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Reagent Water Softening in Illuminators

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Abstract: All of the above predetermined the conduct of studies on the concentration of the suspended sediment layer in clarifiers in the presence of one flocculant and the emergence of the relationship between this indicator and the parameters of the structure, especially at low temperatures of the treated water.

Keywords: reagent, polyacrylamide, effective, treated water, flocculant.

When preparing water for technological purposes, the method of reagent softening is widely used, which is carried out in clarifiers with a suspended sediment layer. The nature of the structure formation of the solid phase of the suspended sediment layer has a significant effect on its physicochemical properties. In order to intensify the sedimentation of suspended matter, and therefore, the work of the structure, coagulants and flocculants are used. In this case, such parameters as the water temperature [1-3] and the concentration of the solid phase of the contact medium are of great importance.

However, the use of coagulants leads to excessive consumption of lime, which is equivalent to its dose and the additional introduction of mineral impurities into the treated water. The use of polyacrylamide (PAA) is effective in cleaning brines in order to improve the conditions for the precipitation of CaCO3 and Mg (OH) 2 and to obtain a more compacted sediment.

All of the above predetermined the conduct of studies on the concentration of the suspended sediment layer in clarifiers in the presence of one flocculant and the emergence of the relationship between this indicator and the parameters of the structure, especially at low temperatures of the treated water. Initially, it was established that the process of interaction of PAA with particles formed during liming of water proceeds both according to the sorption mechanism (the residual concentration of PAA at its dose of 1 mg / L was no more than 0.01 mg / L) and electro-chemical. The latter circumstance is proved by a decrease in the value of the electro-kinetic potential of particles associated with PAA, and in some cases by a change in the sign of the charge. This explanation of the mechanism of the process is consistent with theoretical conclusions.

When studying the features of the process technology, the expediency of introducing a flocculant before liming was revealed, which is due to a more uniform distribution of the flocculant and its interaction with a large amount of mineral particles. For the physicochemical characteristics of the contact medium, a parameter introduced by EF Kurgaev [1] was used.

The experiments were carried out on waters characterized by the following parameters: hardness 7-11 mg-eq / l, alkalinity 3-5 mg-eq / l, oxidizability, content of suspended solids - up to 100 mg / d. At the first stage of the studies carried out in the clarifier model, the sedimentation rate of the suspension was determined at different compositions of the initial waters, softening modes and a combination of reagents at a temperature of 20 ° C. The results obtained showed that when the value changes from 0.1 to 0.35, the speed of free sedimentation of the suspension is in the range of 5-3.2 mm / s. At the same time, to reach the maximum value with an increase in the proportion of magnesium hydroxide in the sediment, the required amount of flocculant increases. In the case of using the coagulant FeSO4 under similar conditions, it is 2.35-2.0 mm / s.

Based on the experimental data, the average value of the technologically optimal dose of PAA, mg / l, was determined, which can be expressed by the formula:

$$D_{ПАА} = 0{,}006 C_{и}\, \alpha_{м}$$

where C is the amount of the resulting suspension, mg / l.

For the practice of water treatment, it is of great interest not only to improve the sedimentation properties of suspended matter, but also to assess the possibility of concentrating the suspended sediment layer in order to conduct the process with decreasing temperature. In this regard, on the model of the clarifier, a relationship was obtained between the specific dose of polyacrylamide DAPA and the mass concentration of the solid phase of the suspended sediment Sv at a given and the velocity of the upward flow of water v_0 = 1.5 mm / s (picture).

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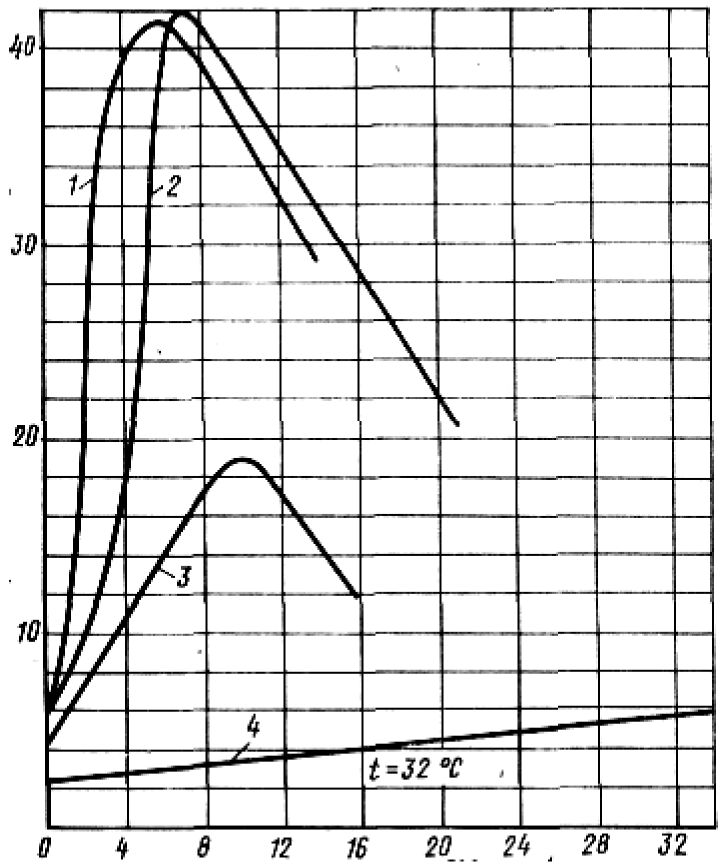

