Enhancement of Sc and Ti extraction rates from Fe-depleted slag by hydrogen peroxide and sulfuric acid leaching

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ENHANCEMENT OF Sc AND Ti LEACHING RATES FROM Fe REMOVED SLAGS

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Abstract

Conditioning of bauxite residue for enhanced Sc and Ti leaching efficiencies was performed in this study. Acidic leaching conditions provided for higher Sc and Ti leaching also result in higher dissolved Fe in leachate. In order to tackle Fe interference, red mud is treated in electric arc furnace for prior Fe removal. Various smelting conditions such as cooling rate (20 º/min, 1400 °/min) and feeding lime (CaO) were performed to obtain slags with different crystallography and chemical properties. All slags were subjected to acidic leaching with 2.5 M hydrogen peroxide (H_2O_2): 2.5 M sulfuric acid (H_2SO_4) combination with a solid to liquid ratio of 1: 10 at 75 º C. Slags were analyzed in term of phase content, crystallinity and morphology by XRD and SEM analyses. Effect of various smelting conditions on leaching efficiencies and kinetics of Sc and Ti was investigated.

Introduction

- Wide application area of Ti as metal, compound and alloys; exhausted primary resources
- Sc has limited primary sources and has to be extracted mainly from secondary raw materials or as a by-product of uranium, nickel-laterite or titanium pigment processing
- Red mud is a very promising material to recover Ti and Sc
- High Fe amount in red mud decreases selectivity of Ti and Sc recovery and increases complexity of precipitation process
- Iron deficient slags, which were produced after electric arc furnace treatment of red mud, were subjected to acidic leaching in order to determine the most optimum slag chemistry and crystallinity.

Methods and Materials

Pyrometallurgical treatment

- Red mud (AoG)
- Reductant: Lignite coke (87% C)
- Flux: Lime (95% CaO)
- Smelting: 100kW EAF
- Batch mass: 2 kg
- T ≈ 1500°C
- Holding time ≈ 1 hour
- Cooling: quenched (water), ambient cooling (air)

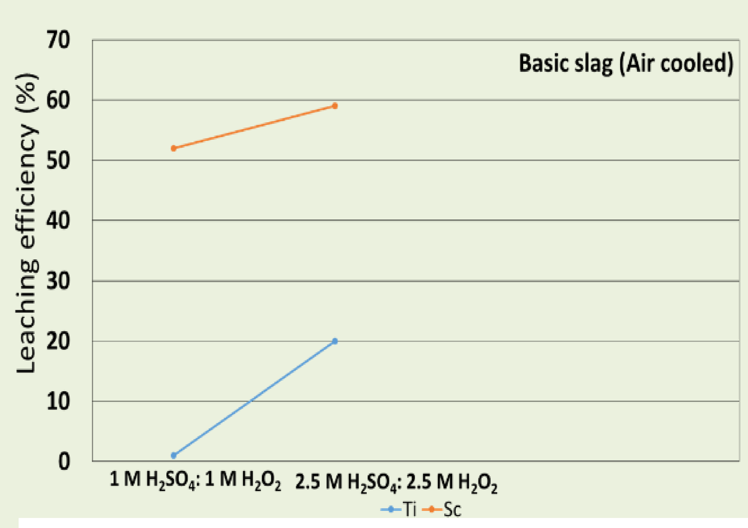
wt.%	Fe_2O_3	Al_2O_3	CaO	SiO_2	TiO_2	Sc (mg/kg)
Bauxite residue	43.5	24	10.2	5.5	5.6	130
Slag	1.8	38.3	43.2	7.6	7.6	170

