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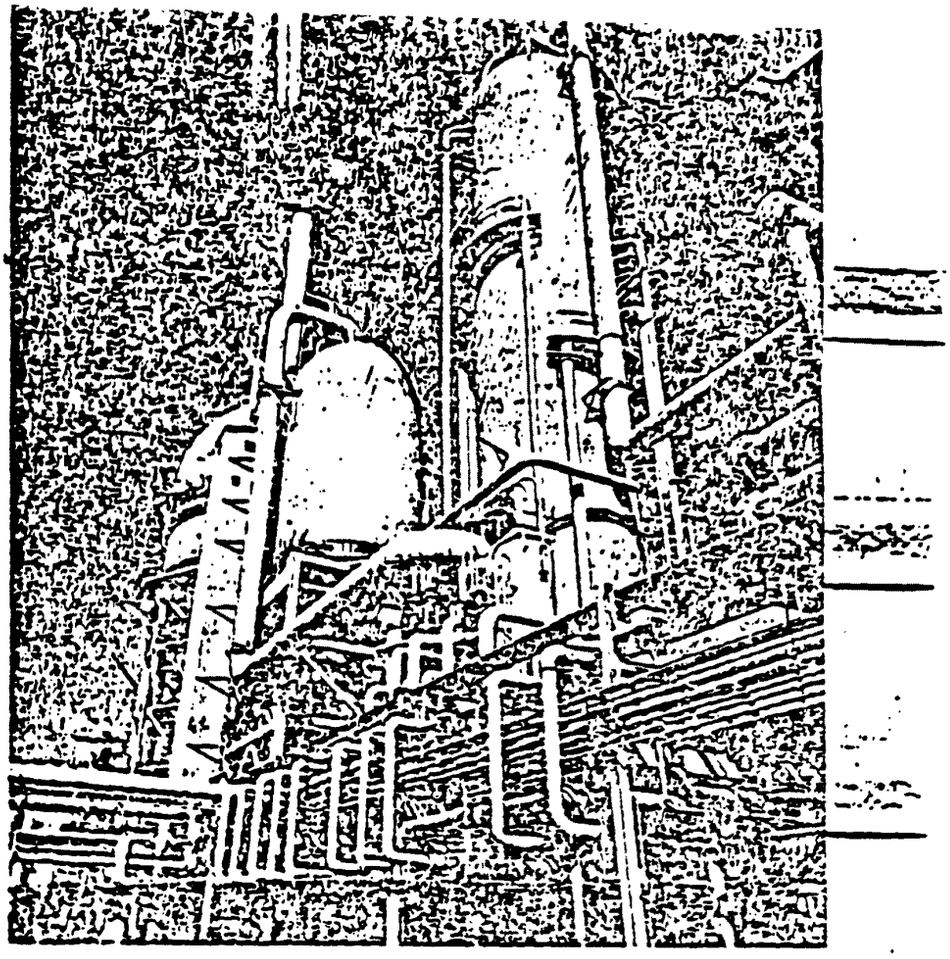
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...tion of new additions to Port Arthur, ..., refinery of Gulf Oil Corporation, ...ulated with hydrous calcium silicate.



P 732 A

Hydrous Calcium Silicate Heat Insulation

Extremely light weight—11 lb per cubic foot—makes handling easy; Simplified Dimensional Standards facilitates nesting and application

E. C. SHUMAN*

...WAYS among the first to recognize ...adopt improved materials and metho... the oil industry has quickly ac...ted a new heat insulation material of ...hydrous calcium silicate type. A ...mically reacted mixture of lime and ...ica, containing small amounts of ...estos fiber for bonding action, the ...w material looks quite similar to other ...id insulating materials commonly ...d in industry. It is not glass in ...ral appearance, its distinguishing ...racteristics are an almost chalky ...ueness and a comparatively smooth ...face texture, even when sawed.

