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BUILDING BOARD OF FIBER AND ASPHALT COATED PERLITE

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This invention relates to an insulating and building board and a process for manufacturing it. More particularly, it relates to an insulating and building board comprising heat expanded perlite and a fibrous organic or inorganic material or both. This application is related to our co-pending application 795,128, which covers a building board comprising uncoated expanded perlite together with a fibrous substance; and to application 795,129, which covers a board containing coated or uncoated expanded perlite, asphalt from an emulsion and a fibrous substance, both applications were filed concurrently herewith.

Perlite is a generic term for certain volcanic glasses which contain relatively small amounts of water entrapped in the glassy structure. Upon rapidly heating perlite to the point of incipient fusion it suddenly expands due to the internal pressure of the vaporized water. If the operation is carefully controlled as to temperature and time a product is formed comprising bubbles, most of which are sealed and have a subatmospheric internal pressure. The material has excellent thermal and sound insulating properties.

If the expansion temperature is high and expansion very rapid, the bubbles may burst, forming shattered fragments having curvilinear surfaces and thin walls.

The major part of the sealed bubble type of expanded perlite floats on water, and there may be as much as 90 to 98% that floats. Most of the shattered fragment type of material sinks in water. This invention is particularly concerned with the sealed bubble type of expanded perlite for use in the novel composition and process herein described.

In a broad embodiment the invention comprises a building board made by forming an aqueous slurry of expanded perlite which has been coated with a thermoplastic material melting above about 100° F., and a fibrous substance, forming the material into a web while simultaneously separating water, and then drying it, with or without consolidation prior to drying.

This invention affords a means of forming the expanded perlite into a board or slab in such a way that advantage can be taken of the desirable insulating properties of the expanded perlite. What is more important, it affords a method of introducing large quantities of asphalt or other thermoplastic material into a board while at the same time producing a lightweight product of high strength, particularly as regards wet strength.

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A usual method of preparing boards containing asphalt is to form a board from a fibrous material, such as wood pulp, bagasse, newsprint, etc., by making a slurry in water, subjecting it to a forming operation to produce a sheet, drying the sheet thus formed, and finally dipping or otherwise impregnating the board with hot asphalt. Usually the boards so produced are impregnated only part way through, either because of the difficulties associated with getting the asphalt to penetrate completely through the board, or because complete penetration results in an undesirable increase in the weight per unit of the saturated board. Thus, if a fiber board weighing about 800 pounds per thousand square feet is impregnated with 400 pounds of asphalt, the total weight of the board is 1,200 pounds per thousand feet. Half-inch board thus produced would generally be impregnated to ⅛ inch depth more or less on each side, leaving a core of unimpregnated fiber. When the board is applied, for example to a building, if the asphalt coating is penetrated, e. g. by nailing, water can reach the uncoated fiber which results in a disintegration of the board. It is apparent that the general utility and applicability of the board is limited by the service to which it is likely to be subjected.

By the present method a board can be produced containing, for example, 400 pounds of asphalt per thousand square feet, weighing about 950 pounds per thousand square feet or less as compared with 1200 pounds for an impregnated fiber board. From this comparison, it is evident that the invention provides a method for introducing asphalt into the board in amounts at least as great as is usually required for the saturation of fiber board in a conventional manner, without sacrificing either strength, weight, or insulating value. A dipped fiber board of comparable wet strength would weigh about 1600 pounds per thousand square feet. The saving in weight, material and handling costs including freight becomes immediately apparent. A further economic feature of the invention is the decreased weight of the structure into which the board is incorporated.

The impregnation of fiber board with asphalt generally decreases the insulating value to a point which approaches that of asphalt itself. With the present invention the fibrous material and the embound coated perlite, as well as the air spaces between fibers and perlite particles and further including the space within the perlite bubbles contribute to improved insulating qualities.

