RENEWED METHODS AT THE IMPROVEMENT OF THE QUALITATIVE PARAMETERS OF THE PRODUCTION IN A CONCRETE CENTER

Vladimir Krumov Gebov

South -West University Neofit Rilski, Chair "Electronic and communication techniques and technologies" Blagoevgrad, Bulgaria 2700 Blagoevgrad, askon@abv.bg

New and modern methods applied at the increasing of the quality and productivity in the concrete center has already been offered and experimental approved.

The incorporation of the iteration method in the practice together with PID controllerfor the maintenance of the portion dosing leads to increasing the quality of the last portion at the expense of lower requirements to the exactness of the dosing of all other portions except the last one. The productivity and the quality of the prepared mixture is becoming definitely higher. Increasing the exactness of dosing of the last portion could be achieved by the pseudo stationary control two-conditional pneumatic.

The incorporated system involves PC with software based on Visual Basic.Net, communication interface with controller based on HCS12 that is managing the devices and the parameters of the technological process.

Keywords: concrete centre, iteration method, quasi-position, quality parameters

1. INTRODUCTION

Under the condition of dynamic construction in the Bulgarian economy shows up the necessity of increasing the qualitative parameters of the construction, strength of the materials, such as their compressive characteristics, also the control at their observation and keeping the constructing requirements. The main components in the construction are different types of concrete blends, which actually could be defined as mixtures based on water, cement, sand, felt and addictive components. The modernization of the concrete hubs is being fulfilled chaotically and out of any control. In most cases the main criteria for the accomplishment of the modernization of the concrete center is connected by achieving the aims of computerization and automation. Namely this prerequisite gives in a certain level a solution of the subjective factor and also the exactness of the final production, but in no way does not achieve the necessary parameters of the batch's quality, that are required by the normative documents of ISO 9001. The conditions of the concrete centers require high productivity for short periods of time, when actually the dump trucks should be loaded. The productivity and the quality parameters are in competition in this case, which requires putting into practice new methods at solving the problem.

2. THEORY OF THE QUALITY OF THE TECHNOLOGICAL PROCESS

Main objective laws at the dosing process

The dosed material should be given with the following equation:

$$G_i(t,\Delta t) = \int_0^{t+\Delta t} S(t)*V(t)*\rho(t)*C_i(t)dt \quad , \qquad (1)$$

where

$S(t)$ - material's flow cross-section

$V(t)$ - flow speed

$\rho(t)$ -flow density

$C_i(t)$ - concentration of the i-th component.

At the dosing process of the material the quantities that get into the dependency are changing. As a result of these changes dimensions occur in the capacity $\Delta Q(t)$, and also the value of the dose. $G(t,\Delta t)$. The main reasons for these dimensions are external factors.

The main part of the capacity dimension could be given by the following equation:

$$dQ = \frac{\partial Q}{\partial S_0}dS_0 + \frac{\partial Q}{\partial V_0}dV_0 + \frac{\partial Q}{\partial \rho}d\rho + \frac{\partial Q}{\partial C}dC \quad , \qquad (2)$$

All factors that actually influence over the dimensions are the cross-section and the speed of the material flow. In this case it means that the productivity of the technological process should be reduced. The main influences over the process are the application of unusual methods at preparing the dose. It is also used the mathematical set of statistical treatment, as well as the theory of the automatic regulation, in particular the discrete regulators.

Very important for the quality dosing is its characteristic as a function of its continuality. If the objective law for a single influence with continuality is:

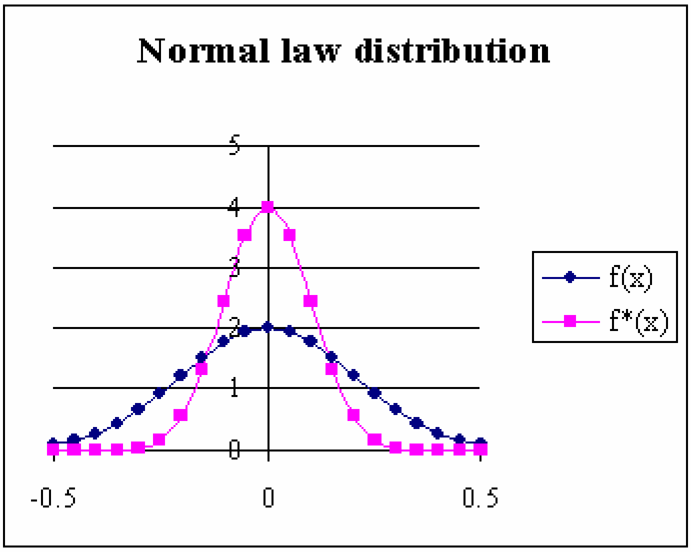
$$G(t,\Delta t_1) = \int_{t-\Delta t_1/2}^{t+\Delta t_1/2} Q(t)dt \quad , \qquad (3)$$

