covering for removable flange covers and fittings at temperatures up to 1050°F for intermittent service and 950°F. for continuous service. This inquiry has been circulated within our membership and it is hoped that, following further discussions at these meetings, a satisfactory answer in this regard may be concluded.

It is hoped that the considerations to be pursued at this meeting will afford an opportunity to finalize the recommended revisions for this specification and that the Bureau of Ships will be able to issue the revised edition at an early date.

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Revision of Specification MIL-I-3053c.

The subject specification is also of primary interest to the Bureau of Ships, however, Mr. W. B. Shetterly is the individual within that agency who is responsible for this activity rather than Mr. J. H. Chilcote who is responsible for SS-C-00466b.

The concern at this time originates from a directive received by the Chief of the Bureau of Ships from the Commanding Officer, U. S. Navy Electronics Supply Office, Great Lakes, Illinois, dated 1 February 1962, which states in part: - "It is requested that this specification (MIL-I-3053c) be amended to include dielectric strength or voltage ratings and applicable tests for all materials. This information is desired for the proper application of these materials and to define the minimum quality level."

This specification, it will be recalled, covers lap, roving, paper, tape, sleeving and cloth. The untreated paper is the only item included which sets forth the dielectric strength and conducting path properties. It is felt by the Navy Electronic Supply office that some data in this regard for the remaining items should also be set forth in this specification.

This subject has been one of consideration and concern by the Bureau of Ships and by A.S.T.M. on previous occasions, however, to all who are familiar with the subject it is obviously clear that the dielectric strength of an untreated cloth or tape or sleeving is practically that of air over the dimensions of the gap provided by these air permeable materials. The materials here under consideration are rarely, if ever, utilized as an electrical insulation media without some kind of a varnish or impregnating treatment such as silicone, Teflon, phenolic or an asphaltic base saturant and the ultimate dielectric strength properties are dependent upon the type and effectiveness of these treatments.

The asbestos textile material in the service here under consideration provides a permanent, thermally stable base possessing excellent elevated temperature serviceability characteristics and the dielectric strength is accomplished through the effective, uniform impregnation of the insulating varnish, afforded by the uniform textile construction of the materials here under consideration.

The dielectric strengths of the untreated materials are of little concern, however, the effectiveness with which the treated product serves as an electrical insulation is a function of the textile construction and uniformity as well as the type and effectiveness of the treatment.

Asbestos textiles provide perhaps the most desirable base material for such electrical insulators because of 1) the ultimate in fiber subdivision which provide the most effective impregnation media, 2) the ability of the asbestos fibers and the textiles composed thereof to be thoroughly and uniformly wetted and impregnated by the treatment, and (3) inherent "agelessness" of chrysotile asbestos, an inorganic fiber, both at room temperatures and at elevated temperatures far in excess of any conditions under which they are called upon to serve today.

It would seem therefore, if the Bureau of Ships is to insist upon a specification of dielectric properties for those materials included in MIL-I-3053c,

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either that agency or the industry as represented by the Institute should specify and standardize upon one or perhaps two typical treatments that may be applied and establish representatively acceptable dielectric strength values on this basis.

It should be noted at this point that the conducting particle test referred to in MIL-I-3053c, paragraph 4.6.5, Note, has been deleted from all A.S.T.M. considerations and is not recognized as an effective test procedure. The recently revised Tentative Specification for Asbestos Textile Used for Electrical Insulating Purposes, submitted for letter ballot in June, 1962, recognizes only the Mapes Magnetic Rating Test as the method for evaluating electrical properties and type for asbestos textiles.

The Evaluation of Cloth Tensile Strength as Influenced by Adhesives and Cementing Agents.

In our studies to evaluate the possibilities of utilizing cloths competitive in weight and construction with Brattice cloth as a lagging material suitable for application in SS-C-00466b, attention has been directed to the tensile strength of the cloths included in this specification in the "as received" state as compared with the "applied" or cemented state. Concern has been expressed from time to time regarding the use of cloths exhibiting widely different characteristics for similar applications at different shipyards. It would appear at first glance that reasons other than the basic properties of the cloth and the requirements of the service to which they are to be subjected motivate such conditions. It would further appear that if economies are to be affected in such constructions and the most effective construction is to be achieved, attention will necessarily have to be ultimately directed toward the establishment of a selection of the best materials to meet the demands.

It is not necessary at this point to review in detail the requirements for the materials covered in this specification, however, it is of interest to observe that the tensile strengths, as received, for plain woven cloths may range from as high as 125# to as low as 40# for the warp, grab strength and from 70# to 30# for the fill grab strength.

