The Technical Committee held its First Quarter Meeting on March 13, 1958 at the Warwick Hotel, Philadelphia, Penna.

IN ATTENDANCE

JOHNS-MANVILLE, INC.
E. Beale, Chairman
J. L. Tucker

RAYBESTOS-MANHATTAN, INC.
M. W. Oliver
M. S. Maier

KEASBEY & MATTISON COMPANY
D. F. Quealy

TALLMAN-McCLUSKEY COMPANY
T. C. McCluskey

PHILADELPHIA TEXTILE INSTITUTE
Dr. M. C. Shaw

AMERICAN ASBESTOS TEXTILE CORP.
E. C. Cutler

SOUTHERN ASBESTOS COMPANY
J. D. McCluer

Since all members had received a copy of the minutes of the previous meeting, it was moved by J. L. Tucker, seconded by E. C. Cutler, that the reading of the minutes be dispensed with at this time.

Reports of Sub-Committees were as follows:

Cloth Committee: M. W. Oliver proposed that a cloth designated as 11P20 be added to the current list of A.T.I. cloths. This cloth is to have the following instructions and properties:

Yarn:	Cut	-	20 single
	Grade	-	Underwriters'
Cloth:	Warp	-	21 ends
	Fill	-	17 ends
	Gage	-	.025"
	Weight	-	.7 lbs./sq. yd.
	Tensile:		
	Warp	-	45 lbs.
	Fill	-	40 lbs.

There are two reasons for proposing this addition to the A.T.I. list of cloths. First, that a similar weight cloth had been submitted to the Navy by competition for consideration for use as pipe lagging, and second that a cloth in this weight range is not now covered by A.T.I. specifications.

In the matter of after heat testing of cloths, it was decided that Dr. Shaw would review his past reports and summarize the data. The summarization was to be in the form of two basic graphs. One is to show strength retention versus temperature for each grade of cloth. The other to show strength retention vs. asbestos content at 400°F, 600°F and 800°F. The Technical Committee realizes that the Sales Promotion Committee also wants information on after heat tests at much higher temperature, however, this summarization will be the first step toward giving the Sales Promotion Committee a useful tool in selling textiles. After this work has been

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Cloth Committee: (Cont'd)

done, then such things as higher test temperatures must be considered and a program set up to carry out this higher temperature testing.

The above points on adding the 11P20 Cloth and the after heat testing were discussed at a joint meeting of the Sales Promotion and the Technical Committee, and it was agreed that they both should be adopted.

E. C. Cutler pointed out an error in the minutes of 1/7/58. The reference to 36P10 Cloth in the Cloth Committee report on Page #1 should be changed to 40P10.

Braid Committee:
The braid specification is now in its completed form and will be submitted to the Sales Promotion Committee for comment and approval. Members of the Technical Committee received their copy at this meeting.

Tape Committee:
It was agreed that AAA and AAAA grades of Tapes should be added to the specification for Industrial Asbestos Tapes.

It was also recommended that the wording under 18(c) of the Industrial Asbestos Tape specification be changed to read as follows:

(c) Tensile Strength After Heating. When required, the tensile strength after heating shall be determined on specimens which have been heated in accordance with Standard Methods of Heat Aging Asbestos Textiles as specified by ASTM.

The revised specification will be submitted to the Sales Promotion Committee for their approval.

A.S.T.M.
There has been no further activity by the A.T.I. in this connection since the last meeting. The A.S.T.M. is meeting on 3/19/58 and M. S. Maier and M. C. Shaw will review the changes recommended to the Tape Specification with the A.S.T.M. Committee.

Nuclear Radiation Committee:
During the past quarter, Dr. M. S. Maier, chairman of this sub-committee, visited Oak Ridge as stated in the minutes of the Dec. 5, 1957 meeting. A detailed report of his visit is attached to these minutes.

As a result of Dr. Maier's visit, it was decided that asbestos fibers be radiated in a Nuclear reactor and the indused radiations be determined. These determinations will be cone by the Oak Ridge Activation Analysis Section, and the cost per sample should be less than $200.00. It was further agreed that the following fibers be radiated.

1. Chrysotile - sample from Thetford District of high iron and a sample of Cassiar of low iron.
2. Crocidolite.
3. Amosite.
4. Anthophyllite.

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Nuclear Radiation Committee:

It was pointed out in the General Meeting on 3/14/58 that if there were those who wished to submit samples for testing under this program, the samples should be sent directly to Dr. M. S. Maier. Samples for this test must be carded fiber used for Textiles and should be properly identified. Because of the limited space and the cost, it may not be possible to test all samples, and Dr. Maier will make the final selection of representative fibers to be tested from the samples submitted.

If possible, a spectroscopic analysis of these irradiated fibers should also be made.

The above program of Activation Analysis will be put into effect as soon as possible.

As the second part of the program for this committee, the same types of fibers, only in the crude state, will be sent to Oak Ridge for their evaluation after irradiation. This is a long term test and will take approximately one year for completion after the completion of a new reactor at Oak Ridge. These tests would be run at the expense of Oak Ridge. Here again, samples of the crude fiber may be submitted directly to Dr. Maier for his selection and forwarding to Oak Ridge.

For further details and more specific comments, see attached copy of Dr. Maier's report on his visit to Oak Ridge.

Respectfully submitted,

Edward Beale, Chairman
Technical Committee

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MT-004020

ATI-109

FELLOWSHIP REPORT

MYRIL C. SHAW

RESEARCH FELLOW

ASBESTOS TEXTILE INSTITUTE

PHILADELPHIA TEXTILE INSTITUTE

PHILADELPHIA, PA.

REPORT #44

March 14, 1958

MS 004615

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MT-004021

Fellowship Report

Introduction

The application and adoption of present day asbestos textiles to the conditions of high temperature and stresses envisioned for the machines of tomorrow requires a full appreciation of the capabilities of the primary mineral with which we are concerned and a high degree of mental agility on the part of those who would utilize these materials to their fullest extent.

In the construction of jet engines and rockets, high temperature materials with high strength, chemical inertness and abrasion resistance characteristics are necessary and essential if they are to be of any value in these fields. As an example of some of the actual conditions encountered the following flame temperatures and gas velocities for typical rocket propellants are known to exist.

	Temperature °F	Velocity ft/sec.
White fuming HNO_3 + JP-4	5030	5215
Liquid O_2 + 75% ethyl alcohol	5150	5480
Liquid O_2 + JP-4	5550	5920
H_2O_2 + Hydrazine	4200	5430
Red Fuming HNO_3 + Hydrazine	4800	5580

The thrust chamber of a rocket engine will directly encounter one of the above sets of conditions, dependent upon the type of fuel used, and must therefore be extremely rugged in construction. Such refractory materials as silicon carbide bonded with silicon nitride are presently providing the high temperature, high thermal shock resistant and physically strong bodies required in this particular application. However, efforts are continually being exerted to lighten the weight of the rocket in order that greater ranges may be attained and so that significant pay loads in the form of war-heads may, if necessary, be conveyed. In this endeavor, it will be necessary to reduce the heavy refractory units in those locations within the rocket where temperatures are to be encountered but where little or no stress or abrasion will be exerted. Thermal insulators and backing materials in some rocket constructions are affected through the use of aerated or light weight refractory cements and in one type of construction a fine hydrocal cement with light weight aggregate has been successfully used in a large number of firings.

Asbestos textile materials, properly designed and wisely utilized should most certainly prove helpful in achieving the desired ends in these endeavors. However, before any applications using asbestos textiles can be promoted it is necessary that both the producers of such materials as well as those who are concerned with their adoption as materials of construction for rocket engines must be fully aware of the high temperature properties and the limitation of such materials. A significant feature in these considerations is the fact that the life expectancy or time during which severe service conditions may be encountered are extremely short, rarely over five minutes and usually in the neighborhood of one minute or less. Realizing that degradation and destruction are normally a function of both time and temperature and that the rate and extent of a thermochemical reaction during the early stages is usually markedly different than is encountered in the latter periods when equilibrium has been

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established, there is much to be learned. We hear of many materials far surpassing their known melting point temperature for short time periods in rocket service. Certain plastics and glass containing objects are withstanding elevated temperature abuse far above their normally recognized capabilities.

To endeavor to define short-term elevated temperature properties on the basis of long-term tests or upon relative atmospheric temperatures tests conducted for short periods of time is grossly erroneous. Many properties of matter are a function of temperature and some may vary markedly with relatively small temperature changes within certain temperature ranges. The thermal conductivity of a material may change due to dimensional and compositional alterations resulting from increased temperature. Electrical properties may likewise be affected. The process of melting for a mineral such as may be represented by chrysotile is an extremely involved reaction. At any given temperature the amount and composition of the liquid portion will be markedly different than at another temperature and if the melt is maintained at a given temperature for extended periods of time the composition and amount of the melt or glassy phase will vary with time until equilibrium has been established.

Therefore, in considering the applicability of asbestos for any of the rocket high temperature applications we must thoroughly investigate these high temperature short term properties if we are to understand them and are to be able to adapt them to the problems at hand.

Experimental Studies

In an effort to investigate the elevated temperature properties of some of the asbestos textile products and to make comparisons between various grades and constructions, a test set-up was adopted that was previously developed and used to determine the high temperature serviceability of a treated leather and some glass textiles. The unit consists of a Glo-bar heating element so positioned that a sample of material to be tested can be placed in contact with and with regularity be drawn or dragged over the heated Glo-bar while suspending a load of 2#. In this work the samples contacted the heating element 4 times per minute for a duration of 7-1/2 seconds over a 4" length. Actually the sample moved over the heating element at a rate of 80 feet per hour. A rough sketch of this unit is set forth in Plate I.

