Measures to achieve technological indicators of wastewater quality in the pulp and paper industry

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Abstract. When switching to technological regulation in the Russian Federation, enterprises were divided into categories of negative impact on environmental objects. The most significant impact is exerted by enterprises of the 1st category of negative impact on the environment. Under the new requirements, such enterprises must receive a comprehensive environmental permit (CEP), in which one of the components is compliance with technological standards. If actual values do not match, enterprises should implement a program to improve environmental performance. The work examined technological solutions for use, which environmental impact will meet the requirements of the best available technologies (BAT). Measures are proposed to achieve the levels of technological standards for the existing pulp and paper industry (PPI), using the method of sulfate pulping. The values of indicators of identification of water management activities used in modern legislation are determined: anthropogenic load index (ALI), impact potential (IP), technological impact index (TII), coefficients of water resources involvement in the technological process before and after events.

Pulp and paper industry (PPI) enterprises are mostly classified as enterprises of the 1st category of negative impact on the environment. According to Russian law, the mass of pollutants discharged by the pulp and paper industry enterprises for substances of 1st and 2nd hazard classes should not exceed the standards for permissible discharges. For marker indicators, the actual specific standards for the formation of pollutants per unit of output should not exceed the values of technological standards.

The calculated values of standards for permissible discharges and the values of actual specific standards for the formation of pollutants are included in the application for a comprehensive environmental permit. If, for any of the above parameters, the actual impact exceeds the established standards, then it is necessary to develop a program to increase environmental efficiency.

Ensuring the specified requirements for the quality of wastewater in production requires the application of the best available technologies. A list of the best available technologies for Russian pulp and paper industry enterprises is given in the information and technical reference book on the best available technologies [1]. The introduction of the best available technologies at the pulp and paper mill enterprises is a high-cost process, therefore, first of all, it is necessary to implement measures that have the maximum environmental potential and the shortest implementation time [2 - 4].
The following best available technologies have been developed for pulp and paper mill with sulphate pulping: dry debarking; extended modified for pulping; closed sorting system and effective washing of unbleached pulp; oxygen-alkaline delignification; ECF-bleaching and chemical production for it; blowing and reuse of contaminated condensates after cleaning in a stripping column; partial closure of the water cycle of the bleaching shop; partial or full reuse of clean cooling water; heat recovery in the production of pulp, paper, cardboard; buffer tanks for collecting leaks; closed cycle of regeneration of chemicals for pulping; collection and decomposition of sulfate soap; isolation and collection of organic solvent; collection of weak and strong gases, followed by burning in specialized furnaces, lime regeneration furnaces, soda recovery boilers; black liquor burning with a concentration of more than 72%; improved flushing of sludges from chemical recovery; dehydration of waste from the chemical regeneration cycle; electrostatic precipitators after soda recovery boiler, lime recovery furnace, boiler for burning bark and sludge from treatment facilities; boilers for burning bark and sludge from treatment facilities, lack of penetration and fuel preparation for them; biological wastewater treatment; dewatering sludge from treatment facilities; improved systems of defective recycling (paper machine and paperboard machine); fiber capture systems from excess waste water paper machine / paperboard machine; local treatment facilities to treatment facilities; implementation in the system an automated dispatch control system; combined heat and power generation [1].

Assessment of the environmental efficiency of production can be carried out by assessing resource efficiency and the level of impact on the aquatic environment.

One of the main indicators of resource efficiency for pulp and paper industry enterprises is the consumption of water resources. Water consumption at the enterprise can be estimated using water utilization factors, these are included [5, 6]:

- coefficient of use of circulating water in the total volume of water consumption, which shows the percentage of circulating water to the total water withdrawal from the water supply source;
- the coefficient of irretrievable consumption and fresh water losses, which is shown as a percentage of how much water is the amount of water from a water object spent on production purposes without returning to this water object;
- utilization rate of water taken from the source. Reflects the proportion of water that is sent to the discharge after production.

The level of environmental impact is estimated by calculating the specific values of the formation of pollutants per unit of output, as well as modern indices, such as anthropogenic load index, impact potential, technological impact index [7].

The specific values of education estimate the amount of pollutants per unit of output, both by individual stages of production and by generalized indicators for the entire production. The indicator anthropogenic load index provides an assessment of the compliance of the negative impact of the same technologies with the indicators of the best available technology, with the help of the technological impact index it is assessed in accordance with the negative impact of technologies on the indicators of the best available technology, and with help of the impact potential index, it is possible to comprehensively assess the specific potential impact of wastewater quality on the volume of wastewater.

Consider these requirements on the example of JSC "Segezhskiy PPM". Biological treatment station of industrial wastewater of "Segezhskiy PPM" JSC is designed for mechanical treatment, neutralization, complete biological treatment and treatment of wastewaters from the main production, mechanically treated domestic wastewater of the city of Segezha, as well as the disposal of excess sludge and sediment in the dewatering workshop of sludge and sediment.

