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Pasting characteristics of hematite/quartz systems

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Abstract

Iron ore tailings are currently disposed underwater in tailings dams as slurries containing from 30% to 50% of solids by weight. Conventional or high capacity thickeners are used to recycle most of the process water at the beneficiation plants. The underflow slurry stream of this unit operation feeds tailing basins either by gravity or by pumping. Alternatively, the preparation of pastes from tailings is a very attractive method since it allows their surface disposal without the need of large dam embankments and it also permits co-disposal with mine waste rock in controlled piles. In some specific cases, filling up exhausted open pits by co-disposal of tailings in a paste form and waste rock can be employed with several environmental related advantages. In the present work some physical and rheological characteristics of the slurries and pastes, prepared in different hematite/quartz systems, are presented and compared with some physical, chemical and mineralogical characteristics of the solids.
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Keywords: Dewatering, Tailings disposal

1. Introduction

Mineral paste is a relatively new concept that has continuously gained room in the minerals industry specifically in the area of mining tailings and waste disposal practices. Currently it is a fact that tailings generated during iron ore beneficiation in Brazil as well as tailings from mining of metallic ores throughout Latin America are disposed in the form of thickened slurries underwater inside settling basins created by dams. Conversely, in several other countries such as Canada, USA, Republic of South Africa, Tanzania and Australia, one can observe a trend to an increasing number of operations employing surface disposal of tailings in the form of pastes and also, when applicable, in the form of pastes mixed with cement to fill up underground mined out cavities (Araujo et al., 2004).

Thickened disposal of tailings presents several advantages in relation to traditional methods still in use namely enhanced water recovery for its recycling as process water, steeper disposal angles of the tailings piles, smaller capital and operating costs and diminished environmental impacts (Sofrá and Boger, 2002).

It is important to point out that amongst the important properties of a paste-fill or cemented paste the following deserve closer attention: shear stress, slump height (as determined by the slump test), repose angle (as determined by the flume test), solid–liquid viscosity, compression strength (as determined by stress-deformation test) and permeability of the filling reached.

In Fig. 1 the range of disposal angles are qualitatively compared for thickened slurries and pastes for varying

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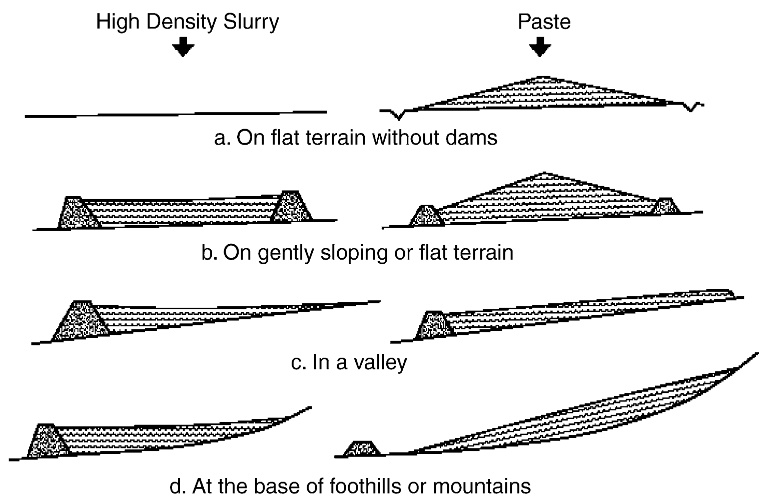

Fig. 1. Disposal angle comparison (after Laudriault, 2002).

topographies, as shown by Laudriault (2002). It can be observed from Fig. 1 that the paste disposal allows a better utilisation of the available area, for all different situations. It can be observed, however, that the geotechnical aspects of the terrain are very important and should be taken into account for a disposal project.

Considering iron ore as a case study, over 60 million tons per year of overall tailings, in the form of slimes and magnetic or flotation tailing streams are currently disposed in southern Brazil in the conventional underwater disposal basins. Raising dam heights (or building new dams) to accommodate extra tailings is a continuous practice of this industry. The possibility of disposing these tailings in a paste would increase current capacity of disposal without further investment and, even more importantly, with decreased environmental burdens in a very significant way.

The objective of this work is to determine some rheological parameters such as slump height, repose angle and viscosity for mineral pastes prepared from tailings of iron ores composed of mixtures of varying mineralogical composition (basically hematite and quartz). The scope of the current work involves correlating rheological aspects with size structure, specific surface area (Blaine Index), chemical and mineralogical compositions.

2. Methodology

Mineral samples employed in this work (samples I and II) are mainly constituted by hematite (Fe_2O_3) and quartz (SiO_2). Pastes were prepared in the laboratory by controlled water addition to a previously dried and weighed powder until the required percent of solids was reached. The two samples presented remarkable differences in their size structures.

The solid component of the pastes was characterised by means of the determination of density (Helium picnometry), size distribution (sieving and laser granulometer), specific surface area per mass unit (Blaine permeability), chemical composition by X-ray fluorescence and wet chemical methods and mineralogical composition by X-ray diffraction.

The slump test was performed employing the simple methodology described by Clayton et al. (2003), as shown in Fig. 2(a). In this test, the slump height is determined as well as the spreading of mineral paste. The slump height is defined as the difference between the ini-

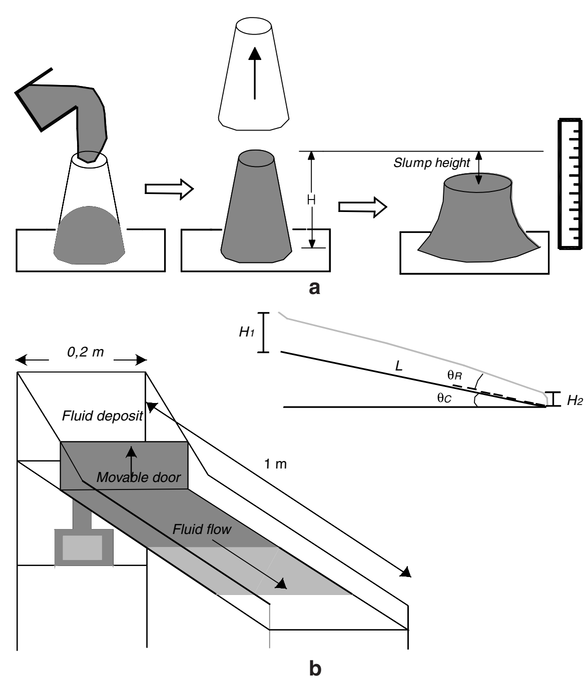

Fig. 2. (a) Slump testing (Clayton et al., 2003); (b) flume test apparatus (Sofrá and Boger, 2002).

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