if we change this continuality and research the function of the dose dimensions in this period of time Δt, should be achieved the following dependency:

$$\frac{G_{зад}(t,\Delta t_i) - G_{ф}(t,\Delta t_i)}{G_{зад}(t,\Delta t_i)} = \frac{\int_t^{t+\Delta t_i} Q_{зад}(t)dt - \int_t^{t+\Delta t_i} Q_{ф}(t)dt}{\int_t^{t+\Delta t_i} Q_{зад}(t)dt} \quad \frac{\sum_{i=1}^{n} Q_{зад_i}T - \sum_{i=1}^{n} Q_{ф_i}T}{\sum_{i=1}^{n} Q_{зад_i}T} \qquad (4)$$

This function is standardized in reference to the assigned dose.

If we accept a normal distribution of the dimensions, the differential law that describes them, should be given with the dependency: $f(x) = \frac{1}{\sqrt{2\pi}\sigma_x} e^{\frac{(x-m_x)^2}{2\sigma^2{}_x}}$, where m_x – mathematical expectation of the dose dimension, σ_x – mean quadratic dimension. In case that we use the normative dimensions of the dose (we are interested in the final result and not in the transitional dosing), the law of distribution is changing in the way it is shown on Fig.1

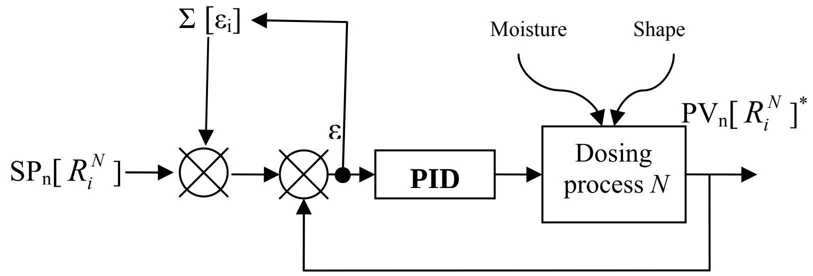


Фиг.1. Distribution of the deviation of the dose depends of time. f(x)- one portion of dose, f*(x) for all of portion in dose

Increasing the number of the portions causes the decreasing of σ_x, as well as centering the dimensions in the distribution law. The main conclusion is that if we create a mixture of consequent doses, σ_x decreases monotonous while the number of the portions in one dose is getting higher. So if we accept, that the imprecise but quick dosing of N-1 portion and compensate the errors in N^{-th} portion, the final result in reference to the dimensions in the final dose should be one and the same in terms of the theory of probabilities. The additive errors of the dosing process are eliminated by software PID control device [1], which is a pretty good solution, when the disturbance has monotonous characteristic with a slowly-changing character. When sharp changes in the dampness of the sluggish material appear, high dimensions of the already required task are available, which intends offering a new method at solving the problem with the exactness of the dosing process.

Iteration method for control of the dosing processes with the main aim-decreasing the dimensions of the dose.

At dosing of different mixtures a list of recipes is used R_i^N , where N is the serial number of the recipe list and is its containing element. At the fulfilling of the recipes appear dimensions of the preliminary asked values, which form error ε at the dosing. As a result of that could be built a closed system with PID law, shown on Fig. 2, where SPn[R_i^N] – asked value of the element of the recipe., PVn[R_i^N] – dosed value of the element of the recipe. The main factors that cause negative influence over the process of dosing of the sluggish materials are the dampness and also the form and size of the material. The dampness changes sharp the pouring quantities of the material, its speed of floating trough the dosing devices, and namely this enables to define the statistic irregularity of the dosed portions of the separate products. Dampness influences also over the necessity quantity of water in the relevant recipe. As much damper is the sand, as less water should be dosed in the outlet product.



Фиг.2. Iteration model of the control dose, based on PID controller for one component of the recipe.

