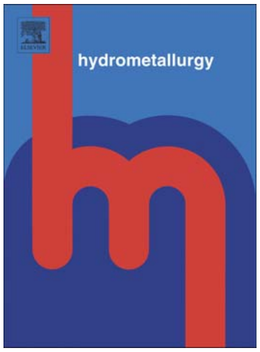

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REACTIONS OF LIME UNDER HIGH TEMPERATURE BAYER DIGESTION CONDITIONS

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ABSTRACT

This paper collates existing information from the literature on the reactions of lime added directly to high temperature Bayer digestions. It examines the reaction of calcium in lime with liquor components to form reaction products. Reactions are considered individually and in competition with each other. Because of the scarcity of information about competing reactions involving calcium / lime, the paper contains some speculation, drawing on different pieces of evidence from the literature to suggest possible reaction pathways. Three lime types have been considered – slaked lime ($Ca(OH)_2$) calcite ($CaCO_3$) and tri-calcium aluminate (TCA, $Ca_3Al_2(OH)_{12}$).

Individual reactions of calcium in lime have been considered with alumina and carbonate, fluorine, vanadium, phosphorus, silica, titanium and iron. Consideration has also been given to the “catalytic” actions of lime in transforming goethite to hematite and enhancing boehmite dissolution.

KEYWORDS

Bayer Process, Lime, Digestion, Impurity Control, Hydrogarnets, Perovskite.

1. Introduction

Lime is often considered as a panacea in the Bayer process. Its uses are so widespread that there is virtually no unit operation where it does not find an application. Table 1 gives an overview of the main uses of lime in the Bayer process, including low temperature applications (not all applications are given). For general references in this area, the interested reader is referred to previous reviews (Whittington, 1996a; Solymar & Zoldi, 1993). For an explanation of terms, see individual sections later in this paper.

Table 1 Non-exhaustive summary of lime uses in the Bayer process

Use of lime	Description	References
Impurity Control in predesilication	Lime added as $Ca(OH)_2$ or TCA to control phosphorus, vanadium and fluoride in liquor	(Bardossy, 1982) – bauxites (Porter, 1951) – phosphorus control (Ostap, 1984) – P, V, F compounds (Kirwan *et al.*, 2009) – carbonate-apatite (Wilson *et al.*, 2002) – fluorine in TCA
Aid to boehmite and diaspore extraction	Lime enhances boehmite extraction by forming $CaTiO_3$ thereby preventing sodium titanate coatings on boehmite which inhibits dissolution. Lime reacts with surface groups on diaspore to form calcium aluminate which decomposes to form aluminate and reform lime (catalyst).	(Zambo & Orban-Kelemen, 1976) – early work (Whittington, 1996a) – and references therein (Gu *et al.*, 1993) – boehmite and diaspore (Croker *et al.*, 2006) – sodium titanate (Ma'lts, 1992) – diaspore extraction mechanism (Solymar & Zoldi, 1993) boehmite and diaspore (Solymar et al., 1992) boehmite extraction
Goethite to hematite transformation	Lime reacts with liberated iron in solution to form iron hydrogarnets which then decompose to form hematite and reform $Ca(OH)_2$. Lime therefore acts as a catalyst.	(Orban *et al.*, 1977) - patent (Whittington, 1996a) – and references therein (Ma'lts *et al.*, 1985) – mechanism and addition point (Murray *et al.*, 2009) – mechanism without lime (Solymar et al., 1992) kinetics
Reduction of desilication soda	Lime (as TCA) reacts with silica in liquor to form silica substituted TCA (hydrogarnets)	(Gu *et al.*, 2002) “Lime-Bayer” process (Smith *et al.*, 2001) – lime distribution