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Раціональні шляхи формування, використання та відновлення виробничого потенціалу металургійного підприємства

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Rational ways of forming, utilization and restoration of the production potential of a metallurgical enterprise

Анотація. *Мета та завдання. Теоретико-аналітичне обґрунтування категорії «виробничий потенціал підприємства»; визначення, на основі аналізу існуючих наукових поглядів, його основних специфічних складових та умов раціональної реалізації його складових у металургійному виробництві; визначення факторів зовнішнього впливу, які визначають динаміку раціонального використання складових потенціалу та ефективні способи формування виробничого потенціалу підприємства. Методика. Комплексний системний метод наукового обґрунтування умов забезпечення позитивного балансу між складовими виробничого потенціалу підприємства та раціонального використання його ресурсно-сировинної складової на основних етапах життєвого шляху виробничого процесу. Наукова новизна. Уточнено сутність «потенціалу» як категорії, що визначає здатність об'єкта або його складових під впливом певних факторів зовнішньої дії трансформувати комплекс вихідних властивостей, сформованих природним або штучним способом, в комплекс споживчих властивостей продукції, які забезпечують мінливі за вимогами потреби суспільства. Практична значимість. З урахуванням стану вітчизняного ГМК та потреб суспільства в забезпеченні його соціально-економічного розвитку запропоновано комплексну схему, запровадження якої дозволить найбільш раціонально використати корисні властивості наявних потенціалів металургійного виробництва.*

Abstract. *Purpose and objectives. To provide a theoretical and analytical substantiation of the category "production potential of an enterprise"; to identify, based on the analysis of existing scientific approaches, its main specific components and the conditions for their rational implementation in metallurgical production; to determine external factors influencing the dynamics of the rational use of potential components and effective methods for forming the production potential of an enterprise.Methodology. A comprehensive systematic approach to scientifically substantiate the conditions for ensuring a positive balance between the components of an enterprise's production potential and the rational use of its resource and raw material component at the main stages of the production process life cycle. Scientific novelty. The concept of "potential" is clarified as a category that defines the ability of an object or its components, under the influence of certain external factors, to transform a set of initial properties (formed naturally or artificially) into a set of consumer properties of products that meet the evolving needs of society. Practical significance. Taking into account the current state of the domestic mining and metallurgical complex and the societal demand for socio-economic development, a comprehensive framework is proposed. Its implementation will enable the most rational use of the beneficial properties of the existing potentials of metallurgical production.*

Introduction. "Potential" as a term has become widespread among scientists to determine rational ways of using available or still hidden material resources, equipment involved in the production process and the capabilities of an enterprise. Their potentials, as components of the total, are realized in the course of a business entity's activities.

Assessment of the overall potential of the enterprise's production strength makes it possible to identify areas for further improvement of existing technologies and to find ways to effectively use its useful components. In addition to the cost-benefit assessment of the technical and economic indicators of the production process, it is important to determine the rational degree of use of the useful properties of the components of the enterprise's initial potential.

Natural resources can be divided into groups according to their "exhaustion": conditionally inexhaustible (energy of the sun, wind, water, atom, etc.); exhaustible non-renewable (mineral raw materials, fossil fuels, etc.) and renewable (materials of plant origin and waste from their industrial processing). It is advisable to distinguish a separate group of man-made waste, which is inevitable at this level of development of science and technology. The latter group, through special treatment, becomes a reserve of raw materials in the context of depletion of the potential of raw materials.

The task important for solving the current problems of ferrous metallurgy is the scientific substantiation of conditions that will ensure a positive balance between the components of the production potential of the enterprise and the rational use of its resource and raw material component at all major stages of the life of the production process, which are implemented according to the scheme shown in Fig. 1.

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factors whose impact on the system will increase the level of utilization of its physical and chemical potential will be determined.

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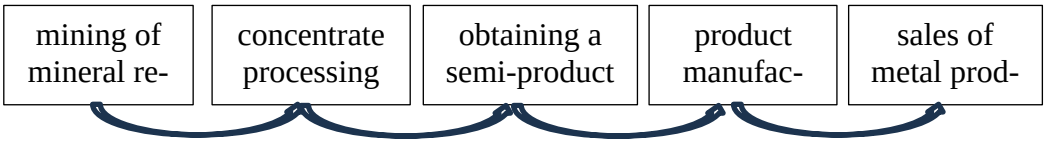

Figure 1 – Main stages of the production process lifecycle

Based on the lifecycle analysis of physicochemical potential of the metallurgical system under study, the factors whose impact on the system will increase the level of utilization of its physical and chemical potential will be determined.

