MICROPROCESSOR-BASED SYSTEM FOR BELT-SCALES DOSING OF MIXED FEED COMPONENTS

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Dosing in weighing and mixing has found an extensive use in a number of industrial processes including the processes of preparing grain mixtures in the mixed feed industry /1/. Continuous flow production processes, which ensure a significant growth of the technical-and-economic indices, have brought about the following complement of processing equipment for mixed feed components in a continuous dosing and mixing section (DMS):
- Dosing belt scales (DBS) based on strain-gauge weighing (Fig.1);
- Continuous (flow) mixer providing for the uniformity of the grain mixture at the outlet of the DMS;
- Weight verifying device (WVD) based on strain-gauge weighing principle;
- Dosing automatic control system (DACS).

Set forth in this paper are the aim of the functioning and the tasks of the DACS, along with the formulation of the DACS system of functions providing for the fulfilment of these tasks. Shown also are the DACS structures of hardware (HW) and software (SW) supports, as well as some peculiar features of the DACS software synthesis on the basis of the aggregate weighing and dosing software system (AWDSS).

**Key Abbreviations:**

- DMS - dosing and mixing section;
- DBS - dosing belt scales;
- WVD - weight verifying device;
- DACS - dosing automatic control system;
- AWDSS - aggregate weighing and dosing software system;
- DDC - direct digital control;
- CCC - control computer complex.

The aim of the continuous dosing and mixing section (DMS) is the production of a standard quality n-component grain mixture in compliance with the assignment Z:

\[ Z = (Q, R, R), \]

where \( Q \) = given overall capacity of the DMS;
\[ R = \| r_i \|, \quad i = 1, n = \text{vector of given parts of mixture components as determined by the recipe;} \]
\[ R = \| r_i \|, \quad i = 1, n = \text{vector of permissible deviations of actual parts of components from given values, as determined by the standard} \]
specifications.

In the mixed feed industry a standard grain mixture is one for which the following expression holds true:

\[
(R - \Delta R) \sum_{i=1}^{n} q_i^B(t) \leq \|q_i^B(t)\| \leq (R + \Delta R) \sum_{i=1}^{n} q_i^B(t)
\]

where: \(\|q_i^B(t)\|\), i=1,n=vector of instantaneous flow rates of grain mixture components at the outlet of the DMS.

The main processing aim of the DACS is to provide for the maximum output of a standard mixture \(M_c\), the quantity of which is determined by the equation:

\[
M_c = \int_0^T Q_m(t) dt
\]

where: \(T_c=\) total duration of time intervals, which is valid for the inequality (2), for the DMS operating time (T);

\(Q_m(t)\)= grain mixture flow rate at the outlet of the mixer.

Since \(Q_m(t) \approx Q_x\), then:

\[
M_c \approx Q_x K_{TH} P_c T \text{(4)}
\]

where: \(K_{TH}=\) DMS utilization factor /4/;

\(P_c = T_c / K_{TH}\) = probability of standard mixture output.

\(Q_x\), \(T_x\) and \(K_{TH}\) are the indices which stand for the output, durability and reliability of the DMS production equipment. Therefore, the IMMEDIATE TASK OF THE DOSING AUTOMATIC CONTROL SYSTEM IS THE MAXIMIZING OF \(P_c\).

Let us take the following structured model /2/ of the continuous dosing and mixing section (Fig. 2) consisting of \(n\) elements type \(D_i=(E_i, T_{pi}, Q_i)\), which is a dosing belt scales (DBS), and one element type \(S=(T_{CM})\), which is a continuous mixer.

Here, \(E_i\) = reduced error of DBS characterizing its static accuracy;

\(T_{pi}\)= mathematical expectation of the time interval during which the integral error of maintaining the given capacity of DBS is equal to zero, which characterizes the dynamic properties of DBS;

\(Q_i=\) maximum capacity limit of DBS;

\(T_{CM}\)= effective mixing time characterizing the smoothing properties of the mixer.

Let us also take the following mathematical models of the processes at the outlet of the structured model elements:

(I) Acting at the outlet of the elements \(D_i\) is an ergodic centered random process:

\[
q_i(t) = q_i^c(t) + \Delta q_i(t),
\]

where: \(q_i^c(t)\)= given flow rate of mixture components at the outlet of the element (coordinating action);

\(\Delta q_i(t)=\) instantaneous deviation of flow rate of mixture components \(\Delta q_i(t)\), being a random process, the cross section of which at any fixed moment of time \(\sigma q_i(t)\) is a random value distributed according to the normal law (standard deviation of \(\Delta q_i(t)\) is determined by the value of \(Q_i\)