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CERAMIC PASTE

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This invention relates to the preparation of ceramic pastes in which clay is used as a binder.

Such pastes, for example refractory fireclay pastes or pastes for earthenware or for wall and floor tiles, which are intended to be hand-moulded or pressed by hand or machine, frequently contain anything from 8% to 50% of binding clay. In one known process of preparing such pastes, the binding clay is first dried and then ground, the ground clay being then mixed with the shortening or leaning agents (also known as "opening agents" and as such herein-after referred to), whereupon the finished mixture is moistened to the desired degree. In another known process, clods of clay, wet as they come from the clay bed, are worked into the opening agents by means of kneading machines of the pug mill or like type, the requisite quantity of water being added to the mixture.

Neither of these processes, however, enables a really high-quality product to be obtained unless the time taken up by the preparation is so long as to make the production uneconomical, the products obtained being therefore, at best, of average quality even if high-grade raw materials are used. The reason for this defect in the known processes is that neither of them ensures a sufficiently uniform and thorough disintegration of the clay, and the resulting lack of homogeneity of the paste impairs the quality of the finished ceramic products. Moreover, these processes are not adapted to develop to the full the inherent binding power of the clay, and therefore a larger proportion of clay has to be used in the paste than is justified by the true inherent binding power. This in turn impairs the resistance of the finished products to various external influences, for example their resistance to slag, to sharp temperature changes or to firing shrinkage and their mechanical strength in the cold dry state.

To these disadvantages is added the further obvious objection, as regards the first process hereinbefore mentioned, of having first of all by expensive methods to remove water from a raw material which is found in a moist state in nature, only to add the water again at a later stage of the process. Moreover, binding clay by being dried loses a substantial part of its inherent binding power.

On the other hand, a process of making clay slips is known in which such large quantities of water are added to the binding clay prior to mixing that, after mixing the binding clay with the right amount of opening agents and other addi-

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tions necessary for the particular composition desired, the moisture content of the finished paste is too high to enable it to be worked by moulding, pressing or tamping unless the excess water is previously removed. This applies even to pastes which, for special purposes, contain only about 3% to 10% of binding clay.

To meet this objection, a process has been used (though only in rare cases) in which the amount of added water necessary for the disintegration of the clay is reduced by the addition of electrolytes which have a liquefying action, so that the clay slip introduces into the paste only that amount of moisture which is necessary to make shaping of the paste possible. However, this is attended by the drawback that the addition of effective electrolytes inevitably results in an increase in the proportion of fusible agents or fluxes contained in the paste, an increase which is most undesirable in the case of refractories.

The object of the present invention is to provide an improved process of preparing such pastes, including refractory fireclay pastes by means of which the objections to and disadvantages of the known processes above referred to, can be largely avoided. More particularly, the invention aims at making possible a thoroughly uniform and complete disintegration of even those clays which are notoriously difficult to disintegrate, and that with the addition of only a relatively small quantity of water, without however increasing the flux content of the paste, so that, after the amount of clay has been put in which is necessary to effect binding, the finished paste will contain only as much moisture as is required to make the paste suitable for the desired shaping operation.

The foregoing object is achieved, according to the invention, by mechanically disintegrating the clay particles—the clay clods having been previously broken up into coarse particles, if necessary—with the addition of no more water than is necessary to impart to the finished paste a consistency suitable for shaping it, and by mixing the resulting clay slip with opening agents and other additions. If necessary, the water content may be increased during the mixing stage, but in no event is water removed from the slip or the mixture.

For reducing the clay clods there may be used known apparatus such as, for example, clay planers or graters or crushing rolls or like mills. To disintegrate completely the coarse clay particles thus obtained, while observing the proportions of added water as discussed above, con-

stitutes that difficulty which known industrial techniques have not hitherto been able to master and which has been overcome by the process according to the present invention.

In order to ensure that the disintegrating apparatus is uniformly supplied with coarsely broken-up clay and water, it is advisable to associate the apparatus with a continuously operating automatic weighing machine which continuously feeds the material to the disintegrating apparatus at a constant rate while water is being supplied to it in a constant stream.

This process is based on an appreciation of the micro-structure of clays, caused by the manner in which they are formed in nature, and of the physical and mechanical behaviour of clays. As is generally known, clays are of flake or sheet structure, the sheets being stacked in substantially parallel laminae with layers of water interposed. Since each water layer approximates to molecular dimensions, the forces due to surface tension are quite considerable, particularly as true wetting of the surfaces of the laminae takes place, this being shown by the ability of clays to swell or expand.

The disintegration of clay is in essence a matter of separating such stacked laminae, and this is only really possible by parallel displacement of the laminae. The clay to be disintegrated must therefore be subjected to the action of two parallel and oppositely directed forces. Such forces are in fact produced in a number of standard machines in use in the preparation of ceramic pastes, but mostly only as subsidiary actions incidental to the real effective action desired, for example in edge mills by the lateral displacement of the pan with respect to the co-operating surfaces of the edge rollers or runners, and similarly also in differential mills (with crushing rolls rotating at different speeds) or in kneading machines with oppositely rotating arms. It has been found however that, though these standard machines operate on the correct principle, their effect is not sufficient to ensure complete disintegration of the clay within an economically tolerable operating time in the conditions of water-content of the clay stipulated by the invention. The reason for this is thought to be that the clay is only incompletely subjected to the effective action of these machines because of the smooth working parts of the latter and the slipperiness of the clay in the wet state, or that the zones of action (which in crushing roller and edge runner mills are practically little more than a line or a narrow band) are too small, or possibly that the operating speed of these machines is not high enough for this purpose, or again that perhaps the distance between those machine parts which act in parallel and opposed directions is too great for this purpose.