With this machine the various materials being tested are subjected to abrasion while in direct contact with the heating element at some predetermined temperature. The Glo-bar heating element is composed of silicon carbide and has very much the same appearance and texture as a carborundum grinding wheel.

Treated Leather.

As previously stated, this machine was first used to evaluate a treated leather presumed to have unusual elevated temperature properties. As a result of tests run in this connection it was determined that the leather exhibited reasonable serviceability at 600°F but at 700°F failure was induced in 10 minutes and at 800°F it failed in 2 minutes. Since it was reported that gloves made of this leather would be unaffected when used in handling cherry red iron, approximately 1500-1700°F, the inaccuracy of this claim was exposed.

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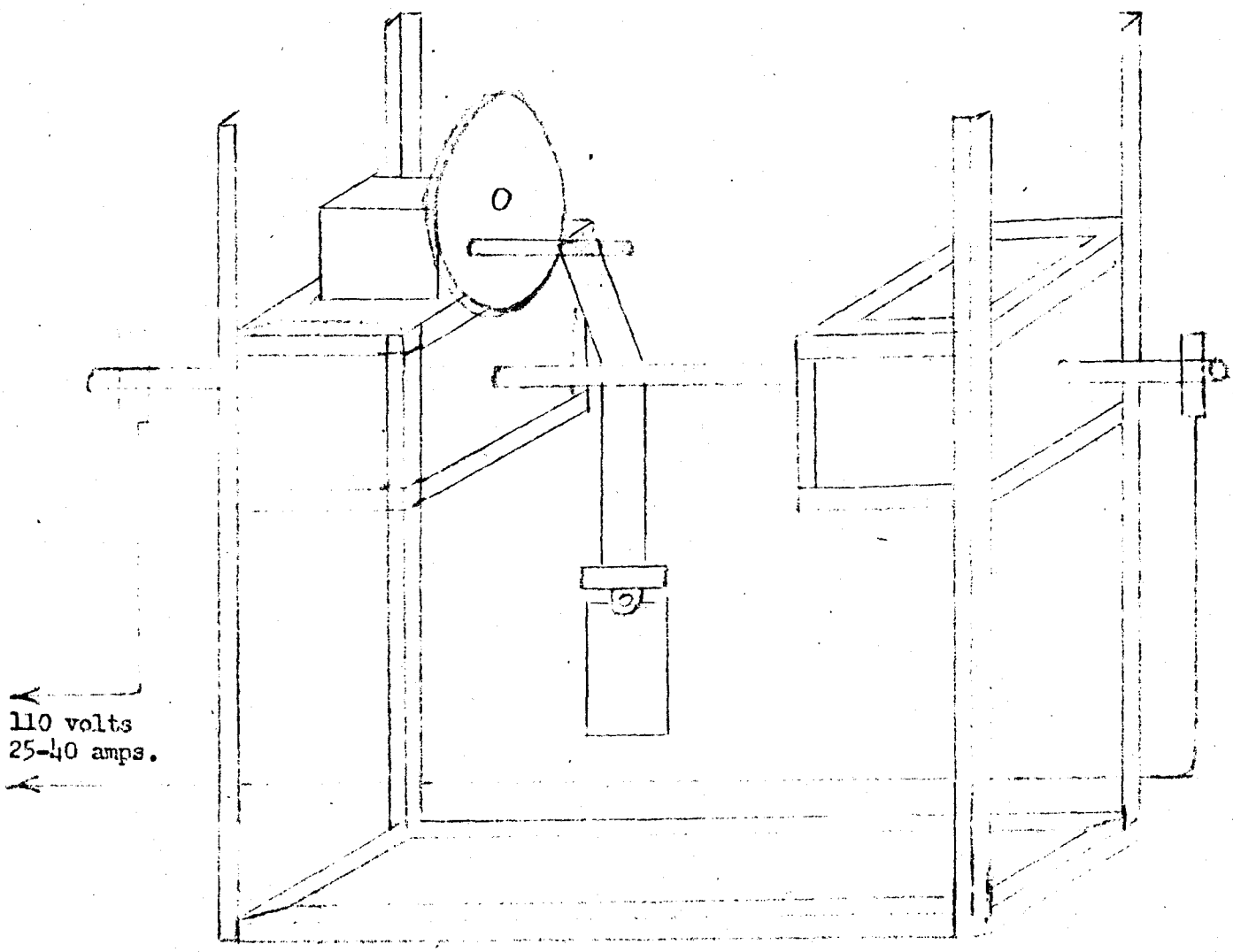

PLATE I

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Glass Cloth.

fabrics composed wholly of glass have also been tested on this machine and it has been found that such materials fail immediately at 1100°F. Immediately upon making contact with the heating element at 1100°F the glass materials melt and the sample tears apart without the benefit of any abrasion.

Asbestiform Mineral Textiles.

In testing asbestos textile materials some very interesting results have been observed. For the most part styles 36P10 and 40P10 in Grades from Underwriters through AAA were studied. However, several other styles of chrysotile asbestos textiles were included, as were samples of a Blue asbestos cloth in a style comparable to the standard 36P10 construction.

Blue Asbestos. Tests performed on samples of blue asbestos revealed that, under the conditions of this test, this material proved quite durable up to 1500°F however, at 1600°F failure was induced after 5-1/2 minutes, at 1700°F failure was promoted after 1 minute and at 1800°F failure occurred upon the second contact or in about 10 seconds. Failure in this latter case was induced primarily due to melting, the abrasive action serving only to a minor degree to hasten destruction.

Chrysotile Asbestos Textiles. Several types and styles of asbestos textile materials were originally studied in an effort to determine the capabilities and scope of the data that might be obtained from tests run on this test apparatus. The results obtained from these exploratory tests served to illustrate the range of values that may be procurred in such tests, ranging from failure upon first contact in the case of the light weight materials to no failure after five hours of subjection to the test conditions for the heavier, high grade materials.

In order that some comparable relationships might be obtained, textiles in styles 36P10 and 40P10, in grades ranging from Commercial to AAA were investigated. During the course of these studies one series of tests produced data that would seem to be inconsistant with logic. It was found in one particular series of tests that cloths in Underwriters grade and higher exhibited greater resistance to destruction at 2100°F than at 1800°F. The following tabulation sets forth the actual data here obtained.

	Time in Minutes at °F.			
	1800°F		2100°F.	
36P10 - Comm.	1.25		1.25	
" Und	7.0		16.00	
" AAA	55.0		68.0	
40P10 - Comm.	1.5		1.00	
" Und.	11.0		18.00	
" AA	13.5		34.0	
" "	20.0	17.5	21.0	23.0
" "	19.0	Avr.	15.0	Avr.
" AAA	52.0		68.0	
" "	61.0	49.0	81.0	83.0
" "	35.	Avr.	100.0	Avr.

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It will be observed that, in the case of the 40P10, Grade AAA cloth, durability was exhibited for 49 minutes (average of three determinations) at 1800°F and for 83 minutes (average of three determinations) at 2100°F. The same conditions were noted for the Grade AA materials but with much less difference. Similar relationships will be observed for the remaining styles and grades listed.

The acceptance of this apparent phenomenon at this point, without further investigation and verification would, of course, be unwise since an explanation covering such behavior is subject to much conjecture and theorizing. It would appear likely, however, that any explanation will necessarily be based upon the development of some high temperature product of inversion which provides a buffer zone between the hot interface which is directly in contact with the elevated temperature surface and the outer surface which is protected from the hot face by the buffer zone material.

Attempts to duplicate this series of observations have not been wholly successful and many more tests will be required before a positive revelation can be made.

Several problems have been encountered in this work which have made it rather difficult to obtain the desired manoeuverability and accuracy in carrying out the tests described above. Power and heating element limitations have made it impossible to carry on the work above 2100°F with any degree of reliability. Also the use of thermocouples as temperature measuring devices have proven unsatisfactory for measuring the surface temperature in which we are interested.

An effort will be made in the near future to overcome these difficulties and it is hoped that through improved design and operation techniques conditions will be attained that will permit the determination of the ultimate characteristics of asbestos and materials produced therefrom which will serve to establish their usefulness in the high temperature applications of the day.

Conclusions

It is becoming increasingly important that more information be ascertained regarding the upper limit serviceability characteristics of asbestos products. Such dynamic conditions as temperature gradients increasing at rates approaching 10,000°F per minute for time durations of ten seconds; pressure range increases of from 100 to 2500 pounds per square inch in a matter of a very few seconds; thermochemical stability and inertness to chemical attack over short periods of time by chemicals that under equilibrium conditions might readily devour the subject materials. These are but a few of the sets of conditions which are being encountered daily and there are definite indications that certain asbestos textile materials are adaptable for many such applications.

It is hoped that we may be able, during the next few months, to specifically determine many of the ultra-high temperature properties in order that we may better ascertain how our materials may be adapted to the conditions noted above.

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MT-004026

The Technical Committee held its Second Quarter Meeting on June 5, 1958 at the Warwick Hotel, Philadelphia, Penna.

IN ATTENDANCE

JOHNS-MANVILLE, INC.
E. Beale, Chairman
J. L. Tucker

RAYBESTOS-MANHATTAN, INC.
M. S. Maier
M. W. Oliver

KEASBEY & MATTISON COMPANY
D. F. Quealy

PHILADELPHIA TEXTILE INSTITUTE
M. C. Shaw

AMERICAN ASBESTOS TEXTILE CORP.
E. C. Cutler

SOUTHERN ASBESTOS CO.
J. D. McCluer

Since all members had received a copy of the minutes of the previous meeting, it was moved by J. L. Tucker, seconded by M. S. Maier that the reading of the minutes be dispensed with at this time.

