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Introduction

During recent months the attentions of the Fellow have been concerned with a variety of subjects. Certain fundamental properties and characteristics of our basic fibers have been under observation and some of the newer fields of utilization and application have been studied. In this latter area we have had an opportunity to become acquainted with some of the new technological demands that our industry will have to meet if we are to supply the necessary materials of construction currently being sought. Competative and some rather exotic materials are being readied for entry in this field and how well our industry advances in improving what we now have, in developing new products with still greater strength, temperature and over-all good construction capabilities and in effectively promoting the full potential and capabilities of our materials will determine in large measure the future course of our industry.

During recent months we attended several important technical meetings and seminars which were related to various areas of interest within the scope of the Asbestos Textile Institute. On October 16, 1962, a Symposium on Fibrous Materials was held in Dayton, Ohio, sponsored by the Fibrous Materials Branch, Nonmetallic Materials Laboratory, Wright-Patterson Air Force Base; on December 5, 1962 the American Ordnance Association held its 44th Annual Industrial Preparedness meeting at the Waldorf-Astoria in New York City, and on December 11-13, 1962 a conference on Structural Plastics, Adhesives, and Filament Wound Composites was held in Dayton, Ohio, sponsored by the Plastics and Composites Branch, nonmetallic Materials Laboratory, Materials Central, Wright Patterson Air Force Base.

One has only to attend such gatherings and to be confronted with the technological tenor of the addresses and remarks issuing therefrom to be impressed by the pace in which we are all being caught up and are being forced to maintain if we are to live and to survive not only as a great country but as a company, as an individual, indeed as an association such as the Asbestos Textile Institute.

The enormity of the budgets to maintain and sustain this pace and the vastness of the space that we are coping with are so great that comprehension is often difficult. When one endeavors to relate the tensile strength of a 35 cut, Grade AAA, asbestos yarn to the contemplated 900 day journey that some space man will make to Mars, in probably the not too distant future, there seems to be a gross incongruity but, in reality there is not. The future of our industry is dependent upon our ability to equate such terminology. The dollar value and the quantities of materials involved in these programs truly staggers the imagination.

In our effort to establish a place for asbestos textiles and asbestos products in this over-all pattern of opportunities and to determine how the products of our industry can be oriented and brought into usefulness in these newer fields of application there must be 1) a complete understanding regarding the basic structural requirements that are to be encountered, 2) complete familiarity with all of the basic properties and capabilities of the materials to be offered, and 3) a knowledge of those other materials that will competatively challenge the ultimate adoption of an asbestos material as the acceptable component or structural unit. An endeavor will be made to relate these parameters and to gain a very general picture based upon the impressions gained at the several conferences attended.

In addition to the above application considerations, certain fundamental properties of chrysotile asbestos fiber related to Magnetic Rating and iron content and the pH value determination techniques have been under investigation. The importance of such values and the techniques involved in making such determinations may not appear important, at first glance, but as we endeavor to enter even wider areas of service and application, greater purity and a more positive knowledge regarding the chemical behavior and surface characteristics of our materials becomes increasingly significant. These test methods are receiving attention at this time as a cooperative effort of the Institute and the American Society for Testing and Materials.

Review of Conferences

Symposium on Fibrous Materials. The report of the proceedings of this symposium furnished only to those who were entitled to be in attendance contains the following statement:—

> "This report is issued for the information of the U. S. Government scientific personnel and contractors. It is not a part of the scientific literature and must not be cited, abstracted, reprinted, or given further distribution".

In order that compliance with this order may be pursued, typical abstracting and citing cannot therefore be accomplished and due to this restriction we can only generalize at this time and cover broadly the subject matter relavent to our interests.

Conference on Structural Plastics, Adhesives, and Filament Wound Composites.

