

Use of rheology modifiers to adapt storage of tailings of enrichment

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Abstract. Topical issues of tailing dumps operation of concentrating factories are to ensure their safety, as complex hydraulic structures, the need to extend the life of existing facilities without allocating land for construction of new ones, obtaining the necessary volumes of clarified circulating water, compliance with increasingly stringent environmental standards, reducing costs and costs. For a more compact storage in tailings dumps of enrichment wastes and large amounts of clarified water, specially developed rheology modifiers Rheomax ETD from BASF tested the technology of polymer flocculation of tail pulp of several flotation and gold recovery factories in the Chelyabinsk region. The polymers of the Rheomax ETD series of various modifications have been tested, with an increase in the consumption of which, in all cases, the angle of the natural slope of the condensed precipitate produced increased and the water loss increased. The results of laboratory studies and some data from the practice of operating the Rheomax ETD technology show that it adapts well to the conditions of existing tailing dumps of concentrating mills, where in a short time, the following tasks should be resolved: washing the beach of the tailing dump, obtaining more volumes of circulating water and improving its clarity, increasing the capacity of tailing dumps by enlarging the amount of the material laid in a cubic meter.

1. Introduction

Tailings storage facilities of concentrating factories are large and highly responsible hydraulic structures in the structure of mining and processing plants, the design and operation of which is strictly regulated by the relevant regulatory documents [1]. The safety issues of these facilities are given great attention around the world in connection with the danger of major accidents, man-made emergencies, the consequences of which can be very catastrophic. Besides technical component, it is of great importance to ensure the social (health of the population) and environmental safety of the tailing dumps.

The need to extend the service life of existing tailing dumps without allocating land for the construction of new facilities and for more compact storage of large volumes of tailings in a smaller area [2,3] is no less urgent in the operation of tailing farms of concentrating mills. For many ore



mining and processing plants, the most acute issue is the lack of water in the area where the enterprise is located, and hence the need to maximize the separation of water from the tailings of enrichment and return it to the technological process. In addition, all activities related to the organization of hydrotransport of tailings, their storage in the prepared tailing pond and recycled water supply, are capital intensive, energy intensive and require large operating costs [4,5]. Therefore, new technological solutions for storing wet tailings of enrichment are constantly being sought, both for the purpose of reducing costs, and for solving the issues of safer operation of these systems and compliance with increasingly stringent environmental requirements.

2. Technological solutions for the storage of tailings enrichment

New technical and technological solutions for storing tails of enrichment are developed and introduced everywhere: storage of tailings in the form of condensed pulp; storage of tailings thickened to pasty state; Tail filtering and dry stacking; thickening of the tailings and filling them with waste quarries or underground excavations; joint storage of dehydrated tailings and waste rock [6-14]. Such projects are being implemented through the construction of tailings thickening complexes, including those with thickeners of a special "paste" design, and often with the installation of expensive volumetric positive-displacement piston pumps for pumping tails with a high degree of compaction, that is characterized by high initial costs and high operating costs [12,13]. Filtration of tailings with cake storage on the fenced area (dry storage) over the last decade has become an alternative way of tailing, especially in fields with small water reserves and restrictions on the capacity of sites, but this technology is today much more expensive per ton of stored tails [14].

Concentration of tail pulp can be carried out not only in thickeners in the factory or in complexes of pasta thickening, but also during the processing of tailings by polymers at the point of release or near the point of release into the tailing pond. To implement such technology BASF concern specially developed high-molecular polymers – Reomax rheology modifiers ETD series (Enhanced Tailings Disposal) [15, 16]. After treatment polymer pulp, due to the unique structure of its molecules, there is a rapid aggregation of the solid particles are tightly bound to each other and the polymer molecules form compact aggregates. This instantly separates the water fraction from the solid particles, which can be returned to the factory as process water in large volumes.

For the first time, polymer modification of tailings at discharge was used as a means of increasing the volume of the liquid phase separated from the tails during storage and also during the clarification of water, and could be very useful, for example, when dehydrating a fine fraction of "red mud", oil sands, coal sludges, mineral sands, can be used for reverse tabulation using a fine fraction [17]. Its advantages are increasing initial deposition rates; compact warehousing of waste; intensification of the fluid loss of the suspension; prevention of the transition of settled solids to suspended state and increase of transparency of circulating water; decrease segregation of particles; increasing the pace of consolidation and / or increasing the slope of the beach, making it an increasingly popular technology for managing tails [15-20].

