Insulation

INTER-OFFICE CORRESPONDENCE

KOPPERS COMPANY, INC.

KOPPERS COMPANY, INC.
MAR 28 1952

TO: Dr. G. F. D'Alelio, Manager

LOCATION OR CONTRACT: Research Department

SUBJECT: Proposed Thermal Insulation Manual

FROM: Production Department

LOCATION OR CONTRACT: Pittsburgh, Pa.

DATE: March 27, 1952

IN REPLY REFER TO FILE:

Please check Insulation Eng

There is enclosed herewith one copy of a draft of a proposed Thermal Insulation Manual. The purpose of this distribution in draft form is to permit time to review and study this draft and prepare comments and suggestions for revision for consideration at a meeting of the Technical Standards Committee to be called the latter part of April, 1952.

It is planned in the completed manual to elaborate on certain sections of this draft, particularly Section V on Application of Materials, and Section VII which will include a number of sketches of approved methods of application, and sketches of insulation accessories. Also, the information in Tab "A" will be expanded to include the characteristics of all principal materials.

The information contained in Tab "A" outlining the characteristics, advantages, and disadvantages of certain products should be treated as confidential. This information has been obtained from various sources, and is subject to further verification, which will be accomplished before placing the manual in operation.

Additional copies of this preliminary manual are available for distribution within your Division as you desire. Additional copies may be secured by memorandum or telephone call to L. J. Dillon, Extension 684.

Fred Denig

Fred Denig

Enclosure

SC-BE-00765

KOPPERS

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PROPOSED

THERMAL INSULATION MANUAL

KOPPERS

KOPPERS COMPANY, INC.

PITTSBURGH 19, PA.

D R A F T

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THERMAL INSULATION MANUAL

APRIL 1952

FOREWORD

The importance of Thermal Insulation in Industrial Plants is just beginning to receive the consideration it deserves. In the past, thermal insulation has been thought of as anything that could be applied to a heated surface. The question of obtaining the material with characteristics that would as nearly as possible match the requirements for the specific job has been neglected in many cases. Yet, this means the difference between the successful job that will fulfill the requirements and wear well in service, and the hit or miss job that does not meet the operating conditions and in a short period of time deteriorates so that replacement at considerable expense is necessary.

In these days of high cost of labor and material, we cannot afford to put the wrong type of insulation on a job; we cannot afford to use improper accessories; we cannot afford to use the wrong type of weatherproofing; and last but not least, we cannot afford to use the wrong method of application.

How are we going about to select the best insulation for the specific job, especially in these days when there are many types of insulating materials on the market, and new ones being developed every year? How are we going to know that when we do select a material that the particular lot of the material which we happen to receive on the job will have the same characteristics as those advertised in the manufacturer's catalog? How do we know that the method of application of the insulating material on the piping, tank, or equipment, is a method that will properly secure the material under the operating conditions which prevail.

For use as an aid in resolving the above important problems, and also some of lesser importance, is the purpose of this manual.

INDEX

The Thermal Insulation Manual is in Eight Sections.

Section I	Contains general information including definitions of terms used extensively throughout the manual.
Section II	Contains information on Insulation Materials.
Section III	Deals with Finishes and Accessories.
Section IV	Discusses Weatherproofing Materials.
Section V	Contains information on Application of Materials.
Section VI	Outlines methods of tests.
Section VII	Contains drawings of application methods and accessories.
Section VIII	Contains information on Maintenance of Insulation.
Tab "A"	Contains Manufacturers' Characteristics of Acceptable Products.
Tab "B"	Outlines a method for analyzing Insulating Materials and Selection Procedure.

SECTION I GENERAL INFORMATION

A. GENERAL

Thermal Insulation may be defined as those materials or combination of materials employed to offer resistance to the flow of heat under ordinary conditions. In its broadest sense, the insulating materials are used to control heat by delivering or preserving the correct amount of heat at the right place and at the proper time, and also for keeping heat away from where it is not wanted.

B. DEFINITIONS

In discussing Heat Insulation, it is important that we define the components which make up the finished item:

1. Insulating Material is defined as the material which retards the transfer of the heat.

2. Insulating Cement is usually a dry mixture of insulating material which when mixed with a suitable proportion of water applied as a plastic mass and dried in place offers resistance to the flow of heat.