Hydrometallurgical treatment

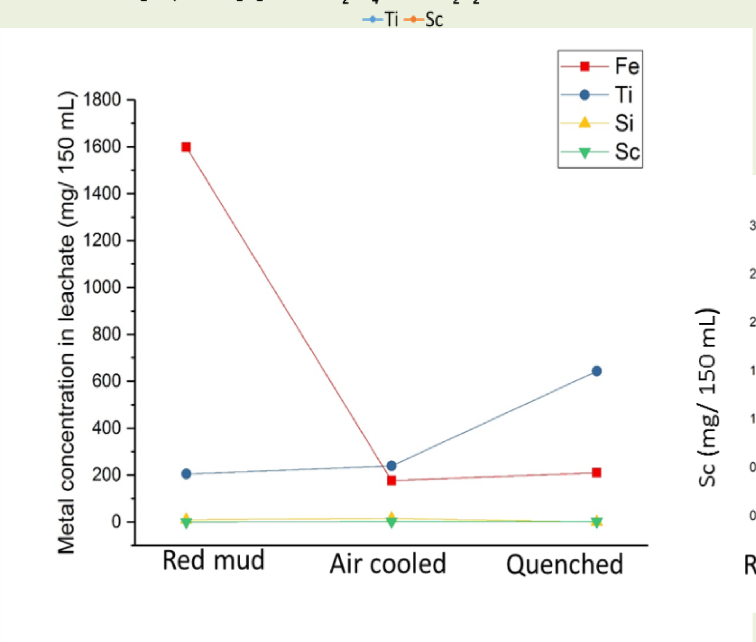
Fe depleted slags and red mud were subjected to acidic leaching;
2.5 M H_2SO_4: 2.5 H_2O_2 , s/l : 1/10 , T=75 °C , t=2 h

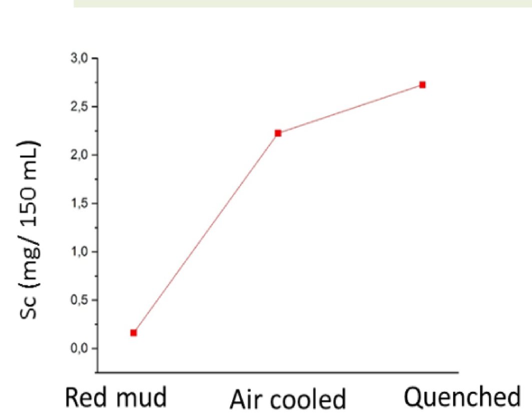
Results and Discussion

Determination of acid molarity



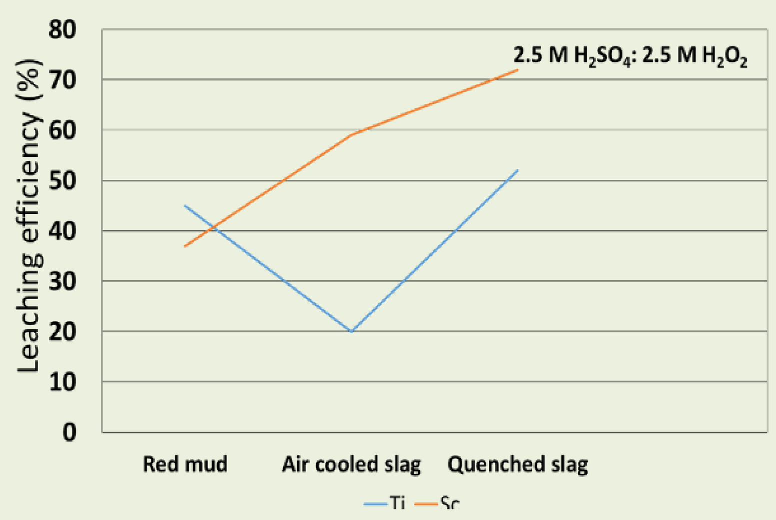
- 1 M ; very poor Ti leaching efficiencies (~ 1 %)
- 2.5 M; sight increase to 20 %
- High amounts of Ca ; calcium sulfate formation that use major sulfate suppress Ti dissolution.
- Low peroxide; gelation tendency was high
- **2.5 : 2.5 is determined to be used**





