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INFLUENCE OF FILTRATION CYCLE DURATION ON THE CAPACITY OF A FILTER PRESS SYSTEM FOR CONCENTRATE DEWATERING

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Abstract

Pressure filtration is widely applied for final dewatering of mineral concentrates, where cycle duration directly affects the number of filtration cycles completed per unit time and therefore the overall system capacity. This paper presents a parametric analysis of the influence of cycle duration on the capacity of a chamber filter press system for copper concentrate dewatering under maximum design flow conditions. The analysis is based on the total chamber volume of the operating filter presses and the complete filtration cycle duration. Increasing cycle duration progressively reduces the available capacity margin and leads to a limiting operating condition. The proposed approach provides a preliminary design-level capacity check and enables assessment of the sensitivity of the selected filter press system to changes in cycle duration.

Keywords: *copper concentrate, filter press, cycle duration, dewatering, capacity*

1. INTRODUCTION

Dewatering represents an important final stage in mineral processing, as the moisture content of the final concentrate directly affects its handling, storage, transport and subsequent metallurgical treatment. For fine mineral concentrates, pressure filtration is widely applied because it enables production of filter cakes with relatively low residual moisture while maintaining a compact equipment arrangement and controlled operating conditions [1-3]. In copper concentrate processing, reliable filtration is particularly important because limitations in the dewatering section may restrict the effective throughput of the concentrate handling system.

Unlike continuous separation equipment, filter presses operate in repeated cycles consisting of successive stages such as chamber filling, pressure filtration, cake dewatering or air blowing, cake discharge and preparation for the next cycle [1,2]. Consequently, the overall capacity of a filter press system depends not only on the installed filtration area and chamber volume, but also on the duration of the complete operating cycle. The cycle duration directly influences the number of cycles completed per unit time and therefore the overall system throughput. Simulation and design studies of filter presses likewise identify cycle configuration and cycle time as important factors governing throughput [4].

In design practice, a reserve between the required process flow and the calculated capacity of the selected equipment is desirable. This reserve decreases as cycle duration increases, while actual filtration performance also depends on slurry properties, cake formation, filling conditions and auxiliary operations [1-5]. The objective of this study

was to evaluate the influence of filtration cycle duration on the capacity of a chamber filter press system and to determine the limiting cycle duration corresponding to 100% utilization of the calculated volumetric capacity.

2. METHODOLOGY

2.1 Basis of the analysis

The analysis was performed for a representative copper concentrate dewatering system equipped with two chamber filter presses operating in parallel. A flow fluctuation coefficient of k_f=1.30 was applied to the nominal process flow, resulting in a maximum design slurry flow rate of 64.03 m^3/h. The chamber volume of each filter press was taken as 8.55 m³. The main input parameters used in the analysis are summarized in Table 1.

Table 1. *Main input parameters used in the filter press capacity analysis*

Parameter	Unit	Value
Number of operating filter presses, N	-	2
Chamber volume per filter press, V_c	m^3	8.55
Flow fluctuation coefficient, k_f	-	1.30
Solids content in feed slurry, w_s	wt.%	55
Feed slurry density, ρ_p	t/m^3	1.75
Maximum design slurry flow rate, Q_{feed}	m^3/h	64.03
Reference cycle duration, t_c	min	14

2.2 Volumetric capacity model

The analysis was based on the adopted chamber volume of the operating filter presses and the complete filtration cycle duration. The chamber volume per filter press is denoted by V_c, while the total chamber volume V_{tot} is determined for all filter presses operating in parallel.

The total chamber volume of the operating filter press system is:

$$V_{tot} = N \cdot V_c\ ,\ \ m^3 \quad (1)$$

where N is the number of operating filter presses and Vc is the chamber volume per press (m^3).

The volumetric capacity of the operating filter press system is calculated as:

$$Q_{FP} = (60 \cdot V_{tot})/t_c,\ \ m^3/h \quad (2)$$

where Q_{FP} is the volumetric capacity of the operating filter press system (m^3/h), and tc is the complete cycle duration (min).

The capacity load ratio is calculated as:

$$L = \left(Q_{feed}/Q_{FP}\right) \cdot 100,\ \ \% \quad (3)$$

where L is the capacity load ratio (%), and Q_{feed} is the maximum design slurry flow rate (m^3/h).

