ATI-113

Minutes of the Technical Committee Meeting of the Asbestos Textile Institute held September 8, 1960 at the Statler Hilton Hotel, N.Y.C.

IN ATTENDANCE

AMERICAN ASBESTOS TEXTILE CORP.
E. C. Cutler

JOHNS-MANVILLE CORPORATION
E. Beale
J. L. Tucker

RAYBESTOS-MANHATTAN, INC.
M. W. Oliver

U. S. RUBBER COMPANY
D. S. Nichols

ASBESTOS TEXTILE INSTITUTE
M. C. Shaw

KEASBEY & MATTISON COMPANY
D. F. Quealy

1. Revision of the A.T.I. standard cloth list was discussed, and it was learned that Dr. Shaw has received a suggested standard cloth list from each member company. Where more than one company is making a particular cloth, this cloth will be included in a suggested cloth list which will be issued for general review, particularly for recommended values of tensile strength and thickness.

2. The Bureau of Ships specification SS-C-00466B dated February 3, 1960 was reviewed, and it was found that there are several parts of this specification which in the opinion of the committee should be revised. According to specification paragraph number, they are as follows:

   3.3.3.4
   It was suggested that for the style 5 glass cloths, glass yarn number should be specified to read "150-2/2 or equivalent" rather than limiting the use of this yarn to number 150-2/2. For example, the less costly 150-4/0 might possibly be used.

   Table IV
   The style 5 glass cloths in table IV are of different constructions, and the same tensile strengths are specified for each. It was the opinion of the committee that each member submit to Dr. Shaw their recommended values for proper tensile strengths. It was also noted that inasmuch as both 1.10 pound cloths are nearly identical, one of them should be deleted. Dr. Shaw is also to be advised as to which one should be deleted from the specification.

   5.2.1 and 5.2.2
   It was noted that ambiguity exists in the specification regarding the 200 pound maximum gross weight for wood boxes. Obviously, this is not sufficient for the heavier rolls of cloth.

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3. Following the committee reports President Griffis briefly reviewed some of the remarks he would offer at the General meeting upon his retirement from office. He then called upon Mr. J. A. Bettes, Chairman of the nominating committee to report upon the results of that committee's activities in drafting a slate of officers to serve the Institute for the next two years. It was here reported that their efforts had been successful and that the officers that would be nominated, following the election of the Board of Governors at the General meeting would be as follows:

President	W. S. Hough, Johns-Manville Corp.
Vice President	T. C. McCluskey, Tallman-McCluskey Fabrics Co.
Treasurer	A. E. Whitfield, Keasbey & Mattison Co.
Sec. & Asst Treas. ..	M. C. Shaw

4. There being no further business to come before this meeting it was moved by Mr. Bettes, seconded by Mr. Peele and unanimously agreed that the meeting be adjourned.

Myril C. Shaw,
Secretary

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MINUTES OF THE ASBESTOS TEXTILE INSTITUTE'S
AIR HYGIENE AND MANUFACTURING COMMITTEE
September 8, 1960

In attendance:

W. C. Atkinson - Johns-Manville Corp., Manville, N. J.
D. T. Austin - United States Rubber Co., Hogansville, Ga.
L. D. Horowitz - Keasbey & Mattison Co., Ambler, Pa.
J. L. Mitchell - H. K. Porter Co., Inc., Charlotte, N. C.
H. E. Palm - Raybestos-Manhattan, Inc., Manheim, Pa.
R. B. Smith - Raybestos-Manhattan, Inc., No. Charleston, S.C.
Hans Walter - American Asbestos Corp., Norristown, Pa.

Guest: Mr. G. S. Mallinson - English Asbestos Co., Ltd., Brislington, Bristol 4, England

The following items were discussed:

DUST COLLECTING EQUIPMENT, SYSTEMS AND SAMPLING:

It was brought to the attention of the committee that the North Carolina State Health Department has recently ordered a Portable Aerosol Photometer. The purpose of this miniature dark-field photometer is to recognize very small particles in the air, to indicate directly and instantly the concentration of particles larger than a given size, to generate, for subsequent analysis, pulse signals porportional to the size of each particle, and to do these things in a fully portable unit. A discussion of the advantages of taking dust samples with a unit like this was held and we will be waiting to see how the unit will be used by North Carolina. In conjunction with this, two member companies exhibited recent dust count surveys which had been conducted by the state agencies at their plants. One state had also included in their survey a noise level count. This particular plant was well below the allowable limit in both the dust and noise level counts. We believe that it would be wise for our companies to include in their pre-employment physical examinations a record of the prospect's ability to hear thus establishing information which would be available in case of future compensation discussions. We also recommend that all employees be X-rayed at least once a year, this is being done by a majority of our members at present. Also discussed w as the re-circulation of air from dust collectors, this can be done if the proper effective filter mediums are used prior to the air entering the department. Mr. Mallison mentioned that this is not permitted in England.

