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Abstract

Analysis of the primary and secondary phases of the work cycle of the universal vibratory reclaimer REGMAS

The subject problem of the dissertation encompasses three scientific fields related to the analysis of the reclamation process of spent moulding sands in universal vibratory devices, represented in investigations by the Regmas reclaimer.

I. Theory and model investigations of the primary reclamation process with a special consideration of energy aspects of the spent moulding sands fragmentation into individual grains surrounded by a spent binding material, or into agglomerates of such grains, up to the average size not exceeding the smallest mesh clearance of the set of sieves of vibratory crushing devices.

II. Theoretical bases and model investigations of the secondary reclamation related to the removal from surfaces of spent moulding sand grains the binding material left after the primary reclamation process. These aspects are analysed in the dissertation on the bases of model investigations realised in the vibratory device allowing changing and intensifying of the reclamation processes.

III. Development of bases of the integrated assessing energy aspects of the spent moulding sands reclamation process, consisting of the primary and secondary reclamations.

The analysis of the research state and energy theories (hypothesis) concerning the refinement process theory, which can be applied in the analysis of the primary reclamation of spent moulding sands, is presented in the I[st] scientific field of the work. Special attention was directed towards models (hypothesis) of Rittinger, Bond, Kick, Charles and Brandt. On the basis of the performed analysis it was found that the Rittinger's hypothesis is the best suitable for the adaptation to the reclamation process. The model tests of this part of the work were carried out with using the research stand prepared specially for this aim. The stand consisted of the model set of crushing sieves mounted in a form of the multiplatform mesh consisting of four riddles with a net of dimensions 400 x 400mm and the mesh clearance, counted from the

top successively: 50 x 50mm (wire φ 4.8 mm), 22.3 x 22.3mm (wire φ 2.46), 5 x 5 mm (wire φ 1mm), 1.80 x 1.8mm (wire φ 0.4 mm). This set of sieves was placed on the vibratory table of dimensions 500 x 500mm, called - in the paper - the platform, which had two rotodynamic motors attached at its bottom. The vibration characteristics of these motors was subjected to accurate investigations in the work. Investigations performed in the model vibratory device, of physical, geometric and process similarity to the Regmas type device, allowed for the qualified and quantified determination of factors, from which the efficiency of fragmentation of spent moulding sands depends. They also enabled to show the role of the primary reclamation stage in devices for the mechanical reclamation of the analogical mechanical working mode as the one occurring in the Regmas type device. The developed investigation method of the primary reclamation creates bases for the comparative analysis of spent moulding sands with regard to the efficiency of the matrix releasing from coatings of spent binding material as well as with regard to the energy demand, necessary for this process realisation.

The IInd research field is related to the analysis of the influence of factors increasing the secondary reclamation intensity, realised in universal vibratory reclaimers, on the final effect of the process, assessed by the quality of the reclaimed quartz matrix. The following constructional and functional elements of the device were analysed: forcing (by shaping of construction elements) the proper circulation of the reclaimed spent moulding sand inside the work space of the device where processes of rubbing, grinding and crushing are realised to remove spent binders from matrix grains; introduction of additional crushing-grinding elements into the buffer space, increasing the dynamics of effects deciding on the process intensity in coordination with the proper frequency of the rotodynamic motors of the device; stimulation the vibration energy and related to it the intensity of the reclamation treatment, by the suitable placement of unbalanced masses of rotodynamic motors. During this research stage the attention was also directed towards determining the allowable values of parameters enabling the reclamation process improvement without the matrix degradation. To recognise this problem, the series of investigations was performed in which fresh quartz sand was subjected to the device operation under the same process conditions as for the secondary reclamation of the spent moulding sand with furfuryl resin. The obtained results entitle to state that in case of a fresh sand the process based on shifting grain sizes in the direction of lower values occurs more intensely for pure sand grains without binder coatings, which constitutes the quasiprotective layer for these influences. Investigations of the material grain size composition, before and after the reclamation process, were used for assessing the energy

aspects of this process. As long as in investigations of the primary reclamation the classic sieve analysis data were used, in case of the secondary reclamation and the quartz matrix degradation effect the laser apparatus for the particle size measurement Analysette 22NanoTec was applied. Due to that, a significant widening of dust products analysis of the performed treatment was possible. The analysis of theoretical specific surfaces of these products, constituting the bases for calculations according to the selected energy hypothesis, was also possible. Obtaining 512 grain sizes of the material within the particle size range 0.01μm-2000 μm enabled the detailed assessing of the influence of the secondary reclamation parameters on the amount and grain size structure of dusts generated by the spent binding material removed from the grain surfaces. This information combined with the determined shape coefficient allowed to stimulate the reclamation treatment intensity, while limiting the matrix degradation.

In the IIIrd research field one of the aspects of utilising the performed investigations for the development of the calculation procedures of the reclamation process integrated energy-consuming, consisting of the preliminary phase (primary reclamation) and of the main phase (secondary reclamation). It was proved that the obtained calculation values - differing in assumptions - allow to obtain mutually similar results. They introduce - important for the complete estimation of the degree of the matrix releasing from the spent binding material - data concerning effects of the primary and secondary reclamation to the total reclamation balance and to the process energy consumption.

The presented in the hereby dissertation approach to this problem is a novelty, which has no references in the currently available subject literature.