

Import Phase-Out of Scientific Analytical Instruments and Equipment

¹V.V. Kachak, ²V.E. Moiseenko and ²A.A. Vasin
¹Federal State Scientific Institution “Analytical Center”,
Talalikhina Str. 33, bldg. 4, Moscow, Russia
²Moscow State Technical University (MSTU),
B. Semenovskaya Str. 38, Moscow, Russia

Abstract: This study deals with the issues of import phase-out of analytical instruments and equipment being in high demand in Russian scientific organizations. The results of the analysis of Russian and foreign scientific analytical instruments being in demand in the domestic market of scientific products have been presented which comparison has shown that the share of Russian-made equipment in the total amount of the instrumentation stock of scientific organizations engaged in research, measurement and test activities does not exceed 20%. Over 300 analytical instruments and equipment produced by Russian and foreign manufacturers have been assessed. The list of Russian manufacturers of analytical equipment, producing competitive scientific instruments and equipment has been determined. Comparison of technical characteristics, cost, reliability, possibilities for service maintenance of equipment allows us to conclude that a number of Russian companies engaged in development and production of analytical instruments have significant potential for creation of their own instrument base of analytical equipment highly competitive with those of the advanced foreign countries.

Key words: Analytical instruments and equipment, common use centers, import phase-out, competitiveness, foreign analogs, technical characteristics of the devices

INTRODUCTION

One of the most important elements of the development of Russian scientific, economic and technological basis is the availability of modern scientific instruments and equipment.

The development of domestic instrument engineering has led to the formation of the aggregate of scientific instruments and equipment that are in demand in various industries and the economy for the practical use by scientific, educational and industrial corporate consumers of instruments and equipment.

The use of modern scientific instruments and equipment, relevant or superior in its technical characteristics to the foreign analogs, must contribute to the priority directions of development of science, technology and engineering in the Russian Federation as well as to the solution of priority scientific problems and achievement of significant scientific results. Therefore, the issues of assessing the current state and determining the ways of development of domestic scientific instrument engineering are of high importance.

Currently, the most advanced scientific equipment and instruments of domestic and foreign production which availability allows us to address complex and urgent scientific and technological problems are concentrated in the scientific equipment common use centers (Kachak, 2014; Kachak *et al.*, 2015).

These centers are an important part of modern Russian science infrastructure which was mentioned at the meeting of the council under the president of the Russian Federation for science and education (Georgia, 2013).

ANALYSIS OF RUSSIAN AND FOREIGN SCIENTIFIC INSTRUMENTS BEING IN DEMAND IN THE DOMESTIC MARKET OF SCIENTIFIC PRODUCTS

This study presents the results of a study of the current state of Russian scientific equipment on the example of scientific organizations, universities and industrial organizations that represent the scientific equipment common use centers. The >3,000 scientific instruments and equipment have been studied. Evaluation of instrument base was carried out by the following parameters:

- Name of the instrument
- Instrument mark
- Country of manufacture
- Instrument age
- Instrument cost
- Corporate consumers of instruments and equipment

Table 1: Proportion of the Russian analytical equipment in the instrumentation stock of scientific organizations

| Field of research of scientific instruments and equipment (methods of measurement) | The main types of scientific instruments and equipment | The percentage of Russian and foreign equipment (%) |
|--|---|---|
| Microscopy | Scanning probe microscopes | 44-56 |
| | Optical microscopes | 7-28 |
| | Electronic microscopes | 2-98 |
| Spectrometry | Mass-spectrometers | 5-95 |
| | Atomic absorption spectrometers and atomic emission spectrometers | 31-69 |
| | NMR-spectrometers | 0-100 |
| | IR-, UV-, Visible, Raman spectrometers | 0-100 |
| Chromatography | Other types of spectrometers | 19-81 |
| | Gas chromatographs | 12-88 |
| | Liquid chromatographs | 15-85 |
| X-ray studies | X-ray fluorescence diffractometers | 13-87 |
| | X-ray fluorescence spectrometers | 5-95 |
| Other research methods | Microanalyzers, the rmoanalyzers and surface analyzers | 11-89 |

Our studies have shown that the structure of the considered instrument base consists of several major groups of equipment such as analytical instruments, technology-oriented instrumentation, scientific laboratory instruments, auxiliary instruments necessary for the research, measurement and test activities.