Another advantage of this invention lies in the fact that the asphalt is uniformly distributed through the board so that the entire board is rendered waterproof and of high wet strength. This means the board will not disintegrate even if soaked with water. This contrasts with the general practice of only partially impregnating the fiber board, leaving a core which is susceptible to the disintegration effects of water should the film of asphalt on the outside become broken. The board of the present invention can be cut or sawed on the job to any size or shape. The resulting material is still waterproof and has the same high wet strength as the original board from which it was cut. On the other hand, if a partially impregnated slab or fiber board is cut, provision must be made to seal the raw edges, otherwise water can penetrate to the interior and the board falls to pieces.

Expanded perlite has a great affinity for asphalt. Likewise, it is in no way changed or damaged by temperatures of the order of those required to coat the perlite with asphalt of any melting point. Any quantity of asphalt can be added to the perlite up to a maximum at which the asphalt causes the particles to stick together. The coated product should flow freely something like wet sand when hot, and even more freely when cold. The amount of asphalt which can be added and still maintain this property will depend to a large extent upon the surface area of the expanded perlite.

The asphalt-coated particle, either with or without a wetting agent being added, can be made into a slurry with fiber and can be formed into a board in a manner familiar to the fiberboard and paper industries. The particles are distributed more or less uniformly throughout the body of the finished board. The asphalt tends to render the entire board waterproof, and it has good wet strength.

The mixing of fiber with coated expanded perlite in the manner herein described makes it possible to form the particles into boards, sheets or mats which can be nailed or otherwise fastened to ceilings, walls, etc. The added fiber increases the strength of the expanded perlite board. The board, in addition to thermal and sound insulating value, is resistant to fire. Although fibrous material of organic origin is combustible, nevertheless in the preferred percentages used in these boards the tendency is to burn but slowly and the fiber tends to carbonize leaving the expanded perlite in place. As a result considerable fire protection is furnished. Even when high percentages of fiber are used the board will not readily support combustion of itself.

In one specific embodiment the invention comprises a board containing asphalt coated expanded perlite and a fibrous material of organic or inorganic origin, said board being made by forming a slurry of the mixed components in a liquid such as water, and then filtering or otherwise removing the water in such a manner as to form a web or sheet, generally followed by consolidation such as pressing it to the desired thickness and density, and drying the product thus made.

In another specific embodiment the invention comprises a process for manufacturing a board including the steps of forming a dilute slurry in water of expanded perlite and fiber, said perlite being coated with a thermoplastic material such as asphalt, and then forming the mixture into

a web, at the same time removing water, consolidating the web thus formed to a desired thickness, and finally drying it to produce the board.

Although the sealed-void type of expanded perlite is preferred in many of the board compositions coming within this invention, it is possible to use the shattered fragments. Coating of the shattered fragments with asphalt tends to agglomerate them and entrap bubbles of air with the result that an aggregated particle formed of the coated shattered fragments acts in much the same way as the sealed-bubble type of particles. Instead of sinking in water as the uncoated broken material does, the coated, saturated fragment will largely float.

The coating of the particles with asphalt increases the strength of a board over that which can be obtained by uncoated perlite and has the further effect of increasing the wet strength of the board. This is important, as indicated above, because boards comprising fiber alone disintegrate under the influence of water.

The fibers used in many building and insulating boards are cellulosic or ligno-cellulosic. When beaten in water these materials may become hydrated, that is, water penetrates into the fiber to form a gell-like mass on the surface of the fiber; or may develop minute fibrillae extending from the principal fiber particle. When formed into a mat or sheet, the fibers become interlocked and bind themselves to each other. Upon drying the sheet shrinks and has a certain amount of strength either because the drying gell-like surfaces of the fibers cement them together or because the fibrillae of adjoining particles become entangled. The extent of hydration, if this actually occurs, or fibrillation, if such is the mechanism, has a profound effect on the strength of the board. The greater the beating and hence hydration or fibrillation, the stronger the final board.

Increased beating results in a slower stock; that is, the water runs away more slowly from the mat or felt on the board machine.

