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PROCESS OF MOULDING OBJECTS

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This invention relates to the moulding of objects from powdery or granular material in a matrix. It has been found that products are frequently obtained which locally exhibit differences in density which are in many cases undesirable. This is particularly the case with the so-called cold moulding, or when the moulding material does not contain any binder or contains a but limited percentage of binder, i. e. at most 30% by volume of binder.

The present invention has for its purpose to obviate this drawback and to permit the obtainment of objects of high density.

According to the invention, this may be achieved by applying a layer of lubricant, for example consisting of stearic acid, bees wax, graphite, paraffine oil or the like, between the walls of the matrix and the said moulding material and by moulding subsequently.

As regards the effect of the invention, it may be remarked that the degree in which this effect occurs depends on various factors related to each other, such as the dimensions of the moulding, the flowing ability, and the internal friction of the moulding material, as well as the smoothness of the matrix wall.

Thus, it has been found, for example, that the said phenomenon of local differences in density becomes more manifest in moulding elongated objects, in which the average section normal to the direction of moulding is considerably smaller than that in the direction of moulding. In this case the use of the invention generally produces a considerable effect. Further, it has been found that the effect will exist to a smaller extent, according as the moulding material has a higher flowing ability or a smaller internal friction, and according as the matrix wall has already a greater smoothness. Consequently, it is evident that there may be cases in which the effect occurs to a but limited extent.

The use of lubricants, also in the form of a thin layer of fat or fatty acid on the matrix wall, with the hot moulding of moulding materials of artificial resin having a high percentage of artificial resin, such as the known materials of artificial resin having saw dust as a filler, has been proposed to counteract the known adhesion to the matrix wall. As a matter of fact, the invention consequently applies only to those cases in which the problem, the solution of which is the object of this invention, occurs.

The objects are preferably preformed in known manner, for example by means of an automatic tableting machine, and subsequently moulded in accordance with the invention. A form of construction in which a product thus preformed is provided with a layer of lubricant, for example by immersion in a liquid or dissolved lubricant, before proceeding to definitely moulding is very satisfactory.

The local differences in density which preformed objects may exhibit are decreased or eliminated by using the invention, but the process may also advantageously be applied to preformed objects which do not exhibit such differences in density, since during the subsequent moulding in a matrix to obtain the desired density the occurrence of differences in density is counteracted. The invention also permits of several preformed parts being moulded to form one unit.

A very important domain of application of the invention is that of electricity, both for the manufacture of insulating and of conductive or magnetic objects, since in such cases differences in density are mostly highly undesirable. But also in cases in which especially for mechanical reasons the obtainment of products of high and at the same time uniform density is essential, for example in the manufacture of objects obtained by moulding followed by hardening, which utilise a pulverulent alloy, or in the manufacture of whet-stones utilising a pulverulent mixture of polishing material and a binder, the use of the invention is of importance.

Examples

(1) Iron powder had added to it 3% by weight of nitrocellulose dissolved in a mixture of ethyl acetate and amyl acetate. This solution was stirred with the iron powder to form a paste and subsequently thickened by evaporation whilst stirring on a water-bath to produce a dry granular mass. Rods of 8 mms ϕ and ± 30 mms length were moulded from this mass with the use of a pressure of 5 tons per cm^2. For this purpose a quantity of this granular moulding mass was introduced into an annular matrix having a bottom die and a top die so that the moulding pressure attacked on two sides.

After moulding, the cylindrical rod obtained was taken out of the matrix and sawn into pieces of 4 mms length and subsequently the specific weights of all cylindrical pieces were determined. The specific weight of those cylindrical rods which had engaged one of the two dies amounted to 5.24. On the other hand, the specific weight of the piece from the middle of the product only amounted to 4.78. The inhomogeneity of the product thus moulded was consequently very

great. This became also manifest in the magnetic permeability of the material; the ring permeability in the centre of the cylinder amounted to 10.2 and that at the ends 15.2.

Using the same matrix moistened with a solution of stearic acid in alcohol before the moulding material was introduced into it, the specific weight of those parts of the product which had engaged the dies was after moulding 5.27. The specific weight of the middle of the moulded cylinder was now 5.10. As compared with the first-mentioned case, the inhomogeneity of the product had consequently decreased. Now, the ring permeability was at the ends 15.6 and in its centre 14.0.

