Automated control systems for wastewater discharges in the pulp and paper industry

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Abstract. The algorithm and the experience of implementing automated systems for monitoring the quality of waste in the pulp and paper industry in the framework of a unified system of industrial environmental control are being considered. The required list of wastewater parameters subject to automated control is determined. The main technical and operational characteristics of automated wastewater quality control instruments included in the unified state register of measuring instruments are being considered. The problems of introduction of automated wastewater quality control systems in the Russian Federation are being considered.

The vast majority of pulp and paper industry (P&P) enterprises belong to the first category of negative environmental impacts, i.e. they have the maximum negative impact. The masses of discharge and the concentration of pollutants in the wastewater of P&P constantly vary depending on a large number of parameters: operating modes of technological and treatment equipment, chemical composition of raw materials and reagents, output volumes and etc. It is obvious that the environmental impact of these enterprises should be recorded in an automated mode.

In the worldwide practice, automated wastewater quality control systems have proven themselves well. Russian Federation has also been successful in implementing such systems with controlling emissions pollutants. For example, In the Moscow area the emissions from a number of industrial enterprises have been monitored automatically for over 10 years. The practice of introducing automatic industrial emission control system in Moscow has demonstrated their effectiveness in making environmentally significant decisions. Once industrial emission control system of enterprises are commissioned, a significant amount of excess pollutants is recorded.

According to the current Russian legislation, enterprises discharges of the 1st category of negative impact on the environment must be controlled every 2-3 hours [1]. Automatic wastewater quality control devices must be installed directly at the wastewater discharge, including deep water discharges, but no later than 4 years after the enterprise receives a comprehensive environmental permit.

The introduction of automatic quality control systems for wastewater by P&P will allow receiving of timely information about the actual concentrations of pollutants in the wastewater and discharge parameters, keep a statistical record of pollutant concentrations. Therefore, based on processing of statistical data, enterprises will be able to determine the optimal parameters of the technological process,
which will reduce the anthropogenic load on the water environment, and in case of incidents and emergency situations, it will allow you to take timely measures to localize them. Automated wastewater quality control systems of enterprises should become the basis for regional control of the negative impact on the aquatic environment [2-3]. The implementation of this approach is entrusted to the authorities of Rosprirodnadzor, on the basis of which a register of facilities that have a negative impact on the environment has been created. Systematic data on industrial wastewater quality control will be automatically transferred to this registry.

The creation of an automatic control system at pulp and paper industry enterprises includes the following stages:

- determination of stationary sources of discharges;
- development and approval of the program for creating an automatic control system;
- design of an automatic control system;
- supply and installation of required equipment to create an automatic control system;
- acceptance and commissioning of the automatic control system.

A general view of the automated control system is shown in the figure 1.

![Figure 1. Functioning scheme of an automated wastewater quality control system.](image-url)

Automatic means of measuring and recording indicators of pollutant discharges must meet the requirements of the legislation of the Russian Federation on ensuring the uniformity of measurements and ensure the transfer of information over information and telecommunication networks in accordance with the data transfer format approved by the Federal service for supervision of natural resources to the state register of objects that have a negative impact on the environment.

Automatic controls must be installed at all outlets of P&P enterprises, through which more than 15% of the mass of pollutants is discharged. Automated control tools should provide automatic wastewater sampling for analysis, directly measuring the given parameters of the wastewater itself, transmitting the control results to the technical means of recording information on the results of measurements of pollutant discharges averaged for every 2 or 3 hours. Automatic wastewater quality control systems.
must remain operational in case of failures in the power supply system, emergencies and accidents, failures in the process.

The unit for recording and transmitting information to the state register must maintain reliable information about the information transferred to the register for at least one year, the time and dates of stopping and resuming the operation of automatic measuring instruments in case of their stopping, and the identification data of each source of pollutant discharges.

Registry software must receive record and store information for at least 7 years.

According to Russian legislation, the following parameters are determined automatically in wastewater: the concentration of pollutants in mg/m³; volumetric flow of wastewater discharge in m³/h; temperature of discharged wastewater in °C; pH; COD in mg/dm³; turbidity. The limit of measurement of the concentration of pollutants by automatic measuring instruments should provide an upper limit of measurement of at least 2.5 times the approved value.