Properly made hydrous calcium silicate is different from other insulating ...terials now on the market because ...its unique combination of physical ...aracteristics. Although it has a den...y of only 11 lb per cubic foot, it has ...n average flexural strength in excess ...50 psi and a compressive strength of ...0 psi. Insolubility in water and incom...ustibility are two more of its outstand...g characteristics. It is effective through...t the entire temperature range from ...ro to 1200 F. Because its thermal con...uctivity is comparatively stated at 0.39 ...100 mean or 0.51 at 500 mean tem...erature, it is frequent practice to ...ecify 1-in. less thickness for Kaylo ...sulation than for "combination" in...ulating materials in the range from 500 ...1200 surface temperature.

This new material is produced under patents numbered Re. 23,228, 2,517,127, and other pending patent applications.

Hydrous calcium silicate insulation has been used principally in the medium and high temperature range, because it is in this range that the material performs to greatest advantage. It may be used also as a low temperature insulation, provided proper vapor seals are employed.

Hydrous calcium silicate insulation products of certain types have been manufactured and sold commercially by Owens-Illinois Glass Company since 1943. The story of how this company researched and developed the non-glass insulating material is interesting. It is also an inspiring example of the American Way. Without the vision, resources, and technical know-how of "big business," this material would not be on the market today.

Development of hydrous calcium silicate products began in 1938. The company wanted materials of construction to supplement its Insulux glass block, already well-established, and it had a great deal of manufacturing and engineering experience with the two principal markets used in hydrous calcium silicates—lime and sand.

Many other companies and groups have experimented with various hydrous calcium silicate products. Work had been done in Germany in the early 1920's. Several independent research organizations and manufacturing companies in the United States and Canada had attempted to develop commercial materials during this period. One group was able to produce experimentally

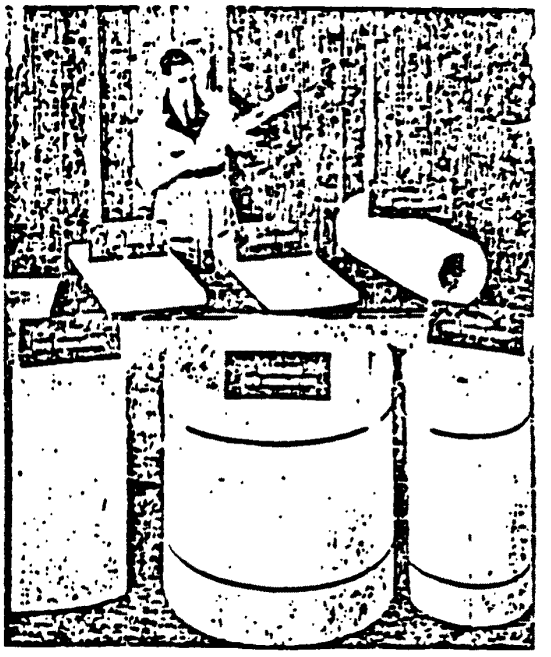
*Director of research, Kaylo Division, Owens-Illinois Glass Company.

