INTEGRAL ESTIMATION OF DRINKING WATER QUALITY

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ABSTRACT
The article attempts to define the legal niche for new indicators of water quality, to coordinate them with the system of the existing indicators applied today by water supply facilities for various purposes, and to forecast consequences of applying them in the future. In the article, the authors substantiate the need to develop and implement integral estimates of the drinking water quality in the context of standardizing and legal regulation of drinking water supply. Groups of indicators that characterize the quality of drinking water have been considered. To perform the study, the authors have analyzed the methodic approaches on integral estimation of drinking water, surface waters and treated wastewater. The approaches of SUE “Vodokanal of St. Petersburg” to the integral estimation of drinking water quality have been described in the manuscript. The authors of the article have defined the areas of using integral estimates for the purpose of informational provision of consumers when selecting the best available technologies of preparing water and other purposes. The article also considers the issues on technical regulation of drinking water quality.

Keywords: drinking water quality, drinking water integral estimation, water quality classification, treatment quality integral indicator, water treatment technologies, technical regulation.
1. INTRODUCTION

Issues related to developing and introducing integral estimating of the drinking water quality have been discussed by the expert society and regulating authorities for at least ten years. This article is an attempt to define the legal niche for these new indicators, to coordinate them with the system of the existing indicators applied now by water supply facilities for various purposes, and to forecast consequences of applying them in the future (Abuzyarova 2014; Aleksandrovskaya and Rozental 2012; Bayborodin et al. 2010; Gandurina 2003; Khramenkov et al. 2002; Vinogradov 2007).

1.1. Substantiation of Integral Approaches to Estimating Drinking Water Quality

On the national level, legal relations on the drinking water quality are regulated by the standards set in several legislative acts related to various law branches. In particular, regulating mechanisms are found in the legislation about water supply and removal, sanitary and epidemiologic welfare of population, technical regulation, and water legislation and other federal laws and bylaws that directly or indirectly touch on drinking water quality.

Based on the peculiarities of legal regulation of drinking water quality, the task on quality integral estimation is solved within multiple interests of subjects of the legal relations. In particular, the parties concerned include, on the one hand, various groups of drinking water consumers from the industrial and residential sector, and, on the other hand, water supply organizations, their subcontractors and suppliers, investors, concessioners and lessees. Also there one more party represented by regulating and monitoring institutions, social organizations, etc.

The parties concerned have the right to obtain information about the drinking water quality. However, the need in the level of its specification differs depending on subjects of the legal relations.

In accordance with the legislation, consumers may exercise their right for true and required information about the quality of drinking water both by groups of indicators and in whole.

When rendering a service in the area of centralized water supply, in a number of cases consumers need to identify drinking water as suitable or non-suitable for drinking, useful or dangerous for the person’s health (Bubnov and Buymova 2014; Kiselev et al. 2011).

These needs actualize solving the task on substantiating approaches to developing and introducing an integral estimation of the drinking water quality (Kiselev et al. 2011; Kobylyanskiy and Vasilenko 2015; Zhitkov and Makalskiy 2010) that can be considered as criteria to define efficiency of production and investment activity, as well as applied and planned technologies in water supply.

1.2. Standardizing Drinking Water Quality

Today, to estimate the drinking water quality, a rather complicated and cumbersome system of indicators is applied, which has been formed in accordance with sanitary and hygienic requirements. Above all, it is focused on the health protection and on the goals pursued by the federal sanitary and hygienic control. It is stipulated by tasks of the production control over
facilities belonging to the centralized drinking water supply systems (Alekhina et al. 2013; Alifanova 2013; Antipov et al. 201; Flyanku et al. 2015). The general requirements to drinking water quality are stipulated in Article 19 of the Federal Law No. 52-FZ dated 30.03.1999. According to it, drinking water must be safe in terms of epidemiology and radiation, harmless by its chemical composition, and must have good organoleptic characteristics. The system of hygienic standardization defines the degree of compliance of drinking water quality with hygienic standards based on indicators of maximum allowable concentration (MAC) separately for every substance contained in the drinking water (Onischenko et al. 2010).

Along with the component estimation, the legislation determines the cases that require applying generalized indicators of water quality, and allow providing information that departs from the mode accepted in the hygienic standardization system and related to every separately taken substance from the list of standardized and controlled indicators of water quality (according to various documents, this list contains above 1,000 ingredients) (Zhitkov & Makalskiy 2010).

