REDUCING THE ENERGY INTENSITY OF MULTI-PRODUCT MACHINERY PRODUCTION BY IMPROVING THE CORE PRODUCTION INFRASTRUCTURE

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Abstract: *Multi-product machinery production forms a machine park of an industrial organization, so the finished products must provide high-quality and economic indicators while using them in productions. The problem of increasing the level of production efficiency is analysed in such organizations depending on the improvement of the basic production infrastructure. The new, quantitative indicators are presented, which help justify the interrelations of material, labor and energy production costs. The necessity of implementation of innovative technological processes at the preproduction phases is justified, which allows to reduce the level of material intensity, labor intensity and energy intensity of production and increase the efficiency of the production organization.*
KEY WORDS: *MECHANICAL ENGINEERING, PRODUCTION PHASES, INFRASTRUCTURE, MATERIAL INTENSITY, LABOR INTENSITY, ENERGY INTENSITY.*

In order to create a powerful and efficient economy, it is necessary to form a corresponding industry which will provide the necessary basic resources to the other sectors of the economy and form the appropriate material and technical base. The harmonious implementation of these processes in space and through the time enables to form a kind of structure which guarantees the balanced development of all sectors of the economy and promotes the effective solution of existing social and economic problems.It is necessary to ensure the rapid and progressive development of multi-product machinery production (machine-tool construction) as it forms the basic tools of industrial enterprises and creates the necessary mechanical assembly for the production and technological processes. For the timely solution of the problems, it is necessary to ensure the efficient and competitive activity of a multi-product machinery production organization (hereinafter - manufacturing company). For this reason, a manufacturing company must systemise all the integrated processes that are implemented from the formation and design of ideas (R&D, technical and organizational preparation of production) to the production and realization of new products.

For this purpose, the manufacturing company by using the marketing division's instruments included in its logistic service, studies the changes in the market on the basis of which the necessary information base is formulated for innovation policy and restructuring the manufacturingcompany's infrastructure.

In the framework of the innovation policy realization, in the manufacturing company must be developed and realized the upgrade of the range of the corresponding innovation programms' products (improvement of manufacturing products, implementation of new products) and introduction of new technological processes. In order to implement the developed strategic plans, the manufacturing company needs to carry out the reconstruction of production and technological and organizational processes which improve the existing production infrastructure and the new technological processes and new production methods are implemented very fast and efficiently.

Multi-product machinery production, being the main source for the production of machinery and equipment, promotes the increase of the level of labor productivity in the other sectors of the economy. The technical re-equipment of production, the application of new advanced production and working methods are the basis for the increasing the manufacturing productivity and expanding the segment of the manufacturing company in the market.

The improvementof the level of productivity and qualitative indicators of the finished products, produced in multi-product machinery production, is one of the main factors in reducing the intensity and increasing the quality of products which are produced in the practical production by using them.

The correct formation of the main production infrastructure has the key role for increasing the productivity of multi-product machinery production which is important in generating the production costs. The improvement of the main production infrastructure of manufacturing company gives an opportunity to raise the level of production effectiveness by reducing of production costs. In multi-product machinery production the efficient use of material and labor resources and the reduction of their costs plays the key role in reducing the production costs, as they have the major share in total production costs.

The results of the conducted research show that in multi-product machinery production, the full intensity has the following structure: technological intensity is 60-65%, service intensity is 15-20%, maintainance intensity is 15-20%: In multi-product machinery production, first of all, it is necessary to accurately predict and justify the value of technological laborintensity, as it is the main strategy for increasing the labor and production productivity.

In multi-product machinery, the level of technological labor intensity depends on the level of material intensityof production but the level of the energy intensity of production in its turn depends on the level of labor intensity of production. Therefore, in the production should be used such kind of production and technological processes which will first of all reduce the level of material intensity of production.

The results of the conducted research show that in multi-product machinery production the main production phases technological intensity has the following structure: preproduction phase - 15-20%, design - 45-55%, assembly - 20-25%, other technological processes - up to 10%. Hence, the major share of technological labor intensity (about 60-70%) has preproduction and design labor intensity phases. So, we could say, that the value of these phases directly depends on the level of material intensity of production. The production phases that are mentioned in the industrial organization are also energy intensity.

The level of labor intensity of design phase is determined by the level of the technological processes progress, which are used in the preproduction phase. At this stage the use of innovative technological processes gives an opportunity to increase the degree of accuracy of the preforms' output. As a result, their shape and size is brought closer to the shape and size of the finished parts, minimizing the volume of waste disposal. This helps to reduce the level of material and labor intensity, which leads to the decrease of energy costs in the manufacturing company.

The analysis shows that the level of labor intensity directly depends on the level of material intensity and the level of material intensity depends on the degree of accuracy of the used preforms. It is justified by the modification of the well-known formula for determining the labor intensity in the design phase which is illustrated as follow:

$$t_{1ij} = \frac{m_{1ij} - m_{ij}}{n_0 Shb} \quad (1),$$

where the numerator is the volume of waste disposal, the denominator is a constant value for the given type of preform[1].

[1]**Abrahamyan V.**Increasing the effectiveness of multi-product machinery production through the management of the organizational and innovative processes.Yerevan, 2010, p. 141

We can conclude, that the value of technological labor intensity of designing is directly proportional to the value of the preform mass (or waste disposal).

It is necessary to use progressive technological processes for reducing the value of material intensity in the preproduction phase, which will give an opportunity o minimize the volume of waste disposal. As a result, the mass of used materials will be reduced as well as the level of energy and labor intensity in the design phase.