EXCLUSIVE

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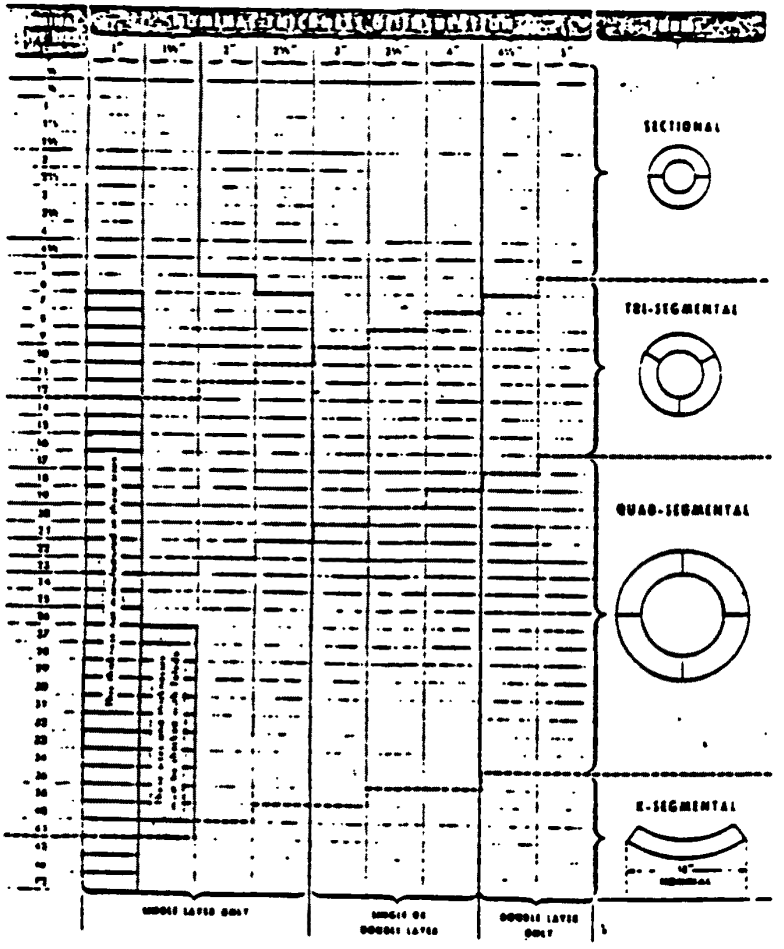


Applicator saws pipe insulation to fit short run.



Standard forms of hydrous clacium silicate heat insulation.

Chart of sizes, forms, and thicknesses of hydrous calcium silicate insulation.



limited quantities of a calcium silicate product which they called Microporite. It was a structural material, and there is an experimental house on Long Island today, which is built almost entirely of this material, except those parts that are exposed to weather.

Until the company's physicists, chemists, and engineers studied the component materials and learned the details of their reactions, however, no one had produced a stable, uniform product with the advantages now found in the hydrous calcium silicate.

Research had reached the pilot plant stage of manufacturing by the outset of World War II. Hydrous calcium silicate heat insulation, then being made at a converted brick plant at Berlin, New Jersey, was approved by the U. S. Navy, which used it for marine insulation. Even in those early days, the material proved stronger, more durable, and easier to handle than others tested.

After the War, construction began on a quarter-mile-long manufacturing plant at Sayreville, New Jersey, and manufacturing of hydrous calcium silicate began there in March, 1948.

The original plant at Berlin, New Jersey, where the forerunner of today's hydrous calcium silicate heat insulation was first produced, has been remodeled and enlarged almost continually to become a sizable and modern factory, from the outside looking much like a typical glass plant. The glassman who enters it, however, finds himself in strange surroundings.

The Sayreville, New Jersey, plant, although little changed on the outside since its construction, has undergone extensive change within during the past four years as the company has perfected improved processes.

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Other Calcium Silicates

Calcium silicates, of course, are not new to the chemist. Portland cement can be called a calcium silicate, for example. Even some types of glass can be called calcium silicates, although being man-made products, they are not typical members of the family. Kaylo insulation, however, is a chemically reacted product, and is a permanently set and stable product when it leaves the plant. Portland cement is an incompletely reacted chemical compound insofar as ultimate use is concerned and does not reach its permanent set until mixed with water. Glass is a fused product using no water, its raw materials melted and blended at high temperatures.

The manufacturing of hydrous calcium silicate insulation is essentially a chemical reaction operation. Lime, silica, asbestos, and water are mixed to form a slurry that is poured into metal molds to shape the desired product. The reaction of this slurry is accelerated by the use of elevated temperatures in large pressure vessels called indurators. After induration, or hardening, the material is dried to practical commercial limits. It should be noted that, because a chemical reaction is involved, there is no "binder" in any Kaylo insulation.

