[8] M.R. Garmsiri, H. Haji Amin Shirazi, The effect of grain size on flocculant preparation, Miner. Eng., 65 (2014) 51-53.

[9] M.R. Garmsiri, H. Haji Amin Shirazi, A new approach to define batch settling curves for analyzing the sedimentation characteristics, Journal of Mining and Environment, 3 (2012) 103-111.

[10] W.P. Talmage, E.B. Fitch, Determining thickener unit areas, Ind. Eng. Chem., 47 (1955) 38-41.

[11] M.D. Green, D.V. Boger, Yielding of suspension in compression, Industrial & Engineering Chemistry Research, 36 (1997) 4984-4992.

Please cite this article using:

M. R. Garmsiri, M. Hosseini Nasab, The Effect of Solids Concentration, Flocculant Dosage and Particle Size on Dewatering Behavior of Tailings Sample at Shahrebabk Copper Complex. *Amirkabir J. Civil Eng.*, 49(4) (2018) 645-652.

DOI: 10.22060/ceej.2017.11933.5102

As is shown, suspension solids concentration had a remarkable effect on thickener performance. It is evident from Figure 3, thickener discharge solids concentration was reduced with increasing solids concentration. Thus, the results obtained in laboratory scale was confirmed in full scale. It could be concluded that, dilution of suspension was an essential stage of thickening.

3- 3- The effect of particle size

Figure 5 shows the effect of particle size on settling flux varying flocculant dosage.

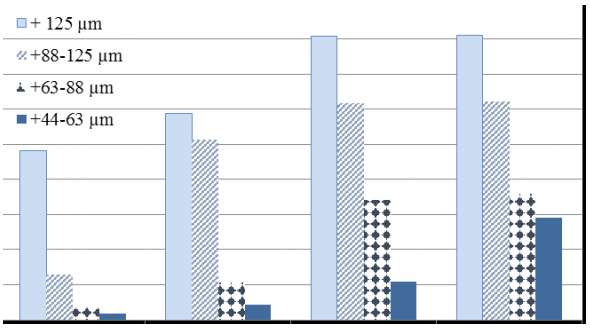

Figure 5. The effect of particle size on the settling flux

According to Figure 5, a significant increase in settling flux was observed with particle size. Results indicated that, in the presence of 10 g/t flocculant, settling fluxes was obtained in the range of 0.38 and 9.7 t/m^{2}h for the size fractions of +44-63 and +125 µm respectively. It could be suggested that, with certain flocculant dosage, setting flux and thickener capacity were reduced with particle size. Furthermore, settling flux observed for the combination of particle size fractions and flocculant dosages such as +44-63 µm and 30 g/t, +63-88 µm and 20 g/t, +88-125 µm and 10 g/t was similar and about 2 t/m2h. It could be said that, the required flocculant dosage was increased with reducing particle size to get to a certain settling flux.

It is noticed from Figure 5, there is a plateau in settling flux in the range of 30 to 40 g/t flocculant. The reason may be attributed to maximum floc size achieved with flocculant dosage. This is implied that, there is a maximum settling flux due to increasing flocculant dosage which could not be exceeded. The reason why this result was not observed for fine fraction is that, fine fraction needed more flocculant to display a plateau.

With the purpose of evaluating the effect of particle size on compressibility, settling tests were conducted with 60 and 110 µm particles in the presence of 10 g/t flocculant. Results indicated that, final heights of 3.05 and 3.7 cm were obtained with 110 and 70 µm particle sizes. It is deduced that, coarse particles showed a better compressibility than fines. Thus, not only settling flux, but also compressibility of suspension depressed with fine particles. Fine grinding in copper concentrators has a number of detrimental effects in thickening. In order to confirm the results, the effect of -75 µm fraction on the thickener in full scale has been investigated (Figure 6).