Since tensile strength in the "applied" form is the significant characteristic in this application and not necessarily the strength in the "as received" state, and since most applications are affected by cementing or pasting, it was felt that some consideration regarding the influence of the application media upon the ultimate tensile strength would serve a useful purpose. Several cloths, most of which are typical of lagging cloth materials, were selected for study in this investigation and two adhesives, representative of those commercially available and used, were selected as the application media.

Sample Preparation. The test samples for tensile strength measurements in these studies were 1"x6" cut-strips, in the warp direction. In order to obtain such test specimens, a cloth sample 12"x6", the 6" dimension being in the warp direction, were processed. The sample preparation was accomplished by applying an adhesive to one face of the cloth, for one series of tests and to the two faces of the cloth for a second series of tests, following which the specimens were applied onto a sheet of light weight aluminum foil and troweled and smoothed down to achieve good adherence. Each specimen so processed was then set aside and permitted to air dry for 24 hours.

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Following drying, the 12"x6" sample was cut into 12 test specimens having the dimensions 1"x6". Three such test specimens were first tested for tensile strength as air conditioned and three additional samples were placed in an oven and heat treated for 4 hours at 200°F., after which the tensile strength was also determined.

Aluminum foil back-up media was selected in order that the effectiveness of the bonded combination of the adhesive and the cloth might be best evaluated. It was essential that the adhesive coated fabric, once applied onto the back-up media, would not in any way be affected by the back-up either through the absorption of all or a portion of the adhesive, or by chemically attacking or altering either the cloth or the adhesive. Aluminum foil seems to satisfy these requirements and contributes very little in tensile strength, actually to an extent of less than one-half pound which is not determinable on the testing machine used.

Adhesive. Two Benjamin Foster adhesives were selected for this investigation, both of which are extensively used on board ship for lagging cloth applications. The adhesive used for the plain asbestos cloths was Benjamin Foster-Fibrous Adhesive, 81-27. This is a sodium silicate base adhesive and cannot for that reason be used in conjunction with asbestos-glass combination cloths.

The asbestos-glass combination cloths were applied using Benjamin Foster-Lagfas, Type 2, 81-42W, recommended by the manufacturer for all adhesive applications where glass cloth or glass insulation is to come in contact with this adhesive.

The amount of adhesive used for each test was determined and these values are reported for both one side and two face applications.

Results. Table I sets forth the results obtained in this first series of tests. It will be observed that the tensile strength improvements obtained for the air-cured plain cloths with the one side applications using adhesive 81-27, covering sample #1 through #12, ranged from 32.1% to 113% and for the two side applications from 27.6% to 243%. It is significant to note that the same magnitude of improvements was not obtained on the samples which were heat treated at 200°F for 4 hours. In fact, in most cases, the heat treated samples were inferior when compared to the air cured samples.

On the other hand, the glass-asbestos cloths applied using the 81-42W, Lagfas adhesive, samples #13 through #16, exhibited markedly different characteristics than those above noted for 81-27. The air cured samples with one side applications showed only slight improvement in two cases of the 22P10G cloths and in one case of 22P10G some degradation was noted. In the case of 18P10G more marked improvement was found. For these latter cloths, the two face applications, air cured, were only slightly better than the one side applications. However, the heat treatment of the asbestos-glass 81-42W combination at 200°F for 4 hours resulted in a considerable improvement in strength, ranging up to 52 percent for the one face and 61 percent for the two face treatment of 22P10G and 76 percent for the one face 18P10G cloth to 79 percent for the two face treatment on the same cloth.

