DISTINCTIVE FEATURES OF "SCIENCE-INTENSIVE PRODUCTS" AS INNOVATIVE WITH ESPECIALLY HIGH PROPERTIES

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Abstract: In this article the author grouped the main types of science-intensive products in the following types: precision alloys - soft magnetic with special physical properties, special electrotechnical alloys, deformable magnetic-hard materials, alloys with a specified temperature coefficient of linear expansion, alloys with specified elastic properties, alloys with high electrical resistance; special corrosion-resistant steels and alloys, special heat-resistant and high-temperature alloys by different characteristics.

Keywords: INNOVATION ACTIVITY, APPLIED RESEARCHES AND DEVELOPMENTS, METAL PRODUCTS, SCIENCE-INTENSIVE PRODUCTS

1. Introduction

Theoretical and methodological content of concepts: "innovation activity", "innovative" and "high-technology products" is examined in a number of researches of Russian and foreign economists.

2. Results and Discussion

According to the definition of the Russian Statistical Yearbook, "innovation activity" is a type of activity related to ideastransformation (the results of researches and developments, other scientific and technological achievements) into new or improved products and services introduced to the market.

This definition is quite complete and accurate, and the most significant is that it is based on all statistical processing of factual information about scientific and technological achievements in Russian industry and comparison with foreign indicators.

The results of innovation activity are realized both through the creation of fundamentally new technological processes and materials characterized by new consumer performances.

According to the definition proposed by the Organization for Economic Cooperation and Development (OECD) in conjunction with the EU's Bureau of Statistics, "Innovation is the introduction of a new or significantly improved product (service) or process, a new marketing method or a new organizational method in business practice, organization of workplaces or external relations " [1].

The OECD Recommendations distinguish four types of innovation: product, process, marketing and organizational.

The basis for creating fundamentally new technologies and products is new scientific knowledge obtained as a result of scientific researches.

The definition "scientific researches" is interpreted in the Russian Statistical Yearbook as "an increase and a search for new fields of knowledge applications".

The expert in the field of knowledge-based economy, a member of corr. RAS Kleiner G.B. evaluates knowledge (cognition) as the same resource as fixed assets, financial, managerial funds, etc. Knowledge embodied in a new technology and fundamentally new products acts as the most important resource for their creation [2].

Innovative activity combines new scientific knowledge and its materialization realized through innovative technologies and equipment into innovative products.

Scientific organizations are the main source of new knowledge formation, and scientific developments being a direct product of their activities are the basis for innovative technologies and products creation.

This particularly relates to applied researches and developments.

According to the definition given by Glukhov V.V. [3], "Applied scientific researches include studies aimed primarily at applying new knowledge to achieve practical goals and solve specific problems". And if "fundamental science studies the world irrespectively of the practical application possibility, applied sciences are oriented towards the knowledge application through their implementation in specific scientific developments transferred for later use by an industrial enterprise".

In market conditions, applied scientific developments have become a product which implementation determines the financial condition of scientific institutions.However, the studies conducted on the metallurgical complex show that due to the impossibility of modern equipmentmanufacturing by Russian enterprises, the scientific developments of Russian research institutions are unclaimed.

Over the years of market reforms the development of Russian engineering industry was systematically underfunded. Therefore, Russian metallurgical enterprises purchase 80-85% of equipment abroad in conjunction with new technologies.

The analysis of applied research institutes interaction with Russian metallurgical enterprises shows that every year it becomes more difficultto receive a contract from industrial companies. Orders are received only for the acquired technologies development, as well as partially for the modernization of existing ones.

Due to the need for more effective and widespread use and commercialization of scientific developmentsresults, the direct production of science-intensive products is becoming increasingly important for research institutes.

Innovative products produced directly by scientific institutions should be labeled as "science-intensive industrial products" in contrast to the generally accepted and broader concept of "innovative products" which is mainly produced in large quantities by industrial enterprises.

There are several features that allow naming innovative products as science-intensive ones:

- particularly high new characteristics (regarding to the basic structural material - ready-made metal products, particularly high strength and ductility, corrosion resistance in aggressive environments, frost-resistance at temperatures of -200 ° C, special magnetic properties and elasticity), provided by using a set of scientific knowledge, produced in research institutions;
- production based on the potential of scientific knowledge concentrated in applied scientific institutions, high-tech experimental equipment and qualified scientific and technical personnel;
- products output in relatively small quantities, regarding the production of high-tech metal products from several kilograms to 5-10 tons per year.

It would be incorrect to correlate the definition of science-intensive products to a share in research and development (R & D) costs (by some recommendations at least 10%).

Therefore in metallurgical production the structure of the cost price of innovative products is very much determined by the cost of raw materials. For instance in the production of metal products from high-alloyed steels, it is the costs of alloying elements that will have the largest, sometimes predominant share in the cost of production.

A high share of costs for expensive elements (for example, tungsten, molybdenum, etc.) sharply underestimates the share of even very high costs for the payment of highly qualified scientific and technical personnel.

Iron and steel industry produces different types of carbon, low-, medium- and high-alloyed steel products. The production cost of each type of product is determined to a very large extent by the share of costs for alloying elements.

The costs of certain types of metal products production vary considerably depending on doping level (Table 1).

Table 1.1 -The structure of costs for the production of certain types of innovative products, differing in various doping levels,%

Structure of costs	Innovative products by doping level			Carbon metal products for mass production
	High alloyed steels	Alloyed steels	Low alloyed steels	
1. Sourcematerials (iron ore, alloying materials, etc.)	80	70	66	60
2.Process fuel	10	15	17	22
3. Expensesforprocessing, including:	10	15	17	18
3.1. salaries	3	4	5	6
3.2.depreciationdeductions	3	5	6	6
3.3. others	4	6	6	6

Separate evaluation of costsstructure for processing allows excluding the influence of the cost factor of alloying elements.

