METHODS OF DECREASE OF THE INFLUENCE OF VIBRATIONS AND ASPIRATION WHEN DEFINING THE WHEAT PARAMETERS IN INDUSTRIAL CONDITION

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Electronic systems for optimising of some of the processes of wheat preparation are designed. They are based on the measurement of the parameters above. Due to the necessity of continuous action on line, a lot of measurements are accomplished indirectly. Some of the correlations among the wheat parameters are presented. These correlations enable the calculation and regulation of the milling indicators by the help of electronic systems. The precision of the measurement is influenced by a number of factors: characteristics of the measurement converters, adequacy of the set models, significance of the inner and outer interference influences of the measuring system, etc. This article deals with the influence of the vibrations and aspiration, which is among the commonly met situations of application of the electronic devices for measurement and control of the wheat parameters in industrial conditions. Different methods and algorithms for reduction of this negative influence over the systems for measurement control are considered.

Key words: grain, vibrations, measurement, modelling.

1. Introduction

The final technological, correspondingly economic, result of the milling factories depends to a great extend on the preparation of grain for milling. Most of the processes of wheat preparation are permanent, which necessitates the design of systems for on-line measurement and control of important parameters, such as moisture ***W***, temperature ***t***, hectolitre weight ***H***, limpidity ***L***, etc.

Fig. (1) shows such a system [2].

By definition, the grain moisture is the percentage of water in one weight unit of grain. When we measure the moisture ***W*** by means of indirect methods (capacity method, microwave method, etc.) in most cases as an indicator of the wheat moisture we use the change of physical properties in a measurement volume, filled with the sample of wheat, which is being tested. In this case we can judge of the water quantity in grain with defined volume by the change of the corresponding physical parameter and not by the given weight. To define moisture correctly, grain density corrections must be introduced. The parameter representing this density is the "volume weight". This parameter is known under the name of "hectolitre weight" ***H*** because it presents the weight of one hectolitre (100 litres) grain in kilograms.

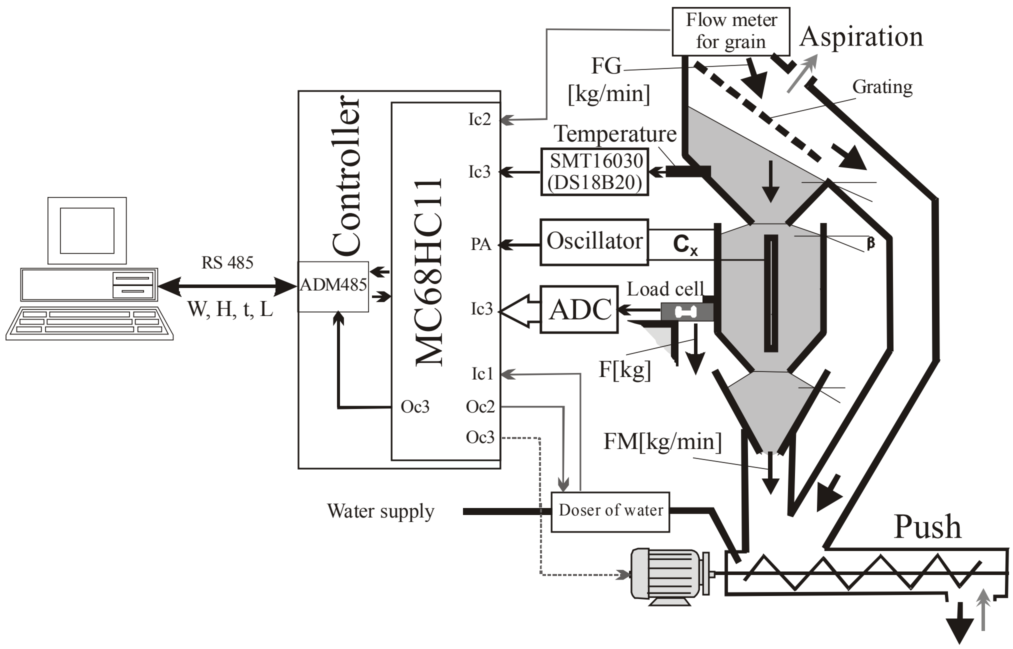


fig.1. Structure of the system

2.Vibration influence on the measurement of hectolitre weight

The measurement of hectolitre weight (fig.1) is accomplished by means of tensometric method. The controller, build on the base of processor MC68HC11, measures the force ***F***, exerted upon the tensometric sensor by the measurement container.

When measuring the hectolitre weight on-line the vibrations of the neighbouring machines in the industrial premises influence the process in two ways:

- directly influence the weight measurement;
- influence the arrangement of grain kernels in the measuring container, thus changing the coefficient of internal friction of grain.

There is [5] an algorithmic method of decreasing the influence of vibrations when dosing loose materials. It is applicable in case of discrete dosing and is related to the precision of the concrete dose.

In the case of perpetual on-line measurement of hectolitre weight the direct influence of vibrations on the weight sensor can be eliminated by the help of prolonged time to calculate an arithmetical mean.

