

Non-Destructive Testing in Belarus

Nikolai P. MIGOUN, Svyatoslav A. NOVIKOV

Institute of Applied Physics, National Academy of Sciences,
Academicheskaya, 16, Minsk, Belarus 220072
Tel: 375-17-2841081, e-mail: migoun@iaph.bas-net.by

Abstract

Current state of non-destructive testing and technical diagnostics in Belarus (technical-organizational, scientific, training and other aspects) are presented in the paper. The organization of scientific studies and practical works in this field, education of specialists and certification of personnel, standardization and metrology, the leading organizations and their basic directions of research activity are briefly described.

Keywords: non-destructive testing, Belarus, basic researches.

Introduction

Republic of Belarus has comparatively high-developed industry among former Soviet Union countries (per capita income in 2007 was about 5900 euro). It includes dozens first-rate machine-building ("BELAZ", "MAZ", "MTZ", "GOMSELMASH" and etc.) plants, crude oil-refining enterprises ("NAFTAN", "Mozyr oil refinery") and many other industrial plants, branched networks of railway lines (more than 5000 km), oil- and gas main pipelines (more than 10000 km) etc. This is only a small part of industrial and transport objects highly needed of modern methods and means of non-destructive testing (NDT) and technical diagnostics (TD). That is why the government pays specific attention for the development of basic and applied researches in the field of NDT & TD, which are carried out in the frame of so called State Programs of Scientific Researches. The structure of these programs and main national research centers in the field of NDT & TD are briefly described in the paper. General characteristics of leading educational and certification centers, coordinating societies and structures are described as well.

The organization of scientific studies and practical works in NDT and TD

The National Academy of Sciences of Belarus (NASB) coordinates development financing of basic and applied scientific research in Belarus. At present the studies in the NDT are carried out mainly within the framework of State Integrated Program of Scientific Research (SIPSR) "Technical Diagnostics" (2006-2010), which concentrated the most urgent scientific projects in NDT & TD. Many branches of the national economy of the country are interested in the realization of this Program. The Institute of Applied Physics of NASB, where the majority of known NDT methods are developed is so called parent organization of SIPSR "Technical Diagnostics".

This Institution functions as the parent organization in the field of NDT & TD in Belarus as a whole. There are two State customers of the SIPSR "Technical Diagnostics": the National Academy of the Sciences of Belarus and the Belarusian Emergency Situations Ministry.

The purpose of program - a study of physics of interaction of magnetic, electromagnetic, acoustic and others fields with the materials, the elements of constructions, other objects for the purpose to develop new highly effective and competitive methods, means, information technologies of nondestructive testing and technical diagnostics, adapted to the production and the objects of the national economy of Belarus and ensuring an increase in its quality, safety of operation and functioning. Some projects in the field of NDT & TD are carrying out

within the framework of other State Programs of Scientific Researches (for example, "Electronics", "Mechanics, "Building and Architecture", the projects of the Belarusian Republican Foundation for Fundamental Research Belarusian). Mostly the projects are financing both from the budget and additionally by the interested enterprises. The obtained scientific results are usually used in the industry. Some projects find an application within the framework of so-called State Scientific and Technical Programs financing both from the budget and by the interested industrial enterprises (for example, the Programs "Standards of Belarus", "Welding", "Technologies and the Equipment for Machine Building", "Instruments for Scientific Studies", etc.). Some researches in the field of NDT & TD are conducting at the branch scientific research institutes and enterprises.

Practical control-diagnostic works in Belarus are carrying out by quality control departments of enterprises, and also by state or non-governmental accredited NDT laboratories, whose quantity at present comprises more than 170.

The important organizational and coordinating role in the practical work in the field of NDT & TD plays the Belarusian Association on Nondestructive Testing and Technical Diagnostics (BANDT&TD). It is been one of the member-founders of the European Federation for Non-Destructive Testing (EFNDT). The basic purposes of the BANDT&TD is assistance to an improvement in the quality, competitive ability, reliability and safety of production, produced and exploited in Belarus, the attraction of the scientific and technical potential of the country for creating of new methods and technical equipment of NDT & TD, certification of personnel. Besides it realizes one more important task: provides the news service of enterprises and organizations of the country in the field of NDT & TD by means of the publication of news bulletins, conducting of exhibitions, conferences and seminars.

