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POROUS CERAMIC PRODUCT AND THE  
MANUFACTURE THEREOF

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This invention relates to porous ceramic products, and with regard to certain more specific features, to porous ceramic products of heat-insulating and like characteristics.

Among the several objects of the invention may be noted the provision of a process for manufacturing porous ceramic products of the class described which utilizes a combustible material as a porosity-creating means; a process wherein swelling, bloating, and cracking of the products during the course of firing is effectually minimized; a process of the class described wherein valuable constituents of the combustible material are recovered; a process wherein combustible materials are first carbonized at low temperatures to eliminate large quantities of vapors, explosive gases and the like, and then combined with the ceramic material; a process wherein grog or non-plasticizable material is produced separately or in intimate mixture with the combustible material; and a process of the class described which is easily and economically carried out with maximum recovery of valuable by-products. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, steps and sequence of steps and features of synthesis which will be exemplified in the description hereinafter and the scope of the application of which will be indicated in the following claims.

It has been found that combustible carbonaceous material, when mixed with clays and the like, plasticized, molded, and burned, evolves considerable quantities of volatile constituents and gases which permeate the mass and render it highly porous and valuable as insulating, or filtering, material. In general, however, the evolution of volatiles and gases is so violent at distillation temperatures, that bloating, swelling, and cracking of the masses is engendered, and, consequently, the percentage of well-shaped products in a batch is decreased.

I have found that the difficulties inherent in the distillation or carbonization of combustible carbonaceous material as pointed out above can be eliminated by distilling or carbonizing the combustible substance at low temperatures prior to its incorporation with the clays. This preliminary distillation or carbonization is sufficient to drive out substantially all of the volatile constituents, which are preferably collected and condensed. A subsequent mixture of devolatilized combustible material and clay may be heated or fired to proper temperatures without

violent ebullition of vapors and the like, and, correlatively, without bloating, swelling, or breaking.

Among the various combustible materials I have found suitable for use in my invention are bituminous coal, lignite, coal shales, wood, other vegetable material and the like. This combustible material is carbonized or devolatilized, at temperatures up to the order of 600° C., and is then comminuted to a fineness of the order of 150 mesh. The present invention is concerned particularly with the use of the aforementioned bituminous coal as the combustible material. Bituminous coal has hitherto been considered impossible of use in the present type of process, because, in its natural state, it is neither friable enough nor does it absorb water in the plasticizing operation sufficiently to permit of the desired molding of the clay, and because, upon firing of the bricks, volatiles were evolved in such quantities as to rupture the brick with explosive violence. High temperature coke made from bituminous coal is disadvantageous in that it is too completely devolatilized and does not engender the desired porosity, and because it, like the native coal is too water-repellent to be plasticized with facility. It is only with the advent of satisfactory low-temperature carbonization processes, such as the herein-described 600° C., that bituminous coal has thus become available for use as set forth in the present invention, because semi-coke, the product of a low-temperature carbonization of bituminous coal, is not water-repellent, is excellently friable, and contains an optimum quantity of volatiles to achieve the desired porosity without excess gas liberation and ruination of the shape of the product.

The clay to be used depends largely upon the nature of the desired product; for example, fire clay or diaspore clay is preferably used where a refractory product is desired, while ordinary clays may be used for the manufacture of low-temperature insulating bricks or filtering media. The clay is also preferably ground to a fineness of the order of 150 mesh.

The devolatilized combustible material and fresh clay, both comminuted, are thoroughly intermixed and then plasticized with suitable plasticizing agents. Water is a satisfactory plasticizing agent in general, and is particularly valuable with clays having a high hydrated aluminum-silicate content. Chlorides generally, and acids, are particularly adaptable to clays having high alkaline-earth metal contents. Alkalies are valuable plasticizing agents with clays

of high silica content. It is to be understood, however, that the plasticizing agents mentioned herein are interchangeable, with excellent results.