In the Chelyabinsk region, there are many ore mining and processing plants (MPP), and some of them are currently experiencing problems with the storage of tailings enrichment due to increased processing of ores, filling existing tailing dumps to the design level, difficulties with the permission to allocate land for new tailings from the side environmental authorities and with extremely high capital costs for construction, a shortage of recycled water and its insufficient clarification in the settling pond of the tailing dump. Therefore, laboratory tests of polymers of the Rheomax ETD series on the tails of some flotation and gold recovery plants were carried out.

3. Research methods

The testing was carried out on the tails taken in the production cycles of the concentrator factories, by specialists of official dealers of the BASF concern, using the standard methods and test protocols of the BASF concern. The procedure for carrying out laboratory tests is described in [21].

4. Results and discussion

Polymers of the Rheomax ETD series of various modifications were tested on the tailings of flotation enrichment. The results are shown in Table 1. The dosage was chosen reactants empirically for each type of tailings, proceeding from a homogenous structure of condensed precipitate the least prone to spreadability and maximum return water. This would significantly extend the life of existing tailing dumps by means of more compact tailings storage or, if necessary, quickly wash the beach, and also return a large amount of clarified water to the production cycle.

The following general regularities were obtained: with an increase in the dosage of the reagent, an increase in the angle of dissolution of the condensed precipitate was observed in all cases (Figure 1), an increase in water yield after 10 minutes, the isolated drain was pure. At small dosages, a condensed precipitate formed with small and medium floccules, with a granular, unbound structure that was destroyed with little mechanical action. Practically on all the tails the modification of Rheomax ETD 9010 showed the best results for the reached angle of sediment spreading and water yield. For the tailings of Buribaevsky MPP, the maximum values of the studied parameters were obtained using a modification of the Rheomax ETD 9005 polymer. Using Rheomax ETD 9030 polymer, the worst results were obtained in comparison with other considered modifications. For each type of tail, it is necessary to select its own polymer modification and its consumption, which will ensure the optimal solution of the tasks.

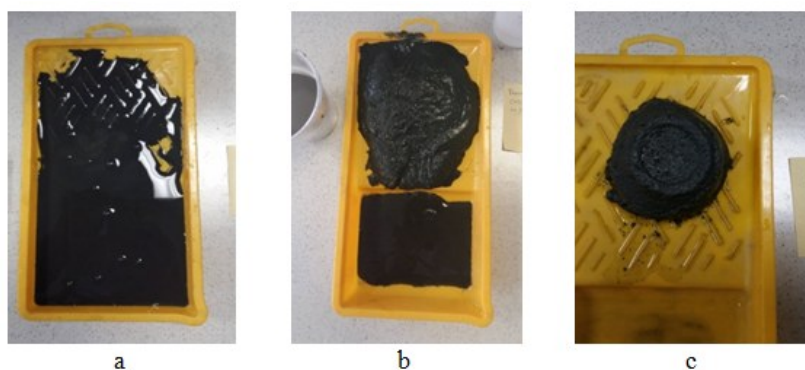


Figure 1. Appearance of the sediment without treatment with reagent (a) and after treatment with reagent Rheomax ETD 9010 with a dosage of 135.6 (b) and 216.9 g / t (c).

For the tailings of the Gaisky MPP (a study of 2016), the possibility of using Rheomax ETD technology as an alternative to the technology of tail thickening to fill a spent quarry was considered. Despite the fact that using Rheomax ETD 9010 with a dosage of 105-152 g / t, quite satisfactory results were obtained on the structure of the resulting precipitate and its flowability, it was concluded that this technology can not serve as an alternative to the technology of pasta thickening of tails. In contradistinction to the storing of pasty tails into the open cut, which separate a small amount of water or do not separate free water at all, when treating tailings with Rheomax ETD polymers, water will be released directly into the settler bowl and thus contact the quarry sides. Consequently, the probability of falling into the groundwater filtering through the fractures in the sides of the dam of return waters remains very high [21]. In studies on the tailings of the Gaisky MPP in 2017, it was shown that with a Rheomax ETD 9010 consumption of up to 90 g / t, an even layer of flocculated material will be obtained throughout the entire tailing site, which will increase the amount of tailings dump in the cubic meter. At higher flowrates Rheomax ETD 9010 150-180 g / t, a precipitate with high spreading angles of 42-57° forms, which indicates the possibility of conical storage of tailings treated with Rheomax ETD technology.