The vibration influence on the coefficient of internal friction of grain, which on the other hand influences the density of grain filled in the measuring container, can be examined by the help of the stand below (fig 2).

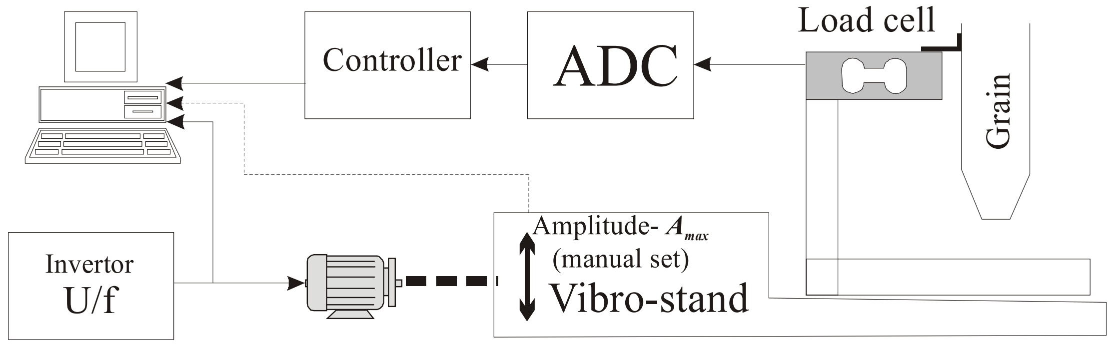
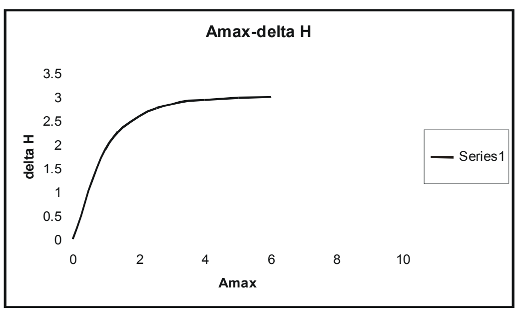


fig.2 Experimental stand for examination of vibration influence

The received results (fig.3, fig.4) show that if the vibrations do not coincide with the resonant frequency of the measuring container, their influence can be compensated by correction of the hectolitre weight, as a function of the amplitude of its fluctuations.



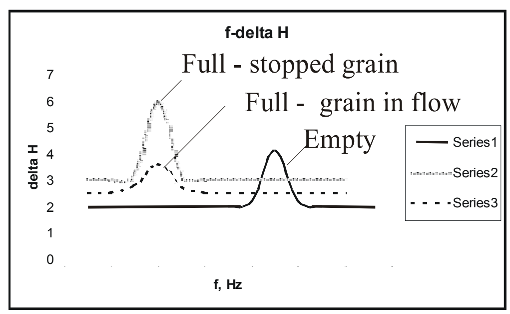


fig.3 Influence of the vibration amplitude *fig.4 Influence of the frequency*

The mathematical model of the correction of the hectolitre weight is:

(1) $$\Delta H = \Delta H_{\max}.\left(1 - e^{-k.D(H)}\right),$$

where $\boldsymbol{k}$ and $\boldsymbol{\Delta H_{max}}$ are constants, ***D(H)*** is the dispersion of the values of hectoliter weight measured for a definite interval of time.

3.Correlations between the hectolitre weight and grain limpidity

The value of hectolitre weight depends on a number of factors, which influence the density of the loaded grain: sphericality, surface condition, the coefficient of friction, moisture, density, size, etc.

There is a correlation between the hectolitre weight and the limpidity when moisture is invariable. The coefficient of correlation [4] between these two parameters can be calculated according to the formula:

(2) $$r = \frac{\frac{1}{n}\sum_{i=1}^{p}\sum_{j=1}^{q} n_{ij} x_i y_j - \overline{xy}}{\sigma_x \sigma_y}$$

According to some studies [1, p.34] this coefficient is:

(3) $$r = 0{,}75$$

On the other hand there is a correlation (fig.5) between the moisture and the hectolitre weight. These correlations enable the application of the correction of the assigned output moisture according to the grain limpidity. The input moisture and hectolitre weight are used as a basis for the definition of this correlation.

