Impact Of The New Vibroexcitation Method To The Screening Process Intensification Of Bulk Materials

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Abstract

The article presents the results of applied research in the field of processing of bulk materials. Namely, screening with the use of new principles of operation of the sorting devices. The result of the work of the authors in this direction is the creation of new technical solutions, which implement the principle of complex excitation of the material on the screen. The principal feature of this solution is that the material acts as the main dynamical phase excitation and additional phase excitation of different forms of orientation. As a result of intensification of both stages of screening, increases the production capacity of the screen. Also as a result of more efficient use of the surface of the sieve can be reduced by metal and power consumption. These conclusions are confirmed by experimental data.

The need for many industries in the machines for bulk materials sorting (screens) of various structures is very high. The confirmation is the fact that just outside of the CIS, manufacturing of screens employs more than 300 enterprises and companies, 90of which - large, including 32 firms located in the USA, 16 - in the UK, 11 - in the Federal Republic of Germany; 6 - in Japan [1, 3].
Literature and patent analyses of recent years show that the interest in screens improvement, the establishment of new structures and new screening ways are increased noticeably. The main development screens trends are intended to achieve the following objectives: improving the efficiency of the screening; improving of performance, reliability and durability of the operation; extension of the scope and technological capabilities.
One of the new, and perhaps the most perspective development directions of screening equipment, at present day, in our opinion, are the screens "with complex excitation of the material." Sometimes the term "dynamic excitation" is used [2]. At the same time this trend can not only create new sorting machines, but also upgrade the existing ones.

The term "screening with complex excitation" called the process when the particles of the bulk material affects several exciting factors such as vibration and rotational motion, or vibration, impact force, etc. One example of complex impact on the screened material is spiral vibrating screen design [3]. This screen is an aggregate that combines the principles of drum and vibrating screens.

An example of screening with complex effect on the material can be generally considered any material excitation methods, when the particles are forced to complex composite movement, while in "no sieve rumble" separation does not occur in the monolayer, but in the "thick layer" of material.

No sieve screen (or vibration segregation qualifier) вЃКвЃКis a new and perspective solution in the area of вЃКвЃКscreening [4]. This development offered by team composed of: Blekhman I.I., Weisberg L.A., Yakimova K.S. and others. This classifier allows solving technological problems of fine classification, beyond the capabilities of conventional screens. In contrast to screens, this classifier do not have problems with sieve wear and clogging of their holes; vibration intensity (energy consumption) - less. In contrast to vibro-flatness separation, the separation does not take place in a monolayer, and in the "thick layer" of material, that provides high performance and possibility of small materials classification.

New excitation principles of bulk material are used in screens using ВкKroosherВњ technology, the screen has the properties of multifrequency resonance oscillation system. Moreover, among the claimed benefits are large capacity, high screening efficiency, guaranteed effect of self-cleaning screens, etc. This type of screen can also be attributed to the screen with complex excitation.

The undoubted example of using the principle of complex material excitation is the development of vibro-blow screens, which are also continuously improved. So, recently, it is proposed to initiate screening surface by "double" blows. Despite the constructive simplicity of the screen, the implementation of vibro-blow mode is available only in certain combinations of structural and dynamic parameters. There are more examples of screening technologies using complex excitation (including the steeply inclined screens, etc.). At the same time these examples are enough to draw a conclusion about the prospects of the use of the principle of complex excitation in the development of new designs of vibrating screen.

Considering the urgency of the research areas in the D.Serikbaev East Kazakhstan State Technical University (EKSTU) research in this area is conducted for several years. The result of this work is series of new solutions for the use of relatively simple designs for devices that implement the principle of complex material excitation on the screenвЃЄs sieve (hereinafter SS - screening surface). The proposed solutions can be used in any type of flat vibrating screens.

All the below results were obtained in the framework of the state budget R & D "Technology of crushing and screening using new methods for bulk materials processing" (customer - MES).

As is known, the essence of the screening process is that the material is sieved on the screenвЃЄs sieve in two steps occurring simultaneously and continuously. In the first step the fine grains pass through the thickness of the material to the SS, and the second - through the sieve holes. The effectiveness of the screening process can be enhanced due to the intensification of one or both stages of the process. But the intensification of the first stage of screening is the most promising way to improve the screens performance.

For this purpose, initially, we proposed new screen design, feed elements (FEs) are fixedly mounted above the screen surface, made in the form of rods, mounted on separate frame (Innovation patent of RK вҺЏ25647, V07V 1/40, publ. 16.04.2012, Bull. number 4). This design allows intensifying the process of mixing the material on the SS, which speeds up the passage of the lower particles class to the sieve. One disadvantage of this solution is decrease of material flow rate (i.e. lost productivity) due to the fact that FEs are the "resistance" of the flow and inhibit it. Material mixing on the sieve is increased, but not enough. The difference in the particles velocities of bulk material with respect to each other activates the process of passing particles of bottom fraction to the sieve surface over the entire layer of bulk material, but the upper fraction begins to accumulate near each rod, which in turn reduces the overall efficiency of the screening process, and as a consequence it reduces screening productivity.