Reports of Sub-Committee were as follows:

Braid Committee
J. L. Tucker, Chairman of this sub-committee, pointed out a misprint on Page #3, Section 4(c) - Construction. This section should be changed to read "not less than three determinations shall be made per shipment". With this revision, this specification is now in its final form and is hereby submitted for acceptance by the Institute.

Tape Committee
Mr. D. F. Quealy was appointed as chairman of this committee and will co-ordinate its activities.

In our discussion of both tape specifications, copies attached, it was pointed out that as they now stand, they do not have tensile strength values. It was agreed to review both specifications for Industrial and Electrical Tapes in order to arrive at mutually agreeable "as received" tensile strengths. The chairman is to contact all technical committee representatives and get their recommendations for tensile strengths on all tapes covered by these specifications.

A discussion on the tolerances and values for feet per pound of the specification for Asbestos Tapes for Electrical Purposes came about as a result of Dr. Shaw's letter of 3/25/58. This letter of Dr. Shaw's listed recommended changes to specification MIL-I-3053a. It was pointed out that these proposed revisions were not entirely in accordance with the current A.T.I. specification. Because of this, it was agreed that the chairman of the Tape Committee would contact the Technical Committee representatives for their recommendations on revised figures, or comments in view of the proposed revisions to MIL-I-3053a.

The values agreed on will be submitted to Dr. Shaw for discussion with proper Government agency.

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GOVERNMENT SPECIFICATIONS.

As shown above under the Tape Committee's report, Specification MIL-I-3053a was discussed and ties in directly with the activities of that committee.

In addition to the recommendations for tensile strength and feet per pound which are discussed above under Tape Committee, the following were recommended as changes to MIL-I-3053a.

1. The tolerance on yardage should be ± 10% instead of ± 7% which is in accordance with ATI tolerances.

2. Technical Committee representatives are to inform Dr. Shaw as to whether or not he should recommend that ATI style numbers be used in this Government Specification.

A.S.T.M.

Dr. Shaw and Dr. Maier briefed the Technical Committee on the discussions held at the A.S.T.M. meeting on 3/19/58, as follows:

1. The A.T.I. specification for Asbestos Tape for Electrical Purposes and the A.T.I. specification for Industrial Asbestos Tapes have both been approved by letter ballot. Both specifications will be accepted by A.T.I. on a tentative basis.

2. The two A.S.T.M. cloth specifications D-677 - Physical Properties and D-577 - Test Methods) have been combined into one specification and is now out for letter ballot. This specification is in the same form as our A.T.I. specification for Asbestos Cloth.

3. Dr. Maier is rewriting the procedure for asbestos determinations as a separate specification as part of his work on the A.S.T.M. committee. Dr. Maier also pointed out that the Knorr Alkalimeter method would be proposed as a referee test method for asbestos determination.

4. The A.S.T.M. has also up for letter ballot the deletion of the total iron requirement.

The above four recommendations were discussed by all present and all were in accord with these actions by the A.S.T.M.

Nuclear Radiation Committee.

Dr. Maier reported that four (4) samples of crude asbestos had been submitted to Oak Ridge for determination of induced radiations and evaluation after irradiation. The samples submitted were Chrysotile (Thetford and Cassiar) Crocidolite and Amosite. These samples have been irradiated, but results have not yet been reported. Dr. Maier has been informed by Oak Ridge authorities to expect a report within 2-3 weeks. This report on the types and energy of the induced radiation will be presented at the next scheduled meeting of the A.T.I.

The second part of this program on Nuclear Radiation as shown in the minutes of the 3/13/58 meeting has not yet been started. This second part of the program will get underway as soon as the reactor now under construction at Oak Ridge is completed. The personnel at Oak Ridge has informed Dr. Maier that the A.T.I. samples will be among the first to be irradiated.

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Edward Beale, Chairman
Technical Committee

Minutes of the Asbestos Textile Institute Air Hygiene and Manufacturing Committee
June 5, 1958

In Attendance:

W. C. Atkinson	Johns-Manville Corp.
A. E. May	Keasbey & Mattison Co.
J. L. Mitchell	Southern Asbestos Co.
H. E. Palm	Raybestos-Manhattan, Inc.
R. B. Smith	Raybestos-Manhattan, Inc.
U. D. Torrance	Johns-Manville Corp.

1. The members present discussed operation of spinning frames and means of dust control at the frames. The results of the discussion are tabulated below:

Mill	# Spindles per Frame	Spindle Speed RPM	Frames per Operator	Dust Collection Equipment
A	144	1700	2	Down Draft
B	140	1400-1500	3	None
C	120	1900	2	None
D	160	1800-2100	1	Overhead Down Draft
E	144	1700	2	None
F	120	1500	2	Down Draft

In several plants reduced spindle speeds were found to be the most practical means of dust control.

2. Mr. Mitchell advised that the Abington System which was installed in 1955 has reduced costs in the card room as follows:

Year	Card Clothing & Tapes	Machine Parts	Total
1953	100%	100%	100%
1954*	58%	29%	45%
1955	82%	49%	67%
1956	53%	35%	45%
1957	44%	26%	36%

*Plant was not operating full time.

The use of the system has reduced the labor required to clean beneath the cards by two men per shift. Hand stripping of the cards - always a dusty operation - has been practically eliminated. The system will eventually be extended thruout the plant for use in cleaning of equipment. The total investment to date is approximately $27,000.

3. Three companies advised they are using Spencer oiling equipment, one company sprays fiber manually, and one company's fiber preparation system is not adaptable for oil spraying. None of the members use oil spray on all types of stock.

4. The following methods are now used by the member companies to determine the amount of dust in virgin fiber:

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Method	No. of Companies
Bauer McNett	2
McClurg	1
Clarke Classifier	1
Quebec Miners	1

At the General Meeting the A.T.I. was advised that the Quebec Miners would cooperate in establishing a method to determine the amount of dust in raw fiber. President Bettes announced the membership of the committee which will represent the A.T.I.

5. Dust Control.

A. Various types of hoods for tape and broadcloth looms were discussed. One member described experimental hoods now in use on tape looms. The Committee will be kept informed of the performance of hoods.

B. Dust counts taken by one of the member companies are now reported as the amount of fiber present as well as dust. The dividing line between fiber and dust is 10 microns.

C. The frequency of cleaning in the spinning and twisting departments was discussed. Cleaning is done when the departments are not in operation and generally every week - although some members do not clean as frequently as in the past.

6. Dr. Shaw received a letter from Sir William C. Fenton advising him of the formation of an Asbestosis Research Council whose "fundamental object is to foster research into the causation and incidence of asbestosis so that appropriate and preventative measures against this disease can be developed". The letter also stated that the Asbestosis Research Council would be glad to cooperate with the Air Hygiene and Manufacturing Committee in any way which will help in eradicating the cause of asbestosis in the industry.

The letter and notes from Sir William Fenton was discussed by the Committee and they recommended that the proposal of the Research Council be accepted. The Air Hygiene Committee will discuss and take appropriate action on any subject presented to the Committee.

7. Mr. Smith presented a copy of Patent #2,824,043 which pertains to an improved method and powder for neutralizing the lung fibrosis producing properties of finely pulverized siliceous materials.

The idea of introducing a foreign material into the air taken into the lungs was new to the Committee Members, but Dr. Shaw advised that it has been in use about ten years.

8. The agenda for the next meeting will include the following:

A. Dust control methods in the Fiber Preparation Department.
B. Dust control methods for tape looms.
C. Discussion of the Q.A.M.A. report.
D. Continued discussion of spinning room problems.

MS 004624

Respectfully submitted,
A. E. May, Chairman

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MT-004030

ATI-109

FELLOWSHIP REPORT

MYRIL C. SHAW

RESEARCH FELLOW

ASBESTOS TEXTILE INSTITUTE

PHILADELPHIA TEXTILE INSTITUTE

PHILADELPHIA, PA.

REPORT #45

June 6, 1958

MS 004625

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MT-004031

Introduction

The Fellowship work during the past quarter has been concerned primarily with two subjects for investigation, 1) reevaluation of the elevated temperature serviceability data for asbestos textiles and 2) heat transfer properties of asbestos textiles.

The elevated temperature serviceability studies were conducted in an effort to provide a restatement of the information currently available and to check, where possible, current production materials against the original data. In this endeavor, two graphical presentations have been drafted and are offered with this report. Both graphs set forth the strength retention characteristics, however, one has the basic ordinate in terms of grade and the second has the ordinate in terms of temperature. It is hoped that one of these charts may provide a readily available and easily understood source of significant information for both the engineer who may wish to use these materials and those interested in manufacturing and sales who are interested in providing the proper material for a given application.

The investigation of the heat transfer properties of asbestos textiles has necessitated the review of a great deal of literature in reference to this subject. There has been very little work conducted in this vein related specifically to asbestos textiles, however, the textile industry as a whole has approached this subject from many angles. The great divergence in the methods of study pursued and the results obtained in these investigations serves to point out the indefinite character of this property as it relates to textile materials. The work here reported would seem to indicate the desirability of pursuing a comprehensive review and study which would serve to define the extent of the limiting factors involved in such considerations and would perhaps provide the parameters of service for known or given conditions of application. In any event, the information today available on this subject leaves much to be desired if it is to serve as the basis for an engineering approach to the application of asbestos textiles to the service where heat transfer considerations require specific definition.