The millions of tiny air spaces per cubic inch that are left in the material after the moisture is driven off give the insulation its light weight and low thermal conductivity. Every cubic foot of insulation contains so many tiny air spaces that the total area of the surface surrounding them is about 100 acres.

By varying the proportion of water in the formulation it is possible to obtain products in various densities. As the density increases, strength becomes greater and insulating value less. The density of 11 lb per cubic foot presently used for heat insulation was established after long research as the one that represents the optimum combination of physical characteristics for that use, from a practical viewpoint.

A 20-lb per cubic foot hydrous calcium silicate is manufactured also, in the form of two building products—insulating roof tile, for roof decking, and core material, for fabrication by other manufacturers into fireproof doors and wall panels.

Unique Combination of Physical Characteristics

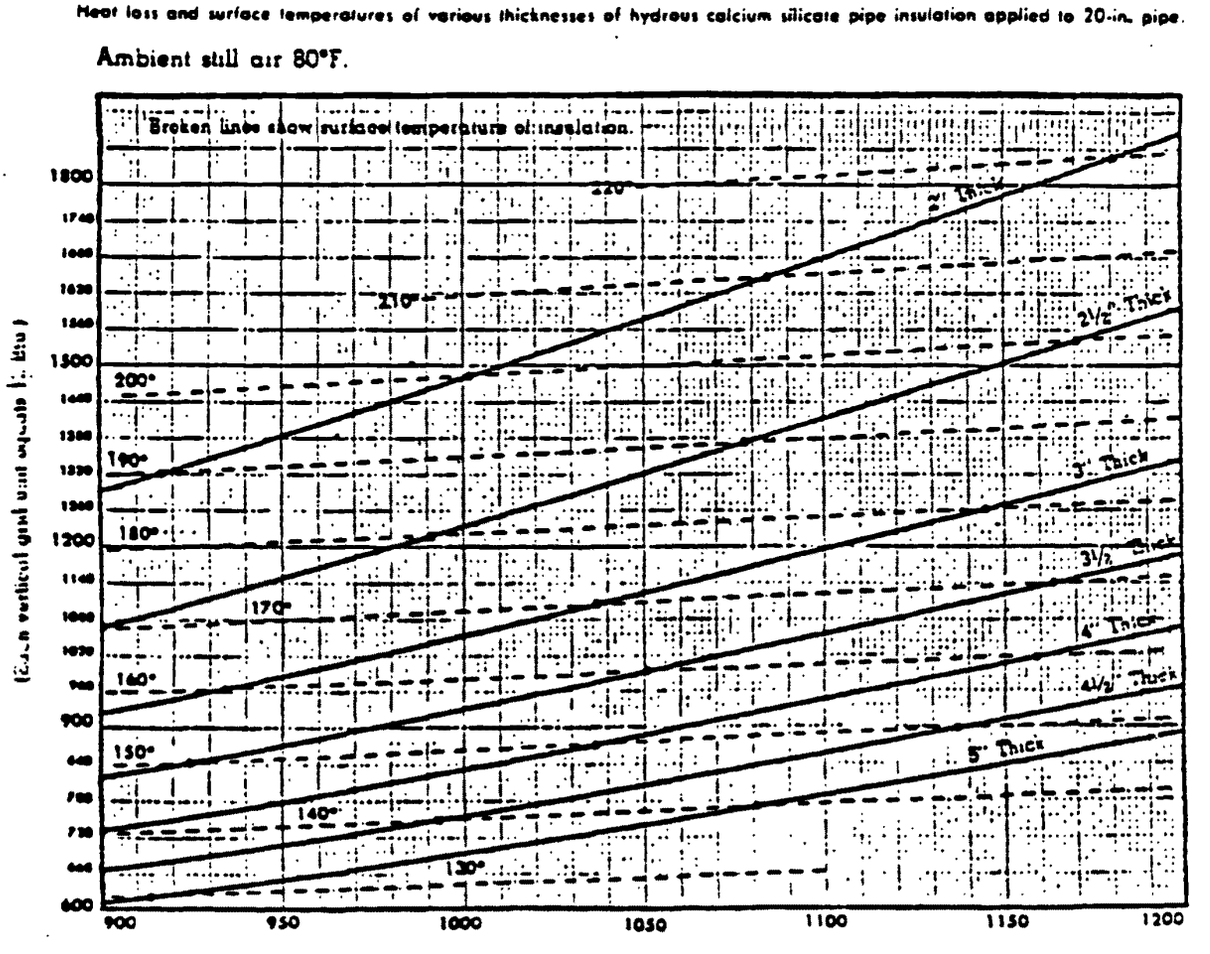
The fire resistance of hydrous calcium silicate is due to its mineral composition, which withstands high temperatures. It will withstand service temperatures as high as 1200 F for an indefinite period, without loss of thermal efficiency. Actually, because exposure to high temperatures drives off residual moisture, the thermal efficiency of the material improves after installation and use.

