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Vacuum granulation – device and ability

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1. POWDER COMPACTING

Degree of powder concentration during forming process significantly influences speed and effectiveness of sintering process. From technological point of view, however, the most important problem is contraction of sintered material. It is obvious, that the lower degree of powder concentration, the higher contraction, and problems of shape precision, dimensions and generation of mechanical stress connected with it.

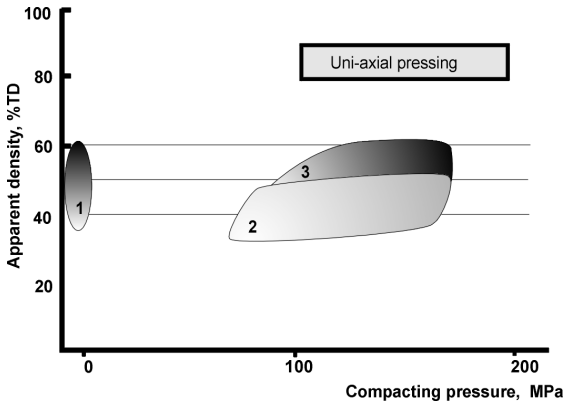

Figure 1 . Specific gravity of ceramic powders die – stampings [1-9].
1 – samples obtained by non pressure die-casting , 2 – powders pressed without treatment,
3 – granulated powders

On the basis of literature it is possible to state that the initial sintering stage, characteristic for pore evolution, featuring minimisation of their surface without visible contraction, is not connected with any specific concentration. At this stage influence of initial density upon its course is not to be expected. The second stage, called intermediate stage, when the biggest microstructure changes occur (minimisation of porosity), is connected with a specific level of concentration.

For different types of initial stages (die-stamping density 45-60% of theoretical density TD, Fig–1), the most characteristic point from which fast changes in pore diameters are observed (thus mixing porosity in general), is a concentration degree equal 83% TD.

Fig 1 shows that the ways applied in preparing powders for concentration process (initial sintering, granulation, using additives for better concentration) do not allow to obtain higher concentration than about 63 % TD.

Powder sintering of 83 % initial density TD, may differ from die – stampings sintering of conventional density. The most interesting, however, is possibility of significant reduction of volumetric contraction in sintering process of materials obtained from powders.

2. TECHNOLOGY OF VACUUM GRANULATION

Technology of vacuum granulation is based on joining a few technological processes; intensive mud drying (slurry from granulated powder), granulation of concentrated slurry, mechanical granules concentration and removing damp. In this technology 'Evactherm' device made by Maschinenfabrik Gustav Eirich , is used. Fig 2 presents its diagram. Intensive R type Eirich mixer is placed in vacuum.

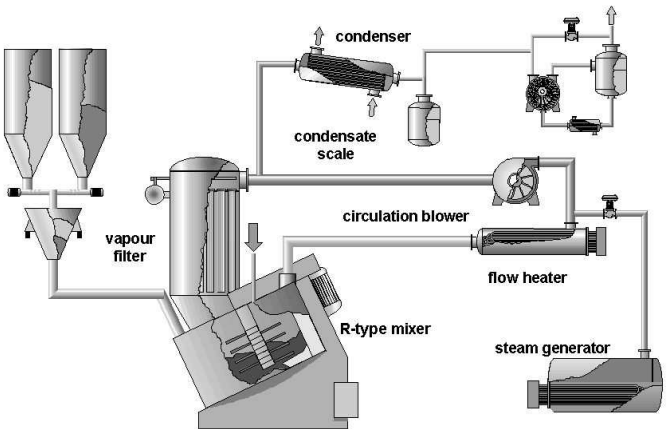

Figure 2 . Diagram of 'Evactherm' device [10]

Powder slurry with possible additives is an initial material. Intensive mixing changes the slurry into fluidised bed, to which overheated steam is blown for drying. With lowered pressure, an intensive drying occurs and the slurry slowly concentrates till the granulation process starts. Granules, which contain quite a lot of liquid, are struck by mixing device and hit walls of a revolving pan. These mechanical action (striking) and fast removing of damp from granules make it possible to obtain high granulate density. It is not possible when applying any other method of powder granulation.

3. CONCENTRATION OF POWDERS WHICH UNDERWENT VACUUM GRANULATION

Verification of presented conception was carried out in the granulation process of aluminium oxide powders (Alcoa T-60 and CT 1200 – Fig 3) in laboratory and industrial conditions.

Results of initial experiments were confirmed by tests carried out on aluminium oxide powders, featuring different graining and relatively similar size grains. In the course of many

technological tests of vacuum granulation, granulated products of 1900-1990 g/l apparent density and theoretical density of 82-86 % TD were obtained. Effectiveness of this new vacuum granulation technique can be seen when we compare density of granulated products made from the same powder, obtained by different methods – Fig 4.