$1-\lambda_м = 0{,}07;\ t = 20^0C;\quad 2-\lambda_м = 0{,}07;\ t = 33^0C;$

$3-\lambda_м = 0{,}16;\ t = 20^0C;\quad 4-\lambda_м = 0{,}3;\ t = 20^0C;$

Another indicator of the contact medium is the value of its volumetric concentration C0, determined by the ratio of the volume of the suspended sediment layer after compaction to the volume of the unconsolidated suspended layer. The determination technique is described in [1, 2]. It is known [1] that the use of flocculants leads to an increase in C0, which is due to the receipt of a denser sediment. The studies have shown that under conditions of maximum utilization of the adsorption activity of PAA in the suspended layer of the sediment, the concentration of the solid phase and the volume concentration of the contact medium increase.

EF Kurgaev [1] connects the volumetric concentration of C0 within the values of 0.05-0.2 with the separation criterion Kc, which characterizes the adhesive properties of the contact medium, by the formula:

$$K_c = (30 + 0{,}5t)\, C_0^2\, H_c\ ,$$

Where t is the temperature, ° C; C0 volumetric concentration; Hc - height of the layer, mm.

This principle was used in calculating K_c based on the results of experiments carried out under various softening modes and a constant height of the contact medium. The data obtained are shown in table. 1 (in all experiments, the height of the layer Rs = 150 mm, the velocity of the ascending water flow v 0 = 1.5 mm / s). The use of a flocculant improves the separation conditions, which in turn makes it possible to reduce the suspension content in the softened water.

At the next stage, the influence of the concentration of the solid phase in the suspended layer on the quality indicators of softened water at different temperatures was studied. An increase in the concentration of the solid phase in the contact medium serves as a prerequisite for both a deeper course of the process and the possibility of lowering the temperature with the same softening effect [4]. Comparison of the results at different softening modes and doses of PAA was carried out on waters of similar quality.

The presented results of laboratory studies convincingly prove that the use of a PAA flocculant before liming water allows increasing the productivity of the process of separating solid and liquid phases during softening of natural water

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by improving the sedimentation properties of the suspension, and, consequently, the rate of its sedimentation. On the other hand, it becomes possible to concentrate the solid phase and reduce the process temperature while obtaining the required water quality.

The load on clarifiers Q varies in the range from 72 to 130% of the nominal. The upper limit is limited by the capacity of the facility. The maximum temperature of the treated water (23 °C) is due to the technical capabilities of the enterprise during the production period.

The operating parameters of the clarifiers obtained under industrial conditions in the studied modes are given in table, from which it can be seen that the introduction of the flocculant into the air separator turned out to be advantageous, i.e., before liming, as evidenced by the increase in the mass concentration of the suspension and the rate of its sedimentation. At the same time, a decrease in the water temperature to 15 ° C did not reduce the softening effect, and the content of suspended solids in the treated water did not exceed ~ 3 mg / l with an increase in load by 60%. Thus, the possibility of draining the process at low temperatures with a simultaneous increase in the unit performance of the clarifier without deteriorating the quality of the treated water has been confirmed on real structures.

conclusions

1. The use of PAA without a coagulant in the process of reagent softening of underground and low-turbidity waters allows to improve the properties of the contact medium: to increase the sedimentation rate and mass concentration of the suspension. The maximum values of these indicators depend both on the ratio of the components in the sediment and on the dose of the flocculant.
2. Improvement of the sedimentation properties of the suspension allows to increase the unit performance of the clarifier, the concentration of the suspended sediment layer - to conduct the process at a reduced temperature without deteriorating the quality of the treated water.

Influence of a flocculant on the adhesive properties of the contact medium under various softening modes.

Table 1

$t,\ ^0C$	α_M	$D_У^{ПАА} x10^{-4},\ кг/мг$	C_O	K_C	Residual content of suspended solids, mg / l	Note
19,5	0,108	5,4	0,141	118,5	4,0	
20,0	0,040	-	0,07	29,4	13,5	Onlyalkalinereagentsintroduced
21,0	0,185	11,0	0,16	155,5	2,0	
20,5	0,189	12,7	0,195	229,3	2,3	
21,0	0,181	16,87	0,169	133,5	3,0	
19,0	0,164	-	0,098	58,86	5,2	Onlyalkalinereagentsintroduced
20,0	0,355	23,8	0,182	198,75	2,1	
19,0	0,290	34,0	0,138	109,8	2,8	
19,0	0,304	-	0,095	53,5	5,8	Onlyalkalinereagentsintroduced

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