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Research Paper

Investigation of Solid - Liquid Separation of the Final Tailing at Zonouz Kaolin Processing Plant

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Abstract: In this research, the separation of solid phase and water in the final tailings of the Zonouz kaolin processing circuit was investigated. The sedimentation of solid particles was investigated by changing different parameters and their effects were evaluated on the initial rate of sedimentation, clarity of clear water, viscosity, and density of the settled pulp. Increasing the pH improved the sedimentation rate, and the settled pulp became denser. Despite the increase in sedimentation rate, the clarity of clear water decreased due to the presence of fine suspended particles at high pH. The use of flocculant, even in a small amount, increased the initial sedimentation rate by six times and improved the clarity of clear water. However, the density of the sedimented part decreased due to the increase in pulp volume.

Keywords: Settling rate, Water clarity, Flocculent, Tailings, Kaolin.

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INTRODUCTION

The amount of water used in the concentrating processes can be significant both economically and environmentally [1]. Water management is necessary for the plants, which should be minimized in the plants, especially in the tailing streams [2]. Mineral processing tailings usually contain significant parts of colloidal and wonderful particles, some of which are composed of clays [3].

The effect of particle properties, size distribution, specific surface area, density, pulp temperature, surface structure, bed porosity, particle sphericity, pulp properties such as solid concentration, pH and zeta, and dewatering performance, has been investigated by researchers [4-8].

Some researchers reported that the sedimentation rate for low solid percentages is higher compared to a pulp with high solid percentages. In pulps with high density, colloids are formed in the form of a network, which relatively reduces the sedimentation rate. [9,10].

Parsafer and his colleagues observed that the size, shape, and density of the flocs change with the increase in the amount of flocculant. The size of the clots increases with the increase in the amount of flocculant, and on the contrary, their density decreases [11].

In this research, due to the importance of reducing water loss in the final tailings of the Zonouz kaolin plant, the effective parameters in the tailing sedimentation process are investigated on a laboratory scale. The effects of the parameters of solid percentage, pH, pulp temperature, type and amount of flocculant, water clarity, pulp viscosity, and density are evaluated after the sedimentation process.

MATERIALS and METHODS

The sample was prepared in the outlet section of the tailings when the circuit was stable. The results of particle size analysis showed that D_{80} is about 100 microns, and 46%, 21%, and 9% of particles are more acceptable than 38 microns, 10 microns 5 microns, respectively. The average XRD analysis on the tailings showed that the main silica phase is in the form of quartz and the percentage of Quartz minerals in the tailings is higher than kaolinite and calcite minerals. In order to measure the viscosity, a drop viscometer was used. The settled experiments were performed in 500 ccs graduated cylinders.

RESULTS and DISCUSSION

According to Figure 1, it is clear that the particle sedimentation rate of the 5% solid pulp is 8.20 cm/min, while this rate is reduced to 0.229 cm/min in the 45% solid pulp. It can be concluded from Figure 1 that the sedimentation rate of particles in different percentages of solids is non-linear, and in three percentages of solids, a change in slope can be seen.

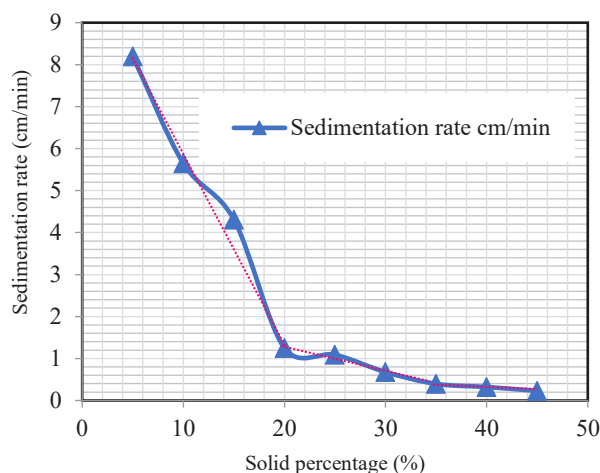


Figure 1. The effect of solid percentage on settling

The changes in sedimentation parameters with the change in pH are shown in Table 1. As it is clear from the results, with the increase of pH from 4 to 8, the sedimentation rate of particles increases significantly from 0.682 cm/min to 1.39 cm/min. In terms of increasing the sedimentation rate in the absence of flocculants,

