

THICKENING TECHNIQUE OF CYCLONE-FLOCCULATED SEDIMENTATION^①

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ABSTRACT In order to increase the concentration of the thickened tailings of iron ore concentrators a new technique of cyclone-flocculated sedimentation was developed by present authors and verified by experiments. The new technique employs efficient hydrocyclone designed by authors in conjunction with a low cost flocculant named KLP. The concentration of thickened tailings was increased to higher than 60 wt.-% and the concentration of thickener feed was decreased to 5.9~9.0 wt.-%.

Key words: cyclone-flocculated sedimentation thickening technique flocculant

1 INTRODUCTION

The Daye concentrator is a large iron ore concentrator located in Daye, Hubei. Its iron grade of running-of-mine has been remarkably decreased with increasing the amount of tailings from 1 000 m³/h to 1 380 m³/h. At high throughput rate the overflow from two tailings thickeners (50m in diameter) caused high solids concentration resulting in adverse mill effects, when the overflow was recirculated for mineral processing operation and serious environment problems resulted when the tailings water was spilled into river. Furthermore, the transfer capacity of transportation pipe system designed for lower throughput rate was far behind the capacity needed. To solve the above first problem a new thickener (50m in diameter) cost more than two million RMB yuan in addition to additional land space is needed and flocculants are commonly used to increase the particle settling velocity in tailings thickening. But under the specific condition of the Daye concentrator using flocculant would be uneconomic, and increasing pipeline transportation concentration of thickener underflow solid should be adopted to improve its economical profit.

Two methods for increasing the concentration of thickener underflow had been used in other concentrators^[1, 2]:

(1) Improving the technological functions and effectiveness of the present thickeners by consolidating their blades and establishing the flocculant-addition system similar to that used at the Waitoushan, Nanfen and Panzihua iron ore concentrators.

(2) Employing two-stage thickening technique to firstly remove the coarse particles and decrease the volume of the second thickener, which has been applied at the Banmoushan and Shuichan iron concentrators.

However, in Daye's case the above techniques will show high capital cost and the difficulty of changing processing flowsheet. Recently, a new thickening technique of cyclone-flocculated sedimentation was developed by authors. The new technique offers lower capital cost and improves efficiency.

2 TECHNOLOGICAL FOLWSHEET AND EXPERIMENTAL RESULTS

2.1 Technological flowsheet

The thickening technique of cyclone-floc-

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culated sedimentation was based on the idea that a part of solids in tailings (>50 wt.-%) may be removed as cyclone underflow, and the cyclone overflow is thickened farther in thickener. The technological flowsheet is shown in Fig. 1.

2.2 Experimental Results

Iron and silicate percent in tailings analyzed are 27.87 wt.-% and 72.13 wt.-% respectively. Other properties measured are listed in Table 1, 2 and 3, including particle distribution, viscosities in different tailings concentrations and iron element fraction in different size range of particle.

Table 1 Particle distribution

particle size range/ μm	wt.-%
+147	14.33
-147~+74	21.13
-74~+45	11.95
-45~+38	3.36
-38	49.23

Table 2 Viscosity in different tailing concentrations

concentration (wt.-%)	viscosity / mPa·s
18	1.75
15	1.25
12	0.85

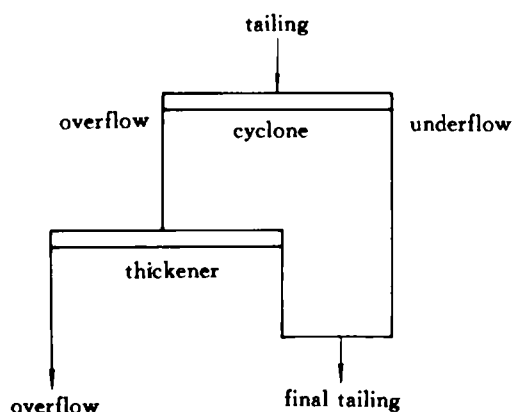


Fig. 1 Technological Flowsheet

It is found from Table 1 that the fraction of particles small than 38 μm in tailings is about 50 wt.-%. This shows it is important to promote the classification efficiency of these fine particles in a cyclone to get satisfactory thickening results. Table 2 shows that the variation in viscosity of different tailings is not obvious. The rheological effects can be ignored in the thickening process. The iron fractions in the ranges of under 147 μm are unvariable (as shown in Table 3).

Table 3 Iron fractions in different size ranges of particle

particle size range/ μm	Iron element fraction (wt.-%)
+147	19.93
-147~+74	29.74
-74~+45	28.57
-45~+38	31.68
-38~+0	28.95

The tailings thickening technique of centrifugal sedimentation in hydrocyclones is very attractive because of the simplicity and economic benefits of the hydrocyclone. But the low efficiency at fine size particle makes it commonly believed that the cyclone is inherently better suitable to classification rather than thickening. On the other hand, flocculation of fine particles in cyclone is not possible since the high shear forces within a cyclone rapidly break up any agglomerates. However, the other advantage of cyclone is the higher underflow concentration than that in thickener which can be used to increase the concentration of final tailings for the economical transportation through pipe. A new type of hydrocyclone with long cylinder part and short cone was applied in the experiment. The adjustable parameters were underflow and overflow openings, feed pressure, vortex finder depth in cyclone cylinder and cone angle.

A series of experiments was made in the cyclone and satisfactory results were obtained. The concentrations of cyclone underflow and overflow were 56~69 wt.-% and 5.9~9.0 wt.-% respectively, the solid fraction

of cyclone underflow was 50~60%, and the concentrations of thickener overflow and underflow were less than 2.5×10^{-2} wt.-% and more than 35 wt.-% respectively. The results show that more than 50 wt.-% solids in tailings will be removed to final tailings and the concentration of thickeners feed is decreased effectively, which may decrease the charge of thickener and flocculant dosage in thickeners. The flocculated thickening experiment in the thickener (350 mm in diameter) with different flocculants, including polyacrylamide, polysulphides, sulphosalts and lime etc. was made in laboratory, and the result showed that polyacrylamide is the most satisfactory flocculant in both performance and operating cost. But it is difficult to use polyacrylamide in water.

The flocculant named KLP, a newly safe multimolecular organocompound, was developed by the authors. The properties of easy solvation and low cost of the flocculant may make it possible to substitute KLP for polyacrylamide. A series of flocculated thickening experiments at laboratory and large industrial

thickeners with KLP flocculant were made and the results similar to that of polyacrylamide were obtained.

3 CONCLUSIONS

The hydrocyclone can be used to decrease the charge of thickeners and increase the solid concentration of final tailings for improving the effectiveness of transportation cost.

The cyclone-flocculated thickening technique was verified to be effective to solve the thickening and transportation in the Daye concentrator. A new flocculant named KLP was developed which possesses the properties of good safety, easy solvation and low cost, and may be the satisfactory substitute for polyacrylamide flocculant in tailings thickening.

REFERENCES

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