ENVIRONMENTAL HEALTH SURVEY:

We are still attempting to lay the ground rules for an Environmental Health Survey among our member companies. This survey, if approved by management, would strive to standardize X-ray interpretation and classification, physical examinations, work area designations, dust sampling and counting. We should develop uniform techniques and records which could be summarized periodically by the membership thus establishing the progress and effectiveness of our control measures. However, as stated, this survey is still in the planning stages.

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GENERAL ENGINEERING TOPICS:

Mr. Mallinson explained and showed photographs of an experimental hopper feeding arrangement with removable containers which they are working on in England. The fiber is placed in a large container in the Preparation Department, rolled to the card hopper where chains are fastened to each side of the container at which time a motor raises the container up and dumps the fiber out into the hopper. This was discussed at great length and proved very interesting.

The methods of applying water to yarns while being woven was discussed. It appears that there are several different ways being employed by our members to accomplish what is known as "WET WEAVING".

One member told of the progress and success which they are experiencing with their New Twister Dust System. They have designed and built this system themselves and have it installed on two twisters. It removes the dust at the ring rail level and is very effective when an end breaks on the spindle. They will keep us informed as to their dontinued progress.

It was stated that Dr. Knox from England visited several member companies while in the states recently, however we are sorry that a general meeting of the entire membership could not be arranged with him while he was here.

PLANT SAFETY:

Under this topic several accidents that had occured since our last meeting were discussed. One member distributed their recently published booklet entitled "Plant-Wide Safety Specifications" and explained how their safety program worked. This was discussed at length and was very beneficial. It was also stated that this program was a joint effort between the Company and the Union and was backed by the Union.

The painting of dangerous parts of machines was discussed and is being done by several member companies. Also discussed was the procedure of reporting accidents and fires at various member companies.

We enjoyed having one of our Associate Members, Mr. Mallinson, visit with us and appreciate his contributions to our deliberations.

AGENDA FOR DECEMBER 15, 1960 MEETING:

1. Factors which will be involved in our suggested Environmental Health Survey.
2. Dust Collecting Equipment and the problems involved.
3. New Developments in Machinery & Equipment.
4. Plant Safety Problems.

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Respectfully submitted,

Ralph B. Smith, Chairman

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FELLOWSHIP REPORT

MYRIL C. SHAW

RESEARCH FELLOW

ASBESTOS TEXTILE INSTITUTE

PHILADELPHIA TEXTILE INSTITUTE

PHILADELPHIA, PA.

REPORT #53

June 6, 1960

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Fundamental Considerations of Elevated Temperature Properties of Significance Related to Heat Transfer.

Introduction

During recent months there have been increased expressions of interest in the elevated temperature properties of asbestos textiles related to the K value or thermal conductivity, specific conductivity, thermal diffusivity and the heat sink coefficient. All of these terms serve to define the significant thermal properties of materials as they are to be adapted to rocket constructions and as components for jet engines where extremely high temperatures are encountered, where thermal insulation is important and where thermal shock due to rapidly changing temperature gradients is usually quite distructive.

In view of this interest and the importance of the subject matter involved, a portion of this Fellowship Report is being devoted to some of the fundamental considerations involved.

The fundamentals of heat transfer are usually reasonably well understood by those who deal in this area of engineering and design and the cause and effect relationships are appreciated in most instances. However, very often all of the principles upon which a given set of heat transfer conditions may rest are not always given proper consideration with the result that there are often experiences of engineering failure or over-designing. We are perhaps not as concerned with over-designing, except as it may influence the original cost or investment involved, as we are with the possibilities of an engineering failure which may result in damage to expensive equipment or injury to personnel. Neither of these extremes is acceptable in an efficient operation and neither will be present if there is a proper understanding of all of the basic principles involved.

It is our purpose here to endeavor to clarify some of the fundamental points of interest which are not always too well understood and quite often are misapplied when the overall elevated temperature serviceability properties of a given material for a specific application are being considered.

Definitions

Thermal Conductivity.