According to a feature of this invention, therefore, the clay disintegration may be carried out in machines whose principal action lies in effecting a parallel displacement of the clay laminations and which are so constructed as to have zones of action adapted to work the clay as intensively as possible, having regard to the properties of the clay.

Thus, for example, a machine particularly suitable for the purposes of this invention is a high-speed disc grinding mill having a zone of approximately radially extending ribs and rotating scoops or clearing blades. A suitable machine is shown in the Eirich et al. patent, No. 2,218,876. Such a machine will rapidly and in

one operation disintegrate the coarsely broken-up binding clay and, the requisite amount of water being added, convert it into a clay slip.

In order to enable the amount of water added in the disintegrating process to be roughly fixed in advance, it is advisable first to determine the moisture content of the clods coming from the clay bed, because it will be appreciated that the amount of water contained therein is apt to vary considerably, and then to calculate from this the quantity of water to be added which, generally speaking, will be about 25% to 35% of the weight of the wet binding clay as it comes from the bed. The additives or opening agents to be mixed with the clay slip so formed may be the usual ones, such as fireclay, silicon carbide, corundum, grog or the like. Other additions, e. g. feldspar and the like, such as are used for earthenware or wall tiles, may also be mixed in a dry condition with the disintegrated clay.

The output of a disc grinding mill when used for slip-making, particularly if the clay has previously been broken or cut into coarse particles of about the size of chicken eggs, is such that for example the supply of disintegrated clay is sufficient at least to treble the output of a large pug mill or trough mixer, because the homogeneous mixing of the clay, thus thoroughly disintegrated, with grog is effected in a surprisingly short time. The clay passes through the disc mill in a few seconds. It is even possible to dispense altogether with edge mills hitherto always used. The mixing is particularly thorough and rapid, if effected in mixers comprising rake-like tools which are eccentrically rotating in opposed direction within a rotating mixing bowl or pan. Such mixers can be charged with deep layers of the materials to be mixed, and also they can be driven at much higher speeds of rotation than machines of the edge runner type. Both these factors tend to increase the output.

However the output of a slip-making apparatus according to the invention is so great, for example, that it can keep several mixers supplied, even if the latter are of the high-output type above referred to. As the disc grinding mill is relatively small and light, it can be mounted on wheels and travelled backwards and forwards between several simultaneously working mixers to supply them. Alternatively, the slip from the disc grinding mill may be fed into one or more storage tanks to be collected therein for subsequent admixture with the opening agents.

The interpolation of storage tanks between the disintegrating or slip-making apparatus and the mixing apparatus is of particular advantage in connection with the present invention. In view of the fact that the disintegrating apparatus is charged with individual clods of clay and that the content of solid matter may vary from one clod to another, it is obviously not to be expected that the solid content of the resulting clay slip in the disintegrator will thereby be adjusted to a value corresponding to that of the whole stock of clay as determined by analysis of average samples. On the contrary, it is likely that the solid content of the clay slip will, by accident, show more or less pronounced departures from that of the clay in stock, to the detriment of the finished products. This difficulty can be avoided by collecting large quantities of clay slip in a storage tank in which there will thus be a greater equalisation of the solid matter content, the slip from the storage tank being then charged into the mixers. In the case of very

exact requirements as to uniformity of water content, the storage tank may be equipped with an agitating or stirring mechanism or with other means for turning over the slip contained therein. Not only is the solid content closely approximated to the average analysis value in this way, but it is also possible without difficulty to determine the water content of the disintegrated clay by weighing a measured quantity of the slip. By consulting a graph on which the solid matter content is plotted against density and thus ascertaining the solid content of the clay slip from its density as determined in the above manner, it is readily possible to calculate the exact quantity of binding clay, in terms of solid matter, which must be added to the mixture in the mixing machine in order to produce the desired composition or consistency of the finished paste.

It will be seen therefore that the process according to the invention may be carried out as described in the following example:

The binding clay, either in the form of coarse particles of clods wet as they come from the clay bed, or in the form of dried clay if available, is disintegrated in a disc grinding mill (or attrition mill as it is also called) with the addition of as much water (usually about 25% to 35% in the case of clay which is already wet) as will cause the water content of the finished paste, i. e. after adding it to the opening agents, to be just below the value necessary for shaping the paste. The clay slip thus formed is discharged into a storage tank provided with a mixing device e. g. an agitator, a vibrator or a circulating pump. A measured and weighed quantity of the slip is then mixed with the quantity of opening agents corresponding to the desired composition and thereby made into a paste which is thoroughly worked and homogenised. Then, if necessary, the moisture content of the paste is corrected by addition of a small quantity of water to bring the paste to a consistency suitable for the desired method of shaping.

The advantages of the invention reside not only in the simplification of the process of preparation of the paste and in the increased output

obtainable thereby, but also in the quality of the finished paste. The proportion of binding clay necessary for the usual methods of shaping is substantially less than in the known processes of paste preparation hitherto used. The paste so prepared to some extent possesses, directly after its preparation, those advantageous properties which pastes otherwise prepared develop only after a lengthy period of ageing. Particularly important properties of the products, like porosity, compressive strength in the dry cold state, resistance to sudden temperature changes and to attack by slag, are considerably improved in comparison with products manufactured by the known processes.

What we claim and desire to secure by Letters Patent is:

1. A method of preparing a ceramic paste adapted to serve as a clay slip comprising breaking raw wet clay clods into small particles, then mechanically working said particles in a high speed disc grinding mill to separate the laminations of the individual micro size clay flakes by parallelly displacing said flakes, while simultaneously adding water in a quantity to make a clay slip.

2. A method as in claim 1, said water comprising approximately from 25% to 35% of the weight of the raw wet clay.

3. A method as in claim 2, further comprising mixing an additive to said clay slip.

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Number	Name	Date
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