J MATER RES TECHNOL. 2016;xxx(xx):xxx–xxx

Available online at www.sciencedirect.com

jmr&t
Journal of Materials Research and Technology
www.jmrt.com.br

Original Article

Iron ore tailings dry stacking in Pau Branco mine, Brazil

Reinaldo Brandao Gomes[a,*], *Giorgio De Tomi*[b], *Paulo Santos Assis*[a]

[a] *Universidade Federal de Ouro Preto – UFOP, Brazil*
[b] *Universidade de São Paulo – USP, Brazil*

ARTICLE INFO

Article history:
Received 1 February 2016
Accepted 23 March 2016
Available online xxx

Keywords:
Dam failures
Iron ore
Tailings filtering
Dry stacking

ABSTRACT

The mining industry has seen several significant dam failures in recent years. Dam failures are associated with errors in design, implementation, operation, and monitoring (Azam, 2014, [2]). Dewatered stockpiling (dry stacking) is a safer alternative to tailings dams (Rico et al., 2008, [3]) for tailings disposal; however, this method has not yet been used in iron ore mines in Brazil, where geotechnical conditions and abundance of water are favorable for the use of tailings dams. This paper describes the results of the study that supported the implementation of an innovative dewatering plant for iron ore tailings in Pau Branco mine, Quadrilatero Ferrifero, Brazil, contributing to improve its sustainability (Gomes et al., 2015, [6]). Magnetic concentration rejects (>45 μm) were feasibly dewatered through high-frequency screenings, and slimes (<45 μm) were effectively filtered in a horizontal filter press, enabling dry stacking of tailings. A comparison with the current tailings dam structure is presented, demonstrating that Capital Expenditure (CAPEX) for the solution proposed here is significantly lower.

1. Introduction

The mining industry has experienced several significant dam failures in recent history. Prior works interpreting the history of tailings storage facility failures have concluded that a lower number of failures and incidents in the two most recent decades evidence the success of modern mining regulation, improved industry practices, and modern technology. Contrariwise, since 1960, a clear trend toward failures of ever-greater environmental consequence has been noted [1].

Tailings dams are often built using the coarse fraction of tailings from mineral processing installations with steep slopes, thereby, saving on cost. To maintain the stability of these structures is one of the most complex activities in the management of mine wastes [2]. Generally, the following reasons are responsible for failures in these structures: (i) use of residual materials from mining operations to construct the embankment; (ii) sequential dam raisings; and (iii) high maintenance costs [3].

A good option for ensuring safe tailings management is dried disposal rather than slurry disposal. Dry stacking is being

* *Corresponding author*.
E-mail addresses: reinaldo.brandao@vallourec.com, gomesreinaldobrandao@gmail.com (R.B. Gomes).
http://dx.doi.org/10.1016/j.jmrt.2016.03.008

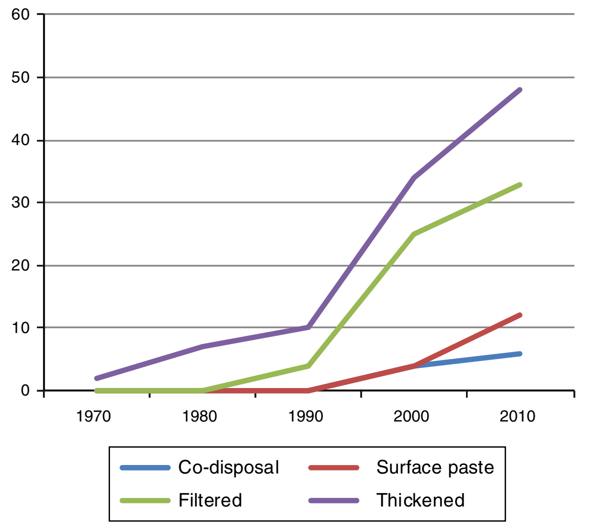

Fig. 1 – Trends in use of dewatered tailings in mining: filtered tailings disposal represents approximately 35% of the method utilized in tailings facilities [5].

