NBIC TECHNOLOGIES FOR A SYSTEM OF INTELLECTUAL SUPPORT OF INNOVATIVE ACTIVITIES OF INDUSTRIAL ENTERPRISES

NBIC-ТЕХНОЛОГИИ СИСТЕМЫ ИНТЕЛЛЕКТУАЛЬНОГО ОБЕСПЕЧЕНИЯ ИННОВАЦИОННОЙ ДЕЯТЕЛЬНОСТИ ПРОМЫШЛЕННОГО ПРЕДПРИЯТИЯ

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Abstract: *Methodical approaches to the creation of NBIC technologies for a system of intellectual support of innovative activities of industrial enterprises (SISIA IE) of the second integration level as a complex of research, educational and production units that generate high-level intellectual products for the operating and innovative production were considered. As examples of integration model realization have been given the functional nanomaterials based on polymer, oligomer matrices and blends for protective, sealing and tribotechnical systems of machines, mechanisms and technological equipment of industrial enterprises and enterprises of the chemical industry.*
KEYWORDS*: NBIC TECHNOLOGIES, NANOMATERIALS, INTELLECTUAL PRODUCTS, INNOVATIVE POTENTIAL, SYSTEM APPROACH, INTEGRATION*

1. Introduction

An analysis of trends in the development of continental government structures and intergovernmental formations shows that there is no alternative to the strategy of innovative development due to a combination of a number of favorable and unfavorable factors associated with fundamental changes in the geopolitical situation during a relatively small historical period, progressive localized population growth, depletion of basic raw materials, ecological conditions of the single continents, world's ocean and the planet [1-9].

This necessitates a deep and systematic study of the multifaceted problem of the impact of innovations on macroeconomic and socio-political development trends both of single regions and state and supranational formations. In this aspect, the task of development of the methodological principles for the formation and development of an innovation strategy for economic entities of various functionality and forms of ownership.

An analysis of the features of the development of the world economic system shows that the strategy of sustainable development of a socially-oriented state is based on the realization of functional innovations in various spheres of the societies functioning. These innovations are combined by a complex of NBIC-technologies with the defining role of new generation nanomaterials.

Innovations that form the modern material, technological and administrative base of industrial production are the result of the intellectual activity of various participants in the life cycle of products – scientific research institutes of the National Academy of Sciences, institutions of higher education, professional institutes for the retraining of personnel, industrial enterprises of various forms of ownership and industry affiliation [3].

Definitely that there is an obvious need for the creation of a specific infrastructure that can ensure the practical organization of innovation policies at the state, regional and subject levels. Practical experience in the creation and functioning of such an infrastructure exists in the industrially developed countries and in the states of the post-union social, political and economic space [2, 3, 5, 6, 8, 9].

Before, we proposed a methodology for the formation of a system of intellectual support of innovative activities of industrial enterprises (SISIA IE) which allows to generate intellectual potential for a permanent increase in the share of innovative products at the total volume of manufactured goods [7].

At the same time, for the practical realization of the SISIA IE in the activities of economic entities, there is need to develop approaches for its integration with the real infrastructure of the industrial enterprise.

The purpose of this study was to develop an algorithm for the functioning of the intellectual support system in the production activities of economic entities of the regional industrial complex during creation of functional nanocomposite materials based on high molecular weight matrices for use in metal-polymer systems of various designs.

2. Research methods

The main method of this research is a system analysis of the features of the Grodno region industrial enterprises functioning. System analysis made it possible to identify the features of the development and practical application of intellectual resources with various functionality in the production activity of economic entities with different levels of innovative development. We focus primarily on the nanocomposite materials obtained by modification of thermoplastic matrices using nanoscale particles with different structure and production technology. The practical approbation base for the developed nanocomposites was Grodno region industrial enterprises have special emphasis on the innovative development – Belcard JSC, Grodno Azot JSC, Grodno mechanical plant JSC, Belvtorpolymer JSC, Zwetlit UE.