As might be presumed from its structure, hydrous calcium silicate has a high absorption; yet it is not permanently damaged by wetting. Even when saturated, it retains a high proportion of its normal strength, and after drying it regains its normal strength and insulating value. It does not dissolve nor crumble.

Its hygroscopicity is low. After six hours exposure in an atmosphere of 120 F and 90 per cent relative humidity, for example, it absorbs only 0.9 per cent moisture by volume.

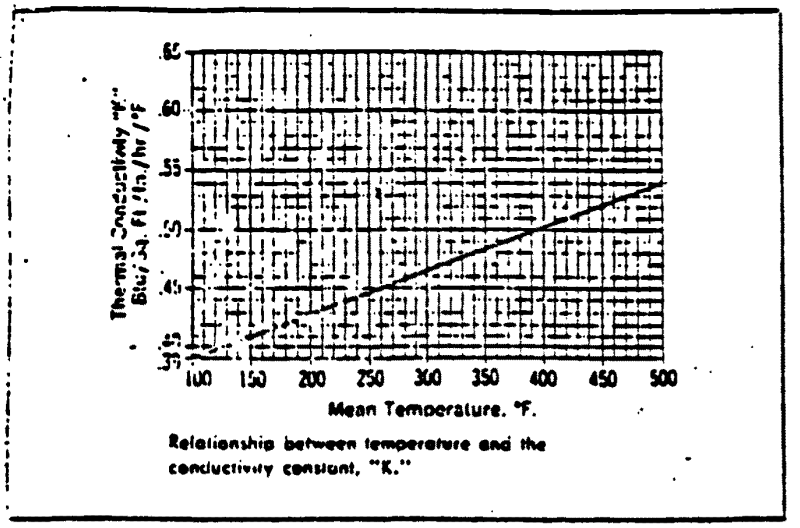
With a —pH factor of about 10, Kaylo insulation is rust-inhibitive. Contact with metal coverings or fasteners, therefore, offers no problem. This includes even

Heat loss and surface temperatures of various thicknesses of hydrous calcium silicate pipe insulation applied to 20-in. pipe.



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Relationship between temperature and the conductivity constant, "K."

aluminum, unless the insulation is saturated.

The material has remarkable dimensional stability. Linear shrinkage after 24 hours' exposure to a temperature of 700 F is only 0.8 per cent, and only 1.5 per cent after exposure to 1200 for the same length of time.

Wide Range of Forms

Hydrous calcium silicate heat insulation is made in two basic forms in which heat insulating block and pipe insulation are further divided into many other forms. All units are 36 in. long.

For the insulation of flat surfaces there is flat block. For the insulation of vessels from 6 to 60 ft in diameter, there is curved block. Thicknesses from one through five inches in increments of one-half inch are available for both forms. Widths are three, six, nine, twelve, and eighteen inches.