To eliminate this drawback, design with dynamic FEs was proposed, which is communicated an oscillatory motion by its own vibration actuator, or by screen box oscillations (the design protected by innovative patents of the RK - [5, 6]). That is, the fundamental feature of this solution is that the material is affected by basic dynamic phase of excitation generated by the main drive vibration screen, and additional phase of excitation (generated by FEs) of different forms of orientation.

Intensification of screening stages is provided by: firstly, active motion of FE relatively bulk material particles, resulting in an inhomogeneous behavior of individual material monolayers (active mixing); secondly, more efficient sieve loading that allows creating the conditions to maximize pushing and mixing forces. At the same time, the increasing spread of the kinetic parameters of particles material behavior should have a positive impact on both screening stages.

As a result of the two screening stages intensification, the productivity increases. Also as a result of more efficient surface use is possibility of metal consumption reduction, and as a result, screen power consumption. The main advantage of the proposed screening method is that it can be used for the modernization of all types of flat screens.

To check the proposed solutions, a number of theoretical and experimental studies were carried out. There is developed the mathematical probability model of screening process using a new method of bulk material excitation. The laboratory experimental setup (physical model) was manufactured (fig. 1). A number of researches on computer visualization of the proposed models were done. The obtained data show that the use of renewable energy leads to intensity increasing of lower grade passage of bulk material to the sieve on 6.6 ... 13.3% (fig. 2).

Moreover the required screening performance is increased by 10 ... 17%. Electricity costs are increased by only 5 ... 7%. Currently, the research is continuing in this direction, in order to conduct the experiment on the development of a new industrial device design for screening process intensification. Thus, it can be concluded that authors proposed a new way to improve the efficiency of the screening process (by appropriate design of new units), which has a significant effect on the screening process kinetics and the concentration state of fine particles in the granular layer;