Fellowship work, in addition to the above reported projects, has been concerned with, 1) Revisions in Specification MIL-I-3053A; 2) endeavor in the attainment of ultra-high temperatures for adoption in the continuation of elevated temperature serviceability tests for asbestos textiles and 3) checking asbestos content determination method proposed by C. Z. Carroll-Porczynski, i.e., burnout at 700°F instead of 1500°F., as normally done. This method has come to the attention of A.S.T.M. sub-committee A-4, and all interested members are investigating the possibilities here involved.

In addition to these formal investigations we have been happy to be able to be of service to several of the members in performing Abradoflex tests and asbestos content determination check tests. As the equipment in our laboratory is available, we are pleased to perform such tests, however, we would ask the indulgence of all who seek such tests when a delay in reporting the results is encountered. All tests are run in the order of their receipt at our laboratory and quite often, when there are several tests lined up, some delay in reporting is encountered.

We trust that the work of the Fellowship meets with the approval of all concerned as we ever strive to investigate those matters and perform those tests that are of greatest interest to our membership as it represents the asbestos textile industry. Your comments and suggestions are our only means of knowing how well we are serving you and the asbestos textile industry.

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MT-004032

MS 004626

Elevated Temperature Characteristics of Asbestos Textiles

ATI-109

An asbestos textile may be composed entirely of asbestos or chrysotile fibers or it may be made up of a blend of asbestos fibers with varying amounts of an organic fiber, usually cotton. The resistance to degradation by heat is principally a function of the asbestos content and the higher the asbestos content the higher will be its elevated temperature serviceability characteristics. However, features of construction, weight and weave may also influence the elevated temperature properties and there should be an appreciation of the potential influence of these factors if the most efficacious addption of an asbestos textile to a given application is to be affected.

The generally accepted system of grading or classification for asbestos textiles includes six grades as shown in Table I.

Table I

Grade	Asbestos Content by Weight
Commercial Grade	75% up to but not including 80%
Underwriters Grade	80% " " " " " 85%
Grade A	85% " " " " " 90%
Grade AA	90% " " " " " 95%
Grade AAA	95% " " " " " 99%
Grade AAAA	99% up to and including 100%

Manufacturing operations are such that as the asbestos content is lowered and the cotton or other organic fiber content is increased, it is possible to utilize asbestos fibers of a shorter length than when there is a complete absence of or only very small amounts of organic fiber present. The organic fibers normally serve as a carrier fiber in the manufacturing operation and contributes quite markedly to the original strength of the textiles so formulated.

However, as the grade of these textiles is increased and the organic fiber content decreases, it becomes necessary to improve the grade of the asbestos fiber used, that is, to utilize asbestos fibers of greater length. This action serves to improve both the high temperature degradation resistance characteristics and the tensile strength properties over the entire range of serviceability.

Asbestos textiles are manufactured in a great many styles and constructions, each being designed and manufactured to meet a specific application. Present day fabrics normally range in weights of from 1.00 to 3.70 pounds per square yard in single cloth constructions and yarns ranging from 8 to 35 cut are utilized in affecting the several varieties of designs and weaves. The varying conditions of design and construction definitely influence the physical properties and elevated temperature characteristics of each type of cloth and the extent of this influence must be understood if there is to be a proper application of these materials.

The elevated temperature serviceability characteristics of a wide variety of asbestos textiles have been determined as a function of the tensile strength retention properties and this information is set forth graphically in Plates I and II. The interpretation of the data as set forth must be considered on the

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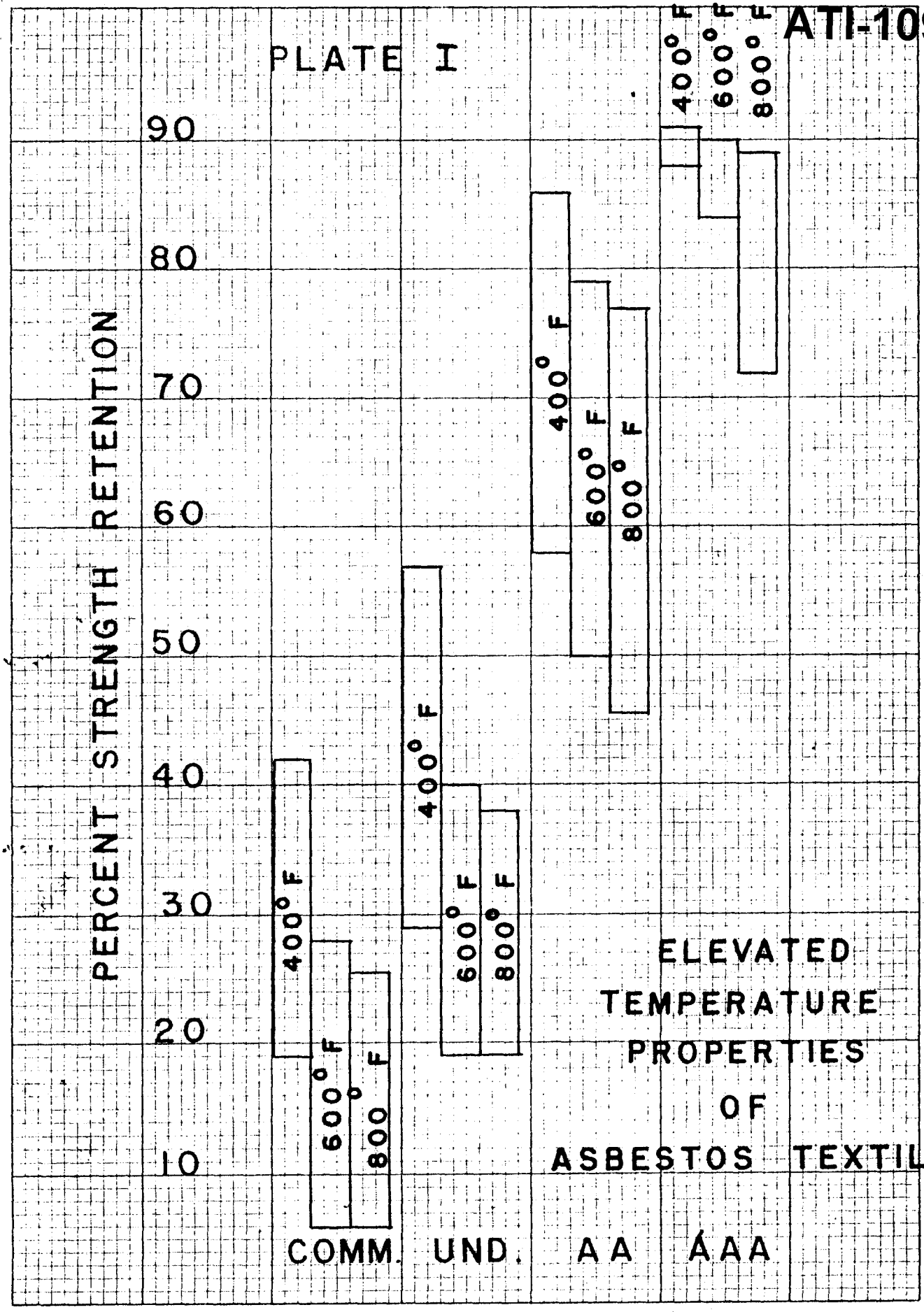

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PLATE II

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basis of the variables of grade, design and construction as previously discussed. The values here presented may be considered minimum values since they are based upon the results of 24 hour tests, however, materials subjected to shorter periods of exposure at any one of the three temperatures of test will exhibit higher strength retention values than are here shown. The 24 hour test, upon which this work is based, provides degradation approximating 85% to 90% of that to be expected in long range service covering several weeks or months of exposure and for this reason, the information here offered should be practically factual for long term service applications.

Generally speaking, it can be assumed that those cloths composed of the finer cut yarns will exhibit the highest strength retention characteristics. As a rule, the finer cut yarns contain the greater amounts of high grade or long fiber and this factor contributes to greater initial and subsequent retentive tensile strength properties. Therefore, in utilizing the data as graphically presented, the upper values within a given unit representation might be considered to be representative of those textiles composed of the finer cut yarns and as the yarn cuts decrease in number the tesnile strength retention values should also decrease within the ranges as shown. For example, Underwriters Grade cloths as a whole, at 400°F, have a strength retention range of from 29% to 57% as represented by the bar graph. It might well be considered that such cloths as 22P16 and 17P24 will rest within the upper range of the bar graph while such cloth as 36P10 would be located in the middle and lower areas.

The information here presented represents an industry-wide evaluation of those asbestos textiles so represented for the current period of production. As manufacturing techniques improve it is to be expected that the ranges of values will also improve and that the serviceability characteristics will increase in value, moving the bar graphs as shown gradually upward.

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Comments on Elevated Temperature
Serviceability Graphic Presentation

The study here offered is in response to a request by the Sales Promotion Committee of the Institute for a more easily understood yet complete graphic presentation of the elevated temperature properties of asbestos textiles. Two graphic methods are here offered and a choice of one or the other should be accepted by all in order that a uniform presentation to the consuming trade may be offered.

It would appear that to the informed individual there is little to recommend one graph over the other since the same data can be obtained from both with equal ease. However, Plate II would seem to show the gap between Underwriters and Grade AA cloths more pronouncedly than is evident from Plate I. It is shown on Plate I, however the graphic relationships are so altered that it is not too clearly evident.