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Table I

Cloth No.	Weight Oz.	Tensile Strength - Pounds per 1" cut-strip										Heat Treated - 200°F 4 Hrs.				Adhesive Add-on Lbs. / Sq. Yd.	
		Air Cured					% Improve.					One Side		% Improve.		One Face	Two Face
		As Received	One Side	% Improve.	Two Side	% Improve.	One Side	% Improve.	Two Side	% Improve.	One Side	% Improve.					
1	17	60.5	82.3	36.2	121.3	100	92	52.0	97.3	61.0				1.2	2.26		
2	22	83.5	110.3	32.1	106.6	27.6	107.6	29.0	95	14.0				1.15	2.01		
3	36	68.5	94.0	37.3	225.3	243	94	37.2	177.3	159.0				1.24	3.16		
4	22	37.4	53.6	43.3	82.6	121	48.6	30.0	82.6	121.0				2.04	3.54		
5	12	44.8	73.6	64.3	105.3	135	68.0	52.0	103.0	130.0				.74	1.37		
6	12	39.8	70.0	76.0	101.6	155	61.6	55.0	87.6	120.0				1.38	2.22		
7	12 (Bratt.)	101.6	102.0	---	115.3	13.8	63.0	---	74.6	---				0.65	2.10		
8	22	92.2	133.3	44.5	218	136	111.0	20.4	182.6	98.0				1.71	2.38		
9	22	82.0	134.0	63.5	214.6	163	118.5	44.5	187.6	129.0				1.74	2.48		
10	26	70.0	149.7	113.0	190.3	173	128	83.0	173.3	147.0				1.71	2.74		
11	36	77.0	127.3	65.5	232	200	109	41.5	189.3	146.0				2.06	3.36		
12	12	67.0	110.6	65.0	193	188	96.6	44.0	168.6	152.0				1.15	2.16		
13	22G	115.0	118.6	3.1	120.6	4.9	153	33.0	160.3	39.5				1.16	1.97		
14	22G	116.0	96.3	---	99.6	---	135.6	16.3	169	39.0				1.13	2.20		
15	18G	83.0	110.0	32.5	117	41	146	76	149	79				1.67	2.26		
16	22G	145	146	---	166	14.5	221	52	234	61				---	---		

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The results of these preliminary studies serves to corroborate the general understanding regarding the effectiveness of asbestos fiber as a reinforcing agent in a cemented or bonded fabrication. The fact that strength improvements of up to 243% in tensile strength were accomplished in these limited studies would seem to indicate that the establishment of the proper relationship between fiber grade, cloth construction and adhesive characteristics may well provide an area of investigation which could conceivably provide a logical basis for properly defining lagging cloth requirements.

Brattice cloth, a widely used ship board material, exhibits poor, "as applied", tensile strength characteristics under the conditions of the test conditions here pursued, showing no improvement for the one face treatment and only a 13.8 percent improvement for the two side treatment, air cured. Further, after heat aging at 200°F. for 4 hours this material shows a loss in tensile strength of from 101.6 pounds, as received, to 63.0 pounds and 75 pounds respectively for the one face and two face applications.

One of the most significant and disturbing results of this study is the observation that there is a loss in the tensile strength characteristics for the plain asbestos cloths, as applied with adhesive, after the heat treatment at 200°F. for 4 hours. This would seem to indicate that there may be some degradory attack by the sodium silicate and that some improvements could be affected through improvement in this area of interest.

In summarizing, we would call attention to certain specific cases here set forth which would seem to provide a basis for future studies.

(1) In comparing cloths #5 and #6 with #7 (Brattice Cloth) all of which are 12 ounce cloths, it will be noted that the "as received" tensile strengths are 44.8# and 39.8# respectively for the asbestos textiles compared with 101.6# for the Brattice cloths. In the "air-cured" one face applications the asbestos cloths show tensile strengths of 73.6# and 70# against 102# for the Brattice cloth while the strength for the "air-cured" two face applications are 105.3# and 101.6# for the asbestos cloths against 115.3# for the Brattice. However, after heat treatment at 200°F for 4 hours, even though there is marked degradation in strength for all cloths concerned, the asbestos cloths exhibit higher strength characteristics than the Brattice cloth in all cases except one. Cloth #5 having strengths of 68 and 103 pounds respectively for one and two face applications and cloth #6 having strengths of 63 and 74.6 pounds respectively compared with strengths of 63.0 and 74.6 pounds for the Brattice Cloth, provides a significant relationship. It becomes ever more apparent as a result of these observations that a light weight asbestos cloth can be constructed which will possess much more desirable properties and serviceability than Brattice cloth.

(2) The greatest improvements here noted were for the heavier, 36 ounce cloths which showed 243% and 200% strength increases respectively for the two face applications, "air-cured", although it will be observed that the improvement for these same cloths, following the one face only application, was quite modest, being in most cases no better than most of the cloths here studied.

(3) The recommended adhesive coverage rate for 81-27 adhesive is 40 to 60 sq. ft. per gallon which is the equivalent of 1.4# - 2.0# (wet weight) per square yard. The one surface applications here studied were in most cases well within this range. The recommended coverage rate for 81-42W is 85 to 100 sq. ft. per gallon or 0.84# - 1.00# per sq. yd.

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(4) As a result of these studies it would seem that some improvement should be sought in the elevated temperature serviceability of the adhesive-cloth combinations. Whether it is the adhesive or the cloth construction that is the principle contributor to the degradations which occurs at the elevated temperature here used must be established and corrective measures pursued on the basis of these determinations. Also, it would seem advisable to establish the proper yarn construction and cloth construction necessary to accomodate optimum amounts of adhesive in order that maximum bonding characteristics may be achieved. The extent of the range obtained in these limited studies serves to indicate that proper considerations in these regards should prove fruitful.

