

DYCLAR™: CLEAN WATER PLUS COST SAVINGS

**CASE. EXPERIENCE OF
USING DYCLAR™
DYNAMIC
CLARIFICATION
TECHNOLOGY AT THE
KOSTROMOVSKAYA
MINE (MMK-UGOL)**



Sergey Tsivilyov, Governor of the Kemerovo Region, at the opening of the Kostromovskaya mine treatment facilities on Miner's Day (August 28, 2018)



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Challenge:

Over the past few years, the environmental requirements to the quality of water discharged by enterprises into natural water bodies have become much stricter. For industrial facilities, regional authorities established discharge limits (DLs) for all types of water pollution. Which are calculated in accordance with the methodology approved by decrees of the Ministry of Ecology of the RF (the term "Water Management Area Impact Limit" – IL is also used).

The most typical pollutants in the coal mining industry of discharged water are suspended solids, which are present in significant concentrations, 100 mg/l and more, after the water treatment in sewage regulators. The rate fee to discharge one ton of suspended solids in 2018 was 1,016.29 RUB, and in case it exceeds the discharge limit, the said rate is multiplied by 25. With an average discharge flow rate of 1,000 m³/h, the suspended solids content of 110 mg/l (averaged over the year), and a DL of 10 mg/l, the fee in respect of this indicator alone would be 67,075 RUB per day, i.e. 24.48 RUB mio per year.

State policy guarantees industrialist's to introduce new wastewater treatment technologies and upgrade the existing treatment facilities, resulting in capital expenses (establishment or reconstruction of the FAs) and operating costs (water consumption for own needs, operating costs, costs for the purchase of consumables and spare parts, as well as wages of maintenance personnel). Technologies based on sediment ponds are definitely required for the preliminary stage clarification of mine water, but they aren't able to ensure the treatment of water from suspended solids and colloids to the required level, so the customer's goal is to select an effective solution that will address the problem of waste water treatment in the long term with the lowest possible capital and operational expenses.

Task:

The process flow chart of wastewater treatment at the Kostromovskaya mine (OOO "MMK-Ugol"), part of the PAO "Magnitogorsk Iron and Steel Works" group, failed to ensure the achievement of modern requirements and limits of discharge into natural water. The high probability of pollutant discharge and unstable quality of mine water treatment poses risks to the region's environment. The customer set a task to introduce innovative technologies for the treatment of waste water discharged into a natural water body, the Sukhoi Log stream (Barnaulka-Ob-Kara Sea water system). MMK-Ugol announced a tender for construction of 575 m³/hour wastewater treatment facilities for the main production site, Kostromovskaya mine. The terms of reference included three stages of work:

- Achieving a capacity of 405 m³/h and ensuring that the waste water is treated to the DL in terms of suspended solids only.
- Increasing the capacity to 575 m³/h and commissioning of a sludge dehydration unit.

- Providing the DL in waste water for all substances and impurities.

Solution:

Before construction of waste water advanced treatment facilities at Kostromovskaya mine, a typical solution for mine water clarification in sewage regulators was utilized, which provided 131.9 mg/l average suspended solids content in the discharged water, while the discharge limit was 40 mg/l.

Mirrico Group (Water Technologies and Services Division) took part in the tender with a proposal to build wastewater treatment facilities based on the DYCLAR™ innovative technology of dynamic clarification. Competitors proposed classical technologies based on pressure filters with combined loading, as well as foreign technologies based on pressure flotation and ultrafiltration membranes.