3. Results and discussions

The analysis of the research of domestic and foreign scientific schools in the field of the formation and development of the postindustrial economy, defined as the "knowledge economy" ("new economy") demonstrates the need for a system approach to the organization, development and intensification of innovation activities of industrial enterprises [5-7]. The main idea of the system approach is the permanent increase of the capacity (ability) of economy entities to produce innovative products with high parameters of consumer characteristics. Such parameters ensure sustainable economic and social development of the industrial enterprise in the near and far term in accordance with the basic principles of the National Sustainable Development Strategy of the Republic of Belarus adopted at the legislative level.

The most important criteria for the realization of system approach is the creation of conditions for the generation of intellectual products of various functionality. These conditions determine all the stages of the productive activity of a economy entity in accordance with the current legislation regulation of economic, technological, social, organizational and other rules and laws.

For the practical realization of the system approach in accordance with the requirements of the national strategy, a system

of intellectual support of innovative activities of industrial enterprises (SISIA IE) was developed and the principles of its formation and functioning in the interests of development of economic entities of various departmental subordination, functionality and ownership were determined [7]. The presence of basic and variable components in the SISIA IE creates stable prerequisites for the creation of intelligent products of various types, the use of which in the real production process ensures the manufacturing of industrial products with high parameters of consumer characteristics. The realization of these industrial products creates an economic basis for functioning. At the same time, the share of innovative products that have fundamentally new parameters, new consumer value and create conditions for expanding of the occupied market sector or creation of fundamentally new sectors that guarantee permanent sustainable economic development of industrial production in the long term, is increasing. High-level innovations based on new types of materials and technologies create prerequisites for the development of the economy entity in the occupied sector of the market and allow the manufacturer to control the tendencies of its functioning by a consistent (controlled) change of varieties, called the "innovation line".

In this work we will consider the methodology for the realization of the developed SISIA IE in the industrial enterprise of the machine building profile.

To support the effective functioning of the SISIA IE, its infrastructure should include components that ensure the generation of intelligent products for special purposes and their realization in the form of objects of industrial and intellectual property which determine the activities of an industrial enterprise in accordance with the requirements of the subjects of the regional and state regulatory legal base.

These components of the SISIA IE infrastructure include:

- educational component;
- research component;
- production component.

These components are integrated by organizational criterions under the specialized innovation cluster type structure with an appropriate system of administration, economic control and support [3, 7].

The presence of educational and research components makes it possible to realize the integration principle in the formation of aggregate intellectual resources including tangible and intangible intellectual assets belonging to higher educational institutions, a regional industrial enterprise, and a specialized research subdivision [3]. Integration takes place under the internal research at the enterprise in the field of innovative development or tasks of regional, sectoral or state scientific and technical programs.

The feature of the SISIA IE intellectual resources is their adaptation to the real production process and high efficiency of use in the interests of innovative development of a specific industrial enterprise. In addition, the integration principle of its formation makes it possible to change its components depend on the problems of innovative development and carrying out their updating (improvement) in accordance with changing trends in the functioning of the regional, state and global markets.

The functioning of the components of the SISIA IE is carried out as follows.

The presence of an educational component in the form of branches of profile departments of regional and other higher educational institutions (Figure 1) allows to carry out essentially new functions in the interests of an industrial enterprise:

- practical-oriented training of engineers adapted to the current production;
- targeted training of research staff for the realization of internal research;
- practical-oriented training for innovative production;
- targeted retraining of engineering and technical staff and professional development of personnel to reflect trends in innovative development.

The realization of these functions of the SISIA IE educational component allows to increase the intellectual potential of the subdivisions included in the infrastructure of the industrial enterprise in the form of a system of specialized departments that are subordinate to the main specialists – Chief Engineer (CEn), Chief Technology Officer (CTO), Chief Mechanic (CM), Chief Power Engineer (CPE), Chief Accountant (CA), Chief Economist (CEc). The functioning of the educational component, in the activity of which the leading specialists of the enterprise take part, makes it possible in the conditions of the existing infrastructure to realize the principle of practical-oriented training of engineering and technical staff provided by the Education Code of the Republic of Belarus. Also, the terms of adaptation of young specialists to the conditions of current production are sharply reduced and opportunities for the inflow of intellectual resources of the advanced level are created. At the same time, the educational component carries out targeted training of research personnel for a specialized research department for systemic internal research.