Mapes Magnetic Analyser Improvements.

During the past few months efforts have been directed toward the improvement of the power output measuring instrumentation for the Mapes Analyzer in our laboratory. This desired end was accomplished through the insertion of 1) a 12-watt audio amplifier and 2) a Model 249 Eico Vacuum Tube Voltmeter with a 7-1/2" meter in the standard circuit.

In operation, the signal emanating as a result of the excitation of the solenoid may now be amplified to an extent sufficient to cause a full scale deflection on the 7-1/2" meter scale for either 1 MR or 6 MR equivalents.

Through these improvements it is felt that the instrumentation now available to us for such determinations affords the maximum in accuracy and reproducibility.

Conclusions

Much of the work carried out during recent months has been related either directly or indirectly to Federal Specifications and their revision. The light weight lagging cloth study here pursued carries a dual purpose in that it is motivated by the desire to develop an improved cloth to be used where Brattice cloth now finds application and, in addition, by a desire to study the relationship between the cloth construction and cementing or bonding properties. It would appear that the market for asbestos textiles has for sometime been and will in the future be increasingly dependent upon a favorable performance as a cemented or bonded reinforcement. In all probability most of the current production of asbestos textiles were not devised to satisfy the requirements of such applications. Therefore, a knowledge of the requirements for such materials must be secured if full participation in this field is to be realized. Much of the attention of the Fellow is to be directed to these considerations in the immediate future.

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MT-004333

FELLOWSHIP REPORT

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PHILADELPHIA TEXTILE INSTITUTE

PHILADELPHIA, PA.

REPORT #59

September 14, 1962

MS 004928

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MT-004334

Fellowship Report

During the past quarter the Fellowship activities have been concerned with matters related to 1) Federal Specifications and 2) considerations related to the possibility of extending the usefulness of asbestos textiles through the exploitation of the high strength and resilience properties of the chrysotile fiber.

The specification work was concerned with the proposed revisions for SS-C-00466c and MIL-I-3053c, and with the activities at the Military Construction Supply Agency.

Military Construction Supply Agency.

The Military Construction Supply Agency at Columbus, Ohio, was visited during the latter part of June, 1962, and discussions were at that time carried out with Mr. Ernest Sweet of the Standardization Division regarding the activities of that agency with respect to specification simplification and standardization procedures which, it is understood, are being there pursued. It is apparently within the province of this agency to resolve and, if possible, unify specifications covering a great variety of Federal procurements. Asbestos textile items are included within the area of concern of this agency and efforts are being exerted to bring within their scope of authority all possible specifications related to the subject items. In this endeavor it is quite apparent that those who have been assigned the task are not too well versed on the subject being considered and it is not clear at this point whether this agency is as much interested in unifying the specifications as it is in bringing within their scope of activity all of the relevant specifications and cataloging them so as to make all of the specifications into some form of an organized procurement facility. It would seem that unification is the ultimate goal of this agency, however, the task of bringing all of the current specifications and the several federal agencies who may purchase under these specifications into a harmonious, unified system will require a considerable amount of patience and effort.

SS-C-00466c.

At the June, 1962, meeting of the Technical Committee, several recommendations for revision of this specification were proposed and action was taken immediately following the meeting to bring these proposals to the attention of the Bureau of Ships. However, on June 19, 1962, the "d" revision was issued by the Bureau of Ships apparently without regard for the most recent recommendation. It seems apparent that the "d" issuance was in print prior to the receipt of our last recommendation which accounts for the omission.

MIL-I-3053

The question of prime concern that has been raised in connection with the subject specification is related to the dielectric strength of the materials covered. This subject has been thoroughly explored and it is the consensus of opinion that such tests are meaningless on untreated materials since asbestos textiles are normally treated prior to service as a dielectric. Further, there are a wide variety of treatments and the characteristics of the treatment will influence the dielectric properties of the treated product. To attempt to prescribe dielectric strength limits for the materials as covered in this specification would be unrealistic and impractical.

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There are however, several areas of concern with regard to the constructions and tolerances of some of the materials included in this specification and these questions will be pursued in the Technical Committee meeting.

Exploitation of High Strength Potentials of Chrysotile.

It is recognized that several members of the industry do now and have for some time been utilizing asbestos as a reinforcing medium in molded and laminated plastic composites. The efficacy and the potential market for such constructions has been established. However, it is felt that the asbestos textile industry as a whole is not taking full advantage of the market possibilities related to such endeavors.