Biological treatment station consists of (figure 1):

- PPM block,
- mechanical sludge and sediment dewatering workshop,
- blower station,
• reagent storage facilities,
• pond-aerator,
• sludge-collector.

![Flowchart of a typical biological treatment station](image)

**Figure 1.** Scheme of a typical biological treatment station.

Under the existing treatment scheme at the outlet from the biological treatment station, the wastewater parameters exceed the maximum permissible concentrations of pollutants for water bodies of the fishery category of water use, and the actual specific norms for the formation of pollutants per unit of output exceed technological standards. Comparison of actual and regulatory data is given in table 1.

| Name of substance             | Actual concentration, mg/l | Specific forming wastewater: 91,1 m³/ton | MPCₓ (Max.permissible concentration), mg/l | Specific weight, kg/ton | Technology standard, kg/ton |
|------------------------------|----------------------------|----------------------------------------|------------------------------------------|------------------------|--------------------------|
| Suspended substances         | 15.9                       |                                        | 1.4                                      |                        | 0.9                      |
| Chemical oxygen consumption  | 242                        |                                        | 30                                       | 22                     | 5                        |

When analyzing the data of table 1 it can be seen that there are excesses of both technological standards and environmental quality standards. This is due to the use of obsolete equipment used in the process of production and purification process for waste water the biological treatment station [8].

Measures to achieve the required quality indicators at the wastewater outlet can be divided into several areas: reducing the formation of wastewater volumes; reduction in the formation of pollutants in the production process; improving the efficiency station of a biological purification of wastewater.

Modernization of the local mechanical wastewater treatment after wood debarking in the wood-preparation workshop helps to reduce the water consumption of the forestry shop by reusing water to 80% of the existing consumption, as well as reducing the load on the biological treatment station for suspended solids and chemical oxygen consumption by 10%.

Implementation of measures to organize a system for the recycling of water resources in the brewhouse, which will lead to a 20% reduction in the water consumption of the brewhouse by changing...
the pattern of recycled water use in the brewhouse. Also, this event will lead to a decrease in the removal of pollutants to wastewater treatment plants. In the chemical building, a change in the water consumption system can reduce water consumption and, as a result, reduce wastewater disposal at the biological treatment station.

The use of advanced systems on paper machines with the goal of deeper local wastewater treatment and returning them to the production process. These systems will lead to a 30% reduction in the removal of pollutants from papermaking shops, and a reduction in the discharge at biological treatment station will reach 50% from the current levels of wastewater discharged.

Modernization of the aeration tank aeration system by installing fine bubble aeration systems, which will ensure oxygen saturation of activated sludge, increase the efficiency of this biological treatment stage (reduce the biological consumption of oxygen, methanol, phenols, surfactants, oil products), and also reduce energy costs.

Overhaul of secondary sedimentation tanks: replacement of a sludge pump, comb weirs, skirts, central supports. This list of works will lead to an increase in the efficiency of sedimentation of the sludge mixture, a decrease in the removal of suspended solids, which also include an organic substances.

In addition to this, it is possible to envisage the construction of a unit for the purification of biologically treated wastewater using filtering technology on disk filters. When implementing this measure, there will be a decrease in the content of finely divided particles (suspended solids) and organic substances in wastewater.

When these measures are implemented, a decrease in the quantitative characteristics of wastewater will be observed in terms of volume and in content of pollutants [9, 10].

The results of the calculation of indicators and water utilization coefficients, as well as a comparison with the values after measures to modernize production are given in table 2.

| № | Index                                                                 | Factual significance | Significance after events |
|---|------------------------------------------------------------------------|----------------------|--------------------------|
| 1 | Anthropogenic load index, conditional. m³/m³                          | 27.3                 | 14.3                     |
| 2 | Impact potential, unit of impact/thousand. m³                         | 6.17                 | 3.01                     |
| 3 | Technological impact index, unit of impact/ton                        | 0.56                 | 0.15                     |
| 4 | Water recycling coefficient (kres), %                                 | 19.5                 | 37.8                     |
| 5 | Water reuse coefficient (kreuse), %                                   | 5.8                  | 6.7                      |
| 6 | Coefficient of irretrievable consumption and fresh water loss (kcon), %| 0.21                 | 0.5                      |

| Specific indicators (kg/ton)/(m³/ton) |
|--------------------------------------|
| 7 Chemical oxygen consumption         | 22          | 4.9          |
| 8 Suspended substances                | 1.4         | 0.47         |
| 9 Wastewater consumption              | 91.1        | 49.1         |

The implementation of the proposed measures will ensure the value of technological standards for wastewater discharge for chemical oxygen consumption and suspended solids, and reduce fresh water consumption by 45%. Estimated costs of the activities will amount to 256 million rubles. However, the introduction of these technological solutions will allow the company to obtain a comprehensive
environmental permit, become one of the environmentally responsible industries of the North-West Federal District, and significantly reduce environmental pollution charges.

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