In some cases, due to the technological features of a particular production, the energy costs may be absolutely dominant in the processing costs particularly when smelting high alloyed steel.

Due to the dependence of costs structure on processing from a number of technological features, the use of the share of expenses for research and development as one of the reasons to name the products as science-intensive is also unjustified (Table 2).

Table 2 - The main factors and conditions for the production of high-tech science-intensive products in contrast to innovative products.

Indicators	Science-intensive products	Innovative products
Servicepropertiesofproducts	Particularly high service properties	New and improved service characteristics
The nature of demand and industrial scale	Small-tonnageshipments	Industrialproduction
Producer	Applied scientific institutions	Industrialenterprises
Scientific base	Fundamentalappliedscientificdevelopments	Scientific developments controlled by enterprises
Equipment characteristics	Experimentalscientificequipment	Innovativeindustrialequipment
Personnel	Highly qualified research and production personnel	Industrial personnel

A typical example of science-intensive products production in one of the leading scientific organizations of ferrous metallurgy is (FSUE) I.P. Bardin Central Research Institute for Ferrous Metallurgy) is a low-tonnage production of precision alloys of invar class, with high elastic properties, soft magnetic, magnetically hard alloys, amorphous materials, terbium metals [54-56].

Table 1.3 shows the main properties and applications of certain types of science-intensive products: soft magnetic and magnetically-hard materials.

Table 3 - Main properties and applications of soft magnetic and magnetically hard materials.

Alloy grade	Properties	Purpose and application
47NK	Soft magnetic alloy with low residual induction	Inductiveelements
34 NKMP	Soft magnetic alloy with a rectangular hysteresis loop	Magnetic amplifiers, non-contact relays
83NF	Soft magnetic alloys with the highest magnetic permeability in weak fields	Magneticfieldsensors
ТКМ-09-1 ТКМ-015-2	Linear dependence of saturation induction over a wide range of temperatures	Thermal backlashes compensation and magnetic systems drifts
52C7F	Alloyforhysteresismotors	Electricmotors for navigation systems
UNDK15, UNDK18	Deformablehardmagnetic alloy	Elements of navigation systems devices
32N4K	Linear expansion minimum temperature coefficient	Material for high-precision instrumentation
56DGNCh	Linear expansion minimum temperature coefficient in combination with increased corrosion resistance	Elements of navigation aviation systems devices
46 HXTYM	Low temperature coefficient of frequency andtargeted elastic properties	Gyroscopes torsionsuspensions
CM-2A, CM- 10	Increased strength characteristics at high temperatures	Elements of electronic sensors of nuclear power plants
36NGT	The specified temperature coefficient of linear expansion withintherange -200 +400 ° C	Specialdevices
EP288	Alloyforhysteresismotors	Actuation devices
NGK6	Heat-resistant nickel-based alloy	Aviation androcket production

These types of products are characterized by particularly high properties. Thus, non-magnetic high-strength alloys intended for the sensing elements of space instruments have the following characteristics:

- tensile strength σ 90-120 kg / mm^2;
- elastic limit $\sigma_{0.2}$ is not less than 70 kg / mm^2;
- TCLE in the temperature range +20 + 20017,4 · 10^{-6}grad^{-1}.

Therefore, an alloy with a temperature-stable modulus of elasticity is characterized by the following properties:

- temperature coefficient of frequency in the temperature range -60 +150 no more than ± 30 · 10^{-6}grad^{-1};

- the inflection point is not lower than 350 ° C.

The most important factor in the development of science-intensive metal products production with particularly high service characteristics is the growing demand (for 10-15% per year) of high-tech industries such as rocket production, navigation systems, space vehicles, high-precision instrumentation, nuclear power ("Russian Helicopters", Votkinsk and Kaluga radio engineering equipment plants, Voronezh Mechanical Plant named after M.V.Khrunichev).

According to the author's calculations, the production of science-intensive metal products accounts for about 10% of the innovative metal productscost, which share, according to the Russian Statistical Yearbook, in 2013-2014, accounted for 7.5% of total production.

The production of innovative products is accounted by the Federal State Statistics Service of the Russian Federation through Federal statistical observation (Form No. 1 - Technology).Data on the development and use of advanced manufacturing technologies are fixed by the code of novelty degree: new for Russia - 01, fundamentally new - 02. This form provides information on the use of patented inventions in the development of technologies: used - 03, not used - 04.

Information on the use of advanced production technologies is given by the period of the implementationbeginning: up to one year, from one to three years, from four to five years, six or more years.

As for the size of metal products output with particularly high service characteristics, their share in the total output of innovative products is determined by the author roughly based on the processing of statistical reporting formsfor individual high-tech enterprises.

According to the author, their share in value terms is about 15-20% of the volume of production of innovative products.

The cost of high-tech science-intensive products far exceeds the cost of innovative products, especially those containing rare-earth elements - neodymium, yttrium, samarin, erbium, europium and others.

Examples of innovative metal products produced by industrial enterprises include such types as thermo-hardened rails of 100 m length, thick sheet for the production of large diameter pipes laid in corrosive environments, with working pressure up to 120 atm, individual nanostructured metal products, etc.

3. Conclusion

The author grouped the main types of science-intensive products in the following types: precision alloys - soft magnetic with special physical properties, special electrotechnical alloys, deformable hard magnetic materials, alloys with a specified temperature coefficient of linear expansion, alloys with specified elastic properties, alloys with high electrical resistance; special corrosion-resistant steels and alloys, special heat-resistant and high-temperature alloys.

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