The conference was divided into three sessions, each of which was concerned with a different aspect of the over-all consideration. The first session covered Organic and Inorganic Resins and Adhesives with eight papers being delivered, covering a rather wide range of materials. The organic resins discussed included the Polyisocynurates and Polymeric Chelates, the Polyimides, the Polybenzimidazole (PBI), Epoxy and the Phthalocyanine Copolymers. The PBI development by Narmco Research and Development, an affiliate of Telecomputer Corp., appears to be one of the major developments in this field and the author that spoke on the subject was so thoroughly convinced of its revolutionary capabilities that he made the statement that "it was superior to anything now available for structural materials". As a general figure it was pointed out that a 20% resin content composite cured at 350°C and 2000 psi exhibited flexural strengths in excess of 100,000 psi.

However, in most discussions related to these subjects the underlying difficulty seems to rest in the lack of assurance of a complete and repeatedly uniform wetting of the filler or laminant by the resin. The surface chemistry of the materials to be bonded is apparently not well understood and as a result homogeniety is not always achieved, indeed from some remarks expressed, it is rarely achieved to the ultimate extent. While no reference to asbestos as a filler or laminant was made during the course of these discussions, one author suggested that the presence of surface hydroxal groups serve to obstruct resin

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to glass wetting, the significance of this observation as it is related to the use of asbestos in this field is being considered.

Also included in this series of papers was one entitled "Boron-Phosphate Matrix for High Temperature Application by C. H. Vondracek, D. Berg and L. E. Moberly, Westinghouse Electric Corp. A copy of this paper has not as yet been received, however, the remarks as presented would appear to offer some interesting possibilities. In this work, Boron-Phosphate resulting from a proper proportionate mixing of Boric Acid and 85% Phosphoric Acid, is utilized as the bonding and cementing medium for asbestos laminates. Typical properties of such a laminate after curing at 500°C showed a flexural strength of 33,500 psi; Modulus of Rupture of 2.0x 10^6psi; Tensile strength 12,460 psi and Compressive Strength of 52,000 psi. Until a careful study of the report is possible no further details are available, however, on the basis of the oral presentation it would seem that perhaps these considerations would bear some further study.

The second session of the conference was devoted to Filament Wound Composites. Great strides have been made and are being made in this field and the state of the art is apparently being revised practically daily. The selection of the proper mandrel based upon economic considerations as well as the technological requirements has resulted in significant savings and in more efficient manufacturing operations in many cases. One of the most vexing problems that is apparently confronting those engaged in this type of fabrication is that of testing for assurance that all filaments in the finished unit are continuous and that no filament breakage is present that will trigger a premature rupture of the case. Electrically conductive coatings for the filaments are being considered as a possible means of checking this property.

The new S994, high strength glass is currently being evaluated and it does appear to possess from 25% to 30% higher strength properties than the normal E glass filament.

In remarks by Mr. J. A. Kies, U. S. Naval Research Laboratory, concerning the "Vulnerability of Filament Wound Pressure Vessels to Mechanical Damage", it was stated that during the last war, for every plane that was lost in battle, 15 planes were lost to the service through minor failures or damages and that filament wound pressure vessels contributed notably in this area. He stressed the desirability for more rugged construction. It would seem that the abrasion resistance capabilities of asbestos should fit into this picture somewhere.

The final session of this conference covered Reinforcements and was devoted to considerations of Glass, Berryllia Fiber, Sapphire Whiskers, Boron, Carbon and Graphite.

A review of the properties of the new S994 glass revealed that the top usable temperature of this glass approaches 1400°F compared to 1100°F for the "E glass". S994 has a 30-40% higher strength than E glass and is now about $8.00 per lb. which will be reduced to $4.00 per lb. at some future date.

A second paper related to glass fibers discussed the properties of hollow glass fibers and a comparison with conventional glass filaments were made showing that two of the hollow fibers would have the same weight as one solid fiber

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or filament and the thermal conductivity for hollow fiber fabrications would be reduced by some 90%. The considerations at this point are largely theoritical.

Beryllia, Beryllium oxide, fibers also offer unique possibilities in the area of application here being considered. The following physical properties were tabulated as typical of this refractory fiber:

Melting Point	2570°C
Density	3.008
Tensile Strength	21,000 psi @ 20°C
	11,000 psi @ 1100°C
Youngs Modulus	50×10^6 psi @ 20°C
	37×10^6 psi @ 1000°C

Sapphire Whiskers have been under investigation by General Electric Company for some time as structural reinforcements and further basic observations were here discussed. It was revealed that the tensile strength capabilities of such whiskers range from 0.9 - 2.8 million pounds per square inch.