We have found that by adding the coated, expanded perlite to pulp slurries, a given stock is made freer, provided it is initially less free than the perlite. Thus by this invention advantage can be taken of the increased strength-producing properties of slow pulp and at the same time the formability of the stock relative to its freeness is greatly improved thereby increasing the rate of board formation which produces a manufacturing advantage.

We have found that it is also possible to reduce drying time over that made from fiber pulp alone. Just why this is so is not definitely known, but it is evident that the expanded perlite holds water mainly on its glossy surface from which it evaporates quickly and easily when the temperature is sufficiently high. Apparently these dried particles may be heated to temperatures above the boiling point of water since they are no longer subjected to the cooling influence of the evaporating water, and reach a temperature greater than that of the surrounding wet fibers, which remain at or below the boiling point of water, until the water content of them has been substantially eliminated. The higher the heat content of the dry particles, the greater the heat transfer rate to the surrounding fibers by conduction and radiation. Consequently, the rate of evaporation from the wet fibers themselves is increased. The net result is a reduced drying time by as much as one-third over boards made from fiber alone.

The net effect of the improved filtration and formability and increased drying rate is an increase in production capacity, both in the board machine and the drying chamber. On existing plants this means increased plant capacity for a given rating in fiber insulating board. For new plants it means a reduction in capital investment. All of this adds up to decreased production costs. This, coupled with the fact that improved products are obtained, means an advantage for the process and its product over those formely made from pulp alone.

Another effect which is of substantial importance in this invention is the improved strength of the boards and the greater flexibility as to the type of board that can be produced.

Temperatures of 275–325° F. or higher are generally employed in the driers. At these temperatures the asphalt coating on the perlite particles becomes substantially fluid. Migration of the asphalt into the fiber may occur resulting in binding the fiber to the perlite and in improving wet strength. At the same time, however, the asphalt does not flow away from the particles to form a continuous phase throughout the board. This means that the natural matted, felt-like structure, taken on when the fibers are formed into sheets or mats by the wet process described herein, is retained with the added advantage of the effect of the perlite and the asphalt contributing to the lightweight, strong board of this invention. If it were attempted to incorporate as much asphalt into fiber by dry methods and hot molding, the resulting board would have an altogether different character. Such boards are heavier and denser, generally having lower insulating value.

The expanded perlite used in this process as previously indicated, preferably is of the vesicular or sealed bubble type comprising a major portion of particles having sealed bubbles, but may also comprise the shattered bubble type. The bulk density of the expanded perlite suitable for this process may range from about 1 to 20 lbs. per cubic foot and is preferably of the order of about 5 to about 15 lbs. per cubic foot. Mesh sizes larger than 20 mesh may be used but for many purposes material passing 30 mesh and finer is preferred. In this way a lighter weight, more uniform finished product can be produced, which is advantageous.

The expanded perlite may be coated with a thermoplastic material such as asphalt having a melting point of about 100° F. or preferably 140–250° F. by contacting the expanded perlite with molten asphalt or the like in the proper proportions. The perlite is quickly and readily wetted by the coating material and a uniform coating can be prepared. The coated material, after cooling to room temperature, flows much like dry sand. It is preferred to correlate the amount and melting point of the asphalt so that the coated product can be handled in this manner.

The coated perlite has the advantage of being waterproof. The finished board does not absorb water to a damaging extent either when in contact with it, or from moisture from the air. The wet strength is higher than any commercial fiber insulating board. There is also a manufacturing advantage in that filtering and drying time is reduced.

The proportion of asphalt or other coating substance may vary substantially, depending upon the particle size of expanded perlite and its

bulk density and the type and quality of board desired. Thus, for expanded perlite weighing in the neighborhood of about 8 to 15 pounds per cubic foot each 100 parts by weight of expanded particles may be coated with from about 1 to about 150 parts by weight of asphalt. The proportion of asphalt to a large extent depends upon the amount of surface of the expanded perlite. In general the greater the particle surface, the more asphalt it is possible to incorporate on a given weight of expanded perlite without the particles sticking together. The actual amount that can be used is to some extent governed by the melting point of the asphalt and by the method that is employed for applying it. The character of the expanded perlite is also important, i. e. whether it is of the sealed bubble type or has many shattered fragments.