Education of specialists and certification of NDT personnel

In Belarus the education of specialists in the field of NDT & TD is carried out at a number of universities. First of all this is the Belarusian-Russian University, which has already carried out 21 graduates of engineers on the specialty "methods and instruments for quality control and diagnostics of the objects' state". Several years ago the department of the instrument-making department and the department of machine building of Belarusian National Technical University began preparing engineers in this specialty as well. The first graduate in this specialty is on the way this year at Belarusian State University of Transport. The important element of personnel training in NDT & TD is the activity in the sphere of certification of personnel competence of control-diagnostic laboratories. At present there are two certification bodies of NDT personnel in Belarus, which work according to the widely used NDT methods (UT, PT, ET, RT, LT, MT, VT). Both of them are situated in Minsk, one is located in Belarusian State Institute for advanced training on standardization, metrology and management of Standardization Ministry of Belarus, the second - in the Institute of Higher School. In 2007 the first of them extended the sphere of its activity to the thermal NDT method and the mode of deformation state monitoring. For the first time in the country the training on these methods started at the Scientific-Methodical Center of the IAPh.

Standardization and metrology in the field of NDT

The important role in the field of certification, metrology and standardization in NDT & TD plays Gosstandart of Republic of Belarus (the Standardization Ministry of RB), whose chairman V.Koreshkov is the Deputy Chairman of the Scientific Council of the SIPSR "Technical Diagnostics". Every measuring means worked out for NDT & TD purposes have to pass metrological attestation being checked for corresponding requirements. The development of the procedures of metrological attestation and state acceptance tests is usually carried out by the developers of NDT means NK together with corresponding specialists of Belarusian State Institute of Metrology. The elaboration of NDT standards is usually accomplished in accordance with annual plan of state standardization. At the IAPh functions the Technical Committee (TC) on standardization in the field of NDT & TD. One of the main tasks of TC - examination and working out the proposals, directed to ensure realization of united scientific and technical policy on standardization, the development of state standards,

other normative documents, and also works for the intergovernmental, international standardization on NDT & TD.

During the last several years a number of the standards in NDT & TD harmonized with the European standards were developed. Another TC on standardization, which is located at the Institute of Powder Metallurgy of NASB, carries out an activity in the field of standardization in NDT for welding. This TC worked out some standards and other normative documents connected with NDT of welded joints last years.

The leading organizations in the field of NDT & TD

As it's been mentioned above, the Institute of Applied Physics of NASB (IAPh) is parent organization of SIPSR "Technical Diagnostics" and the leading organizations in the field of NDT & TD in Belarus as a whole. Besides the IAPh is one of the term-founders of the World Federation of NDE Centers (WFNDEC).

Basic scientific directions of the researches at the institute: physics of non-destructive testing and technical diagnostics; the development of methods and means for NDT & TD of materials, products and technological processes; basics of information technologies for NDT & TD. Applied problems to be solved: the analysis of matter structural arrangement, testing of hardness and other physical and mechanical properties of materials and products; testing of geometric parameters of articles, coatings and surface-hardened layers; analysis of deformation modes of various metalwares, detection of discontinuities of materials by various methods; thickness measurement of layers and materials; diagnostics of state for materials, products and dynamic systems under exploitation and functioning. More detail information about the institute is available at web site <http://iaph.bas-net.by>.

In the institute the following methods of NDT & TD are developed: ultrasonic flaw detection, various methods of thickness measurement of coatings and surface-hardened layers; penetrant testing; pulse magnetic testing; thermoelectric method; eddy-current method; magnetic Barkhausen noise method; methods of microwave detection of defects and imaging; various methods of metals and dielectric structure visualization; contact dynamic methods of testing; the methods of reconstruction of images in the X-rays from incomplete and noisy data and others. More detail information about the institute is available at web site <http://iaph.bas-net.by>.

The researches in the field of NDT & TD are conducted also at other institutes of the NASB (Institute of Physics - optical NDT methods, United Institute of Machine Building - methods of vibration monitoring, Institute of Heat- and of Mass Transfer - thermal methods), at the departments of several universities (Belarusian- Russian University - magnetic-tape and ultrasonic techniques, Belarusian National Technical University - optical and electro-potential methods, Belarusian State University - methods of vibration monitoring, Vitebsk State Technological University - capacitive method).

Basic directions of research activity

There are some well-known results of the basic scientific researches in the field of NDT & TD, especially in physics of magnetic, penetrant, acoustic and microwave NDT methods. Last years especially actively are developing the directions of investigations, based on the use of up-to-date information technologies for NDT & TD. This makes it possible both to enlarge the possibilities of the already developed means and technologies of NDT & TD and to develop new, more informative and more reliable methods. Among the developments of the IAPh, which found a wide practical use at wide variety of industrial enterprises in Belarus and abroad, it would be appropriate mention here the following:

- automated equipment for ultrasonic testing of the bonding defects between Ni-resist cast iron insert and main material of diesel engine pistons^[1];
- automated eddy current and ultrasonic systems for the inspection of cylinder cast iron sleeve of diesel engine^[2];
- wide variety of devices for the determination of solid materials (metals, rubber, plastics, concrete etc.) mechanical properties based on contact dynamic methods of testing^[3];