1.3. Object and Subject of Legal Regulation of Drinking Water Quality

The legislation, strategic and program documents define drinking water as an object of legal regulation that has different legal status: it is a product, a utility resource, commodity, a result of service on water treatment, a resource of life sustenance, and a natural resource. Under such multiple meaning of drinking water, mechanisms of legal regulation must take into account peculiarities of its legal status that make it possible to use integral estimates of its quality, where it is applicable and reasonable.

According to experts of the Scientific Research Institute for Environmental Problems and specialists from SUE “Vodokanal of St. Petersburg”, mandatory requirements on defining the drinking water quality by all containing indicators expressed by natural specific values (mg/l) must cover sanitary and epidemiologic regulation, and production control, the requirements of which are determined within the sectoral legislation on water supply and removal. In other cases it is reasonable to apply integral estimates of water quality expressed by relative and non-dimensional values (Nefedova et al. 2015).

Order of the Ministry of Construction of the Russian Federation No. 162/pr dated 04.04.2014 approves a list of reliability, quality, and power efficiency indicators of water supply and removal facilities, as well as a procedure and rules of defining target and actual values of such indicators that characterize these facilities. According to this order, drinking water quality is characterized by relative indicators that show the share of samples that do not comply with the determined requirements expressed in percent.

2. METHODOLOGY

2.1 Methodology of Risk Estimation and Integral Estimates of Drinking Water

Methodical recommendations MR 2.1.4.0032-11 “Drinking Water and Water Supply in Settlements. Integral Estimation of Drinking Water of Centralized Water Supply Systems by Chemical Harmlessness Indicators” that were approved by the Principle State Environmental Health Officer of the Russian Federation on 31.07.2011 provide for the opportunity of integral estimation of drinking water quality by chemical harmlessness indicators based on the methodology of estimating risk for the population’s health.

MR 2.1.4.0032-11 offers a model to calculate the integral estimation of drinking water on chemical harmlessness indicators.
2.2. Method of Comprehensive Estimation of Surface Waters

In order to estimate the water quality in waterbodies, the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) developed methodical instructions RD 52.24.643-2002 “Regulating Document. Methodical Instructions. Method of Comprehensive Estimation of the Surface Waters Contamination Level using Hydrochemical Indicators”.

The main goal of these methodical instructions is defined by cl. 78 of the Water Code of the Russian Federation: providing the state with the stipulated statistical information about the level of the country’s surface waters’ contamination by hydrochemical indicators. According to this method, the most informative comprehensive estimates include the following:

- Specific combinatory water pollution index (SCWPI);
- Class of water quality.

This method classified water quality based on SCWPI indicators. This classification makes it possible to divide surface waters into 5 classes depending on their pollution degree. The more water is polluted with a complex of polluting substances, the higher its class is.

2.3. Integral Indicator of Wastewater Treatment Quality

The use of integral estimates is acknowledged as reasonable when estimating the quality of treated wastewater by technological standardization system. To calculate technological standards, technical references (TR) on the best available technologies (BAT) determine values of technological indicators. In particular, technological indicators for biological treatment technologies are determined in the BAT TR: TR-10-2015 “Wastewater Treatment by Using Centralized Water Removal Systems of Settlements and Urban Districts”.

TR 10-2015 defines the integral indicator of treatment quality (IITQ) by the limited list of indicators – only by technological indicators at the stage of biological treatment of wastewater, and only by one type of negative impact on water facilities – polluting substances. The IITQ value is defined for every certain sample of wastewater or (by average data) for a certain object.

As applied to the task on integral estimation of wastewater quality, it is offered to consider the non-dimensional parameter of IITQ as a specific mass parameter that shows how this wastewater is in total more polluted than the wastewater with the technological indicators that are equal to the target technological indicators (TTI).

2.4. Approaches of SUE “Vodokanal of St. Petersburg” to Integral Estimation of Drinking Water Quality

Specialists of SUE “Vodokanal of St. Petersburg” offered a more flexible tool to estimate the drinking water quality based on integral estimates.

According to this approach, it is necessary to divide the quality indicators into groups by the nature of the contaminant and class of its danger in compliance with the classification accepted in the current statutory documents. As an integral estimation of the drinking water quality it is offered to use the SSS index, where S1 is epidemiological & radiological safety, S2 is chemical safety, and S3 is physiological safety. The SSS index is represented schematically in Fig. 1 and calculated according to the formula: $SSS = \sum_{i=1}^{n}(A_{av}^i/MAC_i^i)$, where $A_{av}^i$ is an average value of $i$ substance concentrations per year defined for the determined period (for example, year) by all control points; $MAC_i^i$ is a standard of drinking water quality by the $i$ indicator that is legislatively determined on the state level (SanRaN 2.1.4.1074-01, HS 2.1.5.1315-03, HS 2.1.5.1220-07); $i$ is a number of indicators taken into account when defining the SSS index.
In order to obtain the quantitative value of the integral estimation of the water quality used for drinking water supply in Saint Petersburg, it is offered to bring the registered quality indicators of water to the value of their share in the MAC determined by the current standards.