The most important part of both Russian and foreign instrumentation stock of the scientific equipment is analytical equipment. The availability of modern complex analytical instruments with high performance and a wide functional range allows scientists and researchers to conduct multimethod interdisciplinary studies in various fields of science and obtain the world-class results.

Analysis of the range and characteristics of the studied analytical instruments and equipment as well as the list of corporate consumers of this equipment allowed us to determine the most popular group of analytical instruments which operating principle is based on research methods and measurements:

- Microscopy
- Spectrometry
- Chromatography
- X-ray studies

Total 350 instruments have been studied which year of manufacture does not exceed >5 years and the cost is not <1 million rubles. They include: microscopes 100 units, spectrometers 120 units, chromatographs 40 units, diffractometers 50 units and other analytical instruments 40 units.

Evaluation of proportion of Russian equipment in the common array of analytical equipment is of high importance. Such evaluation allows determining the level of interest of Russian companies in acquiring the scientific equipment of domestic production for research purposes.

Table 1 shows the evaluation results of the percentage of costly Russian and foreign scientific instruments and equipment used in research, measurement and test activities.

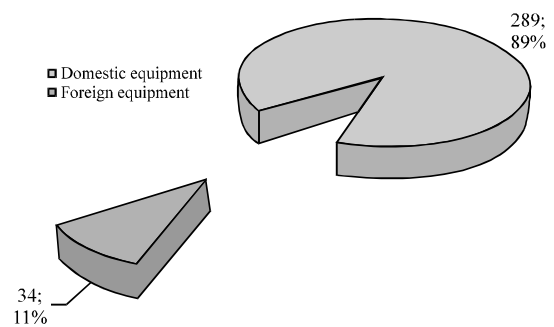


Fig. 1: The ratio of domestic and foreign analytical instruments used for research

We should note that the proportion of high-precision, expensive analytical equipment of Russian production does not exceed 11% on average as shown in (Fig. 1).

Thus, we can conclude that the Russian scientific organizations prefer instruments of foreign production when compiling the list of equipment purchased for research.

Nevertheless, the Russian manufacturers of scientific equipment now have a fairly significant potential for the creation of specific classes of instruments as good as their foreign analogs and even superior to them in some features and functionality. Therefore, given the importance of the transition of the domestic economy from extensive development to intensive one that primarily involves the creation of modern high technology, the further development of Russian scientific instrumentation plays a significant role.

IMPORT PHASE-OUT RELEVANCE

Import phase-out is a kind of economic strategy and industrial policy which aims at protection of domestic manufacturers by substituting the imported scientific instruments and equipment with appropriate instruments and equipment of national production.

The implementation of the import phase-out tasks requires a systematic long-term approach as well as creation and development of relevant scientific and industrial and technological base in various industries of economy.

To reduce the dependence of Russian industry on imports it is necessary to join efforts of scientific, business and governmental stakeholders to accelerate the introduction of new competitive technologies and enterprises.

The implementation of the import phase-out tasks requires a systematic long-term approach as well as creation and development of relevant scientific and industrial and technological base in various industries of economy.

The relevance of import phase-out in the formation of the instrument base of the research infrastructure results from expediency of creation of analytical instruments and equipment that will be competitive on the global market of scientific instruments.

To implement the governmental policy in the field of import phase-out that provides in particular, the establishment of production of goods, works, services and competitive technologies a series of legal documents was adopted as follows (Yeltsin, 2010).

The document states that the strengthening of economic security will contribute to the improvement of state regulation of economic growth through the development of conceptual and programmatic documents of interregional and territorial planning, the creation of an integrated risk control system including an active state anti-inflationary, monetary, exchange rate, money-and-credit and fiscal policy aimed at import phase-out.

This resolution of the government of the Russian Federation established the governmental commission on import phase-out which represents a coordinating body aimed at ensuring coordinated actions of federal executive bodies, executive bodies of subjects of the Russian Federation, local authorities and organizations in order to implement the state policy in the sphere of import phase-out.