For insulation of pipes and tubes from one-half inch to six feet in diameter, Kaylo insulation is made in numerous forms, all to Simplified Dimensional Standards (successive layers "nest"). For tubes and pipes through twelve inches in diameters, it is made in sectional form (two pieces to the circumference). For diameters through 24 in., it is made in tri-segmental form (three pieces to the circumference). For diameters through 11 in., it is made in quad-segmental form (four pieces to the circumference). For diameters to 6 ft, it is made in k-segmental form (pieces nominally 18 in. wide and with various radii of curvature).

Thicknesses range from one inch through five inches, in increments of one-half inch.

The tri, quad, and k-segmental forms are unique, and are made possible only by the high strength and light weight of the material. On larger pipes, they permit the user to reduce greatly the number of pieces applied to insulate a given surface of pipe and reduce the number of joints. The applicator, therefore, handles fewer pieces, yet the light weight of the material makes these larger units easy to lift and handle.

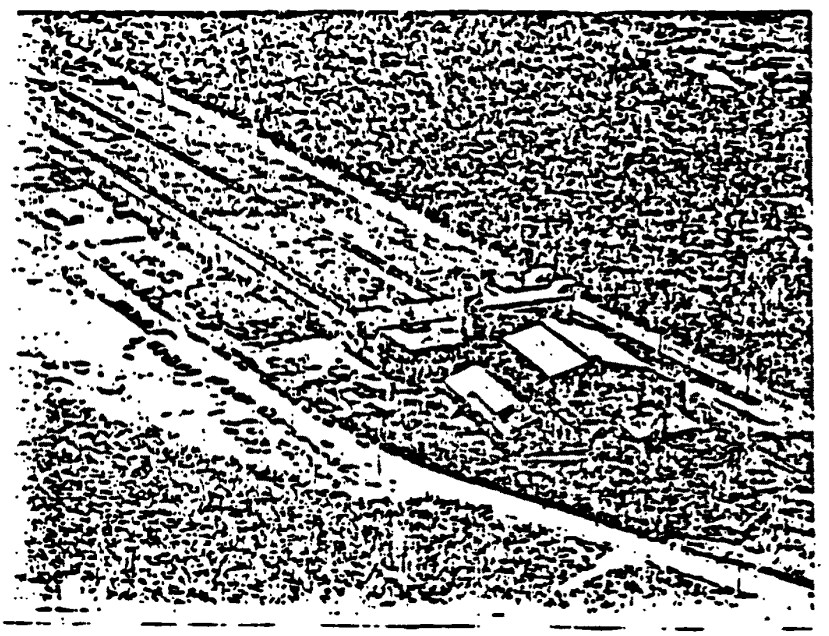
For large pipes with temperatures above 500 F the number of pieces to be applied is reduced even further. In this range it is customary to apply double thicknesses of other insulating materials—a diatomaceous earth type next to the surface in sufficient thickness to reduce the temperature to 500 or lower, and 85 per cent magnesia or other material as an outer layer. Up to 1200, a single layer of hydrous calcium silicate (usually of lesser thickness than the former combination covering) is all that is needed.

A standard 20-in. pipe with a temperature of 700 is a good example of the labor saved by the use of hydrous calcium silicate insulation. With other standard forms and types of heat insulation, the applicator must handle 26 pieces for each 3 ft of pipe. With k-segmental insulation, he handles only three.

All sizes and thicknesses of this pipe insulation are made to Simplified Dimensional Standards. This system was devised by Ray Thomas, staff engineer for Union Carbide and Carbon Corporation, as a means of simplifying the application and storage of pre-formed heat insulation. At the time that Thomas first published his proposal for the system, this company was considering similar ideas. Hydrous calcium silicate was among the first, if not the first, heat insulation to be manufactured in conformance with his system. It is gradually being adopted by other manufacturers.