The studies conducted under their own innovation development plan or assignments of state, regional and sectoral scientific and technical programs create the conditions for the development of innovations for various functionality, which are the basis of innovate activity. Participation of leading researchers in the educational process of branches of profile educational departments raises the level of professional training of students, include developing practical skills in research activities under the specific projects.

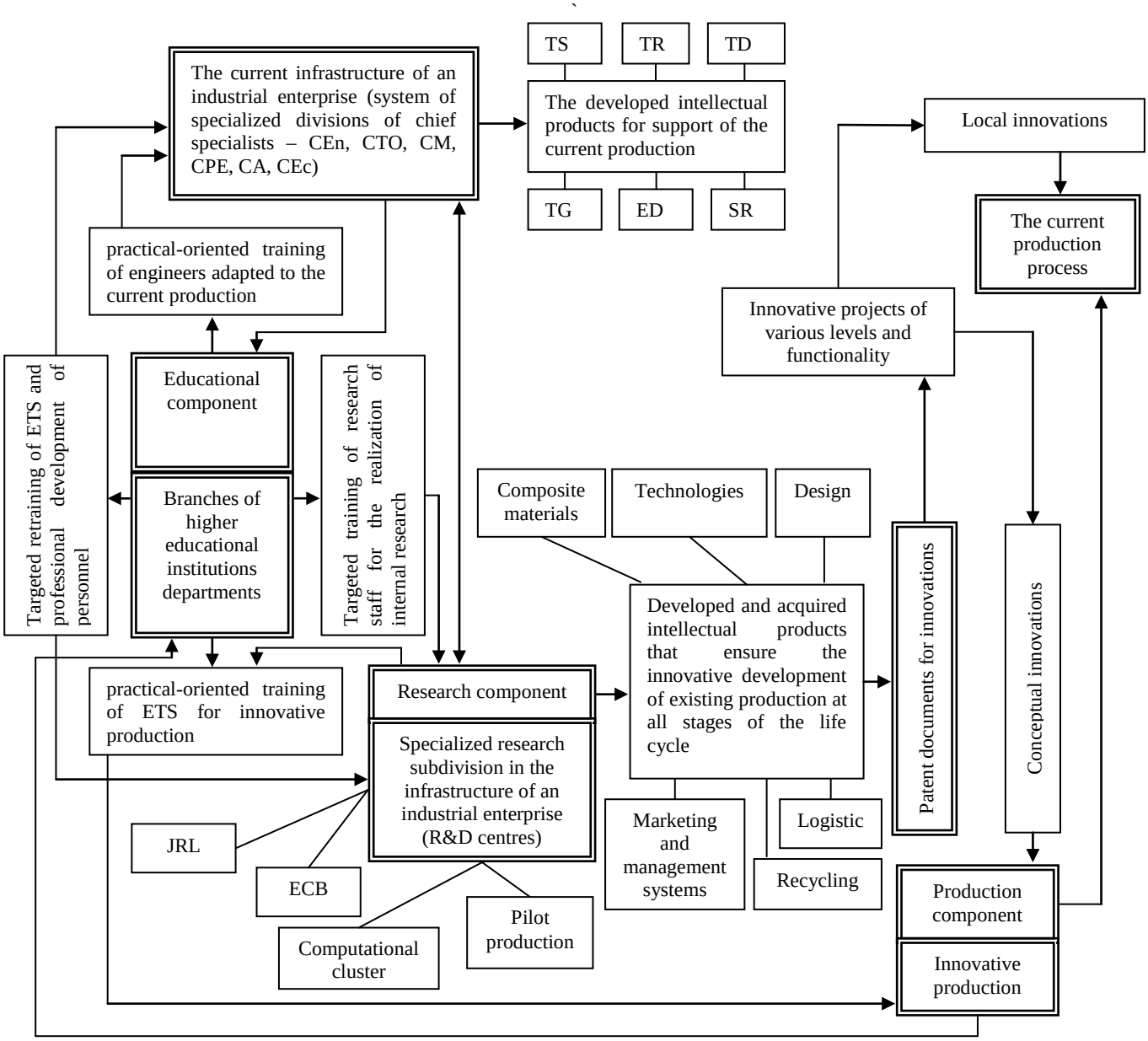
The presence of an educational component allows to solve the clearly expressed problem of staffing of innovative production, which is segregated in the actual infrastructure of an industrial enterprise into an independent subdivision. The increasing of professional competencies of specialists trained at branches of profile educational departments is facilitated by the participation in the educational activity of leading specialists of innovative production.

