About the Technological Scheme of the Ceramic Brick Production Process

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Abstract: *In order to make a burnt brick, it is necessary to mix the solution beforehand: clean clay and sand from impurities and inclusions, mix with water and additives to a homogeneous mass in a certain ratio. Then pour the prepared mixture into molds to obtain blocks of standard sizes. To create a heat-resistant look, you need to use medium-fat clay as a raw material, which has a reddish tint.*

In the production of ceramic bricks, the method of semi-dry pressing and the method of plastic molding are used, each of which has its advantages and disadvantages. In the presence of loose clays and medium-density clays with a humidity of no more than 23-25%, a plastic method of processing clays is used; for too dense clays that are difficult to moisten and process with low quarry humidity (less than 14-16%), a semi-dry method of processing is used. The semi - dry method pressing involves preliminary drying of raw materials, subsequent grinding it into powder, pressing of raw materials in molds at specific pressures tens of times higher than the pressure of pressing on belt presses.

The advantages of semi-dry pressing technology is that the pressed raw brick is placed directly on the furnace trolleys and dried on them in tunnel dryers, or, bypassing pre-drying, it is directly supplied to firing. Complex mechanization production is carried out easier than with the plastic molding method. However, the technology of semi-dry pressing requires a more advanced aspiration system on the paths of preparation and transportation of powder, the use of more high-performance presses. In the course project, production by semi-dry pressing will be considered. The main feature of semi-dry pressing of ceramic products is their molding from powders by compression pressing under significant specific pressure 15...40 MPa. The technological process of manufacturing products by this method includes the following groups of operations: quarrying, preparation of press powder, pressing, drying and firing of products. Quarry work does not have any specifics and is carried out according to the mining and operational conditions of the clay deposit.

Quarry work does not have any specifics and is carried out according to the mining and operational conditions of the clay deposit. Clay is extracted at the quarry by a multi-bucket excavator and transported by motor transport to the storage in the clay storage room of the plant. From the clay storage tank, clay is fed into the silo of the clay powder, and after loosening it is sent to the dosing carried out by a box feeder. Ceramic powders are prepared by drying-grinding and slicker method. In the drying and grinding method, clay is subjected to successively coarse crushing, drying, grinding, sifting and moistening. Clay is crushed on disintegrated rollers, and

dried in drying drums with a direct current, since with a counterflow there is a danger of severe overheating of the clay, partial dehydration and a large loss of plastic properties. Drying drum 2.8x20, performance depends on the material, power 75kW, overall dimensions - 20000x4750x4464mm, weight - 72930kg.

The temperature of the gases tg1 entering the drum is usually 600...800°C. The reduction of tg1 provides a more uniform fractional humidity, but reduces the performance of the drum. An increase in tg1 above the specified limit is impractical, since it leads to dehydration of the fine clay fraction and causes rapid failure of the drum section. The normal temperature of the exhaust gases t2 should be 110...120 ° C. a sharp increase in t2 indicates the drying of the clay. The temperature of the clay discharged from the drying drum is 60...80° C. The final humidity is 9...11%. When the clay passes through the drum, its granulometric composition changes. Small fractions dry out quickly, are worn to a pulverized state, and large pieces, steaming, stick together and roll into large lumps. This causes a large moisture heterogeneity of the dried clay, which complicates the work of grinding machines. So, with an average humidity of 8.5...12%, the humidity of the largest pieces reaches 15.5...19%. In addition, there is a significant difference in humidity within one piece.

A certain increase in the uniformity of drying is achieved by the device of chain curtains in drying drums, which partially grind the clay, thereby creating conditions for more its uniform drying. But even with the presence of chain curtains, the drying drum cannot be considered a sufficiently technologically perfect unit. Basket disintegrators are used for grinding clay in the production of bricks. SMK-211 coaxial basket disintegrator, capacity - 12.5 t/h, power - 22kW, overall dimensions - 2170x1875x1885mm, weight - 3050kg. They work steadily at clay humidity not higher than 10%. At higher humidity, the clay sticks to the casing and to the fingers of the disintegrators. If there are stony inclusions in the clay, the fingers of the baskets wear out quickly. The thickness of the grinding depends on the frequency of rotation of the disintegrator baskets, the distance between the fingers and the moisture content of the clay. The yield of small fractions increases with an increase in the frequency of rotation of the baskets and a decrease in the distance between the fingers.