As many of the old markets for asbestos textile products decline, and as many elevated temperature demands exceed the inherent capabilities of our basic raw materials it becomes necessary to seek out new fields of service and application for the products of our industry.

Information has just come to our attention which relates how the bituminous coal industry is taking on new life as many new and seemingly strange end uses for the blood of this once thriving industry endeavors to find new veins of life through which it may course. This is an oft repeated story in an advancing and growing industry and world.

While the asbestos textile industry has for many years supplied the plastic laminating industry with a vital basic commodity, there is reason to believe that through a better understanding of the structural and surface properties of the fiber and the ultimate potential capabilities of this unique physical structure, that a much stronger and more serviceable product can be furnished the industry than has yet been produced.

It is well within the scope of reasonableness and I fully expect to see in the not too distant future, asbestos fibers so efficiently and effectively bonded and by means of extrusion or some other more unique technique, spun into continuous filaments having dimensions of but a fraction of the finest asbestos yarn we can produce today. The fibers will be well opened and therefore extremely fine, approaching microscopic dimensions and the bonding medium will be in the form of extremely thin films a few molecules in thickness. Such a filament will exhibit the maximum in resiliency, flexibility and tensile strength. The elevated temperature serviceability will be dependent upon the bonding medium selected, however, in the current considerations this latter property is of minor significance as consideration is primarily directed to the development of high strength structural materials.

A review of our thoughts in this regard is attached as a part of this report.

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MT-004336

Chrysotile as a Strength Imparting Reinforcement

Introduction

In 1946, at the time of the inception of the Asbestos Textile Institute Fellowship, there was an urgency in the desire of many members of the industry to determine more precisely the several critical properties and characteristics of the fibrous minerals forming the asbestiform mineral group, with particular emphasis being directed to the attention of the mineral Chrysotile. More accurate parameters defining serviceability at high temperature and durability under the stress of elevated temperatures combined with physical abuse, were, it was felt, required if asbestos textiles and products which contained asbestos as a major constituent were to hold their competitive market positions with other materials that were making a concerted effort to enter the industrial product field.

Glass in its several forms as a textile or textile competitive product was at that time making serious inroads as a relatively stable material having a degree of elevated temperature serviceability. Shortly thereafter, ceramic aluminum silicate fibers were introduced and, it was then thought, were being readied to replace still other areas of service heretofore covered by asbestos. Pure silica fibers in the forms known as (1) fused silica or quartz fibers and (2) leached glass (Refrasil) were then envisioned and have since that time become commercially available refractory fibers. Also, in more recent years two forms of carbon -- carbon wool and graphite fiber, both of which may be resolved as textiles and which are perhaps the most refractory textiles today, that are reasonably commercially available, serving in many instances where temperatures in excess of 5000°F are encountered for extensive time periods. These are but a few of the causes for anxiety which were welling up in the minds of those whose very industrial existence was dependent upon the manufacture, sale and utilization of asbestos textiles in the early 1940's.

The industry as a group, through the sponsored efforts of the Asbestos Textile Institute, has subsequently endeavored to determine the answers to many fundamental technological questions that have been raised and have also investigated ways and means of improving the products of the industry and of extending the usefulness of asbestos textile materials to meet the varied demands of our ever changing industrial world.

The high room temperature strengths and the favorable space factor characteristics of some of the competitive fiber textiles are such that the asbestos textile manufacturers have been challenged to consider some improvements in these areas. The space factor parameters offered by competitive tapes and cloths has prompted activities directed toward the reduction of asbestos yarn cuts and a resultant lowering of cloth and tape weights to meet this challenge. The elevated temperature serviceability of many asbestos textiles have been improved through various treatments and fiber additives and by techniques of cladding and combining with other constructions to form composites designed to satisfy particular needs.

Most of these efforts toward improvement have resulted either from an impetus promoted by competitive materials entering the market or the demand of technology and industry for new materials to withstand a new service. Many

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of the old markets are a mere shadow of what they were some fifteen years ago, if indeed they have not vanished completely as a result of industrial change and, as modern engineering techniques continue to advance, many of the markets of today will be forgotten in the next ten to fifteen years.