The limiting cycle duration corresponding to a capacity load ratio of 100% is calculated as:

$$t_{c,lim} = (60 \cdot V_{tot})/Q_{feed,}\ \ min \quad (4)$$

At the reference cycle duration of 14 min, the calculated volumetric capacity is 73.29 m^3/h and the corresponding capacity load ratio is 87.4%. The limiting cycle

duration is 16.02 min. The calculation was repeated for cycle durations from 10 to 18 min in order to evaluate the influence of cycle duration on filter press system capacity.

3. RESULTS AND DISCUSSION

The results of the parametric analysis are presented in Table 2 and Figures 1 and 2. The volumetric capacity of the filter press system decreases continuously as cycle duration increases, while the capacity load ratio increases. The maximum design slurry flow rate used for comparison already includes the flow fluctuation coefficient k_f = 1.30 and therefore represents a design condition 30% above the nominal process flow.

Table 2. *Influence of cycle duration on volumetric capacity and capacity load ratio*

Cycle duration, min	Calculated volumetric capacity, m^{3}/h	Capacity load ratio, %
10.00	102.60	62.41
11.00	93.27	68.65
12.00	85.50	74.89
13.00	78.92	81.14
14.00	73.29	87.38
15.00	68.40	93.62
16.00	64.13	99.86
16.02	64.04	99.98
17.00	60.35	106.10
18.00	57.00	112.34

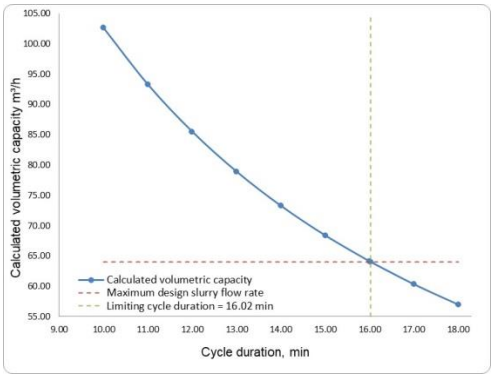


Figure 1. *Influence of cycle duration on filter press system volumetric capacity*

At the adopted cycle duration of 14 min, the calculated volumetric capacity of the filter press system is 73.29 m^3/h, compared with a maximum design slurry flow rate of 64.03 m^3/h. The corresponding capacity load ratio is 87.4%, indicating that the system operates below full calculated capacity under the adopted design condition. As cycle duration increases, the available capacity margin decreases. At a cycle duration of 16 min, the calculated volumetric capacity is 64.13 m^3/h and the capacity load ratio is approximately 99.9%. The limiting cycle duration is approximately 16.02 min, corresponding to a capacity load ratio of approximately 100%.

As an additional check, the maximum design slurry flow rate of 64.03 m^3/h at a slurry density of 1.75 t/m^3 and a solids content of 55 wt.% corresponds to approximately 61.63 t/h of dry solids. At a 14 min cycle with two operating presses, this corresponds to approximately 7.19 t of dry solids per press per cycle, or 0.841 t of dry solids per m^3 of

chamber volume. Actual filtration performance also depends on slurry and cake properties, pressure conditions, filter cloth condition and auxiliary cycle operations [1–5].

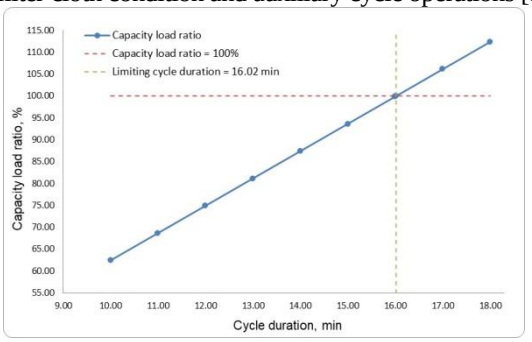


Figure 2. *Influence of cycle duration on capacity load ratio*

4. CONCLUSION

A parametric analysis of the influence of filtration cycle duration on the capacity of a chamber filter press system was performed for two filter presses operating in parallel under maximum design flow conditions. The results show that increasing the cycle duration reduces the volumetric capacity of the system and increases the capacity load ratio. At the adopted cycle duration of 14 min, the calculated volumetric capacity remains higher than the maximum design slurry flow rate, providing an operating capacity margin under the adopted design conditions. The limiting cycle duration is approximately 16.02 min, corresponding to a capacity load ratio of approximately 100%. This value represents the upper limit of the adopted calculation and should not be considered a desirable continuous operating condition, since an adequate operating reserve is required for reliable equipment performance. Accordingly, shorter cycle durations provide the capacity margin required to accommodate variations in slurry properties, filtration conditions and auxiliary cycle operations. The analysis confirms the importance of cycle duration in assessing the capacity of the selected filter press system.

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