3. Lagging is defined as the protective covering or jacket placed over the actual insulating materials.

4. Weatherproofing is the term commonly referred to the compound which is applied over the insulating material or the insulating cement to protect the materials from one or a combination of hazards such as moisture, corrosion, acids, and fire.

5. Insulation accessories include bands, hangers, studs, reinforcing metals and similar appliances used in the application of the insulation.

6. Insulation is defined as the composite covering or the finished product in place.

SECTION II INSULATING MATERIALS

A. TYPES

Insulating materials commonly used in Industrial Plants may be grouped into three general types.

1. Fibrous materials consisting usually of fine fibers with or without binding materials and shaped into various forms with varying physical characteristics. Typical materials of this type are rock wool, slag wool, glass wool, asbestos, and hair felt.

2. Granular materials consist of fine grains which may be furnished loose or cast into forms. The grains in this type of material are considered as separate particles around which gas can be transferred. Typical materials of this type include magnesia, calcium-silicate, and vegetable cork.

3. Cellular materials are those consisting of minute cells sealed off from each other and which gas will pass from one cell into another, but does not pass between the cells. Typical materials of this type are foam glass, foam rubber, and silica aerogel.

B. CLASSIFICATION

Another method of classifying insulating materials is according to the physical structures:

1. Loose - fill
2. Pipe Insulation
3. Block Insulation
4. Batt Insulation
5. Blanket Insulation

C. TEMPERATURE RANGES

Insulating materials are frequently classed according to the range of temperature at which they are used. One such classification is:

Low temperature	-	80°F and below
Medium temperature	-	from 80°F to 600°F
High temperature	-	600°F and above

D. THERMAL CHARACTERISTICS

Thermal characteristics cover the behavior of heat flow through the insulating material. Thermal conductivity is usually expressed as the k value. It is defined as the thermal conductivity expressed in Btu in. per hr. per sq. ft. per ^{o}F. The heat transmitted through a material is influenced to a considerable degree by the density and structure of the material, and to a lesser degree by the temperature at time of testing and whether any moisture is in the material. Therefore, in order to accurately evaluate the k value of different materials, it is necessary to know the thickness and density of the material tested, the mean temperature at time of test, and whether the material was thoroughly dry before testing. Manufacturing literature, unfortunately, seldom gives this information. Furthermore, there has unfortunately crept into the literature on insulation too much emphasis on the k value. The relative importance of thermal conductivity depends upon the specific job. It may be that the operating conditions demand that a maximum rate of heat loss be specified. Or, it may be that certain processes may require that a definite amount of heat be lost, but not to exceed a given figure. In such cases the thermal conductivity characteristic is of great importance. On the other hand, it may be that a reasonable amount of heat loss will be accepted and certain physical characteristics would be the determining factor selection. A typical case such as this would be the top of a tank where the heat control was not too exact and where it might be necessary for operating personnel to walk over the insulation. Here flexural and compressive strength of the material would be more important than the k value.

The principal thermal characteristics are as follows:

1. Conductivity
2. Temperature Range — maximum and minimum
3. Expansion and Contraction
4. Resistance to Flame

E. PHYSICAL CHARACTERISTICS

It may be stated, as a general rule, that from a users viewpoint at least one or more physical characteristics will be an important factor in the selection process. The physical characteristics must meet the requirements of transportation and handling and also of the operating conditions. Some insulation applications are supported by lagging, while in other applications the insulation must not only support itself but also the outer finish. More often than the reverse, the material must be capable of withstanding a certain amount of mechanical abuse, such as being walked on or resisting heavy leaning objects. In such applications suitable high flexural and compressive strengths are highly desirable. It may be that the insulation is subjected to repeated shocks, and in such case, a high impact value would be indicated.