The resistance of a given material to transfer heat is dependent upon the thickness of the material and the Thermal Conductivity, K. Thermal Conductivity is defined as the rate of heat transfer in one direction (perpendicular to an area) per unit area, per unit temperature differential per unit thickness, per unit time (for example, Btu per sq. ft., per degree temperature difference between surfaces per one in. thickness, per hour). Conductivity is a specific property of a material, a rate of heat transfer, and is dependent only upon the mean temperature of the material under consideration. Conductivity, as represented by "K", is not dependent upon the area, thickness or shape of the material but the total quantity of heat that will be transmitted by this material is dependent upon the area, shape and length of path or thickness and "K".

These basic understandings are offered in order that the terms we are here dealing with and the application of these terms to useful engineering data may be clearly understood. Thermal conductivity is normally expressed as the "K

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value" in terms of Btu/hr/sq ft/°F/ft and a specific value or "K" factor has been established for a great variety of materials. Table I sets forth typical "K values" for a variety of materials.

Table I. Thermal Conductivities of Some Representative Materials (1)

	Density (lb per cu ft)	Temp. °F	K (Btu/hr(sq ft) (°F/ft)
Aluminum		68	120.0
Copper		68	222.0
Iron, Cast		68	29.0
Mercury		68	5.0
Silver		68	237.0
Aluminum foil	0.2	90	0.025
Celotex	13.2	90	0.03
Hair Felt	11.0	90	0.022
Rock Wool	10.0	90	0.024
Cotton Tape		100	0.043
Glass Plate		100	0.46
Paper Board, Varnished		100	0.17
Porcelain		100	0.84
Silk, Varnished		100	0.096
Silk, Unvarnished		100	0.027
Concrete		Normal use	0.43 - 1.25
Brick, Refractory		" "	0.34 - 1.25

The "K" factor specifically characterizes the conductivity characteristics of the unit, basic material at a specific temperature of performance. However, the "K" factor may be misleading if, when pursuing conductivity considerations, all of the circumstances surrounding the service are not rationalized. Mr. L. B. McMillan (2) has this to say in this regard: "It is well-known that insulating materials owe their insulating value to porosity, and often it is said that the air spaces are responsible for the low conductivity. That is true as far as it goes, but a more complete statement of the situation would be that it is the multitude of surface resistances at the boundaries of the air spaces which give the material its resistance to heat flow. Because of the close proximity of the warmer and cooler walls of these spaces, the magnitude of each of these surface resistances is naturally small as compared with the resistance at an outer surface, yet because of their multitudinous number the sum of all of these small resistances may result in a total resistance of relatively high magnitude. The solid material between the spaces may be relatively a good conductor of heat, yet if the physical structure of the particles be such as to provide a sufficient number of spaces with their corresponding surface resistances, the resulting product may be a very good insulation. This is illustrated by the fact that the conductivity of magnesium carbonate in the form in which it is used as an insulation is about one-thirtieth of that of the same material in solid form. An even more striking example is the case of carbon, which in the form of graphite has a conductivity of more than two hundred times that of carbon in the form of lampblack."

(1) Heat Transmission, William H. McAdams, (1954)
(2) Heat Transfer Through Insulation in Moderate-and High- Temperature Fields-- L. B. McMillan, A.S.M.E. (1926).

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It is well known that the temperatures of service markedly influence the conductivity of many materials. In Figure 1,(3) examples of the range of such values are presented.

The usefulness of the "K value" of a given material in indicating the overall conductivity of a product or form into which that material may be fabricated rests in the homogeneity of the ultimate product or form. For example, the glass of which fiber glass may be blown may be formed into a solid block or pane, and will have a density of 140 lbs/cu ft and a "K value" at that density of 0.40. That same glass formed as a block of Foamglas, having a density of 10.6, will have a "K value" of 0.035, while that same glass formed as a fiberglas board, having a density of 11.0, will have a "K value" of 0.02.

The hetrogeneity or lack of homogeneity brought about through the blending or mixing of a material with air or some other gaseous product markedly influences the capability of that material to transfer heat. The "K value" of the basic material may remain unchanged but the heat transfer capabilities of the resultant product will be different depending upon the bulk density.

To know the "K value" of chrysotile in its form as a crude fiber would be of academic interest but from a practical point of view it would, in most cases, be of very little practical value. The fiber is always used in an opened condition, blended with either air, resin, cement or any number of other contaminants and these so-called contaminants influence the thermal conductivity properties to a great or lesser degree depending upon the form and density.

The thermal conductivity characteristics of asbestos textiles in the many forms and fashions of its fabrication are becoming ever more important and answers to inquiries in this area of interest are continually being sought. Particularly in the fields of application where ablation and heat sink problems are encountered is thermal conductivity of vital concern.

