

DETERMINATION OF THE LIFETIME OF ENGINEERING PRODUCTS BASED ON INNOVATIVE OBSOLESCENCE

ОПРЕДЕЛЯНЕ НА ЕКСПЛОАТАЦИОННИЯ СРОК НА МАШИНОСТРОИТЕЛНИ ПРОДУКТИ (МАШИНИ) В ЗАВИСИМОСТ ОТ ИНОВАЦИОННОТО ОСТАРЯВАНЕ

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Abstract: The future development of machine building is impossible without innovation. Each subsequent step in the creation of technologies and designs will be based on innovative solutions in the corresponding machine-building field. A special role in this regard will play the proposed approaches and methods for determining the pre-design service life of industrial products in emerging innovative depending of obsolescence. This will be particularly important and significant not only for manufacturers of engineering products, but even more so for consumers that are interested in the better use of their opportunities and increased durability.

Keywords: INNOVATIVE PRODUCT, EFFECTIVE LIFETIME, INNOVATIVE SOLUTION, INNOVATIVE OBSOLESCENCE, LIFECYCLE, INNOVATION

1. Introduction

This report offers a solution determining the service life of machine-building products depending on emerging innovative aging. The proposed approach is mathematical formulas for predicting the effective lifetime, including the time for return on investment, as well as the payback period of machine products. Furthermore, the duration of the life cycle of innovative products is determined and the minimum lifetime for the effective operation of the same. There will be examples of designed and manufactured industrial products in the light of these conditions. This approach can be used for other industrial products when taking into consideration the adverse impact of occurring innovative obsolescence.

2. Life cycle of industrial innovative products (machines)

The life cycle of industrial innovation products (machinery) is a concept which reflects variations in the product from its creation until its decline as the product realization [1]. It includes three major periods – investment, sales (installation and entry into use) and drop in sales. The investment is divided into two parts: risk investment (create innovation - ideas, research and design) and investment in production machinery [6]. The lifetime as the last stage is of special importance in finding the best solution for the duration. Graphically, these relationships can be represented as in Figure 1.

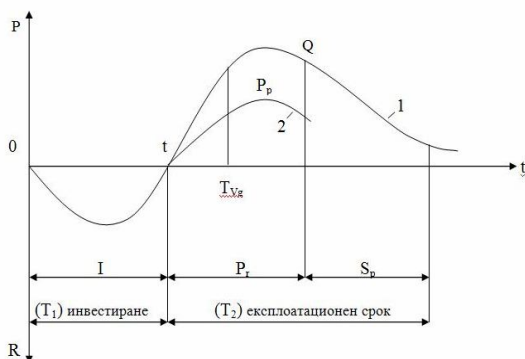


Fig. 1. Life cycle of innovative products

where: P – volume (num., BGN);
t – time;
P_p – the profit curve;
T₁, T₂ – time periods;
T_{vg} – performed volume work of the machines;

Q – number of items in a specific machine;

I – period of input of resources;

P_r – period of return on investment;

S_p – period of drop;

1 – curve defining the changes in the life cycle of innovative products (machinery);

2 – curve of return on money and profit.

In this respect, the factors that determine and influence the lifetime of the machines have the greatest impact on their production. They can be considered barriers to the duration of their service life [5]. They include: the rapid obsolescence of innovative machinery, specific technical parameters of the new machines, lack of good development, the market share of new machines, customer behavior, dynamics, growth, market stability, performance and competitors.

3. Lifetime and innovative obsolescence

For the efficient production of innovative products (machinery) the most important thing is durability. However, it is highly dependent on and influenced by their innovative obsolescence. The greater the risk of rapid onset, the shorter the lifetime of the machines (T₂):

$$(1) \approx T_e$$

where: T_e – time to exploitation.

$$(2) \approx T_n + T_{np} + T_z$$

where:

T_n – time to produce; T_{np} – standing time, regulated by structure of the machine.

The production time includes both technical time and the time for operational details of transport, accommodation, technology and fine regulated by others, or:

$$(3) \approx t_{osn} + t_{sp} + t_z$$

where:

t_{osn} – execution time of basic operations; t_{sp} – auxiliary time (changing tools, etc.); t_z – time to loss.

During T_n to produce a certain volume of products or carry out the workload and to recover the investments for purchase of a

machine. Because the invested funds for the purchase of a machine should be returned as soon as possible for this volume of work performed (V_g) for a specified time T must define optimality. This means that:

$$(4) \quad V_g = Q_{gh} \cdot T_{gh}$$

where: T_{gh} – volume work in BGN; Q_{gh} – production per hour in BGN; T_{gh} – time in hours.

Workload depends on the underlying transactions and the auxiliaries and time loss, which characterizes the production conditions of machine operation. Alternatively volume of work will depend on the parameters of the machine to start work (N_i) and to finished (N_f), with i-work or:

$$(5) \quad N_i \rightarrow \sum_i^n \left[\sum_i^m (Q_i \rightarrow Q_{npi}) \rightarrow \sum_i^m Q_{npei} \right] \rightarrow N_f$$

where: Q_i , Q_{npi} , Q_{npei} – are respectively the main operations and supporting operations and those related to specific production conditions.

4. Determination of the workload for the purchase of the investments

The volume of work should chart as shown in Figure 1 – curve 1, and curve 2 defines the means of return on investments in original purchase of the machine. This is the deadline for payback of the machine:

$$(6) \quad C_o = \frac{U_p}{P_p} - A$$

C_o – period for purchase of machinery; U_p – money to purchase machinery; P_p – earnings (discounted cash flow); A – amortizations, BGN.

Then the volume of work that will include such profits before the machine innovation is out of date will be determined by the formula:

$$(7) \quad V_{gh} = V_{oh} + V_{sph} + V_{zh}$$

where:

T_{vgh} – volume work / time /; V_{oh} – volume of work including mainly time; V_{sph} – supportive time for the whole useful life; V_{zh} – loss of time for the whole useful life.

$$(8) \quad V_{gh} = V_{oh} + V_n$$

$$(9) \quad V_{gh} = V_{sph} + V_{zh}$$

where: V_n – unproductive time for the the whole useful life; V_{zh} can be positive or negative depending on whether losses were foreseen (planned) for the whole period (useful life) or not.

So the equation has the form:

$$(10) \quad V_{gh} = V_{sph} + V_{zh}$$

The optimal useful life T_e will be equal to the optimal volume work T_{vgh} and it in turn, of the period of the coming innovative obsolescence T_{vo} of the machinery or:

$$(11) \quad T_e = T_{vq} = T_{vo}$$

The lifetime of the machine should be determined as early as the design stage and its duration can be calculated as the amount of

work that will make this machine for this useful life. It depends on the potential of the machine to work and produce for a certain period of time and the amount of work but it depends on the operating conditions in which the machine works.

5. Conclusion

The following conclusions can be drawn:

1. We examined the relationship between the lifetime industrial products (machinery) and duration of their obsolescence innovation.
2. Proposed is a way of determining the life cycle of machines depending on the coming innovative obsolescence. For this purpose approach to workload which should make the machine in this useful life is used.
3. The proposed formulation is to determine the workload, which should make the machine recover the money for its purchase.

6. Literature

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