Wastewater of P&P enterprises is a multi-component system containing the following main groups of substances: suspended solids; inorganic components (sulfur and chlorine-containing compounds); organic components (lignin substances, phenols and their derivatives, carbohydrates, resin and fatty acids, sulfur and organochlorine compounds, methanol, terebenthene, formaldehyde and etc.). Currently, 15 to 23 substances and compounds that can be divided into two groups are controlled in wastewater [4]. The first group includes marker parameters that characterize the water content of a number of different compounds. The list of such parameters, in particular, includes chemical oxygen demand (COD), biological oxygen demand (BOD), suspensions, dry residue, colority, and mineralization. The second group includes specific pollutants that are typical only for wastewater from pulp and paper mills. These include, for example, lignin substances, methanol, tallow oil, and other organic compounds.

In accordance with international practice, marker substances are subject to automated control. However, enterprises of the pulp and paper industry often, in addition to the production of basic products, carry out treatment of domestic wastewater in settlements and are producers of thermal energy. Therefore, for them in the list of controlled substances in an automated mode should also include marker substances from non-core industries [5].

For enterprises that purify domestic wastewater with a volume of more than 200,000 m³ per day, it is necessary to automatically control suspended solids, nitrate ion, ammonium ion, phosphorus phosphate. For P&P enterprises, the COD, BOD, total nitrogen, total phosphorus, suspensions, and adsorbed organic chlorine (AOC) [6] should be subject to controlled substances.

The use of automated wastewater quality control systems can be carried out only after making them in the state register of measuring instruments.

However, at present, the State register of measuring instruments does not have automated tools that allow to determine all the listed pollutants [7].

In the registry consists of:

- Analyzers of common, ammonium and nitrate nitrogen, while most of the analyzers can determine either the general form of nitrogen content or separately nitrates and nitrites.
- Phosphate analyzers.
- Analyzers of chemical oxygen consumption.
- Systems for determining BOD.
- Analyzers of suspended solids.
- Analyzers for determining pH and water temperature.

There are no automated systems for measuring AOC. The state register of measuring instruments contains analyzers of various manufacturers from Russia, European countries, Asian countries and America that use various data storage protocols.

Thus, in order to meet the requirements of Russian legislation in the field of wastewater discharge control, the pulp and paper mill should install at least 6 automatic analyzers at the water outlets, and no
control over AOC concentrations will be provided. The development of the project documentation for the installation of a large number of automated control tools is associated with significant operational and technical difficulties.

Most of the presented automated wastewater quality control tools have requirements for climatic conditions and generally remain operational in the temperature range from +5 to +35 degrees Celsius, and sometimes only from +15 to +25 degrees Celsius. Therefore, in the northern climate, where most Russian P&P enterprises are located, the control equipment must be located in a heated room.

Of the automatic controls presented in the state register, measurement sensors such as pH, oxygen, and suspended solids can be dropped directly into the wastewater. To determine the remaining substances, the wastewater must be placed directly in automated control equipment. Therefore, in actual operation, every 2-3 hours will have to manually take wastewater samples to analyze the content of pollutants.

Almost all automated control systems allow you to save measurement results. However, data storage formats rely on various protocols. In some cases, you may need to use a flash drive to access data, and in some cases, access is only possible using specialized hardware or directly from the device's display. This fact makes it extremely inconvenient to transfer control results from various analyzers to a single format. And in fact, automated production control of wastewater quality can be reduced to the manual transfer of data to an information collection system.

Most equipment do not have automated means for remote data transmission so in reality it will be replaced by manual procedures. There are no requirements for protocols for the transfer of information from the enterprise to the register of objects of negative environmental impact.

Therefore, today pulp and paper industry enterprises do not have a real opportunity to introduce a full-fledged automated wastewater quality system.

The installation of automated control systems will require the development of project documentation in accordance with decree of the Government of the Russian Federation dated 16.02.2008 №. 87 “On the composition of sections of project documentation and requirements for their maintenance”, while project documentation may be subject to state examination in established cases, as well as industrial production facility safety.

Thus, the following obstacles can be identified in the organization and implementation of automated wastewater quality control systems for pulp and paper enterprises.

- The absence in the single register of measuring instruments for automated equipment capable of controlling a complete list of marker pollutants. The need to install a large number of automated controls will lead to significant financial costs for the installation and maintenance of these systems. A number of automated wastewater quality control systems cannot be installed at the wastewater outlet in terms of their operational characteristics.
- The operation of automatic wastewater discharge control systems requires highly qualified specialists in the field of maintenance of automated systems, which are absent at most enterprises.
- The absence in the unified state register of measuring instruments for automated equipment designed for all operations, including: sampling of wastewater, analysis of wastewater discharge parameters, storage of control results and transfer of analysis results to the state register of negative environmental impact objects.
- Different equipment manufacturers use different processing and storage protocols.
- Equipment often lacks an automated data transfer system.
- Requirements for the transfer of the results of automated control of wastewater parameters to the register of objects of negative environmental impact have not yet been developed.
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