In view of this interest and concern an effort is here made to show the relationship of Thermal Conductivity to such properties as Specific Heat and Density in the complex determinations of Heat Sink, Conductivity and Ablation characteristics of materials.

Specific Conductivity.

Specific Conductivity relates thermal conductivity with density and the values so determined serve to indicate insulation efficiency. Mathematically it is expressed:

$$S.C. = \frac{1}{Kd} = \frac{in^2}{Btu\ {}^{o}F\ ft^2\ hr.}$$

Examples of the magnitude of the values for such determinations are set forth in Table II and are representative data for typical materials. The higher the values cannote efficient insulation, weightwise.

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(3) The Basic Laws and Data of Heat Transmission; W. J. King, Mechanical Engineering (1932)

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FIGURE I

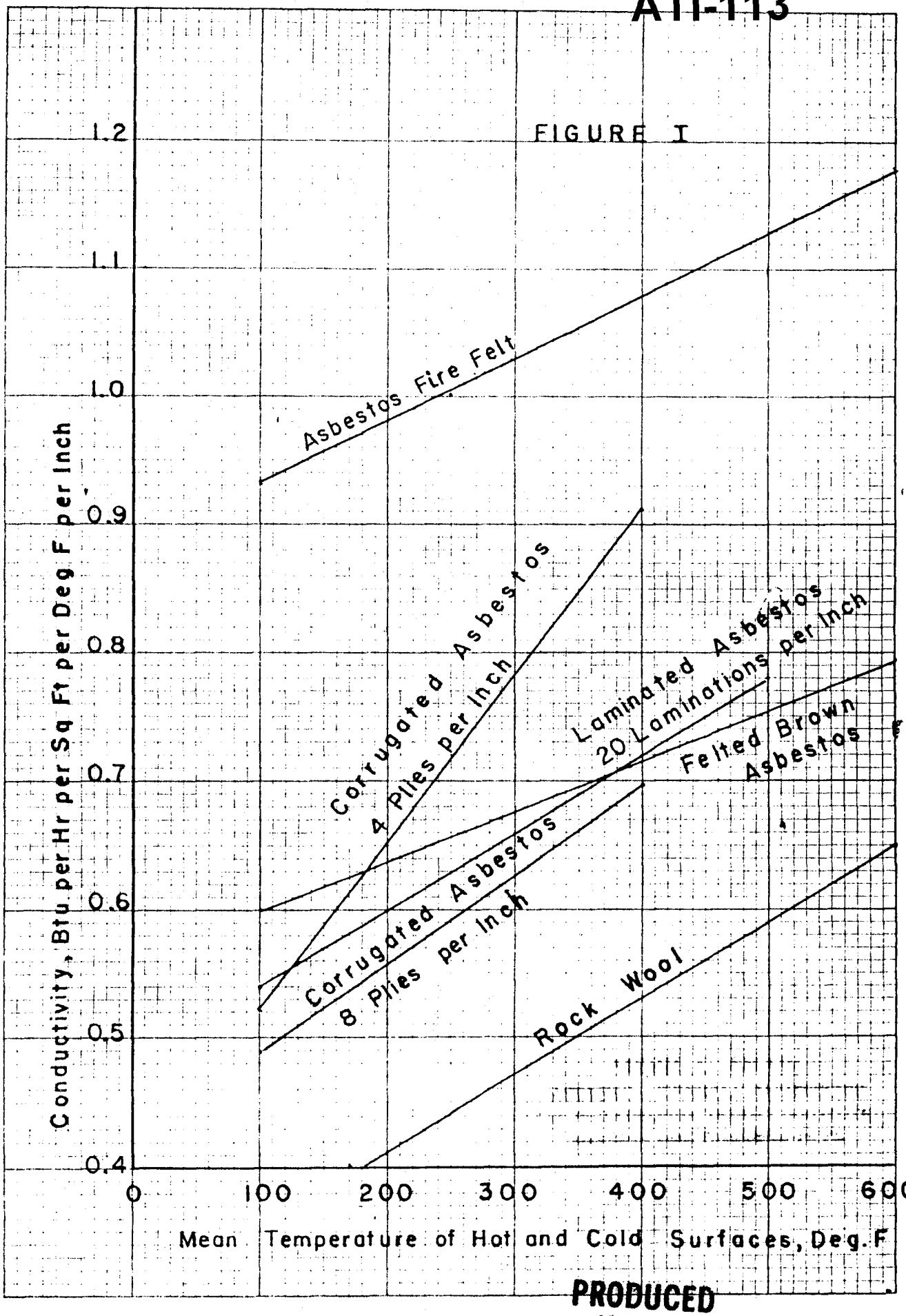

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Table II. Thermal Properties of Some Space Materials as Measured at About 200° Fahrenheit(4)