PURPOSE AND TASKS OF IMPORT PHASE-OUT

The purpose of import phase-out of analytical instruments is to identify and support the Russian organizations that are able to create a competitive scientific equipment comparable or superior in its technical characteristics and functionality to the advanced foreign analogs. Import phase-out of analytical equipment requires addressing a number of major problems (Kachak *et al.*, 2015):

- Determination of the list of Russian and foreign scientific instruments and equipment the most popular in the domestic market of scientific products for scientific research conforming to the world standard level
- Evaluation of the percentage of Russian and foreign scientific instruments and equipment used in research, measurement and test activities in the Russian scientific organizations
- Evaluation of functionality and technical characteristics of Russian analytical instruments and equipment comparable or superior to their foreign analogs
- Formation of the criteria of competitiveness of Russian manufacturers of scientific analytical equipment and
- Determination of the list of Russian companies producing a competitive analysis equipment in order to support domestic producers

COMPARISON OF TECHNICAL CHARACTERISTICS OF RUSSIAN ANALYTICAL INSTRUMENTS WITH FOREIGN ANALOGS

Comparison of technical characteristics of Russian and foreign analytical instruments and equipment the most popular for scientific research shows that the Russian instruments in their certain groups are equal in their technical characteristics to the foreign analogs and even surpass them in some parameters. As an example, we may present the comparative characteristics of some domestic instruments and their foreign analogs. For instance, atomic-force microscope “INTEGRA LIFE” (NT-MDT) and “BioScope Resolve” by Bruker (Germany) (Table 2), atomic-absorption spectrometer “QUANT-2” (LLC “KORTEK”, Russia) and its foreign analogs-contr AA 300 (Analytik Jena, Germany) and Agilent 240 FS (Agilent Technologies, USA) (Table 3).

Technical characteristics of the Russian instrument “INTEGRA LIFE” (Fig. 2) have the same characteristics comparable to the foreign analogs. At the same time, the individual characteristics of the “INTEGRA LIFE” surpass the same of the microscope bio scope resolve in XYZ scanning range (OL), the linearity of the measuring head of the microscope and its removable XY piezo-scanner. Cost of INTEGRA LIFE microscope is significantly less than the cost of bio scope resolve microscope (Table 2).

Technical characteristics of the Russian atomic absorption spectrometer “QUANT-2” (Fig. 3, Table 3) are comparable to the foreign analogs and even surpass their foreign analogs in the basic parameters such as sensitivity for Cu.

Table 2: Technical characteristics of atomic-force microscopes

| Atomic-force microscope instrumenthead | INTEGRA LIFE (NT-MDT) | Bio scope resolve (Brucker) |
|--|--|-----------------------------|
| XYZ (OL) scanning range (µm) | 130×130×25 (±10%) | 100×100×15 (±10%) |
| XYZ (CL) scanning range (µm) | 100×100×20 (±10%) | 100×100×15 (±10%) |
| XY (OL/CL) resolution (nm) | 0.3/1 | 0.3/1 |
| Z (OL/CL) resolution (nm) | 0.1/0.1 | 0.1/0.1 |
| Feedback sensor | Capacitance-type | |
| Linearity (%) | 0.03 | 0.02 |
| Registration system laser | 850 nm | 850 nm |
| Motorized coordinate table | | |
| XY min. step (µm) | 0.3 for range 20×20 mm; 0.07 for range 5×5 mm | 10×10 (±35 pm) |
| Removable XY piezo-scanner | | |
| Linearity (%) | 0.03 | 0.02 |
| Removable Z piezo-scanner | | |
| (OL/CL) resolution (nm) | 0.2/0.5 | <0.25 |
| Cost, rub. | >20,000,000 | >50,000,000 |