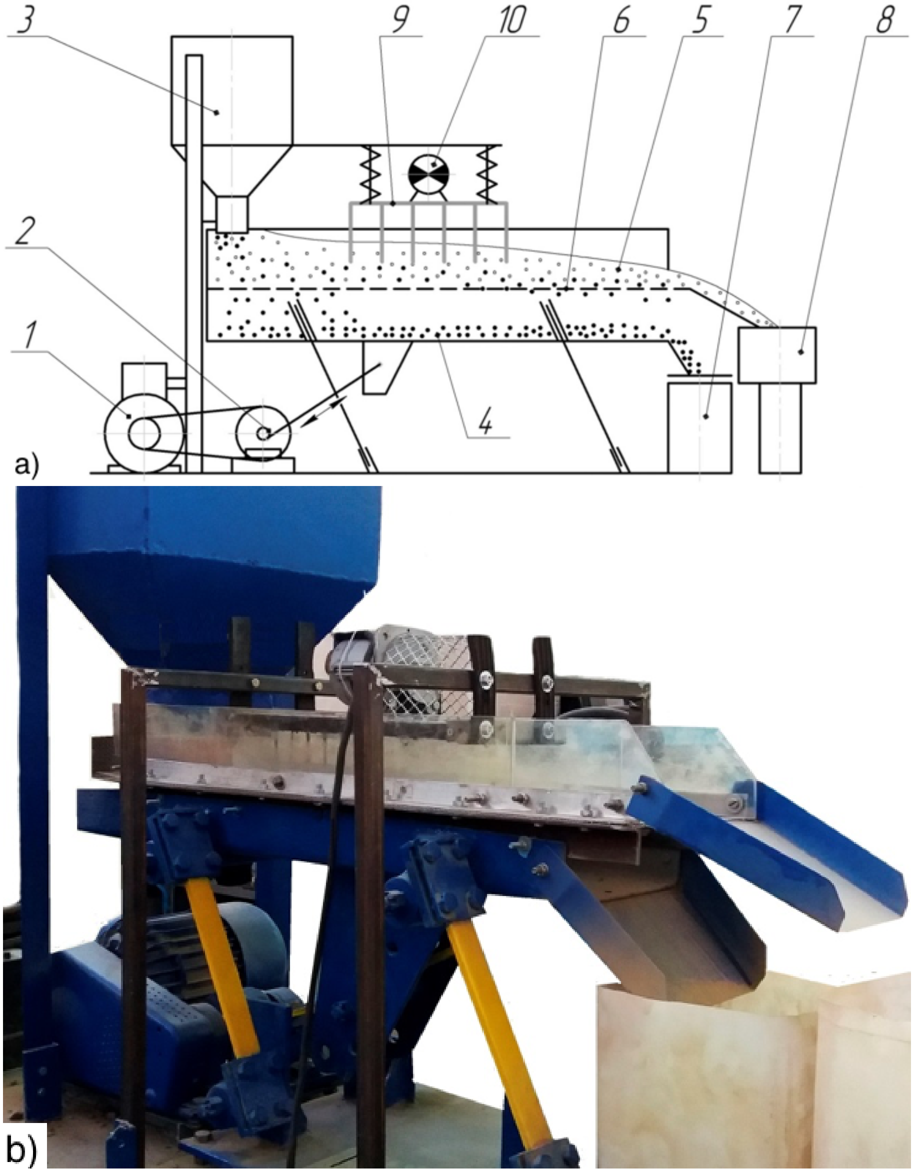

Figure 1: The concept of vibroscreen with additional feed elements (FEs): a) Concept of horizontal vibroscreen: 1 вЃY motor, 2 вЃY vibration generator, 3 вЃY bin, 4 вЃY undersize product, 5 - bulk material, 6 вЃY sieve, 7 вЃY container for undersize product, 8 - container for oversize product, 9 вЃY feed elements (FEs), 10 - generator; b) The experimental installation of the new vibroscreen)

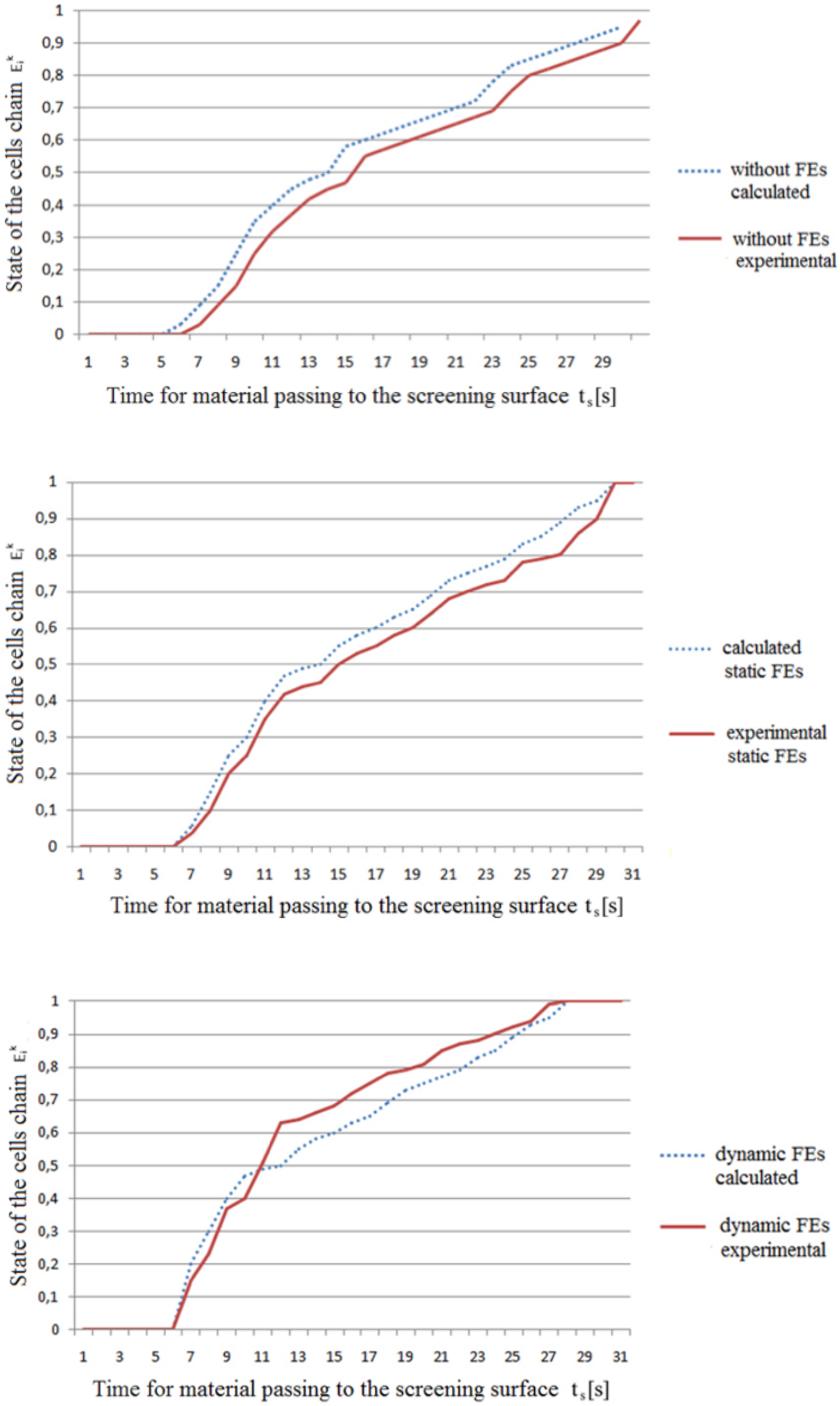

Figure 2: Comparison of theoretical results with experimental studies of the chain state of screened fraction in the 6th vibroscreen cell: a) Without feed elements (FEs); b) With static feed elements (sFEs); c) With dynamic feed elements (dFEs).

it increases the overall screening efficiency due to acceleration of the first phase of screening, i.e. time acceleration of particulate material passage to the sieve.

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