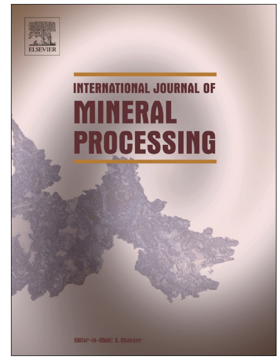
Accepted Manuscript



Selective flotation of rare earth oxide from hematite and quartz mixtures using oleic acid as a collector

George Blankson Abaka-Wood, Jonas Addai-Mensah, William Skinner

PII: S0301-7516(17)30214-4
DOI: doi:10.1016/j.minpro.2017.10.002
Reference: MINPRO 3107

To appear in: *International Journal of Mineral Processing*

Received date: 29 December 2016
Revised date: 30 September 2017
Accepted date: 5 October 2017

Please cite this article as: George Blankson Abaka-Wood, Jonas Addai-Mensah, William Skinner , Selective flotation of rare earth oxide from hematite and quartz mixtures using oleic acid as a collector. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Minpro(2017), doi:10.1016/j.minpro.2017.10.002

Selective flotation of rare earth oxide from hematite and quartz mixtures using oleic acid as a collector

George Blankson Abaka-Wood [a,*], Jonas Addai-Mensah [a,b], William Skinner [a]

[a]*Future Industries Institute, University of South Australia, Mawson Lakes, SA, Australia, 5095.*

[b]*Department of Mining and Process Engineering, Namibia University of Science and Technology, Windhoek, Namibia.*

[*]*Corresponding author. Email: george.abaka-wood@mymail.unisa.edu.au*

Abstract

Flotation, which exploits the differences in the surface wettability of minerals to effect separation, has been crucial in rare earth elements (REE) beneficiation. Monazite, a phosphate mineral commonly containing REE (typically lanthanum, cerium and neodymium), occurs in association with hematite and quartz gangue minerals in some low grade deposits. In this study, the physicochemical properties including contact angle, zeta potential, and floatability of monazite, hematite, and quartz were determined in the presence of oleic acid as a collector. Contact angle measurements indicated adsorption of oleic acid onto the minerals' surface. Zeta potential measurements were used to elucidate oleic acid adsorption mechanism onto the mineral particle surfaces. The flotation results showed poor flotation selectivity between monazite and hematite. Additionally, rare earth oxides (REO) in monazite floated better than both hematite and quartz at all the oleic acid dosages. Zeta potential and flotation results indicated that depressants are required to achieve selective flotation recovery of REO from hematite. The addition of two conventional depressants, sodium silicate and starch improved the selective flotation of REO from both hematite and quartz.

Keywords: collectors, depressants, flotation, monazite, oleic acid.

1 Introduction

Monazite is a phosphate mineral of light REE including cerium, lanthanum, and neodymium as well small amount of thorium. On the other hand, there are trace amount of dysprosium, erbium, and holmium present. Monazite has typical rare earth oxide (REO) of about 70%, with REO fraction constituting; 20-30% Ce_2O_3, 10-40% La_2O_3 (Gupta and Krishnamurthy, 2004; Jordens et al., 2013). Monazite was originally mined mainly for its thorium content. Due to increasing demand of neodymium and cerium, monazite has been receiving significant attention. Australia, Brazil, China, India, Malaysia, South Africa, and U.S.A have large quantities of heavy mineral sands bearing monazite. Neodymium is used for the production of permanent magnets which are used extensively in the automotive industry and manufacturing of motors of wind turbines. Cerium, which is the dominant REE in monazite, has wide range of commercial applications including glass polishing, phosphors, ceramics, catalysts and metallurgy. It is regarded as the most efficient glass polishing agent and also used to decolourize glass by keeping iron in its ferrous state (Castor and Hedrick, 2006; Du and Graedel, 2013; Gibson and Parkinson, 2011; Gupta and Krishnamurthy, 2004; iNEMI, 2014; Krishnamurthy and Gupta, 2015; Zepf, 2013).

Froth flotation, which exploits the difference in the surface wettability of minerals to effect separation has been crucial in REE minerals beneficiation (Abaka-Wood et al., 2016; Jordens et al., 2013). This technique involves complex interactions involving solids (minerals), liquid (water) and gas (air).The versatility of this technique has made it vital in the beneficiation of REE minerals from either high or low grade ores of complex mineralogy. Mineral particles that water wets are described as hydrophilic, whiles those that are not wetted by water are described as hydrophobic minerals (Bulatovic, 2007; Van Oss and Giese, 1995). Flotation separation of monazite from oxides and silicate gangue minerals has been investigated by numerous researchers (Abeidu, 1972; Cheng et al., 1993; Pavez and Peres, 1993; Ren et al., 1997; Satur et al., 2016; Zhang et al., 2017)

Generally, fatty acids (oleic acid or sodium oleate) and hydroxamates are employed as collectors in the flotation recovery of monazite and other REE-bearing minerals. Furthermore, the available gangue mineral phases associated with monazite principally inform the choice of depressants used during selective flotation recovery of monazite. Principal depressants that have been employed in various researches include sodium silicate, starch, sodium sulphide, sodium fluoride and sodium lignin sulphate (Abeidu, 1972; Bulatovic, 2007; Houot et al., 1991; Pol'kin et al., 1967; Satur et al., 2016; Xia et al., 2015; Zhang et al., 2017).

In a previous investigation it was demonstrated that monazite and hematite have an almost identical particle-collector interaction. Anionic collectors namely sodium oleate, hydroxamic acid, and sodium dodecyl sulphate