Table 3: Technical characteristics of atomic-absorption spectrometers

| Atomic-absorption spectrometer | Kortek, QUANT-2 | AnalytikJena Contr AA 300 | Agilent technologies agilent 240 FS |
|---|--|--|--|
| Spectral range | 185-860 (nm) | 185-900 (nm) | 185-900 (nm) |
| Optical density scale range | 0-3 B | 0-3,99 B | 0-3 B |
| Limit of detection by Cu | 15 (µg/dm ³) | 30 (µg/dm ³) | 25 (µg/dm ³) |
| Characteristic concentration (sensitivity) for Cu | 20 (µg/dm ³) | 70 (µg/dm ³) | 200 (µg/dm ³) |
| Corrector for background non-selective absorption | Deuterium corrector | Deuterium corrector | Deuterium corrector |
| Operation with flames | Propane-air acetylene-air Acetylene-nitrous oxide | Acetylene-air Acetylene-nitrous oxide | Acetylene-air Acetylene-nitrous oxide |
| Cost | 2,000,000 rub. | 8,640,000 rub. | 5,280,000 rub. |

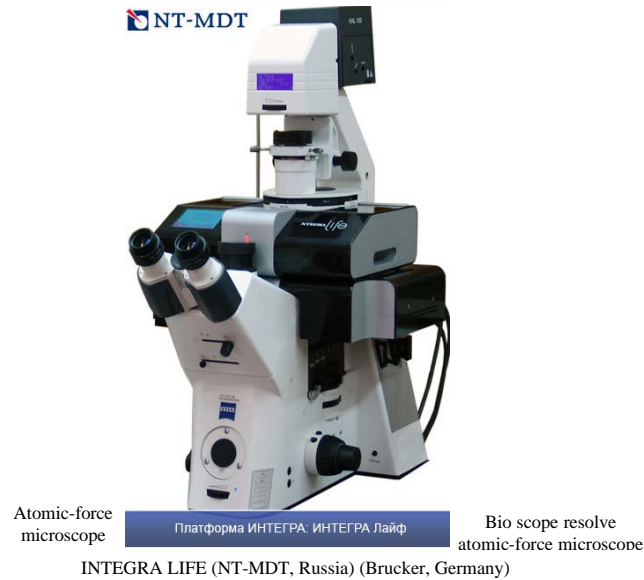


Fig. 2: Russian and german atomic-force microscopes



Fig. 3: Russian and German atomic-absorption spectrometers

EVALUATION CRITERIA FOR RUSSIAN MANUFACTURERS OF COMPETITIVE ANALYTICAL INSTRUMENTS

Evaluation criteria for Russian companies and organizations that produce competitive analysis equipment are:

- Experience of the enterprise in creation of a modern scientific equipment
- Availability of production capacity
- Qualification of human resources
- Nomenclature of products produced by the manufacturer in the field of scientific instrument engineering
- Documentary evidence of the level and quality of products, its competitiveness with the advanced foreign analogs
- Demand for the manufactured products in the domestic and foreign markets
- Ability to manufacture and supply components for the creation of scientific instruments and equipment
- Possibility of reducing the time for creation of a new development
- Production load of equipment

The competitiveness of the products is characterized by:

- Compliance of Russian instruments to their foreign analogs (correspondence to foreign analogs, surpass of foreign counterparts, no foreign equivalents) in particular on criteria such as the level of the technical characteristics of instruments (for example, LECO high-resolution mass spectrometer (Russia) that allow simultaneously obtaining a high scanning speed, high mass accuracy, high resolution and a wide linear range)
- Evaluation of the maximum performance of instruments and equipment
- The ratio of components (domestic and foreign) forming the basis of the relevant instrument or equipment
- Reliable operation of the instruments
- Reliability of measurements and research results
- The availability of certified methods, the development and certification of universal techniques
- Production load of equipment (24 h operation ability)
- Service maintenance ability

Evaluation criteria for Russian companies and organizations that produce competitive products are:

- Competitiveness of the manufactured products

- Scientific and technical potential of Russian organizations that produce the competitive products scientific and analytical instruments and equipment
- Recognition of the scientific and production activities of the company in the development and creation of scientific equipment

The competitiveness of the products is characterized by:

- The level of technical characteristics of instruments
- Compliance of Russian instruments to their foreign analogs
- Similar to foreign analogs
- Comply to foreign analogs
- Surpass foreign analogs
- Have no foreign analogs
- The functional range of the instrument (for example,