The principal physical characteristics are as follows:

1. Density
2. Dimensional Accuracy
3. Resistance to Moisture
4. Resistance to Abrasion
5. Hardness - surface
6. Flexural Strength
7. Resistance to Compression
8. Impact Strength
9. Temperature Effect on Strength
10. Linear Shrinkage at Maximum Temperature

F. CHEMICAL CHARACTERISTICS

The chemical characteristics of insulating materials have not been stressed to any great extent in the past by manufacturers of insulation. These characteristics are, however, of considerable importance, especially in chemical plants and similar installations. It is altogether possible that some fires of undetermined origin in chemical plants have been the result of the reaction between outside finishing materials and certain chemical fumes. It is also a well-known fact that certain materials constantly subjected to alkalinity will deteriorate very fast. For these reasons it is important that the operating conditions in various parts of certain plants be carefully determined. It is entirely possible that in one part of a plant where a certain type of fumes are prevalent, some insulations might not stand up. Whereas, they would be perfectly satisfactory in another part of the plant. The following are the important chemical characteristics:

1. Alkalinity Resistance
2. Acid Resistance
3. Flash Point
4. Auto Ignition Point

G. ELECTRICAL CHARACTERISTICS

It is very rarely that electrical characteristics will be the governing factor in the selection of insulating material. It is only in procedures where the process heating is performed by electrical means that these characteristics need be considered. The important electrical characteristics are:

1. Resistance to Electrical Current

2. Galvanic Action

H. SELECTION OF INSULATING MATERIALS

1. General

After the operating conditions for the specific job have been carefully reviewed and set forth, the important problem confronting the user is then in the selection of the most suitable material that will meet these requirements. It is amazing the amount of improper insulating material that has been placed on piping and equipment. One of the most common causes of such failure is that of the use of material not suitable for the high temperature to which it is actually subjected. Other failures have been sustained due to moisture absorptive materials being used where moisture was permitted to reach the insulation either during the application or in the subsequent operation of the equipment. Still other failures have been caused by materials failing to withstand the physical abuse to which it was subjected.

2. Temperature Ranges

As an aid in the selection of insulating materials, the products of the principal insulation manufacturing companies have been catalogued according to the following temperature ranges:

Low temperature	-	80°F and below
Medium temperature	-	from 80°F to 600°F
High temperature	-	600°F and above

3. Characteristics of Acceptable Products

The company, trade name of product, together with thermal, physical, and chemical characteristics of acceptable products are catalogued and tabulated in Tab "A".

4. Selection of Suitable Materials

A method of selection utilizing an analysis sheet, together with explanatory information, is contained in Tab "B".

SECTION III FINISHES AND ACCESSORIES

A. INSULATING CEMENT

There are a number of insulating cements on the market, some of which are furnished for their insulating properties, and some are supplied merely to act as finished surfaces. When insulating cement is used in connection with insulation of industrial equipment, it is common practice to apply two layers of the cement. First, a mesh wire netting or a glass fabric is usually placed directly on the insulating material. The first layer is then applied over this reinforcing material, usually about 1/2" thick, left rough, and allowed to dry thoroughly. The second layer is then applied also about 1/2" thick and trowelled to a smooth surface. In connection with the application of insulating cement, it is of the utmost importance that the cement have good bonding qualities. A number of cements are on the market which do not have good adhesive qualities; and serious difficulties have been experienced after the equipment has been placed in service. We should, therefore, be sure that the cement to be used has good bonding qualities, first to the insulating material over which it is applied, and second between the two layers of the cement itself.

B. LAGGING

Lagging protects the insulating materials from mechanical abuse and from abrasion due to inherent working conditions. Depending upon the severity of these conditions, lagging varies from galvanized iron jackets to textile or paper covering. Where used indoors, the lagging strengthens a surface and provides a suitable finish for painting. When used outdoors, the jacket also provides strength and a painting surface, and in addition often provides protection from spillage of process fluids which might seriously damage the insulating material. Also on outdoor piping, especially near the connection to vessels or tanks, the lagging protects the insulation from blowing steam from traps.

C. ACCESSORIES

It is important that the accessories used in the application of the insulation be correctly designed, and most important that they be of the proper materials. With many materials now being on the critical list, it is necessary that substitutions be used. However, these substituted materials should be carefully scrutinized to be sure that they are capable of resisting the hazards involved such as corrosion, fire hazards, and similar agents. It is recommended that banding wire and wire mesh be monel metal and that banding straps and holding clips be stainless steel.