Labor intensity of each part of preform included in the finished product structure in the preproduction phase can be determined by the following formula[2]:

$$t_{1ij} = A_{ij}\left(\frac{m_{ij}}{K_{ij}^{m}}\right)^{x_{ij}} K_{1ij} K_{2ij} \qquad (2),$$

where t_{1ij} is technological labor intensity of i part of preform in j production with technological process, m_{ij} is the net mass of i part, the preform of which is made by j technological process, K_{ij}^{m} is the coefficient of the use of material of i part in the case of making the preform by j technological process, K_{1ij} is the coefficient, which considers the impact of production volume at t_{1ij}, K_{2ij} is the coefficient which considers the impact of preform's degree of complexity at t_{1ij}.

The value of technological labor intensity of one machine set of the manufactured finished product can be determined by the following formula:

$$T_1 = \sum_{j=1}^{k}\sum_{i=1}^{N_j} t_{1ij} = \sum_{j=1}^{k}\sum_{i=1}^{N_j} A_{ij}\left(\frac{m_{ij}}{K_{ij}^{m}}\right)^{x_{ij}} K_{1ij}K_{2ij} \qquad (3),$$

where $j=\overline{1,K}$ are the possible types of technological processes for creating preforms, $i=\overline{1,N}$ is the quantity of parts included in the structure of the finished product, the technological processes of their preforms creating and designing are made in that manufacturing company.

In the preproduction phase, the power energy cost per product unit can be determined by the following formula:

$$E_1 = \sum_{j=1}^{k}\sum_{i=1}^{N_j} t_{1ij}\, N_{1ij}\, k_{1ij}\, a \quad (4),$$

where N_{1ij} isthe total nominal capacity of the engines in the machinery and technological equipment used in production of preforms of one machine set parts of finished product with the various technological processes in the preproduction phase, k_{1ij} is the coefficient of nominal capacity use of machinery and technological equipment, a is the tariff of electricity.

By determining the power energy cost before the implementation of advanced technological processes, for creating the preforms in the preproduction phase of production and after the implementation of these processes, the change in the amount of power energy cost caused by the use of innovative technological processes can be determined.

$$T_2 = e^{a_2}\left(\sum_{j=1}^{K}\sum_{i=1}^{N_j}\frac{m_{ij}}{K_{ij}^{m}}\right)^{x_2}\left(\sum_{\varphi=1}^{t}\frac{\sum_{l=1}^{b}\Theta_{\varphi\ell}}{N_1}\right)^{y_2} e^{tz_2}K_{ПТ}, \qquad (5),$$

The conducted research results show that in the design phase of multi-product machinery production, the value of technological labor intensity for one machine set of manufactured finished product is determined by the following formula:

where the first component is the absolute term (e^{a_2} , e=2,71828...), x_2, y_2, z_2 are the power indicators, the second component $\left(\sum_{j=1}^{K}\sum_{i=1}^{N_j}\frac{m_{ij}}{K_{ij}^{m}}\right)^{x_2}$ the total mass of preforms of one machine set parts of finished product, which are designed in the manufacturing company, the third component $\left(\sum_{\varphi=1}^{t}\frac{\sum_{l=1}^{b}\Theta_{\varphi\ell}}{N_1}\right)^{y_2}$ is the coefficient of technical saturation of the design phase of production, the fourth component e^{tz_2} shows the impact of the product manufacturing years in the manufacturing company (it is not taken into consideration in the case of a new product), the fifth component $K_{ПТ}$ takes into account the level of used technological processes progress due to the structure of the used machine assembly[3].

In the design phase of the production, the value of technological labor intensity made by the tehnological equipment of φ group can be determined by the following formula:

$$t_{2\varphi} = T_2\beta_{\varphi} \qquad (6)$$

where β_{φ} is the specific weight of technological labor intensity made by the tehnological equipment of φ group in the total technological labor intensity of the production of one machine set of one finished product.

In the design phase of the production, power energy cost per product unit can be determined by the following formula:

$$E_2 = \sum_{\varphi=1}^{k_2}\sum_{i=1}^{N_\varphi} t_{2i\varphi}\, N_{2i\varphi}\, k_{2i\varphi}\, a \qquad (7),$$

where $N_{2i\varphi}$ is total nominal capacity of the engines in the technological equipment used in production of preforms of one machine set parts of finished product in the designphase, $k_{2i\varphi}$ is the coefficient of nominal capacity use of technological equipment, a is the tariff of electricity.

In the design phase of production, by determining the value of power energy costs before the implementation of progressive technological processes for the preparation of the performers in the preproduction phase and after these processes' realization we can determine the value of power electricity costs' expected saving.

The implementation of new feasible progressive technological processes in the preproduction phase for making high precision preforms allows to reduce the level of material intensity, labor intensity and energy intensity in the production, which provides the cut in the value of production costs.

It is necessary to develop economic mathematical model for economic feasibility of new technological processes implementation, where the objective function is the value of production costs of one machine set of the finished product in the preproduction and design phases of production, and as limitations - the level of material, labor and energy intensity.

The rebuilding of the core production infrastructure in the preproduction and design phases of multi-product machinery production gives an opportunity to use progressive technological processes and high-performance machinery and technological equipment, which enable to get high precision preforms for the parts designed in the manufacturing company and included in the finished product structure. Besides that, it increases the productivity in the design phase of the production, providing the reduction in material, labor and energy resources, and helps to raise the level of efficiency of the manufacturing company.

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[2] **Abrahamyan V.** Problems of Economics and Management of enterprises, industries and complexes. Book 9. RF, Novosibirsk, 2009, p. 26.

[3] **Abrahamyan V.** Modern knowledge-based technology. Regional Annex. RF, Ivanovo, 2016/1, p. 104.