MODEL OF ASSESSMENT OF LEVEL OF POTENTIAL POSSIBILITIES OF THE TECHNOLOGY APPLIED BY THE ENTERPRISE

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Abstract*: In this paper authors cover the problem of creation of automated control systems for the production technology which will provide the given ranges of values of various properties of metallurgical products is considered. For a solution it is offered all properties to lead to a comparable look, having entered a concept of potential of properties. The general vector of technological variables is offered to be defined by finding of rational values of variables for target function which is equal to the general level of potential of properties in the corresponding time frame.*
KEYWORDS*: AUTOMATED CONTROL SYSTEMS FOR THE PRODUCTION TECHNOLOGY; GENERAL VECTOR OF TECHNOLOGIES; ESTIMATED VECTOR OF PROPERTIES; GENERAL VECTOR OF TECHNOLOGY*

1. Introduction/

The article deals with the problem of creating automated production process control systems that provide for obtaining specified ranges of values for various properties of metallurgical products, as well as evaluating the overall technology vector to achieve the required properties. If the first part of this problem was solved methodically long ago, then in the present study an attempt was made to find a way to implement the second task, which allows one to significantly expand the capabilities of the systems under consideration.

2. Discussion of the problem

So, in the offered technique monitoring of the sliding relative mean values of each property and its dispersion is applied to traditional control and the forecast of properties of products and also forecast models of properties are developed. It is possible to evaluate various a vector of technology variables, the providing necessary properties, having used the acceptances of calculation of rating estimates, known from economy [1]. But it doesn't give the chance to define the general vector of technology at which necessary values of all properties are at the same time reached.

3. Problem resolution

For the problem resolution it is offered all properties to lead to a comparable type, having entered a concept of potentials of properties. Consider a vector of estimates of corrective actions. For each property the estimated vector which coordinates are number 1 or 0 is under construction. Number 1 corresponds to a satisfactory situation, and number zero – unsatisfactory. The situation is established according to the provision of the considered point of rather mathematical expectation of the corresponding property. Potential of property is the length of an estimated vector the general level or potential of the applied technology can be determined as average geometrical value of potentials of properties.

4. Results and discussions

The technique of construction and practical application of mathematical model of assessment of level of potential opportunities of the technology applied by the enterprise in a chain is considered: steel smelting – extra oven processing –normal ingot making– heating of an ingot under forging – forging – heat treatment of preparation after forging. We will notice that the wrought product has two working areas which are bearing various loadings in an end product and having the corresponding various mean values of the considered properties for ensuring necessary operability of a product.

In article designing of the model used for comparison of rating estimates of the enterprise during various time frames or comparisons of these estimates at the enterprises making the same products is discussed.

The following technology variables are considered: the chemical composition of metal after smelting and extra oven processing (x_{1i} and x_{2ij}); durations of melting, pure boiling, release from the furnace and all melting (τ_1, τ_2, τ_3, τ_4); values of corrective actions: at extra oven processing z_{2k}, in process to forging z_{3l}, at heat treatment z_{4m}. Each control action is estimated in shares in relation to its normative value.

Implementation of model begins with creation on the experimental data of integrated distributions from the controlling influences and properties of metal for different zones of a forging (hardness H_B; limit of proportionality σ, ultimate strength σ_B and flowability limit σ_T; relative lengthening δ, relative narrowing φ; different types of impact strength of KCU; micro and macrostructure, etc.).

Further using uniform distribution on a segment [0;1] random numbers are played and pass to differential distributions of the considered variables. Then each of differential distributions becomes covered by eight distributions: normal, log-normal, beta-distribution, gamma, t-distribution, logistic distribution, Weibull distribution and uniform.

From them the distribution in the best way covering the experimental data is selected. For each of distributions it is estimated statistical characteristics by means of a packet of Oracle Crystal Ball.

Then forecast models of each property are built, using step regression analysis [2]. Thereby reveal the variables Vs, which are the controlling action for the considered properties, $V_S \in \{x_{1i}, x_{2j}, \tau_1, \tau_2, \tau_3, \tau_4, z_{2k}, z_{3l}, z_{4m}\}$.

But the received equations have a shortcoming: coefficients at variables can have both plus sign, and minus. It's circumstance limits the use of widely used rating models (for example, the R.S. Saifullin and G.G. Kadykov model). This disadvantage is eliminated by using the indicator of potential properties. The quality of model increases also due to inclusion in it of the statistics considering dynamics of change of the function upon transition from one time slice to another.

The potential of the i-th property is calculated as the square root of the sum of squares of the coordinates of the estimated vector:

$$R_S = \sqrt{\frac{1}{n+2}\{\sum(\frac{V_{S_n}}{V_{S_n}^{norm}})^2 + (\frac{\frac{\sigma_S}{M_S}}{SKV_{norm}})^2 + [\Delta(\frac{S}{S_{норм}})]^2\}} \quad (1)$$

Here: V_S – controlling action; σ_S and M_S – the sliding values of average quadratic deviation of property and its mathematical expectation; σ_S/M_S – value of coefficient of a variation, SKV_{norm} – normative value of coefficient of a variation; $\Delta(S/S_{norm})$ – the relative deviation of property S from its normative value S_{norm}.

Further we will determine length of an evaluation vector [3]. The vector is called evaluation because length of a vector gives an assessment to the applied technology. Distribution of each parameter is divided into two parts a vertical which passes through mathematical expectation. The value of each coordinate is selected in a random way from distribution. If the experimental point, lies in the area providing higher level of property, then the coordinate of a vector will be equal 1, otherwise – 0. For example, if the actual content of sulfur and phosphorus is to the right of border of mathematical expectation of distribution, then their coordinates are equal to zero.

If the analyzed indicators are close to normative, then assessment of level of potentialities of technology calculated by a formula (1) will be close to unit. After calculating R_S for each property ($S_S \in \{H_B, \sigma, \sigma_T, \delta, \varphi$, KCU, micro and macrostructure, etc.$\}$), it is possible to determine their geometric mean value, which can be considered an estimate of the level of technology capabilities applied by the enterprise.

5. Inference

Thus, for automated control systems it is proposed to carry out traditional monitoring of the current values of properties and their ranges, as well as monitoring the levels of potential capabilities of the production technology.

6. Literature

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