SECTION IV WEATHERPROOFING

A. GENERAL

Weatherproofing, as the name implies, is the protecting coat on the outside of the insulation. In the Insulation Industry, there are two common types of weatherproofing very predominately used. These are cut back bitumastic materials and emulsified asphalts. The type of weatherproofing to use will, of course, depend on the type of the insulating material which is to be protected and also from the operating conditions where the insulation is to be used. One type of weatherproofing used over insulating materials which are susceptible to moisture might be selected for this characteristic, whereas, a condition existing which demands the protective coating be incombustible might cause the selection of the other type. It is, of course, important that the weatherproofing coating be well bonded to the insulating material. It is also important that it be adaptable for spraying. Also, the acid resistance, alkaline resistance, and certain physical characteristics such as tensile strength are important. The temperature range of the piping or equipment may also influence the selection. In the low temperature range, any moisture is driven inward through the insulation by heat. In this case, it is important the surface of the equipment or piping be protected against corrosion as any moisture will be driven by the hot outside air through the insulation, and the moisture will collect on the outside surface of the piping or equipment. In temperatures of medium range, any moisture in the insulation is driven outward or inward, depending on temperature of atmosphere in relation to that of piping or equipment. This breathing action will for a number of months of the year depend on the time of day, being exerted inward during the day time and outward at night. Corrosion may occur at both the surface of the piping or equipment and at the outside of the insulating material provided that mesh wire or other reinforcing materials have been used in the application. There have been many insulation failures due to corrosion of the mesh wire or other reinforcing materials, and there are on record failures of vessels in Industrial plants which caused plant shutdowns due to corrosion of the steel under the insulating materials. Finally, in the high temperature range, the heat of the piping or equipment drives any moisture outward. Here, while moisture in the insulation must be considered, it is not so important as in the lower limits.

From these considerations, it can be seen that the vapor sealing qualities of the weatherproofing are also important. At certain temperatures with certain types of insulation and certain types of weatherproofing, it is possible that any moisture in the insulating materials will be more or less sealed within. Here the insulation conditions would be similar to a person trying to keep warm wearing a wet overcoat. It is possible that on certain construction when conditions are just right that the pressure might build up sufficient to disrupt the weatherproofing. Unfortunately, we do not have a material at present on the market so that entrapped moisture could be expelled through the surface of the material to the atmosphere but which would not permit moisture from entering from the outside. In other words, a type similar to a flap valve.

Where the insulating material is subjected to extraordinarily heavy physical abuse, it may call for a metal jacket. While this method is more costly as far as first cost is concerned, in some particular cases it has proved most economical in the long run. Also, for indoor installation, where the insulation is covered with a canvas jacket, a good grade of fire resistant paint is very effective.

SECTION V APPLICATION

A. GENERAL

The effectiveness of an insulation depends to a large extent on the manner in which it is applied. Generally speaking, an insulating material with a high k value properly applied will be more effective than a material with a low k value incorrectly applied. As a matter of fact, the principal insulating materials on the market today vary only slightly with regard to thermal conductivity. There is, however, a great difference in the effectiveness of the manner in which they are applied and also in the manner as to how they stand up in service. This, indeed, may very well be the crux of the matter in determining the selection of an insulating material.

B. NEW EQUIPMENT

Whenever possible, the type of insulating material and method of application on new equipment should be determined before purchase. Studs, angle iron, clips, and other devices for fastening the insulation which require welding should be completed before shipment. This is especially important when the vessel or equipment is stress relieved.

C. EQUIPMENT IN PLACE

The following are the ten cardinal rules for the application of insulation. Strict adherence to these rules will prevent a great deal of faulty insulation being installed on piping and equipment.

1. Piping, vessels, and other operating equipment shall be inspected and tested for leaks and mechanical defects. All repairs shall be made before applying insulation.

2. Protection of metal surfaces from corrosion is important. The same care with regards to preparation of metal surfaces over which insulation is to be placed should be exercised as in the case of preparation of metal for painting.