Material	Conductivity K	Specific Heat C	Density d	Specific Conductivity 1/Kd	Heat Sink Coefficient Cd
	$\frac{Btu}{{}^{o}F\ in\ hr\ ft^2}$	$\frac{Btu}{lb\ {}^{o}F}$	$\frac{lb}{in^3}$	$\frac{in^2}{Btu\ {}^{o}F\ ft^2\ hr}$	$\frac{Btu}{in^3\ {}^{o}F}$
Aluminum	98	.22	.098	.105	.022
Copper	211	.09	.320	.015	.028
Graphite	79	.17	.050	.253	.085
Fiberglass Epoxy	.89	.24	.063	17.9	.015
Refrasil Mod. Phenolic	2.3	...	.060	7.3	...
Urethane Foam, Rigid	.48	.41	.006	347	.002

Thermal Diffusivity.

Thermal Diffusivity relates thermal conductivity with density and heat capacity and is expressed mathematically as follows:

$$T.D. = \frac{K}{d\ C_p} = \frac{\frac{Btu}{hr\ ft^2\ {}^{o}F\ ft}}{\frac{lb}{ft^2}\ \frac{Btu}{lb\ {}^{o}F}} = \frac{ft^2}{hr}$$

When K = thermal conductivity
d = density
C_p = heat capacity

Through a proper application of this evaluation, the elevated temperature insulation and thermal diffusion properties of similarly applicable materials can be equated and related.

Heat Sink Coefficient.

The heat sink coefficient relates specific heat and density. The product of these two values for a given material serves to provide information as to its ability to act as a heat sink medium. Mathematically the value is expressed:

$$H.S. = Cd = \frac{Btu}{in^3\ {}^{o}F}$$

Table II provides representative data covering this property for typical materials with the higher values cannoting efficient heat sink properties, weightwise.

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Summary

With this brief analysis and in the presenting of the definitions and mathematical deriviations for some of the elevated temperature properties which

(4) Norair Proposes All-Plastic Rocket. - Frank G. McGuire. Rockets & Missles, February 8, 1960

are currently receiving much attention, it is hoped that some clarifications have been affected. A misunderstanding of the term, thermal conductivity, and the properties related to this term has perhaps been responsible for the greatest amount of misunderstanding and the discussion and data here offered has been rather detailed in an effort to bring these terms into their proper relationships. The effect and influence of temperature upon the properties of materials is not always well understood, however, the data as set forth in Figure I serve to clearly demonstrate this point with regard to thermal conductivity and to further illustrate the significance of this point, Table III is included to show the effect of temperature upon a property as basic as specific heat.

Table III. Specific Heats of Solids(5)
Btu/(lb) (°F)

Temp. °F	Pb	Ni	Fe	SiO_2
32	.0306	0.1025	0.1051	0.1667
212	.0315	0.1132	0.1166	0.2061
1112	.0328	0.1326	0.1737	0.2624
2012		0.1403	0.1505	0.3080
2912		0.1455	0.1460	0.3538

Bearing these facts in mind, it becomes obviously clear how inaccurate it would be to ascribe a "K" value for thermal conductivity or a "C" value for Specific heat, or to attampt to adapt such data in the calculations for specific conductivity or the heat sink coefficient without due consideration of the temperatures at which the materials are expected to serve.

The problems with which we are confronted today are still further compounded by the rapidity with which conditions of service may change. Extremely rapid temperature changes are encountered in all rocket applications and, equally rapid changes in the atmospheric environment, ranging from the earth's atmosphere where air which will support combustion and promote melting is encountered to that of outer space with little or no air but probably composed of a number of rare or inert gases. The thermodynamic considerations involved in these problems will certainly challenge the ingenuity and talents of our engineers and scientists of today and tomorrow.

Conclusions

To date, there have been relatively few materials found or developed that have satisfactorily met the challenge for the components that the rocket and jet engine industries require. The materials requirements for tomorrow will be even more difficult of attainment. We in the asbestos industry do not for the most part know the full potentials of the products of our own industry. Some of the larger members of our industry have been carrying on research during the past few years that has given them some of the answers and some of the basic information upon which improved materials can be formulated. However, the old adage "many hands make light work" is as true here as it has ever been and until the basic information is made available to our industry as a whole our progress will not be as rapid as it might be.

(5) Heat Transmission, W. H. McAdams. 1954

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