THE STATISTICAL THEORY OF INDUSTRIAL SYSTEMS

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Modelling of complex economic systems is an effective method of research. The widespread class is formed by economic systems in which the determined character of observable processes is combined with their stochastic nature. Laws which are observed in systems of an economic exchange, in many respects are similar to what take place in physical (thermodynamic) systems. These laws are proclaimed for thermodynamic systems and systems of an economic exchange as the general principles: Le Chatelier-Samuelson, Carno-Hicks, etc. [1, 2]. On the basis of the given principles functioning of modern mass production can be presented in the form of stochastic process during which the industrial system passes from one condition to another. The condition of industrial system can be defined as a condition of base products of industrial system. The base product (or a subject of work) is understood as an element of industrial system on which during technological processing occurs the deferring of a manpower, raw material, materials and amortization of instruments of work. During technological processing transformation of initial raw material and materials into a ready product by purposeful influence of instruments of work is carried out. The state of a base product is described by microscopic sizes observed during technological process (a microscopic level of the description of industrial systems). Microscopic sizes observed at a microscopic level are: a total sum of the expenses transferred for subject of labor and intensity of expenses in unit of time. It is possible to observe and measure these microscopic sizes, and consequently, and to operate them. The state of system during some moment of time will be certain, if microscopic sizes for each base product are certain, and during any other moment of time are found from the equations of a state of base products. The equations of the state of base products are defined by the engineering-production function of enterprises. To each base product there correspond two equations. As a rule, in technological process of mass production there are tens or hundred thousand base products. As the quantity of base products is much greater than one the solution of system with such number of the equations is practically impossible. Last specification demands transition from the microscopic description of industrial system to the macroscopical description with elements of the probabilistic nature. Such description is made in the present report. The main difficulty in such description consists in allocating for base products of the characteristic of microscopic conditions, which it would be possible to measure at a level of a microscopic condition of the enterprise. Instead of considering the state of the industrial system described in microscopic sizes of base products, discrete function of distribution of the general number of base products in phase technological space is entered in appropriate way нормированная. Each point in the given space will set the state of a base product. It is reasonable to expect, that if there will be lots of base products in technological process this function will be good for approximating continuous function of distribution of base products on intensity of carry of expenses for a base

product. We will break phase space into such number of cells at which the sizes of a cell would be much less than characteristic sizes of industrial system and at the same time containing inside of itself the big number of base products. Instead of fixing exact values of microscopic sizes of a base product, we will characterize approximately a condition of industrial system number of base products in each cell. If the sizes of a cell are small enough, the approached description will carry almost so detailed information, as exact. Thus, for industrial system it is possible to write down the kinetic equation for distribution function of base products on intensity of deferring, similar to the equation in the statistical mechanics. We shall consider continuous distribution function to be normalized. The normalizing condition represents the conservation law of quantity of the base products which are in production process. It is engineering-production function defined from registration data of the enterprise. By implication the engineering-production function in the kinetic equation represents the certain analogue of force moving a base product along a technological chain of production. At such moving there is an influence from instruments of subjects of labor (equipment) on a base product. Thus there is an increase in the expenses transferred on a base product as it moves along a technological chain of production. The equipment influences a base product, changing it qualitatively and quantitatively. It is necessary to notice, that we can speak only about probability of that after influence from the process equipment the base product will be in one state or another. The moments of distribution function are observable and measurable macroscopical parameters of industrial system. The zero and first moments of distribution function have simple industrial interpretation: reserves of base products and their rate of movement along a technological chain. By means of the moments of distribution function the balance equations for the description of macroscopical sizes of industrial system are written down. Multiplying the kinetic equation accordingly by unit, intensity of deferring, and also by a square of deferring and integrating on all range of a random variable, we will receive the equations of balances of industrial system. The equations of balances representing the equations of reserves, rate and a dispersion of base products along a technological chain, are incomplete. The opportunity to receive the closed system of the equations is based on the properties of the function describing work of the process equipment and presence of small parameter, representing the attitude of expenses on separate technological operation to the characteristic cost price of manufacturing of an end-product. From the balance equation the closed system of the equations for the description of industrial system follows. If the rate of movement of base products along a technological chain is set, as a special case from system of the balance equations one receive the well-known in cybernetic economy Forester equation, which is used for the description of industrial-marketing systems.

Keywords
base product, distribution function, phase space, balance equation, engineering-production function

References

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