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Stochastic models of particle distribution in separation processes

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Separation processes are important in industry. The understanding of the fundamentals of granular separation on sieve surfaces is incomplete. It results from the fact that granular matter is a system of many particles interacting via short ranged repulsive and dissipative forces, both normal and tangential to the surface of contact. We can try describing the separation processes by the Newton equations in a deterministic way. However, the models contain quite a lot of simplifications and therefore such models are not very useful. We perceive separation process as process of random character. Therefore, we can use statistical models to describe the separation process. In this article I presented the methodology of modelling and the way of using selected probability density functions. Parameters of these functions were appointed on the basis of regressive methods.

Keywords: *separation, granular matter, statistics, distribution*

1. Introduction

Modelling dynamic systems is a discipline, which immersed out of entire abundance of natural sciences, amongst which mathematics and physics are reckoned to be the most important. On the other hand, modelling is an art of competent connection of mentioned disciplines in order to fit the course of the analyzed process to the course represented by empirical data into the most optimal way.

Possibilities of their explicit deterministic description are strongly limited or simply impossible because the examined phenomena are very complicated. It refers mainly to physical systems with a large number of particles. Great number of predictive parameters connected with the number of freedom degrees for every of them makes the possibility of constructing correct equations of movement questionable. On the other hand, they may never be solved even using the newest numerical machines [17].

In such cases, statistical models (or else stochastic models) have high utilitarian significance. These methods are based on observation of the correctness, which may not appear in systems of this type. These observations are usually dependable on examination of randomization of initial variables and their description using appropriate distribution functions.

Separation process of granular particles is an excellent example of probabilistic experiment, which authors of many publications are trying to define in deterministic frames. Effects of such operations can have only fairly approximate character in the aspect of the course of the given process [6, 8]. If completely naturally, we describe this phenomenon a statistical rank (drawing particles on the surface of the discrete element) then its description will be much more complete for any number of predictive variables [11, 14].

2. Purpose of the work

Distribution of granular mixtures on discrete elements (sieves) has been described in detail in numerous academic publications [4–7, 10]. However, differential equations of the particles' movement have usually been used for the mathematical description of this phenomenon. Generated models, together with imposed initial conditions, can be used for the description of the analysed process. However, it should be rated that values appointed through such models diverge considerably from empirical data. The randomization of the given phenomenon, which results from its nature, is responsible for such "state of affairs".

Deterministic methods of description of the separation process are not possible in some model cases. This is the case when we want to connect variables with each other in the model, but then the number of preliminary conditions and equations of the given model is becoming completely impossible thus making the problem unsolvable [15–16, 18]. Generally, we can formulate every model by the functional relation in the form:

$$y_j = f(x_i, D_k), \qquad i = 1, 2, \ldots, m, \qquad j = 1, 2, \ldots, n, \qquad k = 1, 2, \ldots, o, \tag{1}$$

where y_j is j-dependent variable, x_i makes i-predictive variable, D_k depicts k-parameter of the model.

The need for the improvement of the existing construction solutions in the aspect of the quality of the process separation is mostly displayed in research on possibilities of using sieves with the variable surface geometry. In such case, (symbolically called) geometrical variables are the predictive factors. Analysis of the influence of this type of variables can be carried out using statistical methods and models. The source of inspiration for writing this publication was the attempt to use the statistical model to determine the influence of chosen predictive variables on quality of the particle separation process. Universally known probability distributions were taken into consideration in proposed models [12].

3. Methodology of research

Research was carried out on the stationary experimental stand. A blade sieve of the sectional type is a main work element of the post (Figure 1). The sieve is equipped with