In a generalized form, “production potential” should be defined as sources, means or opportunities that can be used to solve problems to achieve a certain goal in a certain area by creating appropriate conditions for the realization of useful components of the potential. In essence, this category defines the capabilities of the relevant object to use its properties in modern production processes, which have been hidden until a certain time.

The metallurgical industry is a complex of enterprises engaged in multifunctional activities that must be stable in development and resistant to negative risks and threats of both external and internal origin. The balanced use of the properties of the components of the initial production potential of enterprises in this industry ensures its stable development. Interaction of external factors and properties of the potential is a condition for the effective implementation of the life cycle of the production process in terms of final results. The properties of potentials of artificially created methods of external influence are used in almost all known spheres of activity created by using the intellectual component of human personal potential.

During the evolutionary development of society with the corresponding development of the individual's intellect, in accordance with the requirements of society, the quantitative, qualitative composition and ratio of useful properties of the potentials determined for use changed. The capabilities of this component of the individual's potential are used to improve technology and equipment, develop resource-saving, energy-efficient and rational production methods for mineral raw materials and energy resources. This potential also allowed us to develop our own clone, artificial intelligence.

Analytical review of recent studies and publications. The paper examines specific varieties of the category “potential” by identifying their components, sources of origin, conditions of formation, and directions for the rational use of their elements. Data on the depletion of mineral resources indicate that the currently known reserves of mineral raw materials will be exhausted within the coming decades [1]. According to the *Mining Encyclopedia* [2], which is based on research from 2001, deposits of aluminum ores will be depleted in the next 55 years, chromium – in 154 years, coal – in 150, iron – in 173, oil – in 50, and natural gas – in 49 years. Despite the discovery of new deposits of mineral resources, the time when reserves of metal ores and fuel-energy resources will be exhausted is approaching. The recently developed “theory of natural resource depletion” is interpreted as the “onset of natural hunger.”

According to forecasts, the reserves of natural resources will last for only 3 to 6 generations. Therefore, solving this problem is vital for humanity. The period of resource use on our planet can be extended by reducing their consumption, developing methods for their rational use, and involving alternative and renewable energy sources, as well as the useful potential of technogenic waste, in production processes. Thus, in addition to the growing imbalance between societal development and natural resources outlined in [1], it is also reasonable to add the irrational use of the potential of mineral and energy resources in modern production processes as a cause of the current situation.

Since the invention of production methods based on human labor activity, all means created by humans, as well as the possibilities of their implementation and improvement, have come to be referred to as "potentials."

Subsequently, these were classified according to their specific properties, source of origin, usage directions, and impact on the environment.

According to our interpretation — which has the right to exist — in order to evaluate the quantity and quality of the capacities of natural and artificial resources, researchers have borrowed the long-established concept of “potential” from physics, mathematics, chemistry, and other exact sciences.

All material elements around us that have been created by nature can be regarded as components of the Earth's initial potential. Humans use them in their activities.

The strength of the general potential and the rational use of its natural and artificial components ensure a country’s economic independence and sovereignty.

The analysis of research results concerning the essence of the concept of “potential” revealed a tendency toward constant changes in its interpretation [3]. Significant discrepancies were found both in defining the essence of the category “potential” and in identifying its components.

Nineteen approaches to managing the competitive potential of an enterprise were identified, which are reasonably considered its components. The author of study [4], analyzing the evolution of economic thought regarding the enterprise potential from 1981 to 2018, states that during this period, fourteen types of enterprise potential have been distinguished in domestic literature.

The systematization of approaches to defining the essence of the category “potential” enabled the author to identify three main types of potential: resource-based, goal-oriented, and systemic.

In study [5], an attempt was made to classify potentials according to their specific features.

For instance, the authors of [6] classified potential using thirty criteria and identified as many as seventy-four of its types. According to the authors, this makes it possible to reflect various aspects of potential in enterprise management. Reflect – perhaps. But doubts arise regarding their practical application. The author of study [7] believes that the elements of an enterprise’s production potential are resources in any way related to the functioning and development of the enterprise. Choosing the most important ones from such a large number is a complex issue.

The author further defines enterprise potential as a complex system, which makes it impossible to study without identifying its components and the links between them. Once again, defining potential solely as an economic category, the researchers overlook the fact that its origin lies in the exact sciences: mathematics, physics, and chemistry. It must be acknowledged that the essence of the main properties of potentials, as well as the corresponding processes, is physico-chemical in nature.

Thus, the attempts presented in scientific literature to classify the components of potentials based on their specific characteristics are not perfect. The dynamic increase in the number of identified potentials and their components does not contribute to a deeper understanding of the essence of these categories. Many questions regarding the components of the metallurgical enterprise's potential remain debatable. An important direction for further scientific research is to determine the role and influence of production potential in the formation of the enterprise’s overall potential in interaction with other types.