Chrysotile as a High Strength Fiber

The image that appears almost immediately in the minds of most people when the word "asbestos" is mentioned is that of a fireproof mineral or fiber. This vision is understandable since this characteristic has been the one primarily emphasized nearly from the beginning of time to the exclusion of several other significant properties. However, Chrysotile asbestos fibers possess, in addition to relatively good elevated temperature serviceability, several other properties of significance which are rarely utilized to an extent that begins to tax the capabilities. For example, the tensile strength of the individual chrysotile fiber has been reported by various investigators to be in excess of 800,000 pounds per square inch and the flexibility is rated as extremely good. This latter property accounts for some of the success with which such fibers may be handled in textile processing. However, the incorporation of the staple form of chrysotile as a textile fiber serves to vitiate or obscure the tensile strength properties of the fiber. Actually, in the fiber to fiber contact of the textile constructions, the slipperiness which is characteristic of chrysotile serves to restrict maximum strength properties as the fibers tend to slide past each other when a tensile stress is applied to an assemblage of fibers, as in a yarn.

The utilization of asbestos fibers as reinforcement in asbestos-cement products and molded plastic products points up the effectiveness of these fibers as strength and resiliency imparting components in such applications. Resinated and laminated asbestos textiles normally exhibit high strength characteristics if proper impregnation techniques are employed and the curing is such that a true wedding and adhesion between the resin and the fibers is affected. However, in many cases the end results represent but a fraction of the potential capabilities inherent in these fibers due to improper and ineffective techniques employed in combining the several components.

Among the most critical requirements for materials of construction today, whether they be for air-borne structures, shipboard construction or land-locked applications are high strength with elasticity and resiliency combined with the lowest possible weight. The combination of chrysotile asbestos fiber as a reinforcement in a composite properly bonded through the use of a satisfactory resinous or cementation material certainly offers tremendous possibilities in meeting these demands.

Chrysotile as a Structural Reinforcement

The effectiveness of a resinating or impregnating treatment is primarily related to (1) the area of the surface of the filler or reinforcement materials and (2) the success with which the bonding medium activates the exposed surface and in joining all members into a compact unit. Ideally, it is desirable to be able to introduce the fibrous reinforcement material in the most dispersed state of subdivision. In the case of glass, and most other inert reinforcements currently used in such composites this is possible because the fiber diameter

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dimensions are not in the so-called micro-dimensions field. However, in the case of asbestos, the industry through the years has become accustomed to and accomplished in the art of handling bundles of fibers and little or no consideration is extended to the individual fibers where the dimensions range from $200\text{\AA}^{\circ}$ to $400\text{\AA}^{\circ}$. It would seem incumbent upon the asbestos textile industry, as we endeavor to extend the area of our markets and as we seek to better meet the demands of science and technology, that every effort be exerted to obtain the ultimate in every inherent capability of our basic material. We need to accurately determine and exploit that very last pound of inherent tensile strength, that very last increment of resiliency and elasticity and that very last degree of temperature serviceability, if there is to be a full realization of the marketable capabilities of our basic commodity—Chrysotile asbestos.

In order to accomplish this end a more exact understanding as to the nature of the chrysotile and other asbestiform mineral fiber surfaces will be required and the chemistry and physics of these surfaces must be understood. These inherent basic properties may then be exploited to the utmost in order that the inherent properties of the structural unit cell may be imparted with a minimum of distortion and diminution to the final product desired.

A review of some of the properties of chrysotile compared with other fibers that are either similar to or are competitively challenging some areas of asbestos usage may be helpful in properly understanding and evaluating the considerations at hand.

The available significant figures with which we are here dealing are not unfamiliar but for comparative purposes they are tabulated in Table I. These figures are typical of those found in most available handbook sources and are representative of those that have been handed down for perhaps many years. The accuracy of this data is therefore not above suspicion or question and if reference is made to a variety of periodicals and handbooks variations over a considerable range may be found. However, although it is felt that the comparative positions are relatively true and the values reported are well within a reasonable range of useful accuracy, such information must be accepted merely as a guide and, as specific applications are considered, the several conditions of service and fabrication of a given material into a finished product will establish the ultimate figures which will define the engineering capabilities of the finished product.

It will be noted that glass, type E, exhibits a Modulus of Elasticity in the range of 9 to 10×10^6 psi. However, when this same glass is incorporated as a laminate reinforcement, up to 75% of this important property may be sacrificed in a composite which exhibits 2.5 to 3×10^6 Modulus of elasticity. Tensile strength for the same product may be reduced from 200 to 300×10^3 psi for the original glass to from 70 to 90×10^3 psi for the composite. These same comparisons made for asbestos reinforced lamination are often equally distressing and serve to point up an area that requires some attention. It will be noted that chrysotile fibers may have a tensile strength of from 80 to 825×10^3 psi dependent upon the fibers involved and the techniques pursued in obtaining these values. An asbestos cloth having a thickness of $.070$ ", which is in the range for a normal 2.25 cloth, would, if all of the strength capabilities of the chrysotile fiber were made effective, exhibit a grab-test tensile in the neighborhood of perhaps somewhere between $25,000$ and $75,000$ pounds. Normally,