3. RESULTS

3.1. Calculation results

Fig. 2 shows diagrams with the calculated values of SSS indices, and compares them with the indicators of the drinking water quality included in the statutory documents of European Directive 98/83/EU, recommendations of the World Health Organization, and the US and Russian standards. The calculations made for certain groups of quality indicators show that in Saint Petersburg the faucet water is of high quality.

According to the value of the SSS index, the drinking water running in the distributing system of Saint Petersburg has lower values of the determined standards, i.e. its quality is higher.

The SSS index allows making the conclusion about the degree of the drinking water safety in Saint Petersburg. Such estimation is required by various groups of consumers requiring information about the water quality.

3.2. Application of Integral Estimations

The main areas of applying integral estimations of drinking water quality must become the following:

- Comparative analysis of economic and ecological efficiency of water treatment technological schemes;
- Proofs of compliance (or incompliance) with the BAT criteria of technologies that already exist or are planned for implementing at water supply plants;
- Stipulating economic parameters of measures included in plans on improving drinking water quality/bringing into compliance with the determined requirements at the facilities of centralized water supply systems;
Disclosing information about the drinking water quality in the cases provided by the Russian legislation;

Estimating the dependence of the drinking water quality on changing the level of contamination of the water body – a source of drinking water supply, etc.

It will be necessary to use the integral estimations for developing and actualizing the measures included in investment and production programs provided by the water supply schemes, plans of comprehensive development of the communal infrastructure in terms of water supply, other plans and programs implemented in accordance with new legislative requirements and conceptual and strategic documents on providing the population with clean water.

3.3. Technical Regulation of Drinking Water Quality

It is necessary to pay attention to the subject regulated by Federal Law No. 416-FZ dated 07.12.2011 (version dated 03.07.2016) “On Water Supply and Removal”. According to it, the requirements to the quality and safety of water supplied by centralized cold water supply systems are referred to the scope of applying the legislation of the Russian Federation in terms of providing sanitary and epidemiological welfare of the population and legislation about technical regulation (Cl. 3 Art. 1 No. 416-FZ).

This standard of the sectoral law is not fully implemented. It covers only legislative provision of sanitary and hygienic aspects of the drinking water quality because mechanisms of technical regulation of issues related to providing safety of drinking water have not yet been formed on the level of federal law. Adoption of the relevant technical regulation that determines the minimum safety requirements to water treatment and drinking water as a product related to objects of centralized water supply systems would be able to fill in this gap.

In this context it becomes urgent to develop methodological tools on forming the structure and applying an integral estimation of the drinking water quality at the stage of water treatment emphasizing technological aspects of drinking water supply. This is a required step that contributes to solving issues related to technical regulation in the area of water treatment and providing the drinking water quality that complies with statutory requirements.

4. CONCLUSION

1. As a result of analysis, the legal niche has been defined for developing and introducing the indicator that reflects the integral estimation of the drinking water quality in the system of legal regulation of issues related to drinking water supply. Above all, this niche can be filled in by the technical regulation that determines minimum requirements to water treatment. It is necessary to consider BAT TR in water treatment at facilities of centralized water supply systems as an alternative and supplementing tool. At the same time technological indicators defined in this reference as BAT must have a statutory status. The technical regulation and/or TR may include integral estimations of the drinking water quality (like the IITQ in the TR 10-2015).

2. An attempt has been made to logically coordinate integral indicators of the drinking water quality and the system of reliability, quality, power efficiency indicators applied to estimate the activity of water supply organizations, and other subjects of legal relations at facilities of centralized water supply systems defined in the legislation. It is determined that applying integral estimations of the drinking water quality does not come into conflict with the current system of sanitary and hygienic standardization and production control in drinking water supply. Integral estimations can be
considered as criteria for estimating efficiency of the activity and technologies in water treatment.

3. The consequence of taking the decision about introducing integral estimations of the drinking water quality will be a need to develop instructive and methodic documents that define the structure of integral indicator, factors of its formation and mechanism of its application. It will cause certain expenses. However, in the future, when applied, this tool can become an efficient support for comparative estimation of investment offers in water supply and stipulating the selection of the existing alternatives.

4. There is reliable research-methodic and information-technical groundwork for developing integral indicator of the drinking water quality. Its use will make it possible to optimize expenses for implementing this idea.

REFERENCES