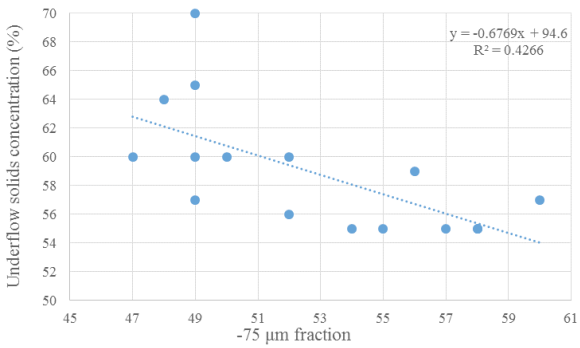

Figure 6. The effect of -75 µm fraction of a deep bed thickener discharge solids concentration

It is observed that, a relative sharp decrease was observed in underflow solids concentration, with increasing -75 µm fraction. Thus, the results obtained in laboratory scale was confirmed in full-scale.

4- Conclusions

In this work, the effect of solids concentration during flocculation, flocculant dosage and particle size on settling flux and compressibility of suspension is investigated. Batch settling tests was used to assess dewatering behavior of suspension. Results indicated that, not only settling flux but also compressibility of suspension enhanced with reducing solids concentration. Furthermore, settling flux increases with increasing flocculant dosage while compressibility of suspension reduced. Moreover, both settling flux and compressibility reduced with increasing fine fraction.

References

[1] L. Cifuentes, I. García, P. Arriagada, J.M. Casas, The use of electrodialysis for metal separation and water recovery from CuSO4–H2SO4–Fe solutions, Sep. Purif. Technol., 68(1) (2009) 105-108.

[2] G.M. Mudd, Sustainability Reporting and Water Resources: a Preliminary Assessment of Embodied Water and Sustainable Mining, Mine Water Environ., 27(3) (2008) 136.

[3] M.R. Garmsiri, H. Haji Amin Shirazi, M. Yahyaei, Introducing mathematical models to define settling curves in designing thickeners, in: Twelfth International Seminar on Paste and Thickened Tailing, Chile, 2009, pp. 129-135.

[4] B.A. Wills, J.A. Finch, Mineral processing technology, Eighth ed., Butterworth-Heinemann, 2016.

[5] E. Amanatidou, G. Samiotis, E. Trikoilidou, G. Pekridis, N. Taousanidis, Evaluating sedimentation problems in activated sludge treatment plants operating at complete sludge retention time, Water Res., 69 (2015) 20-29.

[6] Y. Wen, W. Zheng, Y. Yang, A. Cao, Q. Zhou, Influence of Al3+ addition on the flocculation and sedimentation of activated sludge: Comparison of single and multiple dosing patterns, Water Res., 75 (2015) 201-209.

[7] F. Schoenbrunn, M. Bach, The development of paste thickening and its application to the minerals industry; An industry review, BHM Berg- und Hüttenmännische Monatshefte, 160 (2015) 257-263.

suspension. Then, flocculant was added with the dosage of 20 g/t. After then, the cylinder was inverted three times to mix the suspension and flocculant. After the test was initiated, mud height and corresponding time were recorded. It should be noted that all the tests were carried out in pH=11.5.

With the purpose of estimation of settling flux, settling rate was calculated using a mathematical model [9] and solids concentration was estimated using Talmage method [10]. Moreover, the final height of suspension after 60 minutes was considered to assess compressibility of suspension. Higher final height indicates lower compressibility and vice versa.

3- Results and Discussion

3- 1- The effect of flocculant dosage

Flocculant dosage is the main manipulating variable in the operation of a full scale thickener. Figure 1 shows the effect of flocculant dosage on settling flux.

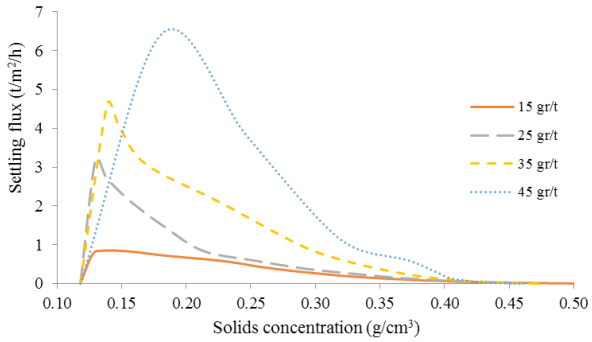

Figure 1. Settling flux versus flocculant dosage

As is shown, increasing flocculant dosage from 15 to 45 g/t led to an increase in settling flux about seven times. The reason is attributed to an increase in floc size and settling rate with flocculant dosage. The same trend was observed in the solids concentration of 7 and 15 %. Notice that, excessive flocculant dosage may reduce the compressibility of suspension. Figure 2 shows the effect of flocculant dosage on final height of suspension.