The data upon which these graphs are established was originally developed and reported in our Fellowship Report #23, December 1952. However, recent work on cloths of current production show that the ranges are apparently as applicable today as they were five years ago. There is, however, some evidence that cloths in Grade AAA are superior after heat aging to those upon whidh this work is based.

It would seem that perhaps it might now be advisable to make a thorough test of current production materials on an industry-wide basis in accordance with the procedures followed in the work here reported. As a result of such an investigation it could well be that certain improvements might be noted and the graphs revised to so indicate that improvement.

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THERMAL CONDUCTIVITY OF ASBESTOS TEXTILES

The thermal conductivity of an asbestos textile may be, under many service applications, one of the most important properties it possesses and under a known or given set of conditions it may be a determinable property. However, to endeavor to ascribe a so-called K factor or factor of thermal conductivity to an asbestos cloth without regard to the conditions of test or application is practically meaningless.

Solid and essentially non-compressible materials and materials that are unaltered physically or chemically during test or service conditions are amenable to specific considerations with regard to their abilities to conduct heat energy. Specific rates of heat transfer can be established and can be expected to be reproduceable under a wide variety of conditions. However, such materials as textiles, which are composed of a heterogeneous combination of solids, and interstices or air spaces; which are compressible to a degree depending upon construction; and, which are subject to physical and chemical alteration at temperatures above 400°F., conduct heat to an extent dependent upon the influence of one or more of the above conditions.

Since asbestos textile materials are primarily considered to be elevated temperature materials, it is important that there is a full appreciation of the extent to which time and temperature may influence the thermal conductivity properties of these materials. Under conditions of elevated temperature there are known chemical alterations that occur and there are also attendant physical changes which may influence the thermal conductive properties, such as, loss of resilience and its resultant effect upon loftiness; contraction and shrinkage, resulting in compaction and loss of loftiness; and as temperatures above 1000°F are exceeded the strength of the fibers may be lowered to a point where destruction is encountered when the subject is exposed to physical stress or abuse. As these dimensional and the inherent specific heat properties are altered the thermal conductive properties may likewise be altered.

The methods used to determine the thermal conductivity of materials vary widely, depending upon the physical characteristics of the materials and the accuracy desired. The K factor determinations for refractory materials are usually conducted for accuracy on an elaborate, so-called guarded-plate instrument which was developed as a result of many years of testing and experience. A similar instrument has been adopted for the evaluation of textiles, however, in most cases the textile industry utilizes one of three methods which serves to provide significant data when intelligently used and interpreted; namely, 1) Disc or plate method, 2) constant temperature method and 3) the cooling method. The disc or plate method has been utilized quite extensively by the writer and is described in an earlier Fellowship report. In the constant temperature method, a body is wrapped with the fabric to be tested and is maintained at a constant temperature by a controlled source of energy. The amount of energy required to maintain the body at the fixed temperature is determined. Absolute determinations cannot be made, therefore, comparisons of results are possible only when the same instrument is used. Finally, in the cooling method, a hot body is wrapped in the fabric to be tested and the rate of cooling measured. The results obtained apply only to the apparatus used and the results may not check when two different instruments are used.

In these three most often used textile testing procedures here discussed the determinations are made at temperatures up to 100°C (212°F). In most cases,

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the asbestos textile user is interested in its serviceability at temperatures much higher than the limits here encountered. To endeavor to utilize the conductivity factor obtained under low temperature conditions in high temperature applications is very likely to be erroneous.

In view of this condition, we have endeavored to develop a procedure and technique whereby reasonably factual high temperature thermal conductivity determinations might be conducted. In these efforts the sample under test was positioned within an insulating refractory chamber so that it would serve as a barrier or diaphram between a heat source (an electrical coil heater element) and a heat receiver. The cylindered test chamber was 2" in diameter by 2-1/2" long. The sample under test was positioned midway in the chamber or 1-1/4" from each end and the chamber positioned so that the lengthwise direction was in a vertical position with the heater coil on the bottom or 1-1/4" below the sample under test. The hot-side thermocouple was placed immediately in contact with the bottom or heated side of the cloth under test and a second thermocouple was placed 1/2" above the cloth serving as the receiver on the cool side of the test unit. A cap or cover was placed over the top section of the chamber.

In conducting a test, the heating coil was turned on and permitted to attain maximum temperature, around 1000°F. before the test cell was placed over the unit and under test. Immediately upon being placed in position, temperature readings were taken on both thermocouples and the temperature difference between the two sections separated by the test cloth were recorded.

The results of a series of determinations conducted in accordance with the above procedure are set forth in Plate I. The data here presented serves to compare the thermal conductivity properties of a selection of two plain and one aluminized asbestos textiles under conditions of free suspension, that is, being in contact only with air on both faces. In an analysis of this data it can be seen that when a temperature of 1000°F is obtained on the bottom side of a 36P10 cloth the difference in temperature of the air within the separated cells is 500°F.

It would appear that under the conditions of this test and at temperatures of 1000°F the difference in grade of the asbestos textile materials has no marked influence upon the thermal conductivity, however, thickness or surface treatment do exert an influence.

There are numerous references in the literature which serve to confirm this observation. Schiefer(1) and others in studying the thermal conductivity characteristics of household blankets found that the thermal transmission in such cases was independent of the kind of fiber but that such transmission was related reciprocally to the thickness of the blanket. Rees(2) in studying a large variety of fabrics also demonstrated the dependence of heat loss or thermal transmission upon one geometric consideration, that of thickness.

Low density materials such as textiles contain a large proportion of air within their structures and thermal transmission through such media is therefore primarily dependent upon the resistivity of the air layer. Actually, the chief

(1) H. F. Schiefer and Others, "Study of the Properties of Household Blankets". Jour. of Res., N.B.S. Vol. 32, 1944, pp. 261-284.
(2) W. H. Rees. "The Transmission of Heat Through Textile Fabrics", Jour. Text. Inst. Vol. 32, pp T 149-165 (1941).

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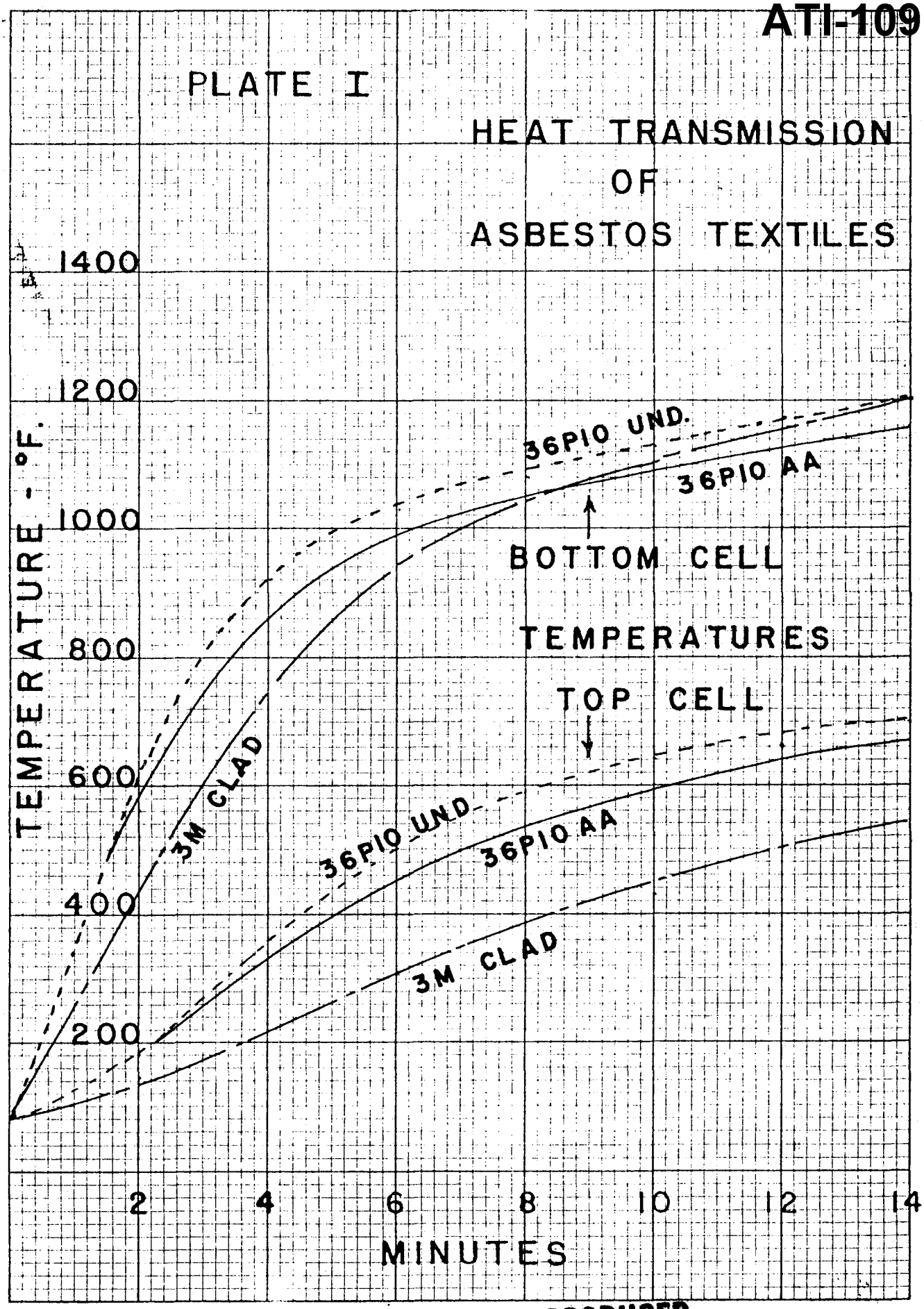
PLATE I

HEAT TRANSMISSION OF ASBESTOS TEXTILES



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function of a textile material is to trap or confine an air layer in order that it may serve as a thermal barrier. Through calculation it may be determined that a normal piece of 36P10 cloth is actually composed of something more than 65% air space.