We believe that reaching a consensus amid the large number of different perspectives on the components of production potential is possible by identifying individual components whose interaction forms the basis of the production process.

The author of [7] concluded that it is impossible to produce highly profitable products and generate profit without the full and rational use of an enterprise’s production potential and the organization of uninterrupted operations. Rational and full use of the initial production potential is a rather complex task, and “full” does not always mean “rational”. At certain stages of the production process, the notion of “full” utilization may even contradict the intended goal. Therefore, the answer to the question of the most optimal ratio of these characteristics can be found through an investigation of the specifics of using the physico-chemical potential of production processes, with a focus on determining a sufficient level of its utilization to achieve the set objective.

Figure 2 presents a diagram of the formation and rational use of the components of production potential at the main stages of metallurgical production, which takes into account:

the specific features of the metallurgical enterprise's activity,

the interconnections between its structural elements,

influence of external factors on the formation of its components,

the correlations between the initial properties of production process components and the qualities and properties of the final product.

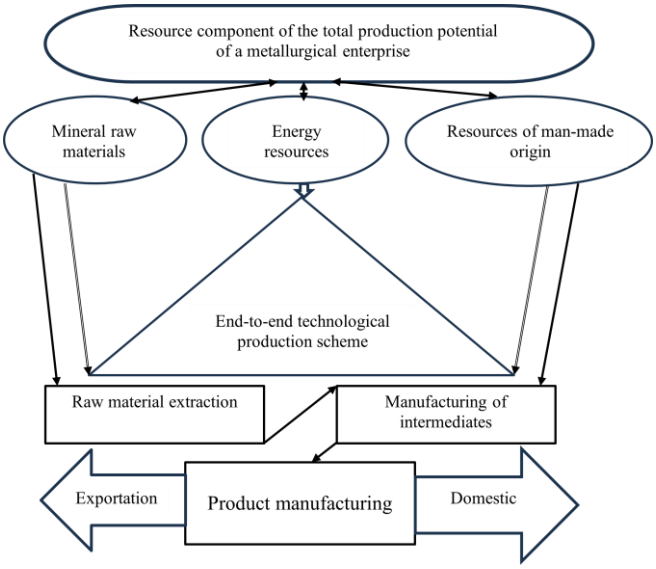

Fig. 2 – Diagram of the Formation and Rational Use of the Components of Production Potential at the Key Stages of Metallurgical Production

The review of scientific sources conducted in this study led to the conclusion that the most widely used interpretation of the term “enterprise potential” is as a combination of natural conditions and resources, opportunities, and reserves that can be utilized to achieve the set goals. As important components of its production potential, it is advisable to define the potentials of raw materials, energy, technology, and equipment. These components, in interaction, determine the characteristics of the production process, and the category of “enterprise production potential”, in our opinion, is more universal in terms of the essence and importance of its components.
It is also necessary to highlight the importance of other potentials as measures for creating conditions for the rational, safe use of the enterprise’s production potential: organizational-management, financial-economic, psychological-emotional, compliance, and other components.

The most common method in modern economic methodology for assessing the enterprise's potential is its cost and expense assessment [8]. In the study of strategic management of the economic potential of a metallurgical enterprise [9], the principles of potential evaluation were substantiated; the characteristic features of the enterprise's potential as an economic system were provided; the factors were analyzed, and the technology of anti-crisis management of the enterprise's potential was defined.

Discussion of Results.

Nature, long before the appearance of humans, created a resource, or more precisely, a raw material-energy potential in the form of deposits of mineral raw materials, coal, gas, oil, and others. Humans, in their activities, utilize the beneficial properties of the components of this potential, which have a physicochemical basis.

In the course of its operations, an enterprise forms its overall potential from the following components, which determine the scope of their functional purpose and realize their potential in technological processes: production, innovation, financial, market, intellectual, organizational, informational, investment, security, and others.

The use of the formed initial production potential of the enterprise should be viewed as creating conditions for transforming the potential properties of the initial object – the metallurgical system – into the real qualities of the newly created object. It is important to note that most studies on determining the characteristics of the enterprise's potential analyze the significant organizational, managerial, security, and economic factors involved in its formation and utilization. However, the crucial issues concerning the use of the initial physicochemical potentials (FCP) of the components of the real metallurgical system remain almost ignored by scientists.

The dynamics of utilizing the components of potential are determined by the specific features and technological needs of the production processes. Continuous and rational use of the beneficial properties of the components of the production potential is one of the conditions for ensuring the stability of the processes that produce high-quality, competitive products. As a result of the use of certain properties, the initial potential requires determining effective sources and methods for its restoration, ensuring its reserves.