Boron, as elemental Boron, offers still another, although somewhat exotic, possibility as a reinforcement for structural composites. This element is 15% lighter than aluminum, harder than sapphire, melts above 3700°F, is moderately oxidation resistant and has an extremely high neutron absorption capability, around 4000 Barnes. Studies are now being pursued in an effort to adapt this material to meet some of the more extreme and exacting demands.

Finally, Carbon and Pyrolytic graphite in fibrous and woven forms are finding unique applications as high temperature reinforcing materials and such limiting characteristics as low strength and the tendency for carbon materials to oxidize are being studied in an effort to improve these areas of serviceability.

Summary of WPAFB Conferences

The papers presented at these two conferences were by and for the benefit of those civilian contractors that carry out research or have research contracts with Wright Patterson Air Force Base. Obviously, very little work or attention has been given asbestos in any form by any of the contractors in the related fields here reported upon. In only one paper, "Boron-Phosphate Matrix for High Temperature Applications", was asbestos mentioned. However, the scope of the work and the wide range of materials studied indicates rather convincingly that apparently there are few materials available today that will completely satisfy the requirements. New fibers of unique compositions and constitution are being evolved, new forms and physical statures are being considered such as whiskers, hollow or tubular filament and assemblages of super fine wire to form fine-cut metallic filaments for textile purposes are being studied with a view to providing materials exhibiting properties superior to anything now available.

The plastics molding and resin impregnating industries have for the most part accepted glass in one form or another as the basic filler, however,

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problems of wetting and achieving the ultimate in homogenity are ever being encountered and the poor abrasion and wear resistance properties cause problems. Perhaps the endeavors by the glass fiber manufacturers to improve the physical constitution of the glass fibers will be fruitful. However, it would seem that with the improvements in the asbestos fiber quality that our industry now enjoys and realizing the capabilities inherent within our industry to furnish a full range of textile products that would be suitable for such treatments, it would seem that our industry and the products that our manufacturers are capable of furnishing should be receiving somewhat more attention than is here indicated.

Research Activity

Magnetic Rating and Iron Content

Within the past year interest has increased in the method and technique for determining the electrical properties of asbestos fibers and products containing such fibers.

Certain interests have been engaged in the preparation of a detailed specification to be adopted as the rules of procedure for such tests. In this, the A.S.T.M. Mapes method serves as the basic procedure and additional, somewhat more specific instructions are included as a part of these specifications.

Other interests have been engaged in endeavors to make accurate determinations where extremely low iron contents and low MR values are concerned. MR values of less than 0.1 and trace amounts of iron are of interest in these considerations.

In addition, there have been questions raised as to the specific relationship between MR, iron content and the conductivity or resistivity of rovings, yarns and ropes that are essentially asbestos.

In reviewing the problems that are being encountered as efforts are exerted to correlate the Mapes Method of analysis with electrical serviceability capabilities, several significant points are obvious. As greater accuracy is sought and a higher degree of reproduceability between laboratories is expected and as values in the decimal range of MR values are to be measured due to extremely low iron contents, there must be a higher degree of standardization of instrumentation and testing procedure among those individuals and laboratories that perform such tests.

However, the standardization of the Mapes test equipment and technique does not necessarily resolve all of the problems. Experience has proven that although the Magnetic Rating does give information relatively indicative of the Fe_3O_4 content, the grain size and orientation of the magnetite grains markedly influences these results as obtained in the Mapes Analyzer and variations in the MR values become proportionately more pronounced as the magnetic iron content decreases. In view of this, it has been felt for some time that other methods of determining either the iron content or the electrical properties should be used to complement or supplement the Mapes Method. Conceivably, three or possibly four test methods might be utilized and so correlated that an area of electrical serviceability might be defined by the property parameters

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determined by several test methods. Within subcommittee A-4, D-13, A.S.T.M., considerations are being given to a resistivity measuring device. Another member of the Institute and also a member of the above A.S.T.M. group has developed what is known as "Magnetic Force Method". Also, in our investigation, we have turned attention to a chemical spot test technique which selectively isolates ferrous iron (the state of iron that must be available if magnetite is present) and reacts to yield an identifiable color reaction. It is hoped that in this latter technique quantitative determinations may be possible through shade and color intensity measurements.