Obviously, these considerations are primarily applicable only to freely suspended, unrestricted and untreated cloths. As cloths are treated in such a way as to close the air spaces or are applied and restricted through pressurized applications such as in packing or gaskets these replationships are not valid. Under these conditions the thermal transmission characteristics increase and approach that of the predominant component that is replacing the air space.

In view of the foregoing discussion it becomes increasingly clear that the thermal transmission characteristic of an asbestos textile cannot be considered a specific value but may cover a considerable range of values dependent primarily upon the thickness of the material as that thickness represents an occluded air blanket.

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FELLOWSHIP REPORT

MYRIL C. SHAW

RESEARCH FELLOW

ASBESTOS TEXTILE INSTITUTE

PHILADELPHIA TEXTILE INSTITUTE

PHILADELPHIA, PA.

REPORT #46

September 12, 1958

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MT-004042

Cerbestos Materials

Introduction

During the latter years of the second World War it became necessary to develop a group of new materials for specific applications in the construction of the rockets and jet engine designs that were then in existance and which were being contemplated. Among these materials were a group identified as "Cermets" which were, as the contracted name implies, a combination of ceramic oxides and metallic materials. The intended purpose of such materials was to provide a product that would combine and possess the desired qualities of both ceramic and metallic materials, such as the high temperature stability of the ceramic materials and the high strength and stress characteristics of the metals. Much has been accomplished in this field since its inception some fifteen years ago and the varieties of cermet products today being manufactured and utilized make up a long, valuable and indespensible list of materials finding new application in the machines, missiles and aircraft of the present and the future.

In extending this approach to the materials and problems of our immediate interest, namely, asbestos textiles, we have on occasions during the past several years made efforts to utilize our knowledge of ceramic materials and processes in exploring new horizons of interest to the manufacturers and consumers of asbestos textiles.

It would seem desirable in many applications to provide a material that will maintain a constant or, at least, a desired level of strength and structure throughout an extended elevated temperature service or cycle. Most material in normal performance tend to degrade at a rather rapid rate as temperatures increase and there have a limited life of elevated temperature serviceability. One of the aims of the investigation here being pursued is to improve, through proper treatment, the upper temperature limit area of serviceability of asbestos textile materials and products manufactured therefrom.

The mineral serpentine, a hydrous magnesium silicate is not greatly different chemically from such ceramic materials as talc, steatite and olivine, all of which are magnesium silicates but which do vary slightly with regard to the $MgO:SiO_2$ ratio. Therefore, it would seem possible that formulations utilizing serpentine as a ceramic component should be possible and that perhaps through some unique forming or shaping process a group of new products might be developed. It has been on these assumptions that our efforts have been exerted and while the endeavors to date represent only the initial undertakings we do feel that a new and interesting field of materials await further development along these lines.

It would be unfair not to recognize and acknowledge the influence that the success of the plastic industry in combining and laminating asbestos and plastic materials has had in this undertaking. It is, as a matter of fact, our hope that these new materials may be fabricated and shaped, in many cases, duplicating plastic parts, with ceramic materials replacing the plastic medium as the bond or continuous phase. However, it is not our intent nor do we think it economically possible for the present, as least, that ceramic bonded asbestos products which we would call "cerbestos" materials, will be competitive with plastic bonded materials but rather that each variety will compliment the other.

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It would now appear that the "cerbestos" materials will find their greatest usefulness at temperatures up to 2400°F for extended periods of time and where thermal shock problems may be encountered. Elevated temperature serviceability properties at temperatures above 2400°F for short periods of time should be as good for "cerbestos" materials as for the plastic materials and through proper development can undoubtedly be made to exhibit far greater serviceability than can be expected from the plastic materials.

Theoretical Considerations

The basis for the greater part of our current work has been the thermochemical relationships that exist between serpentine and kaolin. The phase diagram showing these relationships is presented in Plate I, which is a compilation of many years of intensive research and study undertaken by a great many investigators in the field of thermal chemistry.

Since we are chiefly interested in the utilization of asbestos and particularly asbestos textiles we have confined our attention for the present to that portion of the diagram wherein a minimum of 80% asbestos and 20% kaolin are considered and the dotted line X-X^1 defines our limits for this consideration. The temperatures for this diagram are set forth in the Centigrade scale.

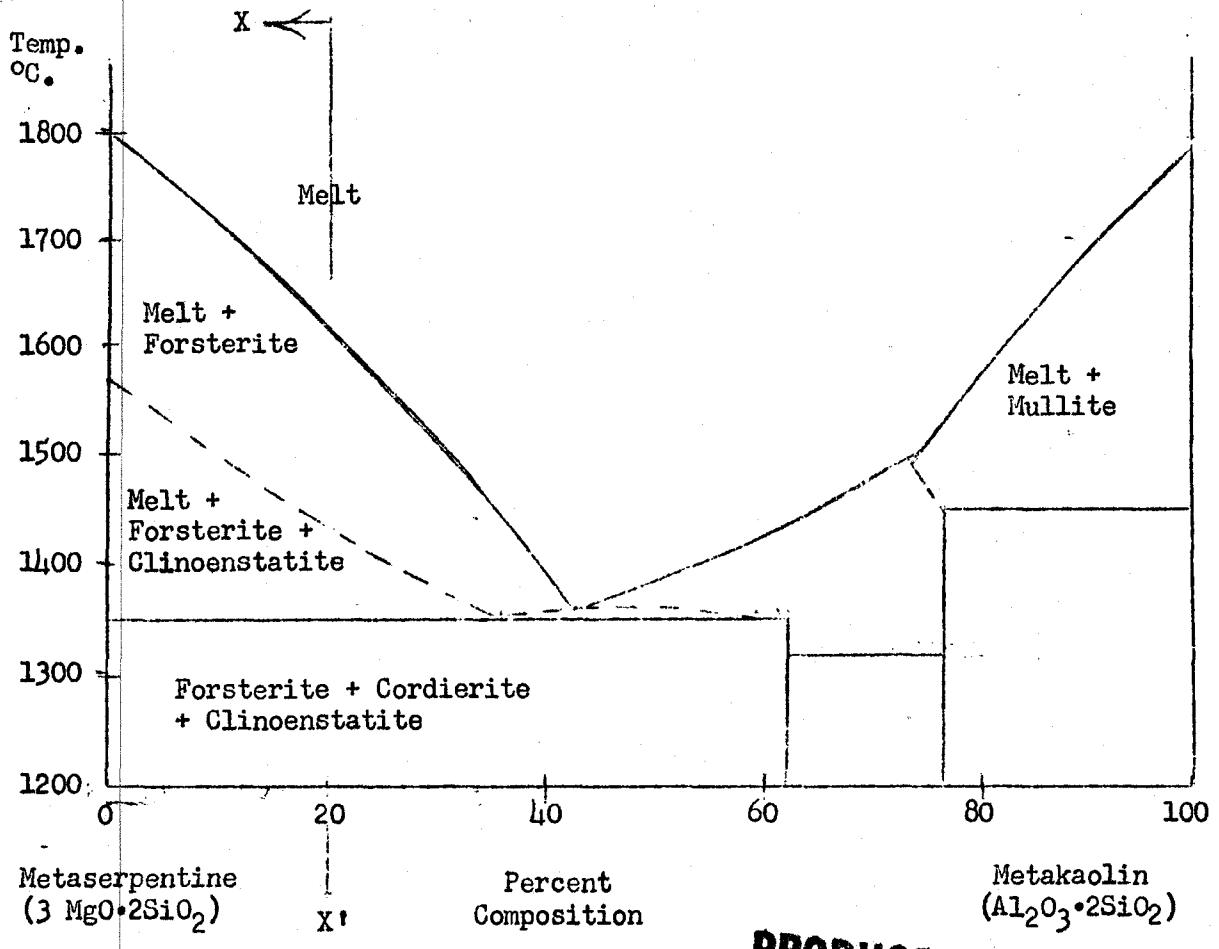

Plate I

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In a very general way an interpretation of this diagram shows that a mixture of 80% serpentine and 20% kaolin, when heated at temperatures up to 1360°C, will decompose into a melt or glass coexistant with Forsterite, Cordierite and Clinoenstatite. From 1450°C to 1670°C only Forsterite and a glass exist and above 1670°C the entire formulation becomes a molted glass.

In adapting this understanding of the high temperature constituents and relationships existing between asbestos and a high temperature ceramic bonding material such as kaolin, we have endeavored to develop a "cerbestos" material that would provide unique fabrication possibilities and at the same time would exhibit elevated temperature characteristics surpassing anything of a like nature today available.

Serpentine asbestos upon being heated up to 1500°F loses strength and structure quite rapidly at temperatures above 1000°F due to the structural loss of the combined water with the resultant defection of the unit lattice. It has been our purpose in this development to attempt to engage thermochemically the defected serpentine structure by reaction with some material that possessed more stability at elevated temperatures and thereby evolve a new formulation having unique properties of fabrication and performance.