Comparative analysis of DYCLAR™ dynamic clarification technology with competitive solutions, i.e. conventional mine water treatment technologies*:

TREATMENT FACILITIES BASED ON DYCLAR™ DYNAMIC CLARIFICATION TECHNOLOGY ENSURE STABLE QUALITY OF WATER TREATMENT FROM SUSPENDED SOLIDS, REGARDLESS OF SEASONAL FLUCTUATIONS IN THE RAW WATER QUALITY AND TEMPERATURE

Indicator to be compared	DYCLAR™ dynamic clarification technology	Flotation with fine filters	Pressure filters (mechanical and sorption filtration)	Membrane technology
Quality Treatment	Less than 3 mg/l of suspended solids in treated water.	Less than 5 mg/l suspended solids in treated water. The operating mode depends on the initial suspended solids content	Less than 5 mg/l of suspended solids in treated water	Less than 3 mg/l of suspended solids in treated water.
Wastewater treatment plant building area	531 m ²	-550–600 m ²	- 1000 m ²	- 700 m ²
Capital expenditures (number of times the reference value)	1 – reference value	2.5–3.0	1.5–2.0	1.2–1.5
Facility own needs	5–10%	10–15%	up to 20%	up to 30%
Operational costs (number of times the reference value)	1 – reference value	1.25–1.45	1.45–1.75 Typical costs: annual topping-up of silica sand, short life span of sorption loading on mine waters (75–100 days)	2.5–3.5 Typical costs: replacement of membrane elements, chemical, and alkaline washing, neutralization of acid, and alkaline wastewater

*The analysis was conducted by industry experts and is valid for 400 m³/h wastewater treatment facilities, with a suspended solids content of 100 mg/l in the source water and raw water COD of 97 mg/l.



Mirrico Group representatives at the opening of wastewater treatment facilities at Kostromovskaya mine

STAGES OF THE EPC-PROJECT (ENGINEERING, PROCUREMENT AND CONSTRUCTION) FOR THE CONSTRUCTION OF WASTEWATER TREATMENT FACILITIES BY THE WATER TECHNOLOGIES AND SERVICES DIVISION:

I. Design at the in-house design center (Nizhny Novgorod).

Designs process chains and equipment, building engineering systems, i.e. heating, ventilation, fire extinguishing, lighting, telephone communications, architectural, construction part, external networks, building exterior decoration, and adjacent territory improvement.

II. Project approval by the State Expert Review Panel.

The State Expert Review Panel assesses the compliance of the design documentation with technical regulations, including sanitary-epidemiological and environmental standards, fire and industrial safety requirements, as well as the assessment of conformity of the engineering survey results with technical regulations. The approved design documentation with a positive opinion of the State Expert Review Panel shall form the basis for the development of working documentation.

III. Development of working documentation, i.e. detailed specifications, engineering drawings, and estimates for the capital construction facility.

Specialists of the in-house engineering center with the involvement of specialized design institutes shall develop sets of working documentation ensuring the implementation of engineering solutions of the capital construction facility adopted in the approved design documentation required for construction and installation works, as well as providing the construction process with equipment, products, and materials.

IV. Supervision of construction works performed by contractors.

Engineering and administrative staff of the division performs planning, organization, supervision of works at the construction site, attends the meetings of command staff and commissions, as well as interacts with supervisory authorities.

V. Installation commissioning and maintenance personnel training.

The drawback of pressure filters is the requirement for max 50 mg/l content of suspended solids in the source water, short filter cycle and short life span of sorption loading.

Membrane technologies ensure a high level of treatment, but impose a number of restrictions in its application: they require an additional step of mechanical water treatment with filtration rating of 200–300 microns and highly skilled personnel: membranes fail frequently due to untimely manual chemical washing, and module replacement price amounts 30-35% of the underlying equipment cost.—3 Pressure flotation units imply significant capital expenditures for equipment purchase and difficulty in maintaining the required flotation mode, as the process is highly sensitive for suspended solids content of the source water, and flotation is often replaced by a sedimentation process, which leads to the flotator clogging.

