9. Methodology of criterion analysis and synthesis of dosing and packaging modules for bulk production

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Introduction. The newest methodologies for creating packaging machines are based on the functional-modular concept. This concept involves the creation of clusters from modules of various functional purposes. When choosing a functional module from a cluster with optimal technical and economic parameters, it is not enough to evaluate it only by technical characteristics. An important factor in this case is the efficiency of performance of the given functions. Quantitative assessment of this factor can be performed using criterion analysis and synthesis**.**

Materials and methods. The theory of criterion analysis and synthesis takes into account "irritating factors" of the packaging process, its disadvantages and errors. Thus, the following factors can be taken into account for the dosing and packaging module of bulk products: the complexity of the process; damage of the product appearance of the packaged item; blows; pulsation; shocks; vibration etc. These parameters can be functionally classified and implemented in the form of special synthesis criteria *Kj* and their corresponding criterion indices *j*.

Results. Based on the photogrammetric analysis of the movement of particles of bulk products in the channels of dosing and packaging modules, it is proposed to take into account the following criterion indices:

- ***n*** - takes into account the number of technological transitions during dosing. To determine its numerical value, the number of executed transitions is counted:

  $n = \Sigma n_j - n_{min}$,

  where n_j are the current values of transitions being performed; n_{min} - the minimum possible number of transitions performed. In the case of n_0=0 with n_j=n_min, where n_0 is the optimal numerical value of this criterion index. That is, when n_0=0, the operation is optimal, which is performed with the minimum possible number of transitions and is reliable and economically feasible;
- ***C*** is the cyclicity of the operation taking into account the duration of the idle run t_x; C=t_x(C)-1, C=0 at t_x = 0, where C_o is the optimal numerical value of this criterion index. At C_0, the operation is continuous;
- ***Cm*** is the complexity of the trajectory of the centers of mass of the dosing objects in time: $Cm=\Sigma C_j$; Cm_0 = 0 at ΣCm_j=0, where Cm_0 is the optimal value of this criterion index. At Cm_0, the trajectory is a straight line;
- ***D*** is the dynamics of the elements of the trajectory of the centers of mass of particles of loose products over time. $D=\Sigma D_j$; D_0 = 0 at ΣD_j =0, where D_0 is the optimal numerical value of this criterion index. At D_0, the dynamics of the operation (shocks, jolts, traffic jams, etc.) are absent.
- ***S*** is the speed of movement of a particle of loose products from a measuring container into a container. This criterion can be calculated using the formula : $S = (1 - f_{out}/f_{in})$, where f_{out} is the cross-sectional area of the output channel from the measuring tank; f_{in} is the cross-sectional area of the input channel into the packaging device or container: S_0 = 0 when *fout =fin*, where S_0 is the optimal value of this criterion index. When S_0 = 0, the channel is not shaped, but cylindrical, and the value of the speed of product movement is close to the speed of free fall of the particle, that is, there will be a maximum value of productivity.

To determine the functional module with the optimally performed dosing and packaging operation, weighting factors f_i were used, which make it possible to obtain weighted sums of the values of the criterion indices.

Based on the research results, a decision matrix is built. In such a matrix, the optimal solution of the module is taken to be the performed dosing and packing operation with the minimum sum of the products of the values of the indices by the weighting factors.

Conclusions. The proposed methodology of criterion analysis and synthesis makes it possible to evaluate the functional modules of dosage and packaging of loose products according to the quality factors of the performance of the specified functions. A similar methodological approach can be used in the analysis of other functional modules of packaging machines according to their characteristic criterion indices.

References

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