Conference Paper

Possibilities of Developing of Metallurgical Data Dumps

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Abstract

Data about the technological production characteristics are sent to the archive, where they will be stored for many years. However, the stored data contains many undisclosed links between technological factors and technical and economic production indicators. The article presents a hypothesis about the possibility of processing data generated during production processes of industrial enterprises by analogy developing mining and physical dumps. The article provides an example of studying the sufficiency of the volume of a data metallurgical dump for constructing mathematical models using the experimental planning method. Samples from real production data dumps can compensate for the difficulties of implementing a modern active experiment in training future specialists in secondary vocational and higher education institutions. It is established that the data accumulated over the year in the production archive contain the necessary combinations of realizations of random variables for the two-factor model. The interval method of varying the levels of variables enables to construct an experimental matrix for a three-factor model as well.

Keywords: data dump, production data, metallurgical data, data analysis in metallurgy, matrix, mathematical planning, production management, model, model parameters identification, interval method.

1. Introduction

In the seventies of the last century, the method of mathematical planning of an active experiment was widely used in applied scientific research, in particular metallurgical research [1]. The method included constructing a planning matrix in coded input variables, constructing mathematical models based on the results of the plan implementation, and finding the optimal values of the variables by steep ascension along the gradient of the resulting response function [2]. The method had significant advantages over the classical one-factor experiment. However, it turned out that they can hardly be implemented in metallurgical production. The main reason is coarseness, inaccuracy of individual experiments accompanied by impossibility, due to time and financial production characteristics, to compensate for the inaccuracy with a sufficiently large number of repetitions of parallel experiments.

Society's computerization has led to the widespread use of high-speed computing in many economic areas, including industry. Every day, the memory of factory computers is replenished with data about the technological production characteristics and the quality of the products obtained. After elementary mathematical processing (calculation of arithmetic mean, percent of fall and growth, etc.), these data are sent to the archive according to the established regulations, where they will be stored for many years. However, the stored data contains many undisclosed links between technological factors and technical and economic production indicators [3, 4].

Over the years, an enterprise (similar to mining dumps of ore mining quarries, where other minerals are inevitably associated with the mining object) produces "data" dumps, which are a source of additional management tools at this particular enterprise, where an active experiment is carried out in a natural, evolutionary way.

Data dumps are data generated in implementing production processes. As a rule, the data refer to the technological characteristics of production and the quality of products obtained.

By analogy with "empty" rocks, mineral dust, the work on which requires their processing and (or) disposal, data dumps are subject to analysis (in order to obtain useful knowledge in the field of solving production management problems) and, possibly, to further deletion (with the aim of memory release of production computer systems).

In addition, samples from real production data dumps can compensate for the difficulties of implementing a modern active experiment in training future specialists in secondary vocational and higher education institutions.

2. Results and Discussions

The first condition for implementing the proposed action is the sufficiency of accumulated data.

We examined a relatively small volume of data dump (3,000 members), which includes data on the chemical composition of carbon steel, for its sufficiency to construct the dependence of the mechanical properties of the alloy on the chemical composition (Fig. 1, 2).

As can be seen from the graphs, the data dump contains hundreds of extreme implementations necessary for its development, with an excess sufficient for variation in the experiment, and sufficient for the combinations provided by the two-factor experiment matrix (Table 1).

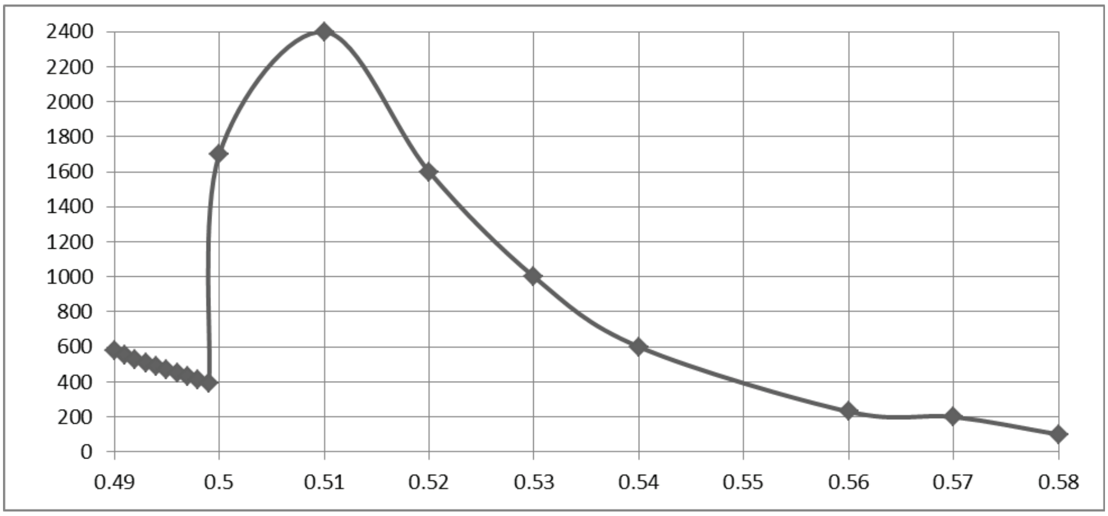

Figure 1: Distribution of the random variable “Mn content”

