

**SOLIDIFICATION BEHAVIOUR OF TITANIA SLAGS**

by

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## PROJECT INFORMATION

This thesis reviews the physicochemical properties of high titania slags produced by ilmenite smelting in order to explain the solidification behaviour of these slags. These slags solidify predominately as a single-phase, namely pseudobrookite. This factor along with furnace temperature and slag composition are likely to influence foaming. Samples were obtained from a pilot scale ilmenite smelter. Samples were prepared for SEM, XRD and chemical analysis. These results were compared to results obtained from FACTSage software, with regards to the phase compositions of the slags.

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## SUMMARY

### Solidification behaviour of titania slags

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The aim of this thesis is to investigate the physicochemical properties and solidification behaviour of high-titania slags produced by ilmenite smelting. Possible reasons for the nearly single-phase structure of the solidified slag are reviewed. It is proposed that the unusual solidification behaviour of these slags can be attributed to the presence of a eutectic groove close to the  $M_3O_5$  (pseudobrookite) composition.

The structure of the solidified slag is likely to be the result of the solidification equilibrium with the freeze lining in the furnace. The freeze lining maintains a slag composition on the  $TiO_2$  rich side of the pseudobrookite. The effect of impurities on the solidification behaviour of the slags is also discussed. The ilmenite composition controls the impurity content of the slag, but since the slags referred to in this paper are produced from low-impurity South-African ilmenites, the effect is negligible.

**Keywords:** high-titania slags, physicochemical properties, solidification behaviour, eutectic groove, pseudobrookite, equilibrium, impurities, titanium dioxide

## SAMEVATTING

### Stollingsgedrag van titaanslakke

deur

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Die doel van die verhandeling is om die fisikochemiese eienskappe en stollingsgedrag van hoë-titaanslakke (geproduseer deur ilmeniet smelting) te ondersoek. Moontlike redes vir die bykans enkelfasige struktuur van die gestolde slak word hersien. Die buitengewone stollingsgedrag van die slakke word toegeskryf aan die teenwoordigheid van 'n eutektiese groef wat naby aan die  $M_3O_5$  (pseudobrookiet) samestelling voorkom.

Die struktuur van die gestolde slak is waarskynlik die gevolg van stollingsewig met die vriesvoering in die oond. Die vriesvoering handhaaf 'n slak samestelling aan die  $TiO_2$ -ryke kant van pseudobrookiet. Die effek van onsuiverhede op die stollingsgedrag van die slak word ook bespreek. Die ilmenietsamestelling beheer die onsuiverheidsinhoud van die slak, maar die slakke waarna verwys word in hierdie verhandeling word verkry van ilmeniet met 'n lae onsuiverheidsinhoud, dus is die effek weglaatbaar.

**Sleutelwoorde:** Hoë-titaanslakke, fisikochemