QUALITY CONTROL OF TECHNOLOGICAL PROCESSES EXECUTED BY MACHINERY AND EQUIPMENT IN AGRICULTURE

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Abstract: *A model of a machine operation with account for systematically important factors has been proposed. It is dealt with practical methods for quality assessment of agricultural machinery and its technological processes.*
The obtained results afford evaluation of the Forage Shredder technological reliability during its operation as component of a flow line.
KEY WORDS: *TECHNOLOGICAL PROCESS, CONTROL, PROBABILITY, RANDOM VARIABLE REALIZATION, OPTIMIZATION*

Introduction

The majority of technological operations in agricultural production are executed by machinery. The objective of equipment performance improvement is related to provision and maintaining of its technological reliability.

In view of the specific conditions of equipment operation, and mainly of their stochastic nature, the most objective and proper assessment of its operational and technological reliability can be obtained with the use of theory of effective operation of equipment as a dynamic system.

Successful performance of tasks by equipment and hence its operational effectiveness lies in conformity of the machine's operational results to the required level.

Background

It is reasonable to define operation of technological equipment or its process notwithstanding its designation and physical nature as "input-output".

In view of such definition, the analysis, synthesis and optimization of equipment parameters or its processes are being performed on the basis of relations between input and output variables.

External disturbances (operation conditions) and control actions (of an operator) are considered as input variables. Agrotechnical, energetical, technical-and-economic indexes of the machine operation are considered as output variables.

Such scheme is a model of agricultural equipment operation and it determines its presentation as a system that transforms input variables into output variables (Figure 1)

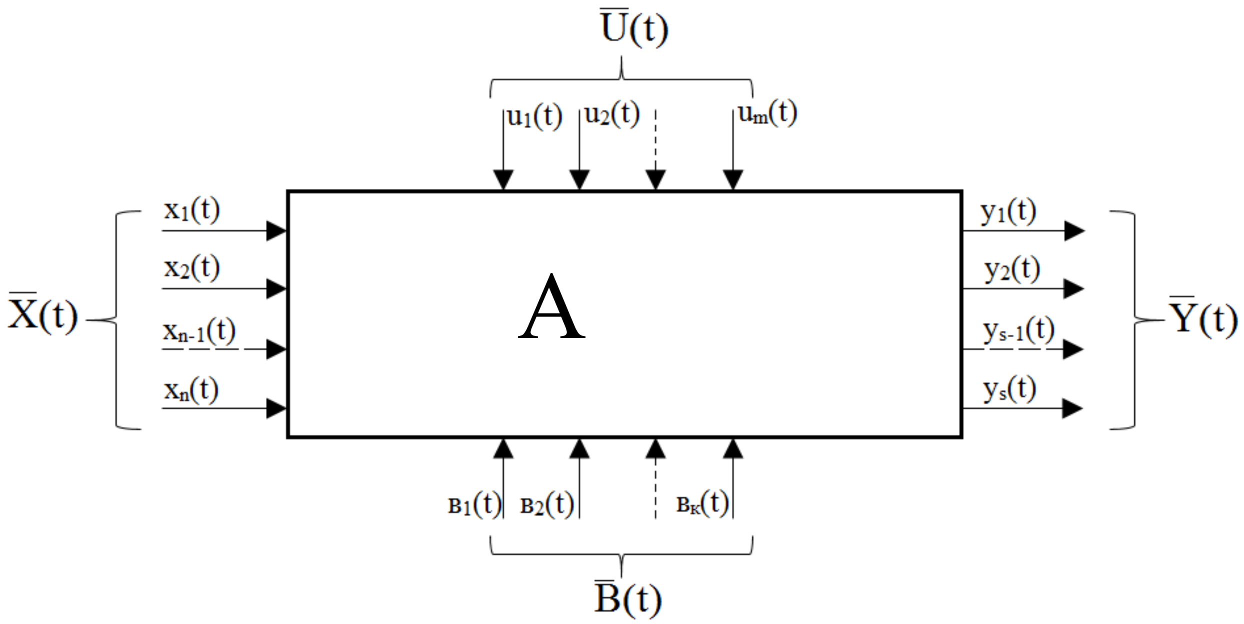

Fig. 1 *- Model of agricultural equipment operation*

Here $\bar{X}(t)$ – is a vector function of input parameters;
$\bar{B}(t)$ – is a vector function of external disturbances;
$\bar{U}(t)$ – is a vector function of control actions;
$\bar{Y}(t)$ – is a vector function of output variables.
A - operator of transformation

Results:

The research object is a Straw Shredder-Feeder as a component of a flow line designed for forage preparation.

Evaluation of dosage unit optimization criterion is the probability of presence of a random process within the tolerance range P_Δ. Here, the greater P_Δ , the better and more uniform the forage feed is. Physical meaning of P_Δ probability lies in the fact that it shows a share of realization time, during which the process is located within the tolerance range.

Studies of dosing and distribution processes show that deviations from average value of a certain forage dose are distributed according to the Gaussian law, that's why the tolerance is symmetrical with respect to the average value.

Realization of a random cut straw feed process $X_i(t)$ is graphically presented in Figure 2, where the defined point X_j shows all components of the random process.