Still better results were obtained in the following manner. At first a product was moulded in the usual manner from the said granular moulding material and then the matrix or the said product was moistened with a solution of stearic acid in alcohol, the product being subsequently pressed again in the same matrix under the same specific pressure. The specific weight of that portion of the cylindrical rod which had engaged one of the dies now amounted to 5.28, whereas that of the portion most remote from the dies amounted to 5.22. The inhomogeneity had consequently still further decreased. The ring permeability at the ends was now 15.7 and in its centre 15.0.

(2) The moulding was effected with tungsten carbide-hard metal powder without any addition in a matrix of 8 mms ϕ, length of the rod to be moulded $\pm$ 20 mms. By using an annular matrix having a bottom-die and a top-die the pressure on the material to be moulded attacked on two sides on the basal faces of the cylinder and amounted to 2 tons per cm^2. The product obtained was taken out of the matrix which was subsequently greased with a solution of stearic acid in alcohol. After this, the rod was moulded again under the same pressure. The average specific weight of the product moulded twice was 4% higher than that of the product moulded in the first manner, due to the central part which was more porous as compared with the extremities of the cylinder being better compressed by the use of the layer of lubricant. The local differences in density had thus decreased to a still further extent.

(3) 100 grams of carborundum powder mixed with an alcoholic solution of 15 grams of phenolformaldehyde artificial resin was stirred to form a paste and subsequently thickened by evaporation whilst stirring to form a dry granular mass. 2 grams of this mass were introduced into an annular matrix of 6 mms ϕ closed on one side and comprising a top-die, the mass being moulded under a pressure of 5 tons per cm^2. The length of a product thus moulded (weight 2 grams) was 28.8 mms. As could clearly be seen, during moulding the points of the product which were more remote from the die exhibited greater porosity than those which were nearer to the die. When the matrix was smeared with a solution of bees-wax in benzene and after the matrix was filled with 2 grams of molding material, a product was moulded under the same moulding conditions, whose length amounted only to 27.2 mms. From this it is clear that the above-stated porosity existed to a smaller extent than in the first-described case. A still better result was obtained when this last product in a matrix of the same size was moistened again with a solution of bees-wax in benzene and moulded again under the same pressure. The length of the product moulded twice had then decreased to 26.4 mms and the local differences in density were again reduced considerably.

(4) 100 grams of iron powder were mixed with 7 grams of phenolformaldehyde artificial resin dissolved in alcoholic acetone to form a pasty mass and thickened by evaporation whilst stirring to form a dry granular mass. For manufacturing a cylindrical object of 6 mms ϕ and $\pm$ 13 mms length provided with a fine screw-threaded on the cylinder surface one proceeded as follows. At first a smooth cylindrical product of 5 mms ϕ and $\pm$ 16 mms height was moulded from the said granular mass in the usual manner under a moulding pressure of 5 tons per cm^2. The product obtained was then greased with paraffine oil, introduced into another matrix of the shape required for this purpose and again moulded under the same pressure.

With the moulding for the second time the material density in the flanges of the screw-thread of the moulded product was greater than if no lubricant was used with the second moulding. Moulded without the use of a lubricant the flanges of the screw-thread are porous. The density of the flanges is lower than that in the centre of the cylinder. When the moulding is effected with the aid of a lubricant this undesirable property exists to a much smaller extent.

(5) 0.6 gram of magnesium hydroxide, 0.3 gram of sodium silicate and 1 gram of talc were introduced into water and this suspension had added to it 100 grams of iron powder. Then the mass was thickened by evaporation on a water-bath whilst stirring. Cylindrical products of 6 mms ϕ and $\pm$40 mms length were moulded from the mass thus obtained, a pressure of 5 tons per cm^2 being applied on two sides during moulding. When moulded normally, the specific weight of the product obtained, taken on the whole product, was 6.0. When the matrix, before being filled with the powder, was smeared with a solution of stearic acid in alcohol, the specific weight was 6.8.

The specific weight of the product moulded with the use of stearic acid as a lubricant is consequently on the average higher than that of a product normally moulded. This is due to the fact that the central portion which is porous relatively to the ends of the cylinder is better compressed by the use of the said lubricant. Local differences in density are thus much more reduced.

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