With an increase in the moisture content of clay, the number of large fractions increases. So, for example, at a humidity of 10%, the sum of large fractions (the residue on the sieve of 25 rel. per 1 cm2) is 96%, and at a humidity of 6% - only 66%. A loose powder of low density is obtained from the disintegrators, which makes it difficult to press products from it. The clay is sifted to separate large grains of powder. String sieves, drum screens (burats), swinging and vibrating sieves are used for this. On string sieves, only very large pieces of clay can be separated, since the distance between highly stretched strings varies significantly due to their bending. A drum screen (sieve-borate) with holes of 0.5...3 mm is used for sifting dry crushed materials. Such a screen allows you to simultaneously obtain several fractions by selecting and installing appropriate sieves. The screening efficiency depends on the moisture content of the material, the size of the holes, the angle of inclination of the screen, its length and the speed of movement of the material in it. The disadvantages of the drum screen are the rapid wear of the sieves and low productivity. In a swinging sieve, the material moves under the action of shocks received during the reciprocating motion of the sieve. Its productivity is 5...15 m^3/h. Vibrating sieves have a high efficiency, reaching 0.9 ...0.96, they make it possible to sift caking clays due to strong shaking of the material and vigorous cleaning of the sieve cells. The sieves have large overall dimensions and small weight with high productivity of 20... 25 t / h, are characterized by simplicity of design and maintenance. The disadvantage of vibrating screens is the significant dynamic loads that they transmit to building structures, which makes it difficult to place them on the floors. Electric heating of sieves increases their productivity. When preparing a press powder, it is not always possible to obtain a powder with moisture content necessary and sufficient for pressing after

grinding. In order to ensure the productive operation of grinding machines and the necessary grinding tonin, it is sometimes necessary to dry and grind clay at a humidity slightly lower than the pressing one, and then moisten the powder again.

Such humidification is carried out by spraying water in clay mixers or steam in special apparatuses. The main requirement that is imposed on the humidifying apparatus is to ensure that when moistening the clay powder, lumps of waterlogged material, the so-called "raisins", do not form. To do this, water is supplied in a finely atomized state, and all the material is mixed at the same time. Good results are obtained when the clay is moistened in a suspended state, i.e. when it leaves the hopper into the mixer. When the clay powder is moistened with steam, the quality of the brick is much improved: it does not appear cracks delamination, increase strength and frost resistance. In all possible cases, it is necessary to avoid re-moistening the clay powder, since it is very difficult to achieve uniform moisture content for the following reasons: in the dried powder, large grains are moist, and small grains are drier, the wet surface always has a lower temperature than the dry one. [1]

Therefore, steam is primarily condensed on the colder, wetter surface of large pieces of clay. Its fine fraction, the driest, is either not moistened at all, or is moistened to a lesser extent, as a result of which the fractional moisture content of the powder is not only not leveled, but sometimes even increases. To equalize the humidity, the powder is subjected to storage in bins. However, this process is rather slow. During the day, practically moisture equalization is achieved within one grain, and it does not occur between individual grains yet due to the relatively small contact surface between them. In addition, moistening the surface of the powder grains reduces its flow ability, which subsequently complicates its storage in bunkers and transportation. Therefore, the process of curing the powder should be considered useful, improving its pressing properties, but it is necessary to strive to carry out this process, if possible, without first moistening it. Drying of compressed raw. At the semi-dry pressing brick factories built before 1950, there was no drying of raw materials in separate artificial dryers. At these plants, it was dried in the preparation area of the ring furnace. In it, the drying process was practically not regulated, which led to a decrease in the quality of bricks and to an increase in the yield of marriage. In factories built later, compressed raw began to be dried in tunnel dryers on furnace trolleys. The drying duration is 16 ... 24 hours.