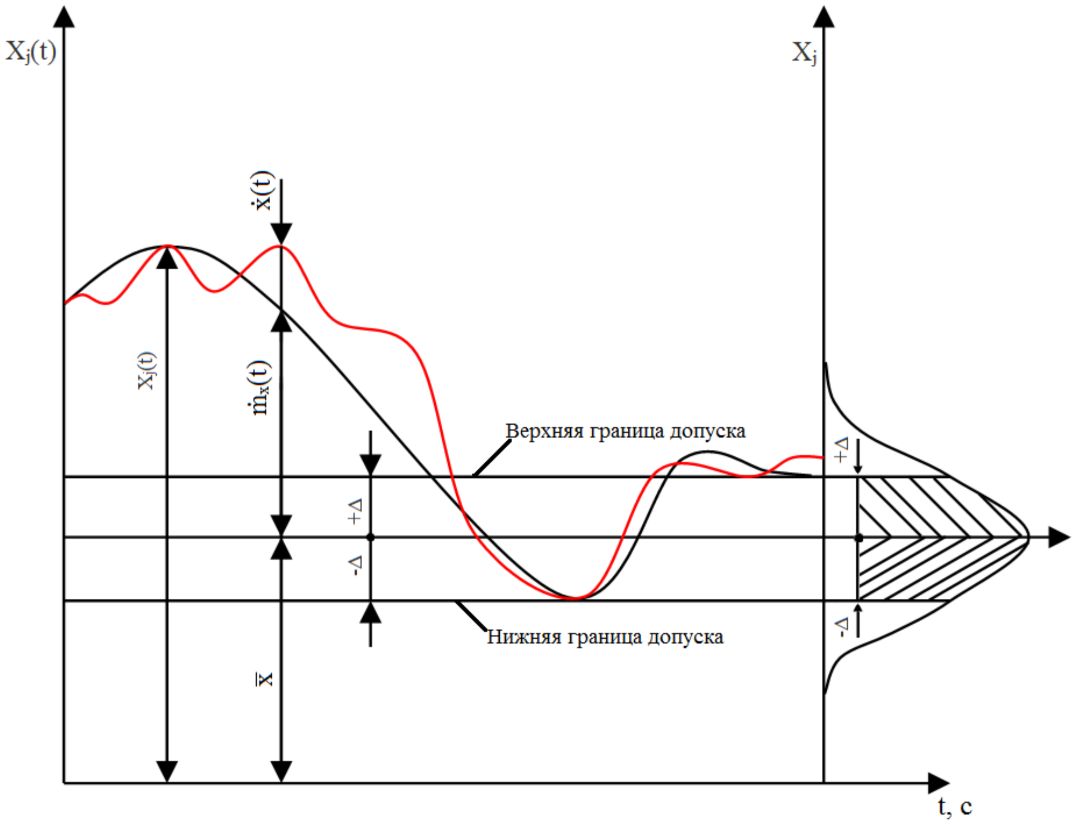

Fig. 2 - Realization of a random straw feed process

On the right part of Fig. 2 there is a probability density plot f(x) of normal distribution of a random variable (feed's deviation from average value). Graphical probability P_Δ is shown as a shaded area under the density curve.

Analytical probability is determined by the formula

$$P\Delta = 2\phi\left(\frac{\Delta}{\nu}\right),$$

Where ϕ - Laplace's function, taken from tables considering $\frac{\Delta}{\nu}$;

figure 2 is a tolerance's symmetry with respect to the average value of the feed;

ν - root-mean-square deviation of a random process for the period of realization, classified as average value $\overline{X}$, i.e.

$$\nu = \frac{S}{\overline{X}}$$

Minimum 60 measurements of random process ordinates are required for such calculation and S should be determined as follows

$$S = \sqrt{\frac{\sum_{i=1}^{m}\left(x_i - \overline{x}\right)^2}{m-1}},$$

Where x_i is the current value of straw feed,

i = 1, 2, … , j, … m;

m is the ordinate value taken for the calculation.

For the purpose of calculation we took a section on the diagram showing cut straw feed by the Shredder, which is recorded by a special purpose cut process flow meter.

Average feed value in this mode of feeder operation is $\overline{X}$ = 2400 kg/h,

S = 680 kg/h. As per agritechnical standards, tolerance for dosage is Δ = 0,15;

$$\nu = \frac{680}{2400} \approx 0{,}28,$$

Probability of the straw feed process presence within the technological tolerance range.

$$P\Delta = 2\phi\left(\frac{0{,}15}{0{,}28}\right) \approx 0{,}4,$$

This means that the shredder provides 40% of cutting in time within 15% tolerance in this mode of operation.

Length of the random process realization is limited in time, thus significant deviations of feed from the average value should be expected at continuous service. Extreme deviations of feed (maximum Q_{max} and minimum Q_{min}) can be determined as per three sigma rule: $Q_{max} = \overline{X} + 3S$ и $Q_{min} = \overline{X} - 3S$. Such approach provides reliability of the conclusion with a probability of 0,9973.

By substituting the experimental values, we have

Q_{max} = 4440 kg/h;

Q_{min} = 360 kg/h.

Conclusion

Shredder-Feeder feeds the cut straw at a highly uneven pace. Measures of the equipment's optimal control in the course of technological operations performance should be provided for when installing the equipment into the feed line.

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