- the installation for pulsed magnetic testing of mechanical properties of steel articles and steel rolled products in production line, which have no any analogues^[4];
- magnetic thickness gauges for measurement the thickness of non-magnetic coatings (chrome, copper, zinc, lacquer, paint, etc.) on steel and other ferromagnetic basis, thick nickel and two-layer nickel-chrome coatings on ferromagnetic and non-magnetic basis^[5];
- advanced Barkhausen noise analyzer for residual and applied stress and microstructure measurement in steels and cast iron; the instrument operating on the basis of magnetic Barkhausen effect for nondestructive testing and diagnostics of ferromagnetic materials, wares, structures and their separate parts^[6];
- effective microwave methods and apparatus for the measurement of parameters of the signal reflected from the subsurface objects in the wall or multi-layered construction^[7];
- unique devices for early diagnostics of the electrical machines of alternating and direct current in the process of operation and at the stage of repair^[8];

The main theoretical principles of penetrant hydrodynamics, investigated in depth at the IAPh, resulted in development of effective methods to optimize PT technological process^[9]; Development of the theory for adaptive image reconstruction and new methods of images reconstruction from incomplete and noisy data in X-ray tomography are successfully carried out at the IAPh as well^[10,11]. New practically perspective results were obtained recently using capacitive methods for monitoring of polymeric materials (Vitebsk State Technological University)^[12], new methods of vibration monitoring of mechanical drives are developing at the United Institute of Machine Building of NASB and Belarusian State University^[13,14]. The development of methods and means of the estimation of residual resource of industrial objects is one of the most urgent directions of studies (Belarusian National Technical University)^[15]. The projects in this subject have priority value within the framework of all scientific studies in the field of NDT & TD.

References

- [1] G.Konovalov, A.Mayorov. Devices for non-destructive testing of adhesion quality of a ni-resist cast iron insert in diesel engine pistons, 8th European Conference on Non-Destructive Testing, Barcelona, June 17-21, 2002, 6P.
- [2] G.Konovalov et al. The Systems for Automated Ultrasonic Testing, 7th European Conference on NDT Copenhagen, May 26-29, 1998, P 140-3143.
- [3] V.A.Rudnitsky, A.P.Kren. Testing of Elastics. – Minsk, 2007, Belaruskaya Navuka, 227 p. (in Russian).
- [4] V.F.Matyuk, et al. The Pulse Magnetic On-Line Controller IMPOK-1B, Rus. J. NDT, 2007, № 4, P12 – 23.
- [5] A.A.Lukhovich, A.L. Lukyanov. New Magnetic Thickness Gauge Based on a Dynamic Method of Measurement of Secondary Magnetic Fields, 9th European Conference on NDT, Berlin, 2006, Proceedings, CD, 6P.
- [6] V.Vengrinovich. Magnetic Techniques for Residual Stress Measurements – Principles, Procedures, Advantages, Limitations, Applications and Case Studies, Int. Workshop on Non Destructive Techniques for Evaluation of Residual Stresses (WONERS 2007), USA, Golden, Colorado, July 27-28, 2007, CD, P150-190.
- [7] V.Mikhnev, P.Vainikainen. A clutter reduction technique for microwave reconstruction of shallow underground targets, Proceedings of the 2nd European Conference on Antennas and Propagation, Edinburgh, UK, November 11-16, 2007, CD, 4P.
- [8] I.Branovitsky et at. Diagnostics of electric-power equipment, Inzhener-Mechanic, 2008, N1, P8-12 (in Russian).
- [9] P.Prokhorenko, N.Migoun, M.Stadthaus. Theoretical Principles of Liquid Penetrant Testing. – Berlin, DVS-Verlag, 1999, 252 P.

- [10] V.Vengrinovich et al. 3D-image reconstruction from low energy fuzzy and noisy 2D x-ray projective data, Int. Conference for Quantitative Non Destructive Evaluation (QNDE-2007), USA, Golden, Colorado, July 29 – Aug. 3, 2007, CD, P93.
- [11] V.M.Artemjev, A.O.Naumov, G.-R.Jaenish. Reconstruction of Dynamic Images in Processes Tomography.– Minsk, BSU Publishing, 2004, 168 P. (in Russian).
- [12] A.A.Dzhezhora. Capacity probes with circular electrode, News of BNTU, №5, 2007, ser. Priborostroenie, P37-40.
- [13] V.E.Starzhinsky et al. Investigations of gear dynamics and vibroacoustic activity lowering by teeth coating employment, 12th IFToMM World Congress, Besançon (France), June 18-21, 2007, P6
- [14] A.Varfolomeev et al. Automated system of machine equipment testing, Technical Diagnostics and Non-Destructive Testing, 2006, N4, P8-14.
- [15] F.Panteleenko et al. Strategy of residual life evaluation for dangerous technical objects, Promyshlennaya Bezopasnost, 2007, N10, P6-20 (in Russian).