The final humidity is 4... 6%. The heat carriers are hot air taken from the cooling zone of tunnel furnaces, as well as their exhaust gases. The initial temperature of the coolant is 120...150° C. Firing of compressed raw. After the drying is completed, the bricks are sent to the tunnel kiln for firing. The process of forming a shard in a semi-dry pressed ceramic product can be imagined as follows. In the mass of clay powder entering the pressing, there are aggregated clay particles of different densities and different hardness, respectively, heterogeneous in moisture. The aggregated clay powder particles themselves are also heterogeneous in hardness, since along with the plastic moistened mass of clay-forming minerals, they contain larger grains of lean material - mainly quartz grains. In the process of pressing raw, individual aggregated clay particles first come together, then their deformation occurs, and in the last stage of pressing, harder clay particles are pressed into softer ones. Drier clay particles penetrate into soft moistened particles. Similarly, hard quartz grains are pressed into softer aggregated clay particles. [2]

The resulting large friction forces cause strong adhesion of individual clay particles into a single aggregated joint. However, in it, individual clay particles still have interface surfaces between them, which radically distinguishes this structure from the structure of the plastic molding raw material, which has a solid mass of "colloidal binder". During semi-dry pressing, an "array" of raw material is formed by the mechanical convergence of individual grains of ceramic powder, in which each grain has a structure similar to plastic dough, and in the raw material there are interface surfaces between them, despite the apparent strong interaction between the powder grains during its pressing. The weakening of contacts between compressed clay aggregates is also

facilitated by the peculiar nature of shrinkage in the semi-dry pressing raw. This peculiarity lies in the fact that in the semi-dry pressed raw material, each clay particle will shrink locally and, as a result, not the entire array of raw material will shrink in size, but each particle separately, moving away from the neighboring one, causing stresses and cracks on the interface surfaces of compressed clay particles. To fill these cracks with the liquid phase, an increased amount of it is necessary, which can only be obtained by increasing the firing temperature.

Thus, the peculiarity of the structure and mechanism of formation of a ceramic shard of semi-dry pressing causes its reduced bending resistance, increased water and gas permeability, the need for higher firing temperatures and, in this regard, the use of ceramic masses with a large sintering interval. The creation of a reducing medium both in the body of the fired brick (by pressing coal into raw) and in the furnace space in the last stage of firing is even more important for the intensification of sintering processes during the firing of semi-dry pressed bricks than during the firing of plastic molding products. After the drying is completed, the bricks are sent to the tunnel kiln for firing. The raw brick is sent to bake, still having a small amount of moisture, about 8-12%. Therefore, at the beginning of firing the bricks are drying out. Then, at temperatures of 550-800 ° C, the dehydration of clay minerals begins. The crystal lattice of minerals disintegrates, as a result, the plasticity of clay is lost, the product shrinks. In the temperature range of 200-800 °C, volatile organic clay impurities and additives are released. At the same time, the rate of growth of the firing temperature reaches values of 300-350 ° C per hour. Then the temperature is maintained for some time until the carbon is completely burned out. A further increase in temperature, more than 800 ° C, leads to a structural change in the product. At this stage, the rate of temperature increase is 100-150°C per hour- solid bricks and 200-220 °C per hour - hollow. After the maximum firing temperature is reached, the temperature retention, for uniform heating of the entire product. Then they begin to reduce the firing temperature by 100-150 ° C. At the same time, the bricks shrink and deform even more [3].

When the temperature reaches below 800 °C, the cooling rates reach values of b250-300 °C per hour. The time for firing a batch of products under such conditions is approximately 6-8 hours. After firing, the structure of the product completely changes. Now it is a stone-shaped object, water-resistant, durable, resistant to temperature changes, and also has other useful properties. Rails are laid on the floor of the canal, on which trolleys with bricks loaded on them are placed close to each other. All this train of trolleys moves along the tunnel at certain intervals of 30 minutes, each time for the length of one trolley. At the same time, one trolley with loaded raw material is pushed into the furnace each time, and one trolley with ready-made is rolled out from the opposite end of the tunnel with a brick. Trolleys are pushed by means of a special pusher or by means of a drive winch and a cable. Next, the brick is sorted and sent to the finished product warehouse. Products made by semi-dry pressing have low bending resistance, have increased water permeability, low frost resistance [4]. In such brick production, a higher firing temperature is required. It is necessary to take into account the large losses on marriage (10-20%), although the quality of the appearance of the brick is very high.

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