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Table I

	$10^3 \times \text{psi}$ Tensile Strength	$\text{psi} \times 10^6$ Modulus of Elasticity	$^{\circ}\text{F}$ Melting Point
Chrysotile	80-825	-----	2770
Glass	200-300	9.0 - 10.0	1600-2100
Stainless Steel	70-285	28.0 - 29.0	2650
Aluminum Silicate	100-180	-----	3200
Quartz	90-130	-----	3000
Nylon	60-128	.15 - .36	----
Cotton	44-109	-----	----
Wool	20-30	-----	----
Carbon	0.9 - 2.1	.16-.23	6000
Graphite	0.4 - 2	.05 - .18	6000

the commercial product, as it comes from the loom, an untreated woven cloth, would exhibit less than 1/2 of 1 percent of this figure, This same cloth, however, properly treated to effectively bring into force the inherent strength characteristics of the fiber structure through a proper resinating or bonding by a cementation medium may exhibit tensile strengths of from 10,000 to 25,000 psi and even higher.

There are few reinforcing media that possess the over-all processing capabilities of asbestos fibers and which potentially offer the high strength requirements for the construction materials of tomorrow. The fact that asbestos fibers possess a relatively high degree of refractoriness offers, aside from the ability to resist destruction at elevated temperature, the capability of permitting high temperature treatments and curing cycles that may serve to more effectively affect the formation of the composites through a more intensive adhesion mechanism.

Adhesives and Adhesion

In considering the problems involved in the process of uniting a heterogeneous mass into a composite, many factors must be organized into a meaningful pattern. There must be established, first, why is the composite to be accomplished; secondly, why were the individual units that are being used selected to make up the composite; and thirdly, how may the units be most effectively joined together in order that the desired finished characteristics may be achieved.

The first question can, in a general way, be resolved with the realization that such composites are currently finding increasing acceptance in the large industrial field encompassing structural materials. High strength - low mass materials are becoming increasingly important and it is felt that asbestos bearing composites can contribute much in these developments.

The second question, with particular reference relating to the selection of asbestos as one of the composite components, is specifically related to the strength characteristics of this unique mineral fiber. The selection of whatever other components may be required for the composite requires those considerations dependent upon the characteristics which are to be built into the structural

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unit necessary to satisfy the end use requirements.

The third consideration is related to the methods and techniques which are to be employed in achieving the desired finished product. In order that the desired ultimate properties may be attained it is essential, of course, that the proper proportion of each ingredient be so mixed and integrated that maximum effective contact may be realized and that such contact may be made as stable and secure as possible. This is just another way of saying that a firm bond or cementing action must be affected. It is within the scope of this last consideration that failures, when they occur, are usually encompassed, either through improper proportions, insufficient blending or integration or inadequate and insufficient cementing action between the many discrete units.

It is recognized by those experienced in the field of adhesives that cementation and adherence is most effectively accomplished through the utilization of thin films of the material that serves as the bonding medium. References to this understanding are illustrated in Charts I and II taken from the publication, Adhesion and Adhesives, by N. A. deBryne and R. Howerick. It has been established by authorities on the subject that as the film thickness decreases and approaches unit cell and molecular dimensions, the inherent structural forces of the molecular arrangement are exerted and maximum strengths are attained; however, as the film thickness is multiplied shear and slippage planes are encountered and these contribute to a weaker and lower strength-imparting structure. McBain says in this regard:

"A film or layer of adhesive in a joint shows a greater strength both in tension and in shear than the same material in bulk. The thinner the adhesive layer, the stronger the joint. The effect of thickness is not appreciable with thick films, but rapidly increases when the thinnest possible films are studied".