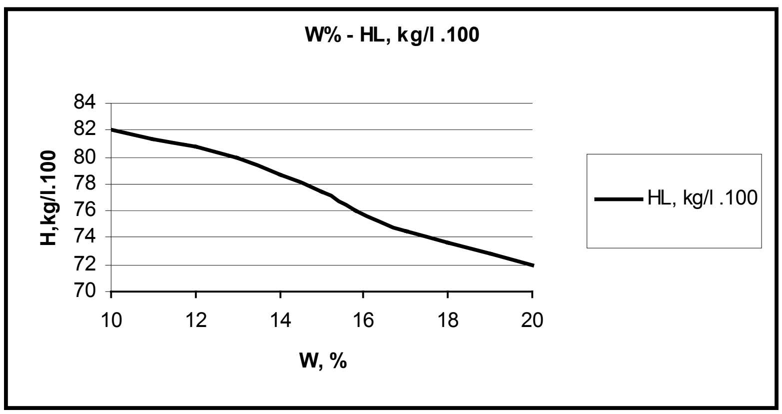


fig.5 Influence of grain moisture on hectolitre weight

The parameter of limpidity influences the choice of conditioning rate of wheat. To define on-line the percentage of limpidity kernels is a difficult task. Therefore, our aim was to design a model of approximate definition of limpidity, which will help for the automatic correction of the conditioning rate. Bearing in mind the correlations, the system for control of technological process uses the following variant:

(4) $$L = a + b.H + c.W + d.H.W$$

The described model does not claim application in metrology. It is a source of input data for automatic correction of the assigned output moisture of the wheat.

4.Influence of the limpidity on the wheat conditioning

The major factors, which influence the process of hydrothermal processing of the grain mass are:

a) moisture and grain structure (limpid and flour);
b) the water used for artificial moistening of the grain mass;
c) the temperature of the grain mass;
d) the time used for the processing of the grain mass;
e) the air medium, in which the process is accomplished.

Limpidity kernels are denser and harder, they absorb water more slowly than the flour kernels. This condition influences the duration of the stay, which must be different with different kind of grain.

Due to constructive and technological reasons the duration of the grain stay in a certain mill cannot be changed at random. When it is restricted, the process of conditioning can be influenced by changing the speed of water molecules entering the grain.

Water molecules enter the inside of the kernel under the influence of diffusion forces.

According to [3, p.189] the diffusion equation is

(5)
$$dM = -D\frac{\partial \rho}{\partial x} dS.dt$$

Consequently, the velocity of carrying the mass along a single unit of surface depends on the diffusion coefficient and the density gradient.

(6)
$$j_M = \frac{dM}{dt}.\frac{1}{dS} = -D\frac{\partial \rho}{\partial x}$$

The coefficient of diffusion of moisture ***D*** is to a great extent influenced by the structural characteristics of the grain and its temperature: for limpid (hard) wheat ***D*** is lower than the one for soft wheat. The decrease of ***D*** with the increase of moisture is explained by the molecular (diffusive) mechanism of carrying moisture [1, p.35]

In our concrete example the acceleration of the process of water entering the kernel can be achieved by the increase of water gradient $\partial\rho/\partial x$, i.e. by adding more water for limpidity wheat. To define the wheat limpidity, the correlations among hectolitre weight ***H***, moisture ***W*** and limpidity ***L***, discussed above can be used. When measuring the hectolitre weight it is necessary to consider the change of the internal friction of the material under the influence of vibrations. This is accomplished by the help of the formula (1).

5. Influence of the aspiration on the automation of the process of grain conditioning

In most mills the machines and transporting systems are aspirated in order to decrease the dust in the departments and to separate the remainders of chaff and wheat husks. The aspiration is accomplished by the help of a fan, which creates subpressure in the transporting systems of mills. In practice, the fan incessantly exhausts a certain amount of air. The capacity and pressure of the exhausted air depend on the fan parameters and the condition and productive rate of the machinery and equipment of the technological line.

For the proper work of the analyzer of wheat parameters (***W***, ***H*** ***,t)***, it is necessary to make sure that the input flow (fig.6) of the measurement container is bigger than F_{pr2} when the moistening process starts. This guarantees the filling of the container with a sample of the processed grain. The passing of grain through the grating (fig.1) is hampered when there is strong aspiration.

The application of the algorithm shown in fig.7 solves the problem of initial filling in the measurement container when strong vacuum is caused by aspiration.

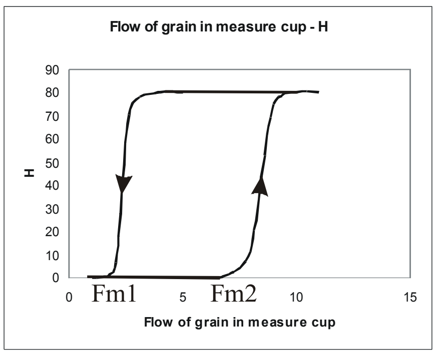


Fig.6. Hysteresis of filling

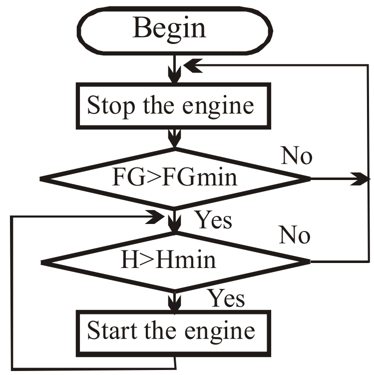


Fig.7. Starting the process

FG here refers to the general grain flow sent for moistening, measured by the grain flow meter.

6.CONCLUSIONS

The methods shown above improve the systems of control of wheat parameters and enable the optimization of the technological process.

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