Perhaps the most important component in all of these considerations is the glassy phase for through its proper development it should be possible to develop a visicular or highly aerated structure at elevated temperatures that would be sufficiently viscous to maintain structure and would exhibit good thermal insulation properties.

Preliminary Investigations

During the course of the preliminary investigations pursued in exploring the many possible methods of carrying out this work, first efforts were directed in an endeavor to establish certain fundamental facts upon which further work might be based.

In efforts, to date, we have utilized only two types of clay. A Georgia Kaolin and a Kentucky Ball clay and a glass frit known as a ceramic body flux. These materials do not, by any means, represent all the ceramic materials that may find application in this work but rather serve to provide compositions that yield products having properties that seem to indicate the interesting possibilities of such materials.

The products, to date, have been formed by a very simple and, no doubt, the least effective method possible. The technique followed was to mix or blunge the clay in a water-sodium silicate liquid to form a creamy slip or suspension of the clay in the water. Upon attaining maximum suspension asbestos cloth, cut to the proper size and shape to form the desired product, was placed in the slip and permitted to remain therein until it had soaked up a goodly portion of the slip. Attaining this state, the saturated cloth was removed from the slip and formed over the desired mold. Pieces so formed were immediately placed in a drier at 200°F where the sample was dried and released from the mold.

Following drying, the products so fabricated were sometimes fired as rapidly as possible to 1500°F -- 1850°F and then subjected to tests, while in other

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cases similar samples were tested without prior heat treatment or firing.

Typical slip compositions were:

A.	Water	500	cc
	Sodium Silicate	50	cc
	Georgia Kaolin	100	gram
B.	Water	500	cc
	Sodium Silicate	50	cc
	Kentucky Ball Clay	100	gram
	Body Frit	25	gram

Through normal soaking and forming, the add-on, based on final dry weight, amounted to from 15% to 30%, depending upon the cloth construction. That is, the product after drying was composed of from 15% to 30% of ceramic body and 70% to 85% asbestos textile.

The presence of the sodium silicate gave the dry products excellent strength and structure and upon subjection to increased temperatures a calcining action of the clay phase occurred which yielded a body having reasonably good strength over a considerable temperature range.

The investigation to date has been purely exploratory and the samples that have been made are truly rough, representing perhaps a minimum in appearance, quality and properties. Improved techniques should yield improvements in all respects.

The samples produced have been subjected to rather simple tests in an effort to determine relatively basic properties. The characteristics of strength and heat resistance are of principle interest at this point and test procedures designed to evaluate these properties qualitatively, more so than quantitatively, have been pursued.

Strength characteristics in terms of transverse strength or modules of rupture were determined on samples of the various materials which had either been formed or cut into strips approximately 3/4" wide by 1/4" thick by 6" long. The transverse test length was 3". Under such conditions the strength was found to run from 200 pounds per square inch to well over 1000 pounds per square inch, depending upon the degree of vitrification attained and the number of laminations consumed in forming.

It is our intention to run such tests under conditions of elevated temperature in an effort to determine the effect of the viscosity and bonding action of the glassy phase resulting from the elevated temperature reactions between the ceramic additions and the chrysotile upon the strength and structure at these temperatures.

Resistance to destruction by elevated temperatures was studied by one of three different techniques: 1) heating directly in an electric oven to temperatures up to 1835°F; 2) heating tubular forms by mounting a globar heating unit within the tube and heating up to 2500°F; and 3) playing the flame of a propane torch at a temperature of from 2000 - 2400°F on the samples.

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The furnace heating test served to indicate the maximum temperature which the materials would stand before excessive softening developed as a result of the development of large amounts of glass. Such tests required approximately 2 hours to attain the maximum temperature. Most of the samples here on display were subjected to this heat treatment and it will be observed that some of the pieces are reasonably hard and fairly well vitrified while others, being somewhat more refractory are merely calcined and will require higher temperatures before the desired maturity is obtained. While these immature samples do exhibit fair strength, it is the purpose of this work to improve and increase the strength in the temperature range between 800°F and the maturing temperatures in the neighborhood of 2500°F., through the proper introduction of the suitable glass forming ingredients to cover this temperature range.

The globar heating of tubular samples provided information relative to the effects of heating on one side only and, in that, served to provide a type of simulative service information.

Tubular samples were formed in sizes having diameters 3/4", 1" and 3" and the two larger sizes were subjected to this test. By this technique, temperature of 2500° were attainable within the tube and the effect of unidirectional heating could be observed. Such tests conducted for periods of several hours indicated the thermal durability of these fabrications.

The torch flame test provided information relative to thermal shock characteristics afforded by a flame at a temperature of around 2300°F which could be directed upon the sample and removed at any predetermined rate. The flame test, using a propane burning torch, served to indicate the thermal shock properties of the various fabrications and, for the most part, these materials resist destruction very well under conditions of rapidly changing temperatures.

By means of these tests it has been possible to determine, in a very general way, how the bodies developed or matured and how resistant to deformation and destruction the bodies were at high temperatures.

Conclusions

The materials here discussed, their specific compositions and their actual physical properties, are quite indefinite. The question as to whether further work along these lines should be pursued rests with those who sponsor the work of this Fellowship. In a general way, the composition and properties have been given and the samples here displayed serve to provide tangible forms for consideration. It must now be determined whether or not materials such as those represented here are unique and, if so, to what useful purposes they may be adapted.

It is our opinion that such materials afford tremendous possibilities. Unique forming methods should make possible new applications. Through the use of evacuation impregnation and pressure impregnation techniques, effective homogeniety of structure should be possible with resultant properties far surpassing anything discussed or shown here.

The ultimate resultant product would be a special type of refractory, light in weight and therefore applicable to present day airborne vehicle

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constructions. Such refractories could be easily and readily formed, would require no firing or preliminary heat treatment prior to usage and would offer a thermal barrier to withstand short term, high temperature service, to mention but a few of the apparent characteristics of the materials envisioned as a result of this preliminary study. Further developments and study should reveal new applications and areas of usefulness.

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FELLOWSHIP REPORT

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PHILADELPHIA TEXTILE INSTITUTE

PHILADELPHIA, PA.

REPORT #47

December 12, 1958

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MT-004049

Fellowship Report

The activities of the Fellow during the past quarter have been chiefly concerned with further considerations related to the requirements and capabilities of asbestos textiles in the upper temperature range, above 2000°F. Much of the information related to the high temperature capabilities of materials for such service appears to be inconsistant based on current understandings and past experiences. An effort to rationalize and establish the practical degrees of serviceability for asbestos textiles and allied materials today available and to endeavor to envision departures from conventional techniques and products to affect a useful and desirable end has been our primary concern during recent months.

Cerbestos materials, those products composed of a combination of asbestos textiles and certain ceramic materials, were introduced and discussed at the last meeting of the Institute and additional work in this direction is being pursued. However, until more specific requirements covering possible applications for such materials are established, further development in this endeavor will be difficult.

Through the efforts of our friends at American Asbestos Textile Corporation, who made their machine shop and machinists available to us, there was constructed a small hand press capable of exerting a pressure of 3000# on a 2" x 2" sample of material or 750# per square inch. By means of this press we have been studying the effects of pressure impregnation and "Cerbestos" laminates. The characteristics of these products related to elevated temperature serviceability and durability and thermal conductivity are presently being evaluated.

In an effort to determine what practical value the "Cerbestos" materials might have and how we might best proceed in our further efforts along these lines, we were privileged during the past quarter to meet with representatives of Raybestos-Manhattan, Inc. at Manheim, Pa., and American Asbestos Textile Corporation at Norristown, Pa., and on these occasions generally discussed the problems and potentials of such materials.

In our discussions and considerations we are somewhat troubled by the fact that in our thinking we are apparently endeavoring to make a direct substitution of one product for another in hopes of accomplishing a desired end. Recent experiences and conferences have made it abundantly clear that this approach to most of our current problems is incorrect. I think that Robert Rulon Miller, President of Dixon Corp., in the introduction to his article in Textile Industries titled "A Look Inside Spinning Drafting", cogently covers this view with these remarks.

> "One of the problems with the whole textile industry, both with the manufacturers of yarn and cloth and those who make the machinery for this purpose, is that we spend so much time trying to make a dollar that we won't sit bach and do some real thinking. This is an American habit, not just a habit of our industry.
>
> Stop and think for a minute and you will realize that nearly everything new, certainly in the textile industry, and in the automotive industry as well, has come from abroad.

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Our long draft as we know it today, both Casablancas and Roth, is European. Our components, our weighting and guiding devices, the elimination of cap bars, the umbrella creel, the modern spindle--all of these things are European in concept.

The old story in the automobile industry is that the only thing on a car that's American is the self-starter. Many things like automatic transmission and seal beam headlights are European.

What we Americans have the ability to do is to take an idea from someone else and produce it by the millions. Beyond that, we are not a group of people who are outstanding in creative engineering.

Our company allows about five years from the time we think of a product until we can realize a profit on it. We think of hundreds of products, and perhaps only one of them is worthwhile.

What we should be doing, and what somebody should be doing somewhere in this country, is to go back to the cotton plant, or maybe to the bales, and say: "O. K., here are some fibers. How do we best get these fibers into a pair of socks or into a piece of cloth or into a yarn?"

We should set up a research group--some who have never seen a spinning frame, along with some who have. We should get completely fresh ideas, because the textile industry is operating with the same basic ideas the Egyptians used."

That is perhaps too severe an indictment and I cannot necessarily agree with this point of view in toto, however, it would seem that if we are to succeed in our efforts to realize some of our hopes for the future, some entirely new concepts of materials development and applications will be necessary.