As a result of tender procedures and pilot testing, the customer opted for DYCLAR technology showing the following advantages over competitors' solutions:

1. Acceptance of source water without restrictions, ability to operate in a wide load range and with variable content of suspended solids in the source water;
2. Ensuring that treated water quality meets the terms of reference and DL;
3. Lower capital expenditures for the establishment of treatment facilities than those proposed by competitors;
4. Lower operational costs than those proposed by competitors:
 - The dimensions of the wastewater treatment facility equipment and building are 30-50% smaller;—
 - The facility's own needs are 5-10% only—, which is 1.5-3 —times less than competitors' solutions;
 - The equipment doesn't require acid and alkaline rinsing;
 - No annual refilling of filtering media is required;
 - No frequent replacement of the sorption load is required.

Kostroma mine challenges

Vladimir Vasiliev, Project Implementation Department Director, Water Technologies and Services Division, Mirrco Group:

- The project at the Kostromovskaya mine was our first experience at a coal mining enterprise. It was also one of the first general contracting projects involving the construction of a separate building with a full range of engineering systems.

A reinforced team worked at the project implementation (formation of the Water Technologies and Services Division occurred in 2018, when United Water Technologies Research Center became a part of Mirrco Group). The work implied responsibility for all stages of the EPCM project: design, expert review, construction and assembly works, equipment supply and installation, field supervision, facility launch, and commissioning, i.e. the whole range of services until the presentation of the completed facility to the supervisory authorities jointly with the customer.

After the customer outlined the task, prior to initiation of the tender process, we tested our own pilot mobile mine wastewater treatment facility at the Kostromovskaya mine and determined the DYCLAR™ equipment parameters. A series of studies and investigations were carried out to prepare the construction part of the project. Then our design department developed design and estimate documentation and obtained a positive review from the State Expert Review Panel.

During the design stages of construction and commissioning of the wastewater treatment facility, we encountered a number of challenges, the solutions to which have strengthened our competencies and improve the technology. Here are a few examples.

The average water temperature in sediment ponds in winter is 5 °C; we used to believe that DYCLAR™ technology was effective in the 12–40 °C range. As part of this project, we carried out further research and prepared an improved solution that is effective at source water temperatures of 3–5 °C.

We were surprised by the discrepancy between the specified capacity of 405 m³/h and the actual consumption of the water fed for treatment. During the launch of the treatment facilities, it became clear that the load on the treatment plant was reduced and inconsistent. We have expanded the adjustment range of the feed water pumping unit capacity and revised the DCS software of the treatment facilities, i.e. promptly installed the frequency converters on feed water pumps, and included automatic adjustment of reagent dosage into the control system algorithm, which provides additional savings during the operation with reduced load.

The customer specified a tight schedule for the facility construction; due to the need to perform a full range of design work, as well as climatic constraints, we started extensive construction 10 weeks before Miners' Day, so that the wastewater treatment facilities became a present to the miners of Kuzbass on the occasion of their professional holiday. We had to cope with a considerable amount of work, so we used all available resources of the Department. The equipment was installed on the fly, and the works were carried out in several shifts, including on weekends; about four subcontractors were involved simultaneously.

We coped with all the additional challenges and the customer was satisfied with the work done. The wastewater treatment facilities we built became a wonderful present to Kuzbass on Miner's Day and the tenth anniversary of the Kostromovskaya mine.

ANALYSTS FORECASTS TRENDS

DYCLAR™-BASED PROJECTS IN COAL MINES:

- Denisovsky Mining and Processing Works (Kolmar Management Company) – design and supply of DYCLAR™ equipment for wastewater treatment facilities.
- Mezhegyugol Coal Company (EVRAZ Group) – design (jointly with Kuzbassgiproshakht Design Institute) of wastewater treatment facilities for the coal mining industry.
- Alardinskaya mine (Evraz Group, Yuzhkuzbassugol Consolidated Coal Company) – supply of DYCLAR-based equipment.
- Kirbinsky Opencast Coal Mine (Rusky Ugol Management Company – supply of DYCLAR™ equipment for wastewater treatment facilities.
- Vorkutaugol (PAO "Severstal" mining division) – design of wastewater treatment facilities.

To learn more about new projects using DYCLAR technology, please, check the news feed at www.mirrco.com and www.dyclar.com

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