5 The plasticized mixture is next shaped or molded into bricks, or whatever form or shape is desired for the finished product. The shapes are then preferably allowed to dry, although this step is not essential. The dried shapes are subjected  
10 to firing, in the presence of air and/or steam or the like, whereby the combustible material is burned from the shapes. With air burning, the products of combustion comprise carbon monoxide and/or dioxide. These products of combustion, forcing their way through the shape,  
15 occasion the porosity of the finished product. Steam may be used in place of air, in which case the gas evolved comprises water gas, which is readily collected and utilized for heating purposes and the like. The water gas produces  
20 porosity in the shapes in much the same manner as the carbon monoxide and dioxide.

After the combustion is completed, the temperature is gradually increased to the point of  
25 incipient vitrification of the clay constituents, which is preferably predetermined. This further heating of the shapes strengthens the bond of the clay materials, and renders the products strong, hard, and wear-resisting. By stopping  
30 short of complete vitrification or fusion, the porous structure of the shapes is retained. After firing is completed, the shapes are preferably annealed by slow cooling, as is customary in ceramic arts.

35 With certain types of clays, it has been found desirable to introduce grog material for the purpose of preventing shrinkage of the product during firing. To incorporate a grog material in my product, I preferably modify my process as above  
40 disclosed by mixing with the raw combustible material, prior to its devolatilization, an appropriate amount of clay which may or may not be plastic or "groggy". The loose mixture of grog forming material and combustible material is  
45 then heated to devolatilize the combustible material in the manner described. Simultaneously with the devolatilization of the combustible material, the clay is dehydrated or partially vitrified to the extent of becoming non-plastic, and  
50 forms a grog for the remainder of the process, which is carried out in the manner hereinbefore described.

The presence of the clay aids in the devolatilization of the combustible material, inasmuch as  
55 the clay forms a heat-conducting medium which assures an even and quick heating of the combustible material. This feature is especially valuable with a wood combustible material, inasmuch as wood itself is a poor conductor of heat,  
60 and considerable time is consequently required for heat to penetrate a charge of wood fines.

The grog material may also be prepared by separately distilling or calcining the clay and the carbonaceous material, and then combining the  
65 distilled carbonaceous material and calcined clay together with fresh plastic clay as a binder and

proceeding as hereinbefore. The clay thus separately heated, as in a rotary retort in the absence of air, becomes a grog material which is substantially dehydrated and non-plastic.

In view of the foregoing, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in carrying out the above objects without departing from the scope of the invention, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. The process of manufacturing porous ceramic products which comprises subjecting relatively low temperature bituminous coal to a distillation whereby volatiles are removed therefrom, comminuting said devolatilized coal and mixing the same with comminuted clay material, plasticizing the mixture, and forming the plastic mixture into shapes, and subjecting said shapes to heat treatment whereby said coal is burned from said shapes.

2. The process of manufacturing porous ceramic products which comprises subjecting relatively low temperature bituminous coal to a distillation whereby volatiles are removed therefrom, comminuting said devolatilized coal and mixing the same with comminuted clay material, plasticizing the mixture with water, and forming the plastic mixture into shapes, and subjecting said shapes to heat treatment whereby said coal is burned from said shapes.

3. The process of manufacturing porous ceramic products which comprises subjecting a mixture of relatively low temperature bituminous coal and clay to heat treatment, whereby the coal is devolatilized and the clay is dehydrated to a grog material, comminuting the mixture and adding thereto comminuted clay, plasticizing the mixture with a suitable plasticizing agent and forming the plastic mixture into shapes, and firing said shapes to burn therefrom the coal and harden the clay material.

4. The process of manufacturing porous ceramic products which comprises subjecting a bituminous coal to a relatively low temperature distillation whereby volatiles are removed therefrom, comminuting said devolatilized coal and mixing the same with comminuted clay material, plasticizing the mixture with chlorides, and forming the plastic mixture into shapes, and subjecting the shapes to heat treatment whereby said coal is burned from said shapes.

5. The process of manufacturing porous ceramic products which comprises subjecting a bituminous coal to a relatively low temperature distillation whereby volatiles are removed therefrom, comminuting said devolatilized coal, and mixing the same with comminuted clay material, plasticizing the mixture with alkalies, and forming the plastic mixture into shapes, and subjecting said shapes to heat treatment whereby said coal is burned from said shapes.

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