An integrated approach to environmental management

E A Zhirnova, I V Trifanov, O A Sukhanova and V I Trifanov

Reshetnev Siberian State University of Science and Technology, 31 Krasnoyarsky Rabochy Av., Krasnoyarsk, 660037, Russia

E-mail: sibgau-UKS@mail.ru

Abstract. The issues of improving the system of environmental management on the basis of knowledge management, risk-based approach, environmental monitoring are covered in the article. As a result of the carried out researches the algorithm of improvement of system of ecological management is developed. The model of improvement of ecological monitoring is offered. Practical recommendations for improving environmental safety and placing points of observation of the state of the environment are presented.

Currently, an integrated approach based on the balance between the environment, society and economy to management is generally accepted in the world practice. The increasing impact of pollution on the environment, inefficient use of resources, improper waste management, climate change, degradation of ecosystems and loss of biological diversity make it necessary for enterprises to adopt an integrated approach to environmental management through the introduction of environmental management systems.

GOST R ISO 14001-2016 offers organizations an approach to protect the environment and respond to changing environmental conditions in balance with socio-economic needs. It emphasizes, however, that the application of this standard does not in itself guarantee optimal environmental results.

In accordance with the requirements of the legislation by legal and physical persons that operate businesses are obliged to comply with the approved technology and requirements in the field of environmental protection and must ensure compliance with the standards of environmental quality through the application of technical means and technologies of deactivation and safe disposal of production and consumption, clean emissions and discharges of pollutants and other best available technologies to comply with the requirements in the field of environmental protection [1].

The system of environmental management of the enterprise (hereinafter– EMS) is a voluntary system designed to achieve the most optimal allocation of resources in the organization to achieve its goals while reducing the negative impact on the environment. ISO 14001 in contrast to the environmental standards contain no specific quantitative standards (emissions, concentrations, etc.) [2]. The standard is based on the basic principle of achieving the requirements: prevention of environmental impact is more efficient and economical than the correction of the consequences, as well as the PDCA cycle that is widely used in management. The PDCA model represents a cyclical process that your organization uses to achieve continuous improvement (figure 1). It is based on the concept of "Plan-Do-Check-Act" (Plan, Do, Check and Act).

Therefore, the standard states that the two organizations carrying out similar activities may meet the requirements of this standard, but at the same time have different obligations set out in
environmental policy, different environmental technologies and objectives, and objectively have a completely different impact on the environment. However, in modern conditions, even at certified enterprises, the environmental management system often remains in its infancy and does not function properly, which undermines the confidence of stakeholders in environmental management, in voluntary certification systems, as a conformity assessment procedure. The survey showed the public distrust toward the certificates of conformity [3].

So the problem of improving the environmental management system as a tool to improve work in the field of resource conservation and pollution prevention is relevant.

The main advantages of using EMS are improved planning and allocation of resources, reducing the possibility of man-made disasters (which can subsequently affect the state of the environment and lead to financial costs for their elimination), strengthening work in the field of resource conservation and prevention of environmental pollution at the production stage.

This paper proposes an integrated approach to the improvement of environmental management of the enterprise, based on the application of knowledge management, risk-based approach, integrated environmental monitoring and interested parties interaction.

We briefly describe the main definitions of the environmental management system. In accordance with GOST R ISO 9001-2016, the environmental management system is a part of the management system used to manage environmental aspects, fulfill obligations and take into account risks and opportunities.

Environmental policy means the intentions and direction of the organization with the regard to environmental performance, formalized by its senior management (figure 1).

An environmental aspect is an element of an organization's activities, products or services that interacts or can interact with the environment. Environmental impact is a change in the environment of a negative or positive nature, in whole or in part, which is the result of the environmental aspects of the organization.

Pollution prevention is the use of processes, practices, technical solutions, materials, products, services or energy to avoid, reduce or control (separately or in combination) the formation, release or discharge of any type of pollutant or waste in order to reduce adverse environmental impacts.
Figure 1. Implementation of PDCA cycle in the creation and development of environmental management system (EMS)

An integral part of the management of any organization that combines the actions associated with the formation of knowledge, their distribution and use, as well as the development of innovation and training is the management of knowledge. The knowledge management system creates a common information atmosphere in the organization, new and improved production processes that ensure the exchange of knowledge between specialists in different disciplines, information exchange and cooperation. There are management tools in knowledge management: an organized brainstorm, "help on the job" training, "storytelling", aid in the workplace, "knowledge cafe", the creation of clusters of knowledge methodology APO, document libraries, wikis, databases, social networking, locator expertise [4-7]. The algorithm for improving the environmental management system based on knowledge management and risk-based approach is shown in figure 2.
Figure 2. Improvement algorithm of ecological management system on the basis of knowledge management.