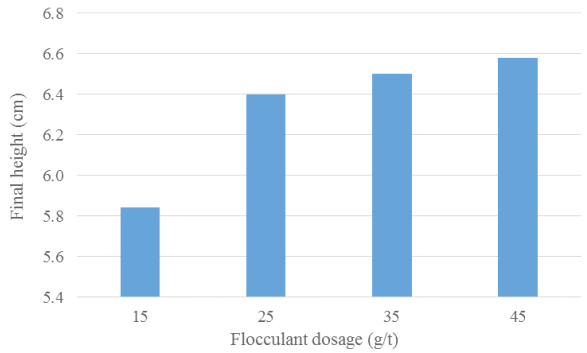

Figure 2. The effect of flocculant dosage on final height

Figure 2 indicates that the final height of suspension was increased with flocculant dosage. It could be said that the compressibility of suspension could be reduced with increasing flocculant dosage. It was found that, although increasing flocculant dosage led to an increase in settling flux, it had a detrimental effect on the compressibility of suspension. Hence, attempts must be made to reduce required flocculant consumption the in thickeners.

3- 2- The effect of solids concentration

Suspension solids concentration during the flocculation is an essential variable in the efficiency of thickening. Settling flux versus solids concentration in flocculant dosage of 15 g/t is shown in Figure 3.

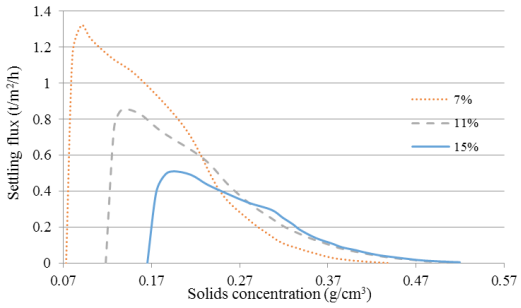

Figure 3. Settling flux versus solids concentration

As can be seen from Figure 3, increasing solids concentration from 7 to 15 % led to a decrease in maximum settling flux from 1.3 to 0.5 t/m2h. The reason may be attributed to transition in settling regime from free to hindered settling. As a result, settling rate and flux as well as thickener capacity was reduced.

The effect of solids concentration on the compressibility of suspension was investigated. At first, two settling tests were conducted with 7 % solids concentration. As the tests were initiated, the solids content of the first cylinder was added to the next and left to complete the test. Afterwards, a suspension with 14% solids concentration was prepared. Therefore, in the same amount of solids and flocculant dosage, the effect of solids concentration during flocculation was studied. Results indicated that the final height obtained with solids concentration of 7 percent was significantly lower than 14%. It was found that, lower solids concentration during flocculation led to a better compression. The reason may be attributed to a loser structure of flocs generated in a lower solids concentration. This result is consistent with the findings of Green and Boger [11].

The effect of suspension solids concentration in full-scale was studied. In this order, the effect of suspension solids concentration after dilution (during flocculation) on the performance of a deep bed thickener at Shahrebabak copper complex was studied (Figure 4).

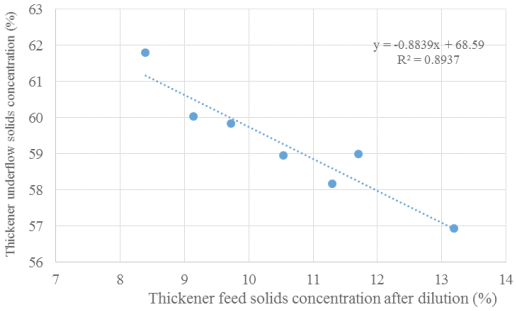

Figure 4. The effect of solids concentration during flocculation on the thickener performance