Under the Simplified Dimensional Standards system, every piece of pipe insulation is made with an outside diameter that corresponds to that of a standard pipe. Under the old system, pipe insulation is made in what are called standard and double standard thicknesses. So-called standard and double standard thicknesses are constant through certain ranges of pipe diameters. Because standard pipe sizes are often actually larger than their nominal diameters (e.g., "one-inch" pipe has an actual OD of 1.32 in., "six-inch" pipe an OD of 6.63 in.), pipe insulation made to the old system will not always nest.

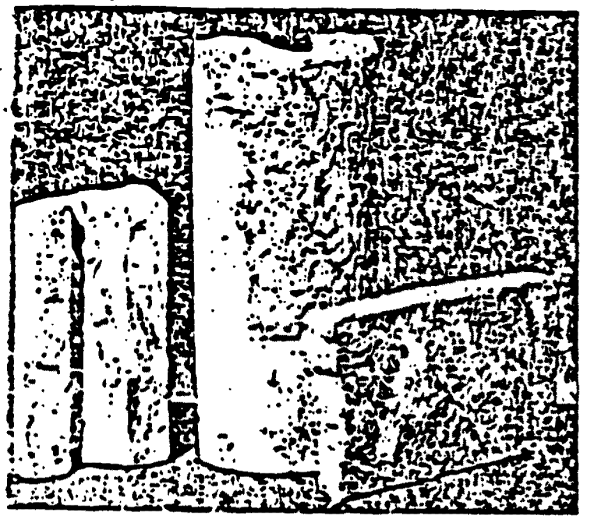
To overcome this handicap, the Simplified Dimensional Standards system varies the thickness of the insulation from nominal thicknesses. So-called "one-inch" thick insulation for a "one-inch" pipe is actually 1.08 in. thick. "One-inch" thick insulation for a "six-inch" pipe is actually 0.94 in. thick. These variations are insignificant as to thermal conductance (and our heat loss charts take actual thickness into account). The



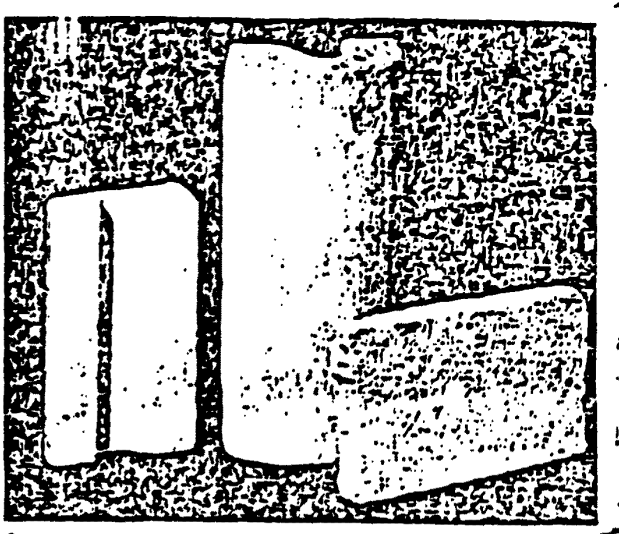
Owens-Illinois plant at Sayreville, New Jersey, one of two plants devoted entirely to the production of hydrous calcium silicate.

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Pieces of insulation under water a week, after being pulled out of mud left by Missouri River flood at Kansas City.



Same pieces after being cleaned under a stream of tap water and dried.

result is that insulation made to this system will always nest. Any size or thickness will fit snugly over either a standard pipe or another size or thickness of insulation.