The tool of ecological management system improvement is storytelling and knowledge cafe. In the first case, to inform interested parties, especially the public about the mechanism of functioning of the EMS, the solution of environmental problems, the dynamics of changes in environmental indicators. Cafe of knowledge (figure 2) is a group of people who creates implements and disseminates new knowledge that will accumulate, analyze environmental information, as well as develop measures for self-improvement on its basis. The social network can be a powerful tool for the exchange of environmental information, providing its members with access to the most important knowledge, connections and advice.

An important aspect is the quality of informing the population about environmental problems. Environmental audit is an independent, comprehensive, documented assessment of compliance by a legal entity or an individual entrepreneur with the requirements, including standards and regulations, federal rules and regulations in the field of environmental protection, requirements of international standards and preparation of recommendations to improve such activities.

GOST R ISO 14001-2016 establishes that the organization must monitor (figure 3), measure, analyze and evaluate its environmental performance. The assessment includes an audit program, compliance assessment, and management review. The organization shall develop, update and apply the documented information in a manner sufficient to provide a suitable, adequate and effective environmental management system.
Metrological and technological quality assurance of measurements is aimed at fulfilling the requirements for measurements in accordance with the legislation. So for the measurements relating to the sphere of state regulation the measuring instruments of the approved type which passed checking shall be applied (item 1, Art. 9 of the Federal law "on ensuring unity of measurements No. 102-FZ" of 26.06.2008).

Measurements of pollutant concentrations in the air and industrial emissions are of particular importance for the environment. The government introduced in April 2018 in the state Duma a bill on the creation of systems for automatic control of emissions of pollutants into the air and discharges into water. In recent years, gas analyzers using the principle of direct measurements are becoming more common, since the use of these measuring instruments allows automating the measurement process, minimizing human involvement. Analysis of the metrological characteristics and measurement techniques underlying in the work allows drawing some conclusions [8-11]. To measure the concentrations of pollutants in the atmospheric air is better to use gas analyzers principle of operation, which is based on gas-phase chemiluminescence or fluorometry. For the measurement of organic compounds possible to use a chromatographic analyzer in the stationary post. Measurement of carbon dioxide is advantageously carried out using electrochemical gas analyzers, as TLV -C of carbon dioxide in the air on average is 10 times more than other major pollutants.
Low-cost electrochemical gas analyzers are suitable for measurements of industrial emissions pollutants. The problem of selectivity is partly solved by the fact that the composition of the exhaust gases is relatively constant and varies in time not so much.

When analyzing the air in the working area to measure the concentrations of ammonia, oxide and nitrogen dioxide, it is better to use gas – phase chemiluminescence, to measure the concentrations of sulfur dioxide and hydrogen sulfide – fluorimetric gas analyzer, measurement of other substances can be performed with electrochemical gas analyzer, taking into account the interfering effect of non-measurable components.

Improvement of environmental management system (figure 3) ensures the efficiency of the system of environmental control of emissions at enterprises, obtaining reliable information on environmental pollution by supervisory authorities and, ultimately, reducing the negative impact on the environment of the country.

The following recommendations can be used to improve environmental safety. In order to optimize the observation points for the state of the environment, it is necessary to place the monitoring equipment on the principle of choosing the priority zones for sources of air pollution, as well as for the aquatic environment. The criteria for selecting priority zones can be based on statistical analysis of observations. At the same time, it is advisable to create a network of environmental monitoring stations equipped with modern control devices created using controllers, digital and analog devices that operate simultaneously in real time and transmit the results of monitoring to the central control office of the city, where there is a simulation, a strategic analysis of environmental pollution processes, risk assessment based on an evolutionary strategy. The influence of geophysical characteristics of the territory where observation posts are placed should be taken into account. Mobile devices (quadrocopters, helicopters, etc.) can be used to determine the places of pollution. To monitor the state of the environment of large areas can be used spacecrafts that can monitor climate change, radiation, thermal and chemical pollution. Based on the results of environmental monitoring, knowledge and management, as well as a risk-based approach, it is necessary to develop an action plan for environmental protection of the population, animals, plants, through the introduction of environmentally friendly technologies, the use of filters and treatment facilities, removal of harmful industries outside the city.

Conclusion
Thus, on the basis of completed theoretical studies:
- an algorithm for improving the environmental management system, based on the introduction of knowledge management tools and risk management to improve environmental culture and awareness of the staff, public awareness and the development of intellectual capital of the organization is worked out;
- a model for improving environmental monitoring, based on the integrated management tools of information interaction of all interested parties, conformity assessment, internal and external audit conducted by independent expert organizations, as well as metrological and technological quality assurance measurements, automation control of environmental indicators is suggested;
- practical recommendations for improving environmental safety and placing points of observation of the state of the environment are presented.

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