نشریه مهندسی عمران امیرکبیر

Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 49(4) (2018) 201-204
DOI: 10.22060/ceej.2017.11933.5102

The Effect of Solids Concentration, Flocculant Dosage and Particle Size on Dewatering Behavior of Tailings Sample at Shahrebabk Copper Complex

M. R. Garmsiri[1*], M. Hosseini Nasab[2]

[1] Department of mining engineering, Sirjan branch, Islamic Azad University, Sirjan, Iran
[2] Department of mining engineering, University of Sistan and Baluchestan, Zahedan, Iran

ABSTRACT: In mineral industries, most of the processes are carried out in an aqueous environment. With the purpose of reducing costs and environmental impacts,the water content of tailing stream should be recovered. Thickening is the most widespread method of water recycling process in mineral industries. In this work, the effect of solids concentration, flocculant dosage and particle size on settling flux and compressibility of copper processing tailings were investigated. Samples were collected from tailings of Shahrebabak copper complex and laboratory tests were conducted. In laboratory scale, settling flux and final height of suspension were examined using batch settling tests. In addition, thickener underflow solids concentration was considered as an indicator of the effect of variables in full scale. Results indicated that not only settling flux but also compressibility of the suspension was improved by reducing suspension solids concentration. Furthermore, it was found that increasing flocculant dosage from 15 to 45 g/t led to an increase in settling flux about 7 times. Moreover, both settling flux and compressibility were reduced with fine particles. Industrial scale studies showed that, increasing -75 μm fraction in thickener feed from 47 to 59 % led to a decrease in underflow solids concentration from 63 to 55 %.

Review History:
Received: 31 August 2016
Revised: 6 December 2015
Accepted: 4 January 2017
Available Online: 14 January 2017

Keywords:
Thickener
Settling Flux
Solids Concentration
Flocculant
Particle Size

1- Introduction

In mineral industries, most of the processes are carried out in a suspension environment. As the process is over, with the purpose of reducing operational costs, water consumption, environmental impacts and achieving to sustainable mining, water content of suspension must be recovered [1-3]. Thickeners are the most common equipment employed to recover water content of suspensions [4]. It is notable that, activated sludge and sewage treatment are another industries which utilize thickeners [5, 6].

Settling and compression are the phenomenon which take place during the thickening. Settling behavior influences the thickener capacity while compression affects the maximum dewatering efficiency. Thus, the effect of variables on settling and compression must be considered simultaneously. In conventional and high rate thickeners the role of settling is dominant, while in deep bed thickeners compression has a major role [7]. It is notable that, flocculants are used in thickeners to enhance settling rate and thickener capacity [8]. The efficiency of a thickener is affected by a number of factors including ore properties, particle size and solids concentration during flocculation. Both settling and compression are affected by these factors.

Settling flux is defined as the amount of solids passes through a unit area of a thickener in unit of time (Equation 1).

Corresponding author, E-mail: m.r.garmsiri@iausirjan.ac.ir

$$S=C\times V(C) \quad (1)$$

Where S is settling flux, V(C) is settling velocity of a layer of suspension with solids concentration of C.

Copper industry is the largest producer of tailings. Thus, an improvement in the de-watering of that is vital. Although a number of workers have studied the effect of variables on settling rate, these effects on settling flux and compression have not been investigated in the literature. In this work, the effect of solids concentration, flocculant dosage and particle size on settling flux and compressibility of tailings of copper processing were examined using batch settling test. Furthermore, the effect of the variables on a full-scale deep bed thickener at Sharebabak copper complex (Kerman province, Iran) is also investigated.

2- Materials and methods

Samples were collected from tailings stream at Shahrebabak copper complex. Representative samples were prepared with relative density of 2.65 and D80= 106 μm.

Batch settling tests were employed to assess settling flux and compressibility of suspensions. Solid sample was mixed with process water to produce a suspension with 11 % solids concentration (wt.). The tests were carried out in a 500 mL graduated cylinder. A commercial anionic flocculant, known as CU43U was used in this research. Flocculant solution was prepared in concentration of 0.1 g/l for 60 minutes and diluted to 0.02 g/l before usage.

The cylinder was inverted 15 times to homogenize the