In addition, neutralized wastes of cyanidation of the gold recovery factory were tested to determine the possibility of applying Rheomax ETD technology for the hydroplanting of enrichment wastes (Table 2). Waste from the enrichment of the gold recovery plant can also be processed using Rheomax ETD technology. The largest spreading angle, as in the previous series, was obtained on the Rheomax ETD 9010 modification, the smallest one on the Rheomax ETD 9030. At the expense of Rheomax

ETD 9010 99.3 g / t, a structured precipitate not spreading was obtained having sufficiently high water yield, which indicates the possibility of using it in the waterproofing.

Table 1. Results of testing of Rheomax ETD polymers on tailings of flotation enrichment.

Material	The solid content in the pulp (g / dm ³)	Reagent	Dosage of reagent (g / t)	Water loss (%)	Angle of slope (degrees)
Tails enrichment of Uchalinsky MPP	433.88	Rheomax ETD 9010	216.9	53	51
			168.1	65	28
			135.6	51	13
		Rheomax ETD 9030	108.5	32	3
			168.1	60	19
			135.6	45	13
Tails enrichment of Miheevskiy MPP	276	Rheomax ETD 9050	108.5	40	5
			135.6	42	18
			90.6	74	20.1
		Rheomax ETD 9010	60.4	71	15.3
			30.2	64	2.3
			15.1	51	0.6
Tails enrichment of Buribaevskiy MPP	235	Rheomax ETD 9005	426.2	91	67
			213.1	72	15
			159.8	60	4
		Rheomax ETD 9010	106.6	52	2
			426.2	62	5
			213.1	25	1
Tails enrichment of Gaikiy MPP (2016)	174	Rheomax ETD 9010	106.6	21	1
			152	94	30
			105	90	25
		Rheomax ETD 9030	60	81	10
			152	93	28
			105	88	22
Tails enrichment of Gaikiy MPP (2017)	252	Rheomax ETD 9050	60	78	6
			152	93	28
			105	90	23
		Rheomax ETD 9010	60	79	10
			182.7	82	57
			158.7	78	42
Tails enrichment of Gaikiy MPP (2017)	252	Rheomax ETD 9010	134.8	77	29
			113.8	72	19
			89.8	70	11
		Rheomax ETD 9050	158.7	78	36
			134.8	75	36
			113.8	73	14
Tails enrichment of Gaikiy MPP (2017)	252	Rheomax ETD 9020	89.8	69	10
			113.8	70	13
			113.8	61	8
		Rheomax ETD 9040	113.8	68	13

Semi-industrial tests carried out on the tailing pits of some concentrators have shown [21,22] that the technology of processing tail pulp by the Rheomax ETD rheology modifiers is well adapted to the

conditions of the tailing dumps in operation. To implement it, the tailings hydrotrack system existing at the factory remains the same, and for mobile polymer solutions, mobile stations for preparation and dosing, located in sea containers, are used.

Table 2. Results of testing polymers Rheomax ETD on the tailings of the gold recovery plant.

Reagent	Solid content in pulp (g / dm ³)	Reagent dosage (g / t)	Water loss (%)	Angle of slope (degrees)
Rheomax ETD 9010	575.46	99.3	55	36
		86.9	43	26
		74.5	43	23
		62.1	35	12
		49.6	30	9
		37.2	27	4
Rheomax ETD 9030		99.3	35	7
Rheomax ETD 9050		99.3	33	21

5. Conclusion

To improve waste storage systems at flotation and gold recovery factories, Rheomax ETD rheology modifiers can successfully apply the tailings processing technology before laying them in tailing ponds. The carried out researches have shown that the polymer modification and its consumption significantly influence the structure of the sediment, its resistance to spreading, and, consequently, allow realizing different variants of storing tailings of enrichment.

The results of laboratory studies and some data from the practice of operating the Rheomax ETD technology show that it is most suitable at existing facilities where urgent topical tailing beach issues should be solved promptly in order to obtain a stable base for the next tier of the dam, increase the amount returned to the dam water circulation and improvement of its clarification, increase of the tailings capacity due to the larger quantity of material placed in the cubic meter.

The advanced technology of utilization tailings tailings makes it possible to carry out important environmental functions to reduce the areas of land occupied by tailing dumps, reduce dusting from tailing sites, and protect natural reservoirs from pollution and rational use of water supply sources.

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