Instead of asphalt, petroleum pitch, coal tar pitch, wood tar pitch, lignite tar pitch; various types of thermoplastic natural or synthetic resins; rosin; latex, either of synthetic or natural origin; and other thermoplastic materials may be employed. Thermosetting resins and plastics may be used although not necessarily with exactly equivalent effects.

These provide excellent films on the perlite particles tending to prevent segregation into sizes during shipping and add strength, and cushioning the coated particles thus reducing breakage during handling. Asphalt is preferred from the standpoint of availability, cost and ease of handling.

The fiberous substances useful herein, may vary substantially depending upon the service for which the board is intended. When making insulating board both from a standpoint of cheapness, availability of material and the benefit to be derived, relatively short fiber materials such as paper pulp, kraft paper pulp, newsprint pulp, bagasse, rags, ground redwood bark and other naturally occurring vegetable fibers, may be employed. Many of these have been used alone in insulating boards available under various trade names.

Long vegetable fibers, such as hemp, cocoa, jute, etc.; or animal fibers, such as hair, pulped leather, silk, etc.; or artificial fibers, such as rayon, nylon, vinyon and the like, may be used. These are classed as organic fibers and are of vegetable, animal or synthetic origin. Instead of organic fibers, inorganic fibers including rock wool, asbestos, glass wool, mineral, etc., may be employed. These materials yield products which are fire resistant and as a rule are used for special purposes where fireproofness or fire resistance are desired.

In general, as previously indicated, the length of the fibers should be sufficient when taken as a whole to entrap or bind the particles of expanded perlite as well as to bind fibers to fibers. The mechanism by which this is done may be considered, as was previously indicated, to be by the entrapment of a gel-like structure of hydrated pulp, or by the interlacing of fibrillae extending from the main body of the fiber as well as due to entanglement of the ultimate fibers themselves. In order to provide the greatest strength in a board with a given quantity of fiber, the best results are generally obtained if at least a substantial part of the fibers or the fibrillae are longer than the diameter of the perlite particle being embound. For the best results at least, the average length of the fibers should be several times the diameter of perlite and the fiber portion of the slurry should be slower than is that of the slurry of fiber and expanded perlite.

The relationship between the diameter of the fiber and the length of the fiber, is also a factor. For example, chemical wood pulp may have a fiber length of three millimeters and a diameter of about 0.03 millimeter. Mechanical pulp may have a particle length of one millimeter and a diameter of 0.02 millimeter. The bonding effect of these two pulps might be entirely different, even though the average diameter of expanded perlite particles included in a sheet or board were adjusted to allow for the shorter fiber length.

Other pulped fibers have been reported to have the following length to diameter relationships expressed in millimeters: Straw—1.5:0.015; bagasse—3:0.015; cotton—30:0.025; linen—25:0.02; hemp—20:0.02.

The optimum relationship of fiber length to perlite particle size may also vary depending upon whether the perlite comprises mainly sealed bubbles or is of the shattered type.

The fibers themselves may be coated with a thermoplastic material, such as those described above, or a material which will coat, penetrate or waterproof the fibers in the finished board may be added in the slurry. These may include such things as kerosene, wax emulsions, linseed oil, drying oils and the like.

The fiber may be pulped by any suitable method of which several are known and conventionally used, to produce a slurry of fiber in water. Stocks composed mainly of longer individual fibers can be made into a slurry by agitation or any suitable method.

A slurry is made of coated, expanded perlite, fiber and water to such a consistency as will readily form on the board machines. These may include continuous rotary vacuum filters, Fourdrinier machines, suction mold machines, or the continuous cylinder type of board machine.