3. During installation, it is important that the insulation does not absorb any moisture. Contractors must be warned not to leave any insulation in process in an exposed condition. When it is not possible to weatherproof each days work, it should be carefully protected before leaving the job. If moisture gets into the insulating material and is sealed in by the weatherproofing, it may be extremely hard to get out, and serious corrosion both to the equipment and the reinforcing material may result.

4. For a good job, it is necessary that the dimensions of the insulating material be uniform. Tolerances to plus or minus one eighth of an inch are commonly required.

5. Moisture is the arch enemy of insulation. Moisture usually gets into insulation from the top by not having proper overhang of roofing; from the bottom by a wicking action of the moisture which has penetrated the bottom flashing and at right angle junctures where filets are not used in the weatherproofing and the insulation cracks at the junction.

6. Insulation is only as good as the fastening which holds it on. Be sure that the method of fastening is proper and that not too much weight of insulating material is permitted between supports. This is particularly true of tank installations, both vertical and horizontal. Whenever possible to obtain, fastenings should be of the non-corrosive type.

7. Any insulation which might be subject to mechanical abuse or scorching shall be provided with a suitable protection such as sheet metal.

8. Wherever chemical spills may occur over insulation, a hood should be provided to protect the insulation from damage.

9. Fire is still public enemy number one in Industrial Plants. In hazardous locations where spread of fire could cause serious damage, the weatherproofing over the insulation should be fire resistant.

10. Where the insulation is subjected to fumes, it is very important that the proper kind of material be selected. Some materials are acid resistant but rapidly deteriorate in alkaline conditions and vice versa. In the same plant, one insulation may stand up in one part of the plant, whereas, it would soon go to pieces if used in another location.

SECTION VI TESTS

A. GENERAL

One of the principal difficulties experienced in the insulation field is connected with tests. Unfortunately, there is no standard method of testing from an Industry wide standpoint. The Mineral Wool Institute has recorded with the National Bureau of Standards a Commercial Standard for testing and reporting Mineral Wool products. The Magnesia Manufacturers Association is working with the American Society for Testing Materials, looking toward a similar arrangement. While these two associations are attempting to work out standard procedures and tests within their own respective associations, each is different and there is nothing on an Industry wide basis. Also, a standardized method of testing is lacking. It is a well known fact that one testing laboratory will obtain different results than another laboratory on the same material, caused by varying testing conditions or equipment. In view of these circumstances, it is important that the reports of the tests be carefully evaluated.

B. SPECIFIC

The following are the tests usually required for insulation. However, when the insulation must meet certain abnormal conditions, then, of course, tests for such conditions must be specified.

1. Handleability. This test is designed to insure that the material can be transported without damage and can be handled as a unit.

2. Thickness. It is customary to specify both a minus and a maximum tolerance, and usually hold to tolerance of plus or minus 1/8 inch.

3. Length and width. For batts and blocks these dimensions are specified, and usually held to tolerance of plus or minus 1/8 inch.

4. Density. It is common practice to specify density as the maximum number of pounds per cubic foot.

5. Thermal Conductivity. The k value is specified for certain temperatures within the range of the insulating material involved. The density of the material for a given k value should be stated.

6. Fire Resistance. The specific type test is usually specified when this factor is desired.

7. Modulus of Rupture. Usually specified as minimum pounds per square inch.

8. Moisture Absorption. The common practice is to specify the maximum percent absorption by weight, and sometimes also by volume.

9. Resistance to Abrasion. Usually specified as maximum percent loss in weight during a specified time of testing.

10. Linear Shrinkage. Exposure to soaking heat at manufacturer's recommended temperature limit for 24 hours after which a measurement is made for shrinkage.

11. Resistance to corrosion, acids, alkalines, etc. Specified according to desired time of testing.

C. TEST PROCEDURES

1. General. What to test, where to test, and how to test are usually perplexing problems for Industrial Plants. This is especially so when the plant does not have a laboratory or when the laboratory facilities are limited.

2. What to test. Every insulation product arriving at a plant should receive some kind of a test. It has been argued that the values for the various characteristics as listed in the Manufacturers Catalog should be accepted as the statement of reputable firms. That, however, is not the question. It often happens in manufacturing operations that due to certain defects in the raw materials used or defects in processing, a particular lot is not up to standard. This, for one reason or another, may not be considered by the plant as cause for scrapping the particular lot in question. There is no way to be sure that the purchaser gets value received except by test either at point of origin or after delivery.