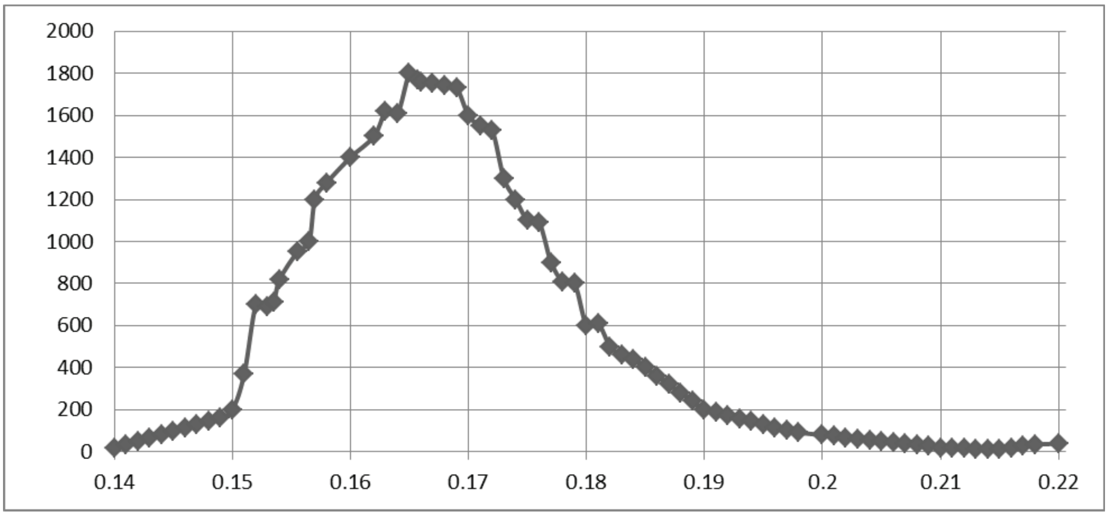

Figure 2: Distribution of the random variable “C content”

However, for a three-factor experiment with random variables studied, the necessary point combinations of the upper and lower levels of factors are practically insufficient (Table 2).

The problem of filling the matrix is solved by applying the interval method of assigning upper and lower levels of variable variation instead of the point one (Table 3).

Table 1: Extreme implementations of C and Mn content

№	C	Mn	Частота
1	- 1	- 1	58
2	+1	- 1	28
3	- 1	+1	32
4	+1	+1	22

Table 2: Extreme implementations of C, Si, and Mn in point sampling

№	C	Si	Mn	Частота
1	-1	-1	-1	8
2	-1	+1	-1	6
3	-1	-1	+1	6
4	-1	+1	+1	1
5	+1	-1	-1	3
6	+1	+1	-1	3
7	+1	-1	+1	3
8	+1	+1	+1	6

Table 3: Extreme implementations of C, Si, and Mn in interval sampling

№	C	Si	Mn	Частота
1	-1	-1	-1	285
2	-1	+1	-1	107
3	-1	-1	+1	127
4	-1	+1	+1	36
5	+1	-1	-1	164
6	+1	+1	-1	75
7	+1	-1	+1	122
8	+1	+1	+1	48

As can be seen from Table 3, the frequency of the required combinations in most experiments exceeds the frequencies of Table 2 by two orders of magnitude. In addition, it is when the interval method was applied only for levels of one chemical element. The upper level of variation of Mn displayed the interval of 0.56-0.57%.

Unlike some other industries in metallurgy, the optimal combination of technological factors found by the method of "steep ascent" may not violate the requirements for other indicators of product quality. For example, the optimal chemical composition of the alloy in terms of strength did not violate the restrictions on plastic properties. This circumstance complicates the application of the effective method of "steep ascent" in an artificial active experiment, which is not the case when working in the data dump.

3. Conclusion

Thus, the data dump even for one year contains enough data to construct mathematical dependencies between the input and output variables of the technological process using the experimental planning method. Here it has no obstacles that did not allow to widely using it in the past in the field of metallurgical production management [5]. Taking into account modern computing tools, data dumps allow both constructing process management models quickly and efficiently and optimizing them, without the risk of violating requirements for other quality indicators. In addition, a large data set will make it possible to more accurately identify the model parameter in such a diffuse object as metallurgy.

Moreover, what is most important, developing data dumps will most accurately identify the model parameters for the enterprise in question, which in turn will provide management that is more successful.

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