At this time there is nothing further to report concerning the resistivity method or the magnetic force method but attention will be given both techniques at the March meeting of A.S.T.M. and the results of these considerations will be made available as they develop.

The chemical spot test which has been under investigation by the Fellow is a technique reported by Prof. Fritz Feigl in the Publication "Spot Tests in Inorganic Analysis". Feigl reports that ferrous iron in solution in a mineral acid will react with organic base a,a' dipyridyl, yielding a red stable complex cation. Ferric iron on the other hand does not react under these conditions, therefore very small amounts of ferrous iron can be detected in the presence of large proportions of ferric iron. As a matter of fact, ferrous iron in amounts of .00003 milligrams are reportedly detectable by this technique. Our efforts to date in this endeavor have generally been exploratory, however, results would seem to indicate that quantitative evaluations should be possible.

In pursuing the several methods under consideration new avenues of approach are envisioned and it is conceivable that through the correlation of one or more of these techniques with the Mapes method, more definitive evaluations regarding the electrical capabilities of our fibers and materials may be possible.

pH Determinations.

Inquiry has recently been directed to our attention through A.S.T.M. regarding the accepted method for the determination of the pH value of asbestos fibers. Our records reveal little information regarding a standard procedure for such a determination and it would seem that as attentions are being directed to more specific data regarding all materials, that some consideration should be given regarding the proper method to be pursued in making this particular determination. Undoubtedly such determinations have been made from time to time by many of those who supply the raw fiber and by those who manufacture asbestos products, since the literature occasionally has a reference to this value. Our Handbook, for example, states that the Ph for chrysotile may range from 9.2 to 9.8. However, up to this time there has never apparently been sufficient interest or cause for concern in this regard to warrant serious considerations as to the methods to be followed in making such determinations. However, as interlaboratory correlations are sought and accurate relative values, if not absolute determinations, become necessary, it seems logical that attention should be directed to the standardization of an accepatable method of test.

It is our purpose at this time to determine the methods and techniques that have been established in those laboratories where such tests have been conducted. Following a study and correlation of this information it should be possible to arrive at mutually acceptable standard procedure for such determinations.

The cooperation of each member company laboratory will be helpful in this endeavor as we solicate aid and information from within and without the Institute membership.

Conclusions

The Fellowship activities during recent months have been concerned with fundamental studies of the fiber and with the application of the fibers as filler and reinforcing materials in structural composites. In order that greater areas of serviceability and application for the products of our industry may be realized, more specific and accurate information regarding the basic fiber units must be established and the characteristics of the wide variety of asbestos textile products as they are incorporated as components in more or less complex systems must be understood. This store of useful knowledge is gradually, if sometimes seemingly too slowly, being brought into the form of a useful pattern and asbestos in one or another of its wide variety of forms is finding its place as one of the important structural reinforcements.

There are two important features that are motivating our work and studies at this time. First, the necessity for more accurate data which defines the properties and characteristics of the materials both basic and fabricated with which we are dealing becomes of greater importance and significance as an effort is made to fit the products of our industry into the engineering and technology of the day. Secondly, as the end use and structural requirements of the materials being sought are made available with somewhat greater clarity than was the case even one year ago, it is now possible to prepare our materials for specific product developments and known areas of application rather than as was the case in the not too distant past when an effort was made to adapt given materials as furnished, without regard to application, to specific end use.

Our efforts will continue to be devoted to studies designed to enlighten all concerned regarding accurate basic data related to both the fibers and products of our industry and to endeavor to best relate these basic characteristics to the proper end use and application for these materials.