3. Where to test. The best place to test is at the point of origin before shipping. Unfortunately, this is seldom possible when dealing with Insulation Materials. We then have to conduct the tests at the plant, and this should be accomplished as soon after delivery as possible.

4. How to test. How to test insulating materials received at a plant presents a considerable problem. None of our plants, and for that matter, very few plants are equipped to make such tests as thermal conductivity, compression strength, shrinkage, and similar tests requiring very special equipment. All plants are, however, by using a little ingenuity, able to make simple tests, and fortunately these simple tests give much valuable information. It is therefore recommended that the following test procedures be adopted for plant tests of insulating material. For plants equipped to make additional tests of specified characteristics, that is highly desirable.

   a. Handleability. This test is designed to measure how well the material transports and how it stands up as a unit. The American Society for Testing Materials have at present under consideration a testing machine which will measure this factor. However, for practical considerations, a machine is not necessary. When the shipment is received at the plant, a representative sample should be inspected and any damage noted. For example, if 100 boxes of material made up the shipment, 10 boxes should be opened and examined. Each unit should be sufficiently coherent to transport without breakage or damage. If a unit does not transport well under ordinary shipping conditions, it is good evidence that difficulty may also be expected when it comes to the application. If there is over five percent damage of the sample tested, it is sufficient cause for rejection. Breakage or damage is defined as of such severity as to render the unit either difficult to apply or substantial decrease in efficiency. For example, a slight corner of a block chipped off might be accepted, whereas, a crack extending through the block would be rejected.

   b. Dimensional Accuracy. This test should also be performed on a representative sample. For a shipment of 5000 pieces, 10 pieces selected at random should be taken as a sample. This proportion should apply for all sizes of shipments except the sample should never be less than 5 pieces.

      (1) Blocks. For Blocks, the length, breadth, and thickness should be carefully measured by best available plant methods. Each block making up the sample should be measured and the average taken. These measurements should be checked against the manufacturer's specified dimensions. A tolerance of plus or minus one eighth inch is permissable.

(2) Pipe Insulation. For pipe insulation, the same procedure should be followed in testing for length, inside diameter and thickness of the insulating material. A tolerance of plus or minus one eighth inch is permissable.

(3) Blankets. The length and width of each unit shall not be less than the specified dimensions. Measurement of length and width shall be on the insulating material and not on the facing. The thickness of each unit shall be as specified with a minus tolerance of one eighth inch and a plus tolerance of one quarter inch.

(4) Batts. The length and width of each unit shall be not less than the specified dimensions. The measured thickness of each unit shall be as specified with a minimum tolerance of one eighth inch.

(5) Rejections. Two percent rejects of the sample taken is sufficient cause for rejection. If the sample fails to conform to this requirement, a second sample similar to the first shall be taken and tested. The results of the re-tests shall be averaged with the results of the original test, and if this average is greater than two percent, the shipment will be rejected.

c. Density. Density is a very important characteristic of an insulating material, and fortunately this test can readily be made at Plant level. Density has a direct influence on thermal conductivity, and also on the compression and flexural strength of a material. Unfortunately, in the trade literature, this important characteristic is often expressed in a loose manner -- for example, some manufacturers express the density of their product with a range of 6 pounds per cu. ft. without stating at which density the thermal conductivity and some of the other characteristics were measured. Density should be expressed as the maximum pounds per cu. ft., and the relating characteristics such as thermal conductivity and compression and flexural strength should be based on this maximum figure. Density is expressed as the weight per cu. ft. and may be calculated as follows:

$$\text{weight per cu. ft.} = \frac{W \times 1728}{A \; B \; C}$$

W = weight of test specimen
A = length of test piece in inches
B = width of test piece in inches
C = thickness of test piece in inches

Rejection - anything over the maximum specified figure should be rejected.

SECTION VII SKETCHES OF APPLICATION METHODS AND ACCESSORIES

SKETCHES

It is proposed to incorporate in this section a number of sketches showing approved methods of application of the various forms of insulated materials and accessories. Also will be included here tables showing optimum thickness of piping and block insulation, and other useful tables.

