Recovery of vanadium from discard titaniferous magnetite slag using the soda ash roast-leach process

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INTRODUCTION

Titaniferous magnetite (titanomagnetite) is typically processed by smelting to produce vanadium-bearing pig iron and titania (TiO_2)-bearing slag, which is generally discarded as waste. The discard slag at Evraz Highveld Steel and Vanadium Corporation (EHSV) contains about 0.9% V_2O_5 and 35% TiO_2 (Steinberg, Geyser, and Nell, (2011). The vanadium content in the discard slag is relatively high compared to the 0.3% V_2O_5 in titanomagnetite mined in China (Zhang *et al*., 2007), the world's principal producer of vanadium (Roskill, 2010). Vanadium is typically recovered from titanomagnetite and vanadium slag (produced from the vanadium-bearing pig iron) by the soda ash roast-leach process. The current study was aimed at recovering vanadium from the discard titanomagnetite slag produced by EHSV using the soda ash roast-leach process. The use of soda ash roasting has the potential to also destroy the refractory spinel phase ($MgAl_2O_4$) in the slag and pave way for the recovery of TiO_2 from the leach residue (Lasheen, 2008).

METHODOLOGY

The soda ash roasting of titanomagnetite slag was conducted in a muffle furnace using fireclay crucible trays under the following conditions: Na_2CO_3 concentration 5%, 10%, and 15%, temperature (1100°C, 1150°C, and 1200°C, and time 30, 60, and 120 minutes) as major parameters. The roasted material was leached using the best conditions established in previous work conducted at Mintek; *i.e*. leaching using deionized water as lixiviant at 70°C, with a pulp density of 65 m/m% solids (mass of solids/ (mass of solids + mass of lixiviant)), pH 7.8, and reaction time 60 minutes. The leach residues were analysed by inductively coupled plasma optical emission spectroscopy (ICP-OES) and powder X-ray diffraction (XRD).

RESULTS AND DISCUSSION

The results of the V extraction from the titanomagnetite slag are shown in Figure 1 and Figure 2 for Na_2CO_3 concentrations of 10% and 15% respectively. The V extraction results for the 5% Na_2CO_3 concentration were generally low. The best V extraction was achieved when roasting was conducted at 1100°C for 60 minutes. The V extractions were relatively low, at less than 30% with both roasting reagent concentrations. However, the V extraction at the best roasting temperature and time increased slightly with increasing Na_2CO_3 concentration in the roaster feed from about 25% to 27% at 10% and 15% Na_2CO_3 concentrations, respectively.

XRD examination of the leach residues showed that a new phase, nepheline ($NaAlSiO_4$), was formed in the titanomagnetite slag. This was attributed to the reaction of sodium with the $MgAl_2O_4$ spinel, a phase that prevents the production of the high purity TiO_2 material from this slag (Goso *et al.*, 2016. The prevalence of the nepheline phase increased with increasing Na_2CO_3 concentration in the roaster feed. These results imply that high Na_2CO_3 in the feed material promotes the recovery of both V and Ti.

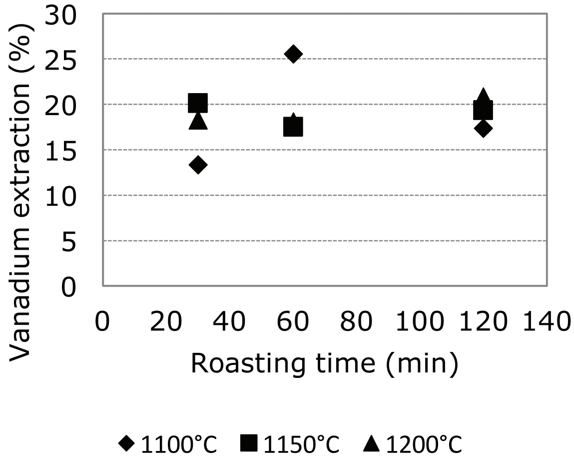

Figure 1. Vanadium extraction profiles as a function of temperature for 10% Na_2CO_3 roast

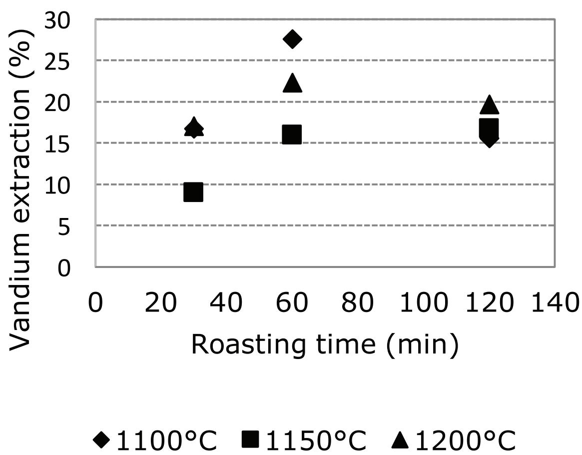

Figure 2. Vanadium extraction profiles as a function of temperature for 15% Na_2CO_3 roast

CONCLUSIONS

The results of the test work have shown that a vanadium recovery of about 27% can be achieved from a discard titanomagnetite slag containing about 0.9% V_2O_5 by soda ash roasting using a feed with 15% Na_2CO_3 concentration, at 1100°C over 60 minutes. The results also show that increased levels of Na_2CO_3 in the roaster feed have the potential to decompose the detrimental spinel phase through the formation of nepheline in the titanomagnetite slag, which would facilitate the downstream production of a high-purity titania material.

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In 2014 I joined Mintek (Pyrometallurgy division) as an in-service trainee student in order to complete a National Diploma in Chemical engineering. In 2015 I registered for B-Tech chemical engineering at the University of Johannesburg and started working as a permanent employee for Mintek as a Technician in training. I am currently based at Mintek as a Technician. During my time at Mintek I have been involved in different project that includes smelting, roasting, leaching, converting, calcining, fuming etc.