To indicate that action in this direction is presently in its incipient stages of pursuance, I would call your attention to a conference I was privileged to attend on Radiation and High Temperature Behavior of Textiles held in New York on November 14 and 15 and sponsored by the New York Academy of Sciences, Polytechnic Institute of Brooklyn and U. S. Navy Clothing and Textile Research Laboratory. At these meetings we heard from such men as J. Fred Oesterling, Deputy Scientific Director, Quartermaster Research and Development Command, Natick, Mass., speak concerning their efforts in the development of protective clothing for the military which will provide the greatest protection against thermal energy emanating from detonated nuclear weapons. So called space fabrics are being seriously explored in this area. In evaluating this work a new solar furnce capable of attaining 5000°F is being utilized.

Also, Willard L. Derksen, New York Naval Shipyard, presented remarks concerned with the effects of thermal radiation on cotton and woolen textile. Much of this presentation was in the realm of theory and bears no consideration here.

In all, there were eleven papers presented and for the most part all were scholarly although some parts were so highly technical as to be of questionable value to the average layman and even scientist at this point. However, there were three papers that were of great interest to me and I am sure will be to

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most of you. I cannot however hope to cover fully these presentations at this time from the notes I took, but will at some future date receive copies of the complete papers which are now being prepared for publication and will make them available to those who may be interested.

The first of the three papers of note was by Dr. Irvin M. Gottlieb, Textile Research Institute, Princeton, N. J., entitled "High Temperature Properties of Organic Fibers". The high temperature characteristics of eighteen natural, synthetic, regenerated and derivative fiber types and blends of these with cotton were discussed. Also, the thermal stability of certain coated fabric systems was statistically evaluated. The second paper, by R. F. Caroselli, Manager, Textile Process and Products Development Laboratory, Owens-Corning Fiberglas Corp., entitled "High Temperature Properties of Inorganic Fibers", presented a survey of the elevated temperature capabilities of the inorganic fiber group including glass, silica, aluminum silicate, metalized inorganic textiles and asbestos. In preparing for this presentation Mr. Caroselli asked for and received from the writer information concerning the elevated temperature capabilities of asbestos textiles and this material was well covered in this presentation. Current information related to the properties of glass, leached glass and fibrous silica were also presented.

The final paper of this interesting group was presented by Mr. I. J. Gruntfest, Aerosciences Laboratory, General Electric Company, titled "Textile Reinforcement in High Temperature Plastics". The result of work conducted at 12,000° K, generated in special electric arc devices, was presented and discussed. The high heat absorbency capacity of organic materials together with their tendency to pyrolyze with the generation of large volumes of gas seems to provide the necessary characteristics for the high temperature serviceability of these materials.

Many of the ideas and concepts presented in these papers were based upon new understandings of the basic tenets of the problems today being encountered. It is not possible, in most cases today, to project or extrapolate current or measureable data into the upper reaches of temperature where accurate measurements of temperature and physical properties are extremely difficult, if indeed possible. In most cases, serviceability at 1000°F or 2000°F bears little resemblence to the serviceability at 5000°F or 10,000°F. In considering a material for these upper temperature services a complete knowledge of the thermochemical evolutions, the characteristics of the char products and the ash residue are necessary if success to any degree is to be attained.

It appeared to me that, in most cases, the men who addressed remarks in this conference were entering and engaging in new fields of though and endeavor as they attacked their several problems. Many of the approaches may be considered at this point strictly "long hair", but the fruits of these labors will only be known after a test and trial.

Those of us interested in promoting the use of asbestos textiles not only for the rocket and jet engine applications currently receiving so much attention but also in the many other fields where new thermal durability characteristics are being sought will of necessity be required to depart from many of our conventional concepts if satisfactory materials are to be developed.

Cerbestos materials represent a departure from conventional fabrications. Resin laminated and bonded asbestos materials for service at 10,000°F and higher is a departure from conventional understandings of the capabilities of such materials. Other and perhaps even more drastic departures concerned perhaps with textile construction and fiber blends will be necessary if all avenues of service are to be traversed.

The thoughts here expressed have been the subjects for serious consideration by the writer during recent months and it is hoped that in pursuance of some of these ideas which may at the moment appear etherial and somewhat abstract we may emerge upon a new and larger horizon of usefulness for asbestos textiles.

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Additional information regarding the reentry problem of ballistic missile nose cones has become available. The nose cone enters the atmosphere at speeds of three to five miles a second. The air in front of the cone is compressed and heated. A strong shock wave is formed and two types of drag result-- a wave drag in front of the cone and skin drag as the viscous air travels over the missile nose.

The reentry time is brief--under a minute--but the shock-wave temperature goes up to 15,000 degrees Fahrenheit, the air layer next to the skin goes to 12,000 degrees Fahrenheit, and the cone surface is at about 5,000 degrees Fahrenheit. Rate of heating is over 2 BTU/sq. in./sec.

This heating is about as severe as that occurring in the hot blast of rocket combustion chambers where heat-transfer rates up to 5 BTU/sq. in./sec. have been measured. It should be noted that the heat transfer in a modern steam generator is about 0.03 BTU/sq. in./sec. and peak values for internal-combustion engines are about 0.07 BTU/sq. in./sec.

As the nose cone enters denser atmosphere, the pressure may go up to 1,000 p.s.i. in a few seconds. A jet plane, for example, may encounter a skin temperature of 650 degrees Fahrenheit at a pressure of 1 p.s.i.

Several approaches are being evidenced in production nose cones. Army's Jupiter nose cone will be long and slender with a rounded tip. The cone itself may be made of reenforced plastic which presumably will burn away in layers--thus heat will be removed. The Air Force Atlas, Titan, and Thor will have very blunt noses and will be constructed of "heat-sink" materials such as copper or beryllium. These materials will absorb heat rather than remove it as in the case of Jupiter.

The Navy is believed to be taking another approach with Polaris--the use of a ceramic absorbing material. It is felt that heat removal, or ablation as it is called, offers the greatest problem to aerodynamic heating. However, within the next five years, as conditions become even more sever, fluid cooling or the use of magneto-hydrodynamics may come into play.

NOTE: The above article from Ordnance, Vol. XLIII, No. 230, Page 300, was read prior to the presentation of the Fellowship Report in view of the relevance of the subject matter to the Fellowship work.

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RADIOACTIVITY INDUCED IN ASBESTOS

Samples of Cassiar Chrysotile, Thetford Chrysotile, Amosite, and Crocidolite were irradiated for one week at a neutron flux of 6×10^{11} N/sec/cm^2 in an Oak Ridge National Laboratory reactor.

The samples were analyzed by a gamma-ray spectrometer to determine the energy of the gamma-rays emitted and their half-life. The energy and half-life specify the element from which the radiation comes. The intensity of the radiation is also measured. This is expressed in curies, that is, the actual number of gamma-rays emitted per second, and in roentgens, which is a measure of the energy imparted to or absorbed by air.

ORNL has reported qualitatively all radioactivities produced, but the quantitative intensity of only the activities of long half-life, Scandium 46 and Cobalt 60. The complete report will include the quantitative intensity of all radiations.

The reported values are listed in tabular form as:

	Cassiar Chrysotile	Thetford Chrysotile	Amosite	Crocidolite
Manganese-56 2.58 hour-0.85 Mev.	Present	Present	Present	Present
Sodium-24 15 hour-1.37 and 2.75 Mev.	Present	Present	Present	Present
Antimony-122 2.8 day-0.57 Mev.			Present	
Chromium-51 27.8 day-0.62 Mev.	Present	Present	Present	
Iron-59 45.1 day-1.1 and 1.29 Mev.	Present	Present	Present (Main Activity)	Present
Antimony-124 60 day-0.61 Mev.		Present	Present	Present
Scandium-46 85 day-0.89 and 1.12 Mev.	1.0×10^{-6} C 2.0 Mr/hr at 1"	1.6×10^{-6} C 2.7 Mr/hr at 1"	0.73×10^{-6} C 1.3 Mr/hr at 1"	0.085×10^{-6} C .15 Mr/hr at 1"
Cobalt-60 5.3 year-1.17 and 1.33 Mev.	0.3×10^{-6} C 0.62 Mr/hr at 1"	0.2×10^{-6} C 0.40 Mr/hr at 1"	-----	-----

The first column gives the source of the radiation - the element and its atomic number, the characteristics of the radiation, the half-life or rate of decay, and the energy of each gamma-ray. The intensity of the radiation is expressed in curies, the actual number of gamma rays emitted per second (1 curie = 3.7×10^{10} per second) and in milliroentgen per hour at 1-inch, i.e., the energy

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absorbed per hour when one inch from the source.)1 roentgen is amount of radiation required to impart 83 ergs per gram of air.)

The accepted safe level is 0.1 roentgen per day over the whole body or 0.3 roentgen per week. Although one cannot make a complete analysis until the intensities of all radiations are known, it appears that the intensity of the radiation induced in asbestos is low enough that it would be suitable for use around nuclear reactors. The extremely low level of activity induced in Crocidolite is to be noted.

The radioactivity can be induced from either a normal component of asbestos or an impurity. Furthermore, the nuclear reaction can produce a transmutation from one element to another, so the radioactive element will differ chemically from the bombarded element. For example, the radioactive Sodium-24 was undoubtedly produced from Magnesium, a normal constituent of asbestos, while the radioactive Cobalt-60 undoubtedly came from nickel, an impurity. The source of the various activities will be indicated by the intensities and chemical analyses.

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