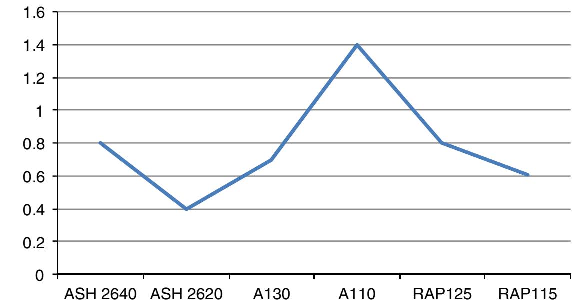

Fig. 2 – Solids flow rate for flocculant type.

applied to areas that have limited space and water resources, and in areas in which topographic and geotechnical conditions contraindicate conventional impoundments [4]. This is shown in Fig. 1, which provides a summary of the relative number of dewatered facilities on a global scale.

Although projects have demonstrated the technical feasibility of iron ore tailings filtering [5], it has not been yet implemented in iron ore mines in Brazil. Some of the reasons include high cost of acquisition and operation, availability of water, and topographical and geotechnical conditions favorable to dam installations. Bibliographic references to studies evaluating dewatering screening for tailings were not found during the development of this study.

This paper describes the tests performed to define the most cost-effective manner of obtaining a dried product to be stacked in a co-disposition structure in Pau Branco mine, Quadrilatero Ferrifero (QF), Minas Gerais, Brazil. The solutions tested include filters, dewatering cyclones and screening for fines (>45 μm) and slime (<45 μm). The results from dewatering, compaction, and stability tests support the implementation of a dewatering plant for tailings dry stacking, eliminating the need of a tailings dam, which is currently in use at the mine.

2. Materials and methods

Vallourec's beneficiation plant produces concentrated iron ore lumps and fines in Pau Branco mine [6]. Tailings are composed of both fines (>45 μm) and ultra-fines (<45 μm). Ultra-fines are generated from the de-sliming cycloning of the magnetic concentration process, and fines are the rejects of this process. Both fines and ultra-fines are disposed in a tailings dam inside the mine operation area. Thickening, filtering, and dewatering screening tests were performed to demonstrate the feasibility of tailings dry stockpiling and eliminate the need of a tailings dam.

2.1. *Thickening tests*

Thickening tests were performed using laboratory scale thickeners. These tests aimed to define the need of chemical conditioning, maximum overflow rate, and maximum solids percentage.

To evaluate the filtering performance for slimes, a leaf test apparatus was used [7]. Cake thickness versus moisture, and filtering rate per unit area were defined. Dewatering of magnetic concentration rejects was evaluated in a high frequency screening, to define the moisture versus time per unit of screening area.

Natural sliming samples, collected from the industrial plant process, indicated 9.8% solids, 7.5 pH, 130 tph dried solids flow rate, and solids density of 3.9 g/cm^3. Magnetic concentration samples indicated 65% solids, 7.5 pH, 250 tph dried solids rate, and solids density ~3.0 g/cm^3. A Beckman PHI 12 PH/ISE meter was used to measure pH.

Initially, to define the most effective flocculant, samples with 5% solids, and 7.5 pH, were collected from the Pau Branco mine industrial plant, representing typical industrial tailings. Anionic flocculant ASH 2620 (Praestol), ASH 2640 (Praestol), A130 (Kemira), A110 (Kemira), RAP115 (Kemira), and RAP125 (Kemira) were tested. A flocculant dosage of 40 g/t was used. Fig. 2 illustrates these results.

It can be seen from Fig. 2 that flocculant A110 showed the best performance for the evaluated flow rate, but its water clearness was not satisfactory. Accordingly, flocculant RAP 125 was chosen, because of its adequate solids rate and excellent water clearness, which was less than 3 mg/l.

Subsequently, different dosages of flocculants, from 30 to 70 g/t were tried. Fig. 3 shows the results.

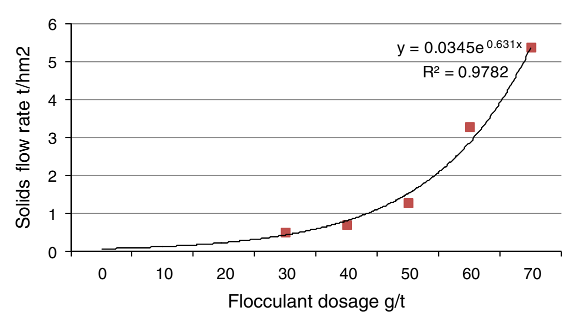

Fig. 3 – Solids flow rate versus flocculant dosage.