LECO high-resolution mass spectrometer (Russia) that allow simultaneously obtaining a high scanning speed, high mass accuracy, high resolution and a wide linear range and others)

- Evaluation of the maximum performance of instruments and equipment
- The ratio of components (domestic and foreign) forming the basis of the relevant instrument
- Reliable operation of the instruments
- Reliability of measurements and research results
- The availability of certified methods, the development and certification of universal techniques
- Production load of equipment (24 h operation ability)
- Service maintenance ability

Scientific and technical potential of Russian organizations that produce the competitive products is characterized by:

- Qualification of human resources
- Experience in creation of scientific instruments
- Availability of technical resources for the production of modern instruments
- Availability of modern scientific technologies

Recognition of the scientific and production activities of the company in the development and creation of scientific equipment is characterized by:

- The quality of the manufactured products (compliance of technical characteristics of equipment to the foreign analogs, or superiority over them)
- Level of demand for the manufactured products in the domestic and foreign markets
- Review of experts in the relevant fields of research

Table 4: Instruments produced by the promising Russian companies

| Manufacturer | Types of instruments |
|---|---|
| JSC "Lomo" | Optical microscopes, spectrophotometers |
| NT-MDT company | Atomic-force microscopes, AFM and spectrometry systems (surpassing foreign analogs) |
| "Spektroskopi cheskie sistemy" (Spectroscopic systems) CJSC | Spectrometric equipment (UV-V is spectrometer (SPEKS SSP), atomic emission spectrometers (SPEKS LAES), fourier transform spectrometers (FSM of several modifications) liquid chromatographs |
| "Lumex" R&D company | Liquid chromatograph (Lumachrom). Spectrometric equipment (atomic-absorption spectrometers, mass spectrometers, infrared spectrometers) |
| "BIOMED" holding company | Optical microscopes |
| "Burevestnik" R&D company | X-ray diffractometers, X-ray spectrometers |
| "Nauchnye pribory" (scientific instruments) CJSC | X-ray analysers |
| "Chromatec" CJSC | Gas chromatographs, Mass spectrometer, NMR-analyzer |
| "KORTEK" LLC | Spectrometric equipment (atomic-absorption and spectrophotometer) |
| "Rezonans nye sistemy" (resonance systems) LLC | Spectrometer |
| "SIMEX" RDCLLC | IR-spectrometers |
| "Chromos" group of companies | Chromatographs |
| "Green star" group of companies | X-ray fluorescence spectrometers |
| "EkoNova" institute of chromatography, CJSC | Chromatograph |

DETERMINATION OF THE LIST OF COMPETITIVE RUSSIAN MANUFACTURERS OF ANALYTICAL INSTRUMENTS AND EQUIPMENT

As studies show about 30 Russian organizations and enterprises produce competitive analytical instruments. They include the company "NT-MDT" (microscopes), the company "Avesta-project" producing innovative equipment for ultrafast spectroscopy, Aquilon JSC developing and producing modern analytical instruments for the control of safety and quality of products, "BIOMED" holding company which produces microscopes and equipment, "Petrel" R&D company producing X-ray instruments and equipment for various purposes, the Institute for analytical instrumentation of RAS producing spectrometric instruments and equipment of different profile, "Lumex" R&D company producing a wide range of analytical instrumentation for luminescence and photometric analysis, atomic absorption spectrometry and mass spectrometry, HPLC and clinical diagnostics, "Chromatec" CJSC developing and producing gas chromatography equipment and other organizations.

Table 4 shows the main types of analytical instruments of the Russian enterprises that produce the competitive products.

SUMMARY

Based on all above-stated we may conclude that the tasks of import phase-out of analytical instruments and equipment used by the Russian scientific organizations are highly relevant. Enterprises, producing competitive scientific production, should be provided with state financial support and tax incentives for the development of national scientific instrumentation.

CONCLUSION

Development and construction of domestic analytical instruments and equipment which functionality and technical characteristics meet or surpass the advanced foreign analogs will help to solve the problem of import phase-out and the further development of the national scientific instrument engineering.

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