MODELING POWER CONSUMPTION MODES IN INDUSTRIAL FACILITY

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Effective management of any industrial facility is possible only in the case where the basic regularities inherent to the project, presented in the form of mathematical description. Mathematical description or the object identification is the basis for a whole range of solutions to manage energy consumption mode tasks.

In general mathematical description is a set of equations and constraints that describe static and dynamic relationships between process parameters in quantities. The processes of metallurgical production are complex objects, whose input and output parameters, as well as parameters describing the internal state of the object depend on numerous factors, often difficult to distinguish. Therefore, obtaining an adequate mathematical description is a very difficult task. In addition, usually it is not facilities themselves with their structural, physical and technological features that are subject to studying and modeling, but their properties, reflected in the values of key indicators and in the interdependence that exists between them.

There are two approaches to the mathematical description of the properties of objects: deterministic and statistic.

The first is based on theoretical ideas about the nature of the process under investigation. The desired coupling equations are derived based on consideration of the physical laws of the phenomena occurring in the object, using various mathematical methods. However, no theoretical consideration is able to accommodate all variety of actual operating factors and conditions, and therefore the theoretical mathematical description to a large extent cease to have effect at the transition to the real conditions of an industrial facility.

The statistical approach is based on the analysis of experimental data obtained directly on the operating object with methods of probability theory and mathematical statistics.

Multiple factor regression method essentially combines two mathematical methods: a well-known method of least squares and the method of statistical estimation of parameters. On their basis it is possible not only to carry out a full statistical analysis of empirical regression equation, but also explore the indirect correlation of rates and factors, i.e., such relations when there is a large chain of causes and effects between them and it is not possible to carry out the direct calculation. This analysis is the basis for the technical interpretation and practical application of a mathematical description of the object.

The work carried out a regression analysis of power consumption of meltshop (EAF) having in its composition an arc furnace and machine "ladle-furnace". In the context of the setup process is extremely important to know the specific parameters of energy consumption per ton of raw material, which is the main purpose of the study.

However, in the construction of the mathematical description of the process of energy consumption, in addition to determining the objectives of the study, the choice of object and the formalization of the task, the most important step is the selection of basic parameters characterizing the process. In general, the formation of a set of factors of production is the hypothesis that is refined sequentially. The reason for extension of the initial hypothesis is the theory of modeled process, the results of previous studies, professional experience of experts.

As between the individual parameters and investigated process there were no strict functional dependency, the task of assessing the influence of factors on power consumption was reduced to the determination of the closeness of the stochastic relationship between them. Assessment of the relationship was performed through correlation analysis, which was to determine the pair correlation factor. The correlation factor between the volume of output and power consumption of EAF shop was 0.96, indicating of mutual dependence of these parameters. The regression pattern of the above values is shown in Figure 1.

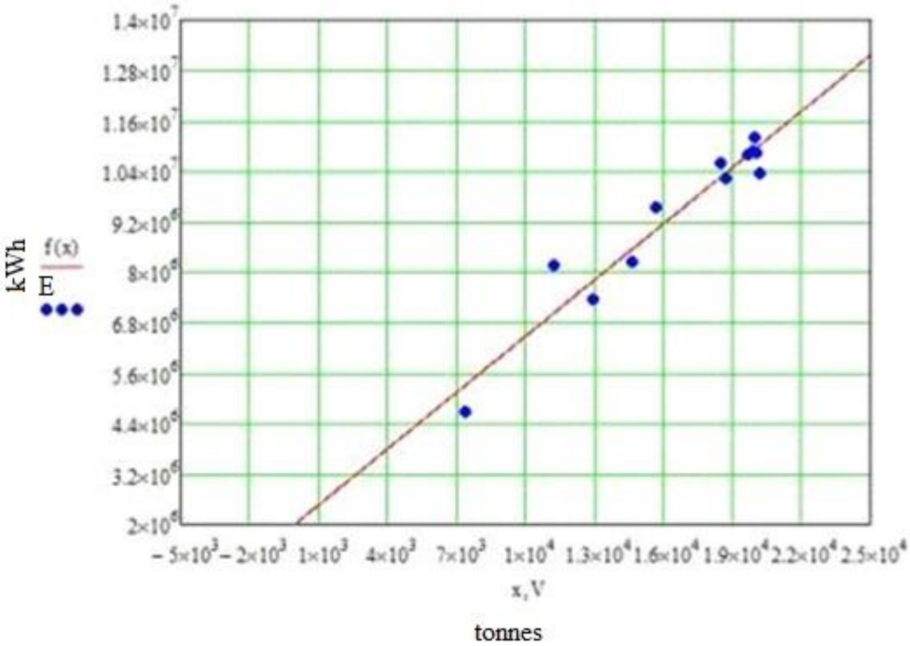

Figure 1.Correlation of power consumption and the volume of the metal for the EAF.

where E - consumed power, kWh; V - volume of output, tons; f(t) - linear regression function.

Analysis of experimental points location shows that as a theoretical equation for this correlation equation of a straight line is the most suitable as shown in the graph.

Analytical expression of the above equation is as follows:

$$f(t) = 2{,}019 \times 10^6 + 446t \quad (1)$$

Evaluation of the accuracy of the approximation was made according to a standard deviation value. For the model shown above standard deviation was 6.64%, that indicates of the high-precision approximation of the statistical correlation.

Parameter of the variable t of the equation (1) in this case determines specific energy consumption for one ton of production.

It should be noted that this specific measure is lower than the rated. The decrease can be explained by peculiarities of the melting process; specific power consumption is significantly dependent on the use of natural gas in the melting process and oxygen blowing. Oxygen blowing reduces the melting stage to one hour, and thus increases productivity. At the same time, the use of 1 m^3 / t of oxygen reduce specific energy consumption by 4 kWh / t.

Using the factor of specific power consumption, as well as knowing the planned volume of production it is possible to forecast the power consumption of the enterprise, which is an important factor in the payment of electricity according to the existing tariffs.

Thus, the analysis of causal relationships and the establishment of a quantitative assessment of the impact of technological factors discussed allowed deeper analysis of the nature of electricity consumption, identify options that determine its level to the greatest extent, to assess the required accuracy of their records, to plan and develop measures for energy efficiency.