two solutions are suggested: 1- adjusting the pH to the range of the isoelectric point, 2- neutralization with multivalent cations and multivalent ions; of course, combining both methods can also happen. In general, with the increase in pH by lime addition and the increase in the concentration of calcium ions in the pulp, due to changes in the surface charge and zeta potential, the repulsion between particles decreases, and the possibility of electrostatic attraction of particles and coagulation increases, which in turn increases the rate of sedimentation.

Table 1. The results of testing the effect of pH on the sedimentation of particles

Sedimentation rate (cm/min)	The density of the settled part (g/cm ³)	Viscosity section settled (cs)	pH
0.682±0.0518	1.433±0.011	5.035±0.475	4
1.087±0.0518	1.581±0.011	3.69±0.475	6
1.39±0.0518	1.614±0.011	5.3±0.475	8

The results of flocculants addition in different dosages have been presented in Table 2. The obtained results showed that the use of flocculant increases the initial rate of particle sedimentation up to 6 times. Based on the results (Table 2), there is no significant difference in the sedimentation rates of three amounts of selected flocculants. In general, it can be concluded that flocculant is effective in the sedimentation rate of particles. However, the amount of flocculant used in the selected range does not have a significant effect on sedimentation. By increasing the amount of flocculant from 1 g/t to 3 g/t, the density and viscosity of the settled pulp decreased.

Table 2. Results of sedimentation test with different amounts of flocculant

Sedimentation rate (cm/min)	The density of the settled part (g/cm ³)	Viscosity section settled (cs)	Flocculant rate (g/ton)
7.71±0.248	1.601±0.011	13.61±0.457	1
6.68±0.248	1.557±0.011	13.53±0.457	2
7.19±0.248	1.492±0.011	3.96±0.457	3
1.25±0.0518	1.628±0.011	15.07±0.457	No flocculant

After 60 minutes of sedimentation, it became clear that the relative transparency of the water increased with the increase in the amount of flocculant shown in Figure 2. The reason for this phenomenon may be due to the greater capacity of the flocculant chains, which collects all particles, both fine and colloidal. However, in the case where the amount of flocculant was low, with a limited absorption capacity, it only absorbed coarse particles.

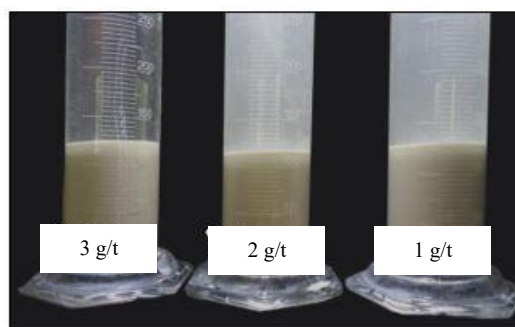


Figure 2. The effect of flocculant amount on the clarity of the water separated from the pulp (temperature 25°C, solid percentage 20%, amount of solution 20 ccs, flocculant type Basflak, pH=7.5, return water)

CONCLUSION

Based on the analysis results, Quartz and kaolinite were detected as main mineral phases and calcite as minor phases in the final tailing of the Zonouz kaolin processing plant. By increasing the amount of flocculant, the water clarity increased significantly due to the possibility of sedimentation of fine particles suspended in water. In the presence of the flocculant, water clarity increased with an increasing solid percentage. Sedimentation rate in acidic pH was lower than in alkaline pH, and the surface charge of particles had an essential effect on the sedimentation rate. According to the conducted experiments, most of the water can be returned using the thickener in the optimal conditions obtained from the experiments.

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