The offered method includes iteration procedure, in which the error from the previous dosing is added to new task for dose SPn[R_i^N]. After all this method let us ignore the exactness for dosing of all N-1 portions and namely this exactness depends only on the last one– N^{-th}, so we could apply extra efforts to improve just its exactness.

Quasi - stationary method for control of pneumatic outfit devices with two stable conditions.

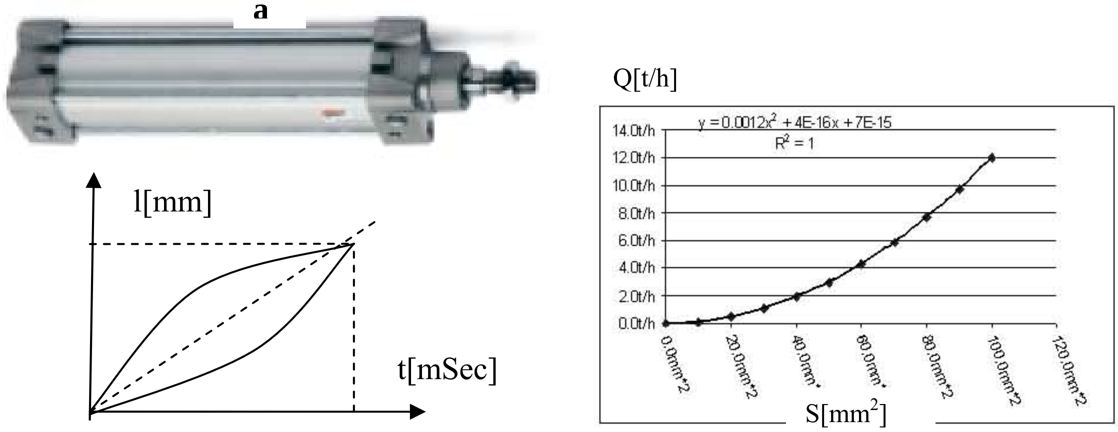
The first dependency (1) permits us to decrease the dimensions at the expense of $S(t)$- material's flow cross-section or $V(t)$- flow speed. At first sight it seems to be impossible for pneumatic devices (Фиг.3.) with two conditions, but lots of experimental data give reliable results.

The maximal speed, which the sluggish product achieve while getting through the dosing valve is $V_{max}=\sqrt{2gh}$, where g is acceleration of gravity, and h is the height of free outgoing of the product. The time that is necessary for achieving this high speed is $\tau= \sqrt{(2h/g)}$. If we accept that the height of free outgoing is around $h\approx1.0$ m, this means that the rime necessary for the sluggish product to achieve this speed is $\tau\approx=0.45$Sec. If we define the term *flexible start* for the sluggish material over the outlet of the dosing valve, it actually changes in reference to the cross-section of the light outlet of the valve. This explains the nonlinear model of the outfit characteristic of the valve, shown on Фиг.3.c, and achieved at this experiment. Defining the flexible start is impossible because of the influence of many factors such as: angle of repose of the material, dampness, size, form etc.

Opening the dosing valve has to be determined by the motions of the pneumatic cylinder piston. The time that is necessary for achieving the final position of the piston is defined by: $t=f(k_{vs}, P_{spl}, S_w, R, F_{res})$, where k_{vs} – is parameter of the distributor, P_{spl}- is pneumatic supply, S_w- work cross-section, F_{res}- resistance couple, R- resistance of the line, fittings and synchronizing battlers. Experimentally has been found out the time necessary for opening the valve τ≈=0.40Sec. The speed of the modern pneumatic distributors is 20÷50 mSec.

Namely this is the main aim of the offered method – not to allow the EM(executive mechanism) to reach final position, which increases the distributive ability of control device.

a



b **c**

Фиг.3.a-Double active pneumatically executable mechanism (PEN), b-output haracteristics of the PEM, c – Output characteristics of the dosing clap for inert materials (CD).

3. EXPERIMENTAL SYSTEM FOR CONTROL OF THE CONCRETE CENTRE

The system for control is shown on Fig. 4.

↑ At its construction is used controller, based on Motorola - HCS12

↑ Electro pult control switches, relays, 3servo-motors, 5 pneumatics valves. It also controls position of the carriage whit inert materials and clap of the mixer.

↑ The capacity of the water control by sensor of the pressure, mounted on water-bin.