Savings by S.D.S. System

The savings anticipated by Thomas in creating the system have proved practical. Because of the interchangeability of insulation made to this system, the number of sizes and thicknesses required to do a given job is greatly reduced. This is particularly beneficial to the user who keeps inventories of material for maintenance. He no longer need keep in stock all sizes and thicknesses that might be required for his insulated equipment. Instead, *he can stock only enough sizes and thicknesses to make up the necessary combinations.*

If processes are changed after equipment has been insulated, thereby necessitating greater insulation thickness, the user can simply apply another layer to his existing insulation. He need not remove the first insulation and apply a new, thicker covering.

It is worth noting that the 1200 F effective temperature limit of hydrous calcium silicate also applies here. Often insulations must be removed from equipment because new operating temperatures exceed 700 or 900 F limits of the material.

Savings in Application

To the engineers who design and specify and to the workmen who apply, the advantages of Kaylo heat insulation products are many, the limitations few.

The "limitations" are tied up with the advantages. One is that the material is so strong and rigid that it cannot be broken and shaped easily around irregular surfaces, a not uncommon practice, though not considered good workmanship. On the other hand, it is this strength combined with light weight that makes it possible to manufacture and apply the insulation in larger sizes than has been previous practice. This same strength makes it possible for the applicator to cut hydrous calcium silicate insulation to fit irregular surfaces or odd spaces with an ordinary saw, or even with a knife. Applicators who use it learn the new "tricks of the trade" quickly.

Applicators appreciate the fact that hydrous calcium silicate is non-toxic and "easy on the hands."

And this high strength makes it possible to walk on insulated pipes and equipment during installation, and also reduces the amount of insulation breakage during construction. The insulation foreman on a large refinery project in Illinois where this insulation was used throughout, remarked recently that the wasted insulation for the entire job could be hauled away in a pick-up truck. Estimators are learning to use a smaller breakage factor when hydrous calcium silicate is specified.

It is not unusual for applicators to mix crushed magnesia insulation with water to form a paste and force it into small areas to be insulated. Hydrous calcium silicate, being insoluble in water, cannot be used this way. This same water insolubility, however, eliminates damage from rain before weatherproofing on outside jobs, and also the need for replacing insulation if steam or water leaks occur in insulated pipes. Refining towers, insulated but not weatherproofed, have withstood 3-day rains and high winds without damage.

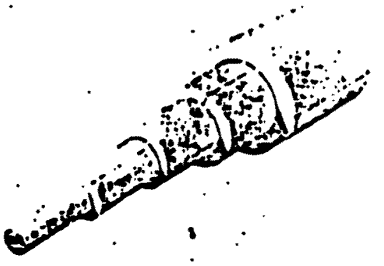
Hydrous calcium silicate insulation is applied in the same manner as other insulating materials. It is available either with or without canvas covering, and can be strapped, wired or pinned to surfaces being insulated. Paints of any type compatible with an alkaline surface can be used. Its nail and staple holding power are better than average. It has good affinity for insulating and finishing cements.

Due to its compatibility with a variety of adhesives, plus the fact that it is made to Simplified Dimensional Standards, hydrous calcium silicate pipe insulation as well as block may be shiplapped to order. Shiplapped insulation fits together like shiplapped lumber, providing staggered joints in single layer application. Skilled applicators often make their own shiplapping in the field, using a saw or even a chipping hammer.

The variety of forms of heat insulation that can be made in the plant or in the field by sawing, drilling, laminating, or combinations of them is almost endless. Skillful, conscientious workmen have found numerous shortcuts using these methods. The engineer and the estimator need only to decide which product promises to be the most economical for their requirements.

Although a relative newcomer to the field this heat insulation is a proved material in the oil refinery and gas processing field. Among the companies using it for major installations are Sun, Texas, Gulf, Sinclair, Standard of New Jersey, Standard of Indiana, Standard of Ohio, Standard of California, Sunray, Pure Oil, Imperial Oil, Phillips, Shell, Cities Service, and Humble. ★ ★ ★

Telescope of sectional hydrous calcium silicate pipe insulation, illustrating how Simplified Dimensional Standards allows nesting.



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