SECTION VIII MAINTENANCE

A. GENERAL

1. Periodic inspection with corresponding maintenance is almost unheard of in the field of insulation. Plants that make inspections at prescribed intervals and designate the jobs that are to be repaired before they deteriorate to the point of causing excessive damage are few and far between. Yet it is a simple procedure that can save many thousands of dollars in the course of a year in a medium sized plant. In the first place, it saves on the magnitude of the job of repair, and in the second place it saves on shut down time of equipment and loss of heat due to defective insulation. If you walk through almost any Industrial Plant, you will find insulation that has been off piping, valves, and even some equipment for as long as a year. It seems as though the maintenance force never gets caught up with the repair of insulation. This immediately brings up another point. It may be that this condition is caused by using the wrong type of insulation for the job in question. Unfortunately, most plants do not maintain historical records. It is not possible to determine with any degree of accuracy the type of insulation on a run of piping or a piece of equipment, the date it was installed, and a record of repairs which were necessary. If more of this kind of information was available, it would go a long way to avoid repeating the same mistakes. Such records are maintained by some plants in the form of "Historical Records". They have proven their worth in establishing valuable information in connection with future plant maintenance.

2. Inspection. It is recommended that all piping insulation and all insulated equipment be inspected twice each year. It has been found that the best periods for making this inspection are during the months of August and March. The repairs necessary after the August inspection can be effected in order to place the insulation in good operating condition for the winter season and the March inspection will indicate the repairs necessary as the result of the usually more severe operating conditions during the winter months.

3. Historical Record. It is recommended that all principal runs of piping insulation and all insulated equipment be listed on a "Historical Record Card." These records should include the insulated materials used, date installed, cost, and a record of all repairs made, and recommended inspection dates. This record will not only be valuable in determining how the insulating material stands up in service but will serve as an aid to insure inspection at specified dates.

THERMAL INSULATING MATERIALS

CHARACTERISTICS	L. & M. 85% MAGNESIA	STD. UNIBESTOS	FIBERGLAS AEROCOR	FOAMGLAS	LAYLO	MINERAL WOOL BLOCK
Form	Preformed - Pipe, Block, Segments	Asbestos fibers, processed into piping insulation.	Felted Blanket	Preformed piping, Blocks and segments	Moulded piping, Blocks and segments	Formed into blocks
Temperature Range						
Max. Limit F	575	750	600	800	1200	1700
Min. Limit F	212	32	not known	not known	100	100
Conductivity						
at 70°F	0.41	0.32	0.28	0.41	0.40	0.39
at 212°F	0.46	0.39	0.38	----	0.45	0.42
at 500°F	----	0.54	----	----	0.54	0.48
Density lbs. per cu.ft.	11	14	1	10	12	18
Compressive Strength	75	12	Blanket mtl.	140	120	8
Flexural Strength	16	42	No figure	100	91	29
Vapor Migration Grains/Hrs.x sq. ft. x ins. of Hg	32.11	--	----	0.00	35.03	--
Ph Value	9.1	10.3	8.3	7.5	9.2	7.8
Strength						
Comp.	Good	Flexible	Flexible	Good	Excellent	Poor
Ten.	Poor	Excellent	Fair	Fair	Poor	Poor
Flex.	Poor	Good	Poor	Excellent	Excellent	Fair

THERMAL INSULATION MATERIALS

CHARACTERISTICS	L. W. 85% MAGNESIA	STD. UNIBESTOS	FIBERGLAS AEROCOR	FOAMGLAS	KAYLO	MINERAL WOOL BLOCK
Resistance to water	Fair	Excellent	Excellent	Excellent	Good	Excellent
Composition	85% Magnesia 10% Long Fiber Inorganic Binder	Long fiber asbestos with binder	Fine glass fibers with binder	Pure glass containing separate sealed cells	Calcium silica blended with asbestos fibers	Mineral fibers with binder
Advantages	Handles and transports well. Fairly easy to apply.	Handles well. Excellent resistance to water and weather.	Very flexible. Fibers will not break down. Light weight. Excellent for piping and valves. Eliminates pipe size stockage.	High compressive strength. Practically vapor proof. Does not depend on weatherproofing for vapor barrier. Incombustible.	High compressive strength. Cuts clean. Easy to handle.	Flexible. Will stand expansion and contraction well.
Disadvantages	Hard to obtain tight fit. Fairly soft. Poor resistance to water and poor bond surface.	Dimensions not always exact, making application somewhat difficult.	No physical strength. Must be protected from physical abuse.	Requires close fitting and must be protected against abrasion.	Not suitable for bridging. Non-flexible.	Soft. Will not resist mechanical abuse.

