Abstract

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«DEVELOPMENT OF AUTOMATED CALS-SYSTEMS FOR SCIENTIFIC RESEARCH OF ANTI-ICING REAGENTS AND IMPREGNATION COMPOSITIONS FOR ROAD TRANSPORT INFRASTRUCTURE»

Relevance of the research topic. Road transport in Russia is the most flexible and mass transportation mode. The main problems are related to the insufficiently high quality of highways and street and road infrastructure, which affects road safety, transportation speed and negative impact on the environment. One of the key aspects in solving these problems is the effective application of the following road chemistry materials: anti-icing reagents (AiR), hydrophobizing impregnations (HpI) and road impregnations (RI). In this direction it is expedient to develop automated systems of scientific research, which allow to carry out work at a high level in the field of creation and use of road chemistry materials. CALS-technology (Continuous Acquisition and Life cycle Support - continuous information support of product life cycle) is chosen as the most promising system of computerized support of scientific research.

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The aim of the work is to develop, using information CALStechnologies, automated systems of scientific research of chemical materials for highway infrastructure (AiR, HpI, RI).

The main **tasks** solved in the work are system research and development on the basis of CALS-technologies of 7 interrelated automated software complexes of computerized quality management (CQM) and development of innovative materials of road chemistry: system analysis of key factors affecting the quality of road infrastructure; modernization of automated CQM-systems and environmental monitoring of AiR; development of an automated system of geo-ecological monitoring with linkage of sampling to specific geobjects (South-West Administrative District, Moscow); development of an automated CQM-system for HpI quality; modernization of an automated CQM-system for RI; automated development of modular RI production; development of a CALS-project for an automated system for control and management of RI production.

Scientific novelty:

1. In the structure of goals and objectives of Russia's development the level of transport infrastructure, which includes road infrastructure, is highlighted. The key factors affecting the quality of road infrastructure are identified. The IDEF0 diagram is used to show the regularities of their interaction at different levels of hierarchy. The place and role of road chemistry materials in the hierarchical system are shown. The relevance of analytical monitoring of these materials by means of automated CQM-systems is substantiated.

2. Functionalities of characteristic grouping and control of analytical monitoring processes were implemented in the modernized CQM-system of PiR. With the help of these functionalities the architecture (information model) of the subsystem on formate PiR was improved, as well as the system element for determining the quality indicator «Melting ability».

3. During modernization of the CALS-system for environmental monitoring of AiR, new basic indicators specified in the current SanPiN-2021 were introduced into the system architecture. For the indicator of radiation activity, the architecture of the subsystem of ecological monitoring of radionuclide content in environmental objects with appropriate methods of analysis and instruments was developed. The architecture of the automated CALS-system of geo-ecological monitoring of AiR has been developed.

4. The architecture of the automated CALS-system of HpI is developed. The architecture includes two types of sidewalks: paving granite tiles and road concrete slabs. For each type, 6 quality indicators with basic analysis methods and specialized analytical equipment are introduced into the architecture.

5. Modernization of the architecture of the previously developed CQMsystem of RI (protective and restoring) in the modern version of the PDM STEP Suite 5.7 software package. It is shown that the key difference of the modernized CQM-system is the use of updated functionality for grouping quality indicators, which allows organizing information into logical categories that are easy to compare and analyze.

6. The architecture of the CALS-system of computer-aided design of modular production of road impregnation is developed, which includes all stages of the development of technological regulations, including «control and management».

Practical significance:

The result of the conducted research is the creation of five automated program complexes of computerized quality management for road chemistry materials. These complexes, developed on the basis of CALS-technologies, provide realization of the following functions: analytical monitoring of AiR, HpI, Ri; assessment of environmental impact of AiR on the environment (including geo-ecological aspects). CQM-systems are implemented in the Center for Collective Use of NRC «Kurchatov Institute» - IREA. A CALS-project for the automated development of a modular pilot plant for RI production, including a monitoring and control system, has been created. Practical significance of the conducted research is confirmed by a patent.

The developed program modules of CALS-systems of scientific research were included in the State contract of the Ministry of Education and Science of Russia GC 16.552.11.7010 "Development of complex research in the field of development of new methods of quality control...", Agreement with the Ministry of Education and Science of Russia № 14.579.21. 0025 "Creation of technology for production of impregnation compositions protecting road asphalt concrete pavements from negative impacts of natural and anthropogenic nature to reduce the resource intensity of their operation" and RFBR Grant No. 18-29-24185mk on creation of an intelligent system for assessing the environmental impact of road maintenance wastes.

The main provisions for the defense:

- System analysis of key factors affecting the quality of road infrastructure.
- Modernization of automated systems of computerized quality management and environmental monitoring of anti-icing reagents.
- Development of an automated system of geo-ecological monitoring with linking sampling to specific geo-objects (South-West Administrative District, Moscow).
- Development of the automated system of computerized quality management of hydrophobizing impregnations.
- Modernization of the automated system of computerized quality management of road impregnations.
- Automated development of modular production of road impregnation compositions.
- Development of CALS-project of the automated system of control and management of road impregnation production.