The stability of the enterprise's activities and its production processes is a factor influencing the final production results, determining both its qualitative indicators and the rationality of the components of the enterprise's potential that were used. Stability is ensured if the potential real resources of raw materials and energy meet the level of current resource needs, sufficient for producing products in the planned period.

Thus, the basis for the majority of processes, both of natural origin and those artificially created by humans, such as the production of metals and alloys, is the use of the physicochemical potential of the resources involved in them. The level of its utilization depends on the effectiveness of external actions on the physicochemical potential of the metallurgical system, which consists of mineral raw materials, energy, and other materials. The externally controlled action, which has its corresponding potential properties (oxidizing, reducing, thermal, etc.), takes the potential of the initial physicochemical properties out of dynamic equilibrium, initiating the development and realization of transformations at the relevant stages of the technological process.

The methods of forming and implementing the physicochemical potential of metallurgical systems (FCPMS) have been realized in modern technologies for the production of ferrous metals and alloys. Further improvement of existing technologies is based on achieving a rational interaction between the resource and raw material component of the production potential and the potential of external influences on the metallurgical system in terms of costs for raw materials and energy.

Conclusions.

Resource potential, as one of the main components of the enterprise’s production potential, which is formed from resources of natural origin and artificially created, is defined as the synthesized physicochemical potential of their initial properties within a material object. The latter, under the influence of external factors, can transform its initial physicochemical properties into a product with the expected quality and characteristics.

The category of “potential” requires not further popularization, but rather an expansion of the spectrum of its components, as yet unused possibilities, which should be determined based on scientific justification of its appropriateness and practical significance for the development of human activities. Greater attention from scientists is required to address the problem of increasing the utilization of the resource and raw material components of the production potential of a metallurgical enterprise by justifying, developing, and

applying effective methods of external influence on the metallurgical system being studied.

It has been established that the development of the concept of restoring the level of development of domestic metallurgical production, which will have significant chances of implementation, is possible through the mandatory fulfillment of the following conditions: reorganization of relationships in the "market – enterprise – state" system; achieving a balance between the pace of development of economic and social processes as required by society; changes in the market conditions of the domestic and international markets for iron ore, energy resources, and metal products, which will ensure the long-term stability of the raw material base of the metallurgical industry and the sustainable development of enterprises in the industry.

In conditions of uncertainty, counteracting the risks that arise when internal regulations, conditions, and rules are violated (the fulfillment of which is mandatory) is the potential of functional properties of the compliance control service, the use of which promotes the targeted, safe, and high-quality use of the components of the enterprise's production potential.

Priority tasks also include creating conditions for enterprises, with substantial support from the state, that will allow for the effective implementation of investment and innovation measures.

Reference

1. Kyseliov, M. M. (2023). *Entsyklopediia Suchasnoi Ukrainy [Encyclopedia of Modern Ukraine]* Instytut entsyklopedychnykh doslidzhen NAN Ukrainy. https://esu.com.ua/article-881633.
2. Biletskoho, V.S. (ed.). (2007). Donbas.
3. Barybina, Ya. O. (2011). Pidkhody do vyznachennia sutnosti poniattia "potentsial" u katehorialnomu aparati. *Naukovyi visnyk Poltavskoho universytetu ekonomiky i torhivli*, 6(51), 48-53.
4. Aliiev, R. (2019). Sutnist poniattia "potentsial" ta yoho skladnyky. *Pidpryiemnytstvo ta innovatsii*, 9, 54–59. https://doi.org/10.37320/2415-3583/9.8.
5. Kvasnytska, R. Tarasiuk, M. (2017). Strukturyzatsiia potentsialu pidpryiemstva. *Visnyk KNTEU*, 1, 73–82
6. Krasnorutskyi, O., Marenych, T., Prusova, H. (2024). Vyrobnychyi potentsial pidpryiemstva yak ekonomichna katehoriia. *Aktualni problemy innovatsiinoi ekonomiky ta prava*, 1, 76-83.
7. Sarai, N. I. 2012. Vyrobnychyi potentsial pidpryiemstva: sutnist ta osoblyvosti diahnostyky. *Innovatsiina ekonomika. Vseukrainskyi naukovo-vyrobnychyi zhurnal,* 12, 100-103.
8. Sabadyrova, A. L. (2011). Potentsial promyslovoho pidpryiemstva: orhanizatsiia otsinky. *Mekhanizm rehuliuvannia ekonomiky*, 4, 115-121.
9. Afanasiev, Ye. V., Nusinov V. Ya. (2013). Stratehichni napriamky hirnycho-metalurhiinoho kompleksu shchodo vyrishennia zavdan zahalnoderzhavnoi prohramy rozvytku mineralno-syrovynnoi bazy Ukrainy. *Efektyvna ekonomika*, 5. http://www.economy.nayka.com.ua/?op=1&z=2061.

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