Note: This is a sample sheet only. Similar sheets will be added to cover all principal products. At this time this information should be kept in Company channels and not shown to manufacturers or their agents. While most of the information shown is accurate, some is subject to further check. Similar information will be furnished with respect to selection of weatherproofing and Insulation Accessories. Compression and Flexural strength represents strengths at which material failed. In Ph value, 7.0 represents neutrality. Below that point indicates acidity, and above that point, alkalinity. Other values such as Impact, Resistance to Abrasion, and Shrinkage will be added when this sample sheet is revised.

A METHOD FOR THE SELECTION OF INSULATING MATERIAL

A. GENERAL

The determination of the insulating material most suitable for a specific job is a very important as well as difficult procedure. One of the reasons why it is difficult is the fact that the literature of the various manufacturers seldom lists all of the characteristics which are important in meeting the operating requirements for the job. It is, therefore, necessary to obtain this additional information either by special inquiry from the manufacturers or by information obtained as the result of tests.

B. PROCEDURES

In order to assist the various activities of the Company which are responsible for selecting the most suitable insulating material for the specific job, the following procedure is recommended:

1. Using the "Analysis Sheet" (copy attached), the operating temperature range of the piping or equipment is entered.

2. The next step is to determine from "Tab A" all of the products which meet the operating temperature requirements and enter the names of these products in the proper columns.

3. Next, the characteristics for the various products are obtained from "Tab A" and listed in the proper columns.

4. Each characteristic on the "Analysis Sheet" is then carefully considered with respect to the importance for the particular job being considered, and the rating for each characteristic is entered in the "Importance Factor" column. In this rating, the designation "A" for "Absolutely necessary", "B" for "Desirable", and "C" for "Unimportant" will be used.

C. EVALUATION

The final step is to evaluate the characteristics of the various products in consideration of the actual requirements for the job. In this evaluation it is desired to call attention to the fact that there is no one perfect insulation, and not often will this system automatically select the one perfect material for the job. It will, however, eliminate undesirable products and will often indicate two or more products which are about the same with respect to balancing the operating requirements against the characteristics of the products. When this condition occurs, then "Cost in Place" of the insulation will probably be the governing factor.

Note: In evaluating the last three characteristics on the Analysis Sheet, experience and good judgment rather than empirical values will have to be applied. How well a material will wear, how well it will transport and handle, and the facility with which the material can be applied, will depend to a great extent on the requirements and conditions of the particular job. For example, it is difficult to state how well a material will wear in service without knowing the operating conditions and without knowing how the material will be protected. For example, rolled fiber glass might wear well on a piping if covered with an aluminum jacket; whereas, it would not wear well if covered with paper. It is, therefore, extremely important that in the use of the Analysis Sheets the three above-mentioned characteristics to rated by the Plant, depending upon the specified operating conditions.

EQUIPMENT _____ HEAT INSULATION ANALYSIS SHEET LOCATION _____

OPERATING TEMP. RANGE _____ DATE _____

CHARACTERISTICS OF MATERIALS	IMPORTANCE FACTOR*	MATERIALS BEING COMPARED					REMARKS
Form							
Conductivity 70°F 212°F 500°F							
Density, lbs. cu. ft. Max.							
Compression Strength, lbs/sq. in.							
Flexural Strength, lbs/sq. in.							
Vapor Migration, Hg test							
Ph Value							
Resistance to Water							
Resistance to Wear							
Handleability							
Applicability							

*Importance Factor
A - Absolutely necessary
B - Desirable
C - Unimportant