The amount of expanded perlite ranges from about 10–75% by weight of the total suspended solids. Other useful ingredients of the finished board can be included such as sizing material of which rosin, paraffin emulsions, etc., are examples; termite repellants; materials which will prevent the formation and growth of algae, etc. These can be added at any desired point before the forming machine or can be added after the web is formed.

A wetting agent for the perlite may be employed when using the coated expanded perlite. This tends to reduce the amount of water mechanically retained by the perlite and also reduces the time for mixing and time for filtering. Less water is retained after filtering, hence the drying time is reduced. These manufacturing advantages are outstanding for this invention.

The mixture is kept agitated to prevent the solids from settling out prior to being deposited on the board-making device. The wet board is then passed between rolls or otherwise compressed to force out additional water and to consolidate the web or units. By regulating the pressure, differing degrees of density of the finished board can be obtained. The board thus produced may be cut into sections of desired size and dried in an oven, generally over a period of about 1 to 24 hours. The moisture content is usually reduced to about 5% by weight.

A standwich of webs or sheets can be made according to this invention. Thus, a core of material, which may have a substantially higher insulating value but relatively lower strength than is desired in the final board, can be made. External sheets or webs of greater strength can be produced, if desired, these being of lesser thickness than the core. The sheets can be laid one on top of the other prior to consolidating or pressing them to produce the final board.

It is also possible to produce a so-called thermoplastic board by this process. To do this the perlite is generally coated with as much asphalt as possible, is made into a slurry and formed into a board, mat or sheet, as previously described, and then, during or after drying, is subjected to a high temperature consolidation under pressure conditions which will cause the asphalt to flow from the perlite into the surrounding spaces. Instead of expanded perlite, other expandable volcanic glasses may be used, e. g. volcanic ash, tuff, pumicite, etc.

The following examples are given to illustrate the process and the product but should not be construed as limiting the invention to the exact materials and conditions shown therein.

Example I

A board was made by mixing expanded perlite weighing 8 lb./cu. ft. and coated with an equal weight of 220° F. melt point asphalt and passing a 30 mesh screen, with pulped newsprint. The proportions were 70% coated perlite and 30% newsprint calculated on a dry weight basis. Rosin size was added. A slurry of 1.85% solids in water was kept suspended by agitation and fed uniformly to a rotary vacuum filter, the web being removed as formed. Filtering rates were increased as shown by the fact that the rate of board formation was nearly doubled that using pulped newsprint alone. The web was cut into lengths, and dried in a hot air oven, the time of drying being reduced to about two-thirds that required for a board of newsprint alone.

The resulting expanded perlite board was strong, tough, of low thermal conductivity and had sound-proofing qualities. It could be sawed and cut to desired dimensions, and nailed in the usual way. It weighed about 950 lbs. per 1,000 square feet.

Example II

A mixture similar to Example I was made using bagasse fiber. Equal amounts of asphalt coated expanded perlite and fiber were used. A strong, lightweight board was produced, having desirable heat and sound insulating properties.

Example III

A mixture such as Example I was made using rock wool fibers. The resulting board was fire resistant and strong. Mixtures of vegetable fiber and inorganic fiber such as rock wool, glass wool, and asbestos wool are also useful.

We claim as our invention:

1. A consolidated asphalt-expanded perlite composition useful as a building board consisting essentially of fibers and asphalt-coated essentially cellular expanded perlite, said fibers comprising 90–25% by weight of the composition and said coated perlite comprising 10–75% by weight of the composition, said perlite being less than 20 mesh size, having a bulk density of 1–20 pounds per cubic foot, and being coated with 1–150 pounds of asphalt per cubic foot of perlite, said asphalt melting at 100–250° F., said asphalt-coated perlite being present as essentially discrete particles, the length of said fibers being not substantially greater than 20 millimeters, the aver-

age length of said fibers being substantially greater than the average diameter of the perlite particles.

2. The product of claim 1 wherein the fibers are inorganic.

3. The product of claim 1 wherein the fibers are organic.

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