↑ The current of the motor of the mixer is controlled by current transform and transducer 4÷20mA.

↑ Temperature of the environment is controlled by intelligent sensor of DALAS – DS1820.

↑ The master interface is accomplished by PC, based on Visual studio – 2005, which affords great interactivity, ergodicity and flexibility at the maintenance of the system. The physical layer of the connection is made by AL-310 USB to RS422/RS485 Converter. Visual studio – 2005 also affords creating screens, graphics, menus, buttons etc. in a way that is easier for the programmer.

↑ The history of the process, alarms and the consistence of the controlled variables are saved in database by ADO.NET. There is a possibility for creating own functions and objects, except the available systems, which gives extra chance for enriching the applications, as well as for sharing the mathematical and systematical resources between PLC and PC.

Results:

- A computer-integrated system has already been created in assistance of Visual studio, with database organized by ADO.NET and controller hcs12 for the maintenance of a concrete center. The main idea of managing is distributed between the software of Visual basic.Net and the assembled program of the controller.
- There is also an iteration method that improves the exactness and the productivity in dosing devices, applied in the technological process of the concrete centers;
- This system has already been created and incorporated in the fodder factory that belongs to concrete centre in Blagoewgrad, G.Delchev.

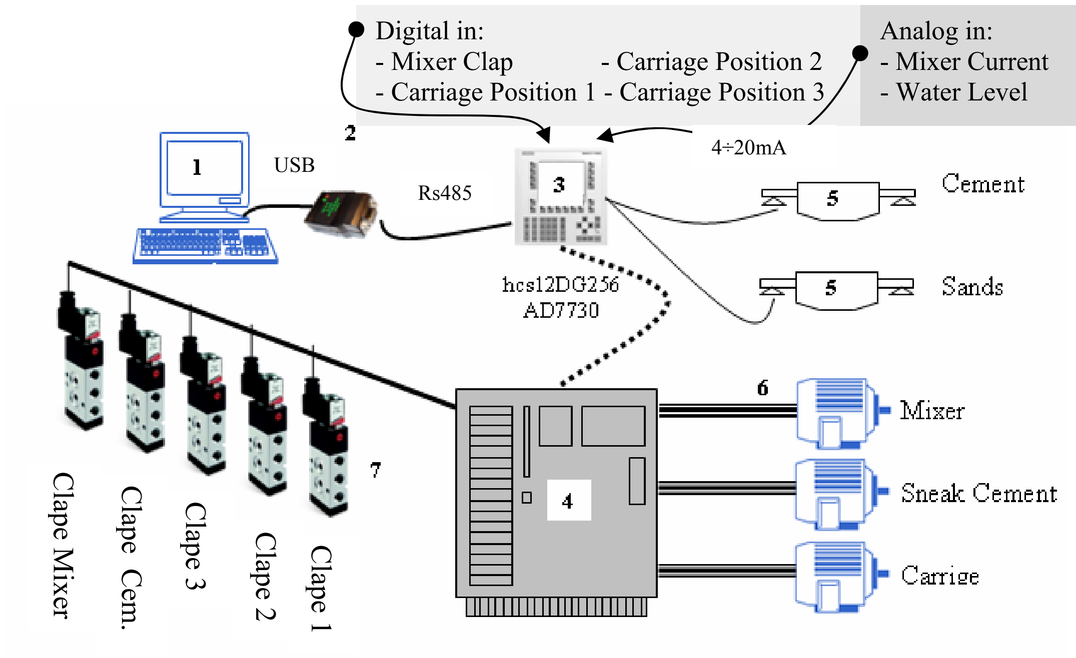


Fig. 2. Organization - control system. 1-PC; 2 –AL-310 USB to RS422/RS485 Converter; 3.µp HCS12& transducer AD7730; 4.Electro pult; 5. Weigh scales; 6. Servo motors; 7.Pneumatics valves

Conclusion:

The incorporation of the iteration method together with PID controller for the maintenance of the portion dosing leads to:

↑ Increasing the quality of the final dose at the expense of lower requirements to the exactness of dosing to all portions except the last one;

↑ Повишаване на производителността и качеството на приготвяната смес;

↑ Extra mixing at the time of transporting of the mixture from the concrete center to the construction site.

↑ Increasing the exactness of dosing of the last portion could be achieved by the pseudo stationary control two-conditional pneumatic EM.

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