The necessary function of the SISIA IE educational component is the organization of targeted retraining of engineering and technical staff and professional development of personnel on the basis of modern achievements of fundamental and applied research realized in the system of the National Academy of Sciences and Higher Educational Institutions taking into account the traditional system of the enterprise's activities.

Thus, the SISIA IE educational component forms the intellectual potential of various infrastructural subdivisions of the industrial enterprise and provides the prerequisites for increasing of the innovation susceptibility of all production activities participants regardless of job competencies and education basic level. The generated intellectual potential, which is in permanent improvement and development, is realized in the form of intellectual products with various functionality, level and application area.

A system approach to intellectual support will allow the development of intelligent products both ensuring the current production process (Technical Specification (TS), Technical Regulations (TR), Technical Documentation (TD), Technical Guidelines (TG), Occupational Protection and Safety Regulations (SR)) and products that determine the strategy of innovative development in accordance with the concept of the life cycle of innovative product. Among such intelligent products are new types of composite materials, energy-, resource-saving and high technologies (high-tech), new product designs, quality management systems, systems of management and marketing, supply chain logistics systems, technologies for recycling of technological waste and depreciated products in accordance with the requirements of environmental legislation.

An important feature of SISIA IE is the development of a complex of patent documentation for created intellectual products in the form of industrial property items (IPI). It allows to ensure the system protection of the occupied market sector and the long-term perspective of its development through the consistent introduction of modifications which are part of the general "line of innovations".



CEn – Chief Engineer;
CTO – Chief Technology Officer;
CM – Chief Mechanic;
CPE – Chief Rower Engineer;
CA – Chief Accountant;
CEc – Chief Economist;
TS – Technical Specification;
TR – Technical Regulations;
TD – Technical Documentation;
TG – Technical Guidelines;
ED – Electronic Data;
SR – Occupational Protection and Safety Regulations;
ETS – Engineering and Technical Staff;
JRL – Joint Research Laboratories;
ECB – Electronic Component Base;
R&D centres – Research and Development Centres

Figure 1 – The main directions of structural modification in materials science and technology of polymer composite materials

Thus, the developed algorithm of the SISIA IE functioning allows to form the intellectual products (intellectual resources of industrial enterprise) that constitute a variety of innovative projects, the realization of which make it possible to carry out production activities and increase the share of innovative products in the total output product. The developed relatively low level innovations (local innovations, maintenances) allow to support a high level of current production and improve its organizational, technological, material, personnel, economic security. High level innovations form the basis for effective activity of the SISIA IE production component that functions as a specialized innovative production.

The testing of SISIA IE as part of the second integration level model at industrial enterprises of the Grodno region enabled to develop the functional nanomaterials based on polyamides, fluoroplastics and polyolefins for the production of tribotechnical coatings for automotive components, compressors sealing elements for liquefied gases and structural components for energy-saving systems. The methodological approach to the creation of nanomaterials with high parameters of functional characteristics

consisted in the introduction of nanoscale (carbon-, metal- and silicon-containing) particles into polymer matrices at the stages of obtaining materials, processing them into products and preoperational treatment.

Experimental and industrial application of products and coatings from the developed nanocomposites based on aliphatic polyamides (PA6, PA6.6), polytetrafluoroethylene (PTFE), primary and regenerated polyolefins (PP, HDPE, LDPE) at the enterprises of the Grodno region was carried out. A patents for an invention and normative technical documentation regulating the using of nanocomposites in machine building were developed.

4. Conclusions

The directions of system intellectual support of innovative activity of regional industrial enterprises were considered. The perspective of the methodological approach based on the implementation of the integration principle of the intellectual potential of the enterprise by combining the intellectual resources of research, educational and industrial institutions and organizations with the use of a cluster scientific-educational and production structure was shown. The effectiveness of the cluster innovative structure was realized due creation of the nanocomposite materials based on thermoplastics for use in the machines, mechanisms and technological equipment with high performance parameters.

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