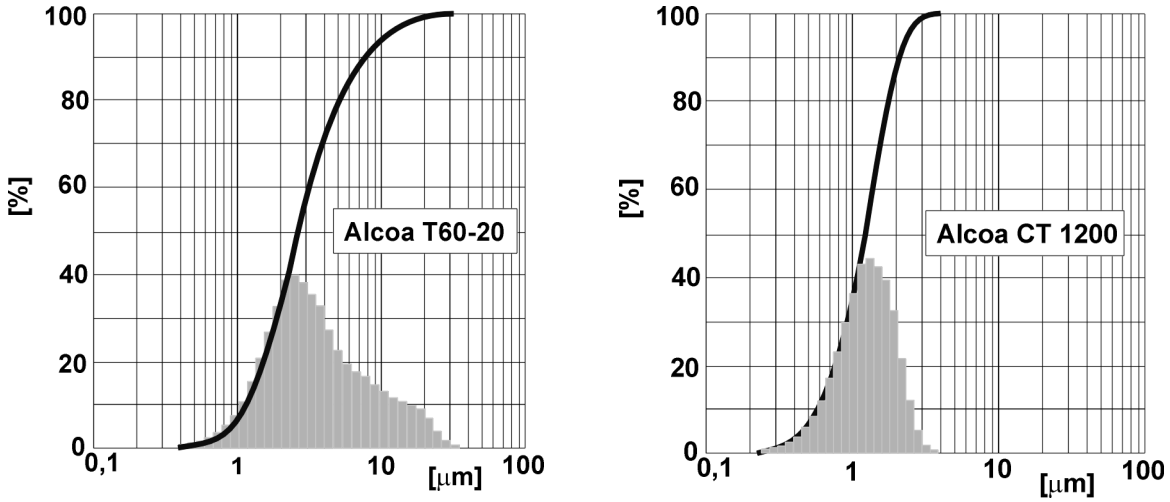

Figure 3.Graining of aluminium oxide powders used in testing effectiveness of vacuum granulation

Very high specific gravity of granulated products obtained in vacuum is due to almost perfect grains packing seen in micro photographs of single granulate fracture. – Fig 5.

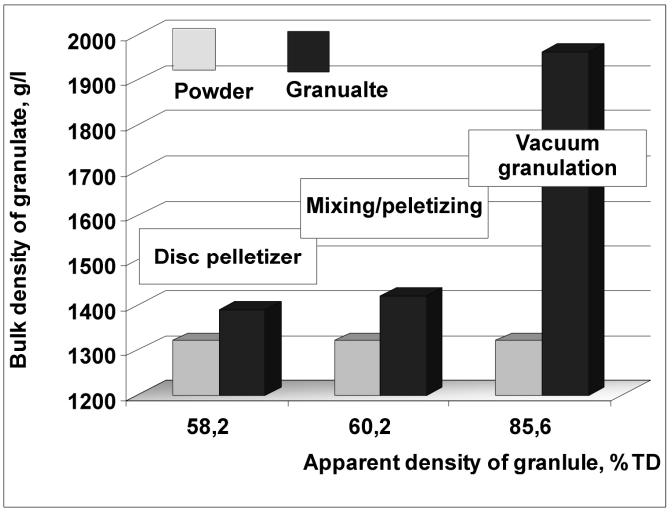

Figure 4 . Comparison of the effectiveness of different granulation techniques

Usability of that new vacuum granulation technology, not only as a process of obtaining characteristic property changes of powders, but mainly as a mean to increase volumetric density of die-stampings, defines the effectiveness of transferring, without losses, thick granulated product microstructure into the product of pressure moulding. Granulated product was tested in different ways before it was press formed in steel matrix, but every time the result was close to the level of granulated product density – Fig 6.

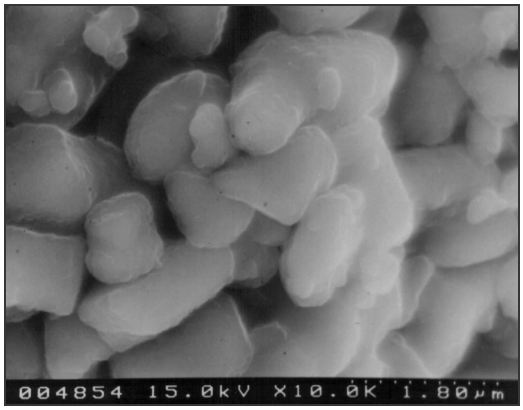

Figure 5. Micro photographs of a single granulate fracture Alcoa CT 1200

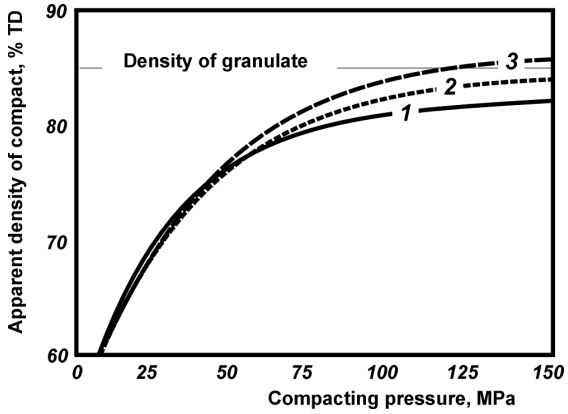

Figure 6. Course of a granulated product concentration process (single axle moulding in matrix) (1), grinded granulated product - below 2 mm (2), grinded granulated product - below 1 mm (3)

4. RECAPITULATION

The idea of using vacuum granulation for effective increase of die – stamping density from ceramic powders proved to be successful. New granulation technology makes it possible to obtain granulated products of concentration equal 80-86 % of theoretical density, and thus reduces burning process, eliminating all negative effects so typical for conventional technologies of high, powder, more than ten per cent linear contraction.

This technology is available for industry and has been tested on many powders applied in production of ferrites, refractory and traditional ceramics and cermets.

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