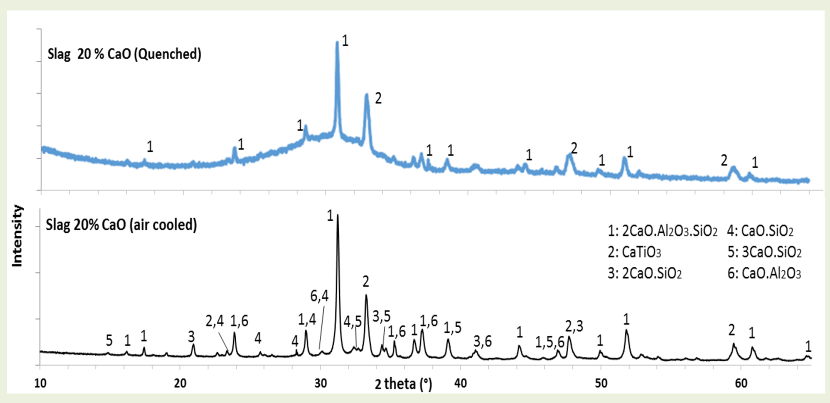
- Metal concentration of PLS highlights almost 3 and 5 folds increase in Ti and Sc: respectively when compared with red mud PLS
- A 10 fold decrease of Fe in leachate indicates selectivity of process.
- For Sc recovery, slag utilization is highly promising

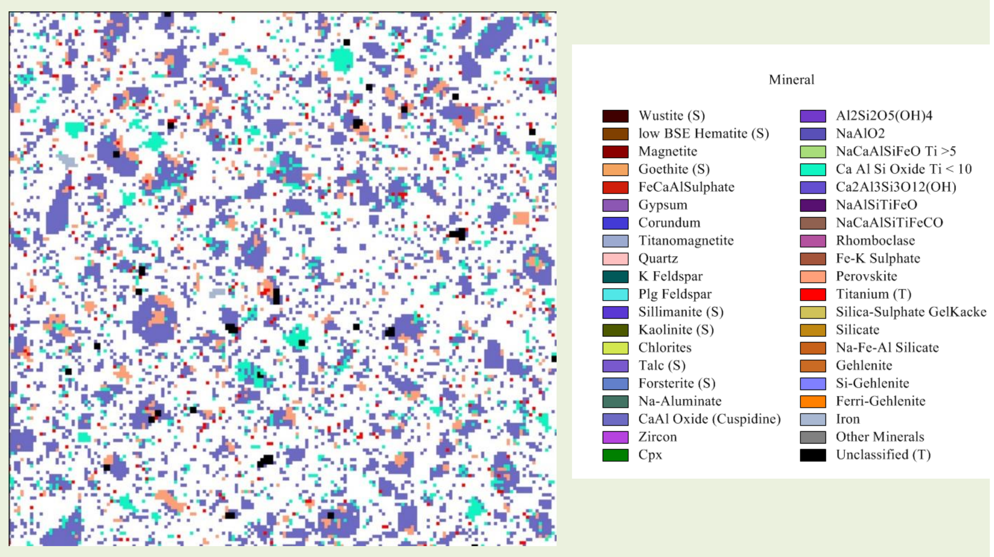
Comparison of red mud and slags



- Suppressed Ti extraction efficiency in air cooled slag
- Slightly increased Ti efficiency w.r.t. red mud when quenched slag is used; due to less crystalline and easily soluble nature
- High Sc leaching from both slags ,especiall from quenched **~94 %**

Investigation of slags crystal structure and minerology





- Quenched slag; poor crystallized with amorphous nature
- Well defined and narrow peaks case of air cooling
- Stable perovksite formation; may be the reason of low dissolution rates
- Perovskite entrapped in CaAl -Si oxide phase

Conclusions

- Removal of Fe before the acidic leaching step improved significantly the efficiency of Sc leachinG (Arial > 28pt)
- CaO-fed EAF treated and quenched slag followed by H_2SO_4: H_2O_2 leaching, 90% Sc recovery
- Owing to the formation of stable perovskite. poor Ti leaching efficiency
- Sc and Ti enriched PLS after leaching of quenched slag
- Scandium (Sc), can then be further treated with purification operations to synthesize a Sc concentrate

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