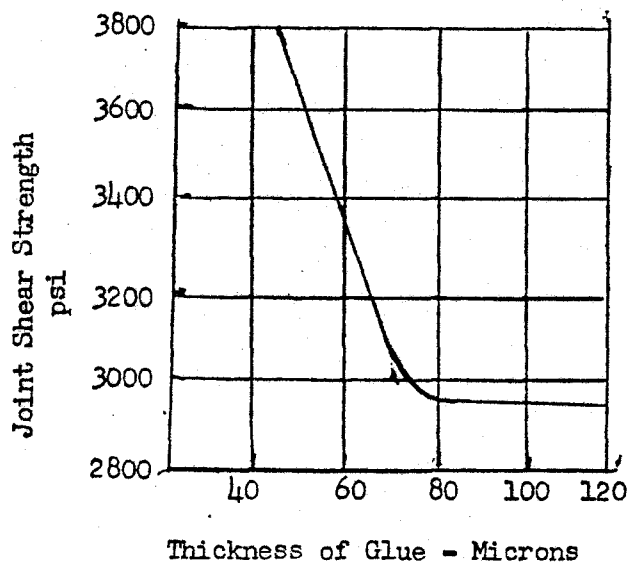


Chart I

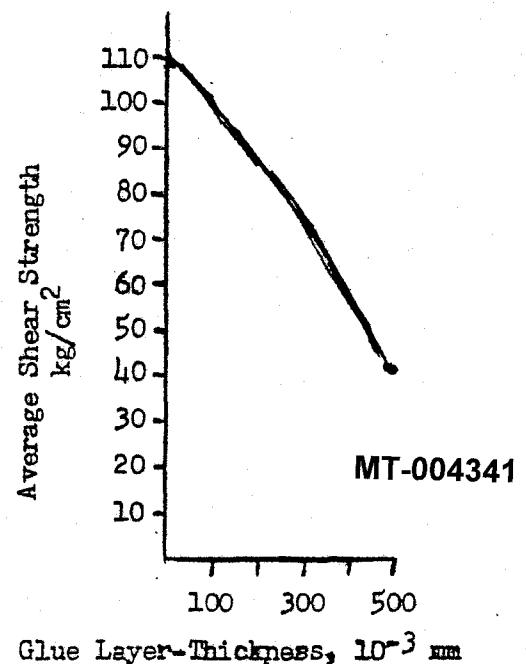


Chart II

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There are, therefore, optimum and critical proportions - bond to bonded - if maximum strength capabilities are to be achieved.

If reference is made to the Handbook of Asbestos Textiles, 2nd edition, page 10, Table E, it will be observed that the surface area of chrysotile asbestos is in the neighborhood of 130,000 to 220,000 sq. centimeters per gram and may be much higher. The meaning of these figures may perhaps be more easily understood if translated into terms which may be more familiar. In other words, a pound of chrysotile fiber, opened to the ultimate, will have in excess of 2.5 acres of surface. In other words, in a yard of Underwriters grade cloth weighing 2.25 pounds per square yard, the asbestos fiber surface that would be exposed if maximum opening were affected, would be in excess of five acres of surface. The possibilities become quite apparent therefore if we envision that tremendous area, composed of fibers most of which are $3/8$ " and less in length, securely bonded together, with a cementation agent some dimensions measured in micron in thickness.

The theoretical considerations here pursued serve to illustrate the possibilities that may be attained through the judicious use of chrysotile asbestos fiber as a reinforcing member. However, the fibers, laps, rovings, yarns and cloths of our industry today perhaps do not meet all of the necessary requirements whereby they would be directly applicable to such processing. The opening and fiberizing of the fiber is undoubtedly one of the key processing operations since the effective exposure of the vast fiber surface is here accomplished. Subsequent handling and processing thereafter must necessarily require that the openness be not disturbed and that entanglement and entmeshment whereby portions of the fiber surfaces may not be advantageously exposed be carefully controlled.

Further, it will undoubtedly be desirable to activate the fiber surfaces through the introduction of a surface conditioning technique which will prepare the fibers to more effectively and perhaps somewhat more tenaciously engage the bonding or cementing medium.

The cementing or bonding medium will vary depending upon the ultimate requirements and such added characteristics as stability under chemical attack, elevated temperature serviceability may be related to the resin or cement utilized.

Conclusions

The considerations here presented are, in the main, very general and have primarily been concerned with resinous and other organic bonding agents, however, it is not intended that inorganic bonding should not receive equal attention when the requirements suggest their usefulness. The Cerastex samples that have been exhibited from time to time have perhaps exhibited the minimum in properties that are attainable through the proper combination of asbestos fibers and a ceramic or other inorganic bonding agent.

It has been the purpose of this presentation to recall to the attention of those familiar with chrysotile asbestos that this mineral fiber has attributes other than elevated temperature serviceability that are unusual and through proper utilization can well provide structural properties that are attainable through the use of few other materials. It is felt that through a properly

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designed and sincerely dedicated pursuit of the possibilities here reviewed that perhaps the market for textile processed asbestos fibers which may serve as strength imparting materials may be equally as challenging and rewarding as is and has been the elevated temperature field.

Our current endeavors are being directed along paths which it is hoped will serve to exploit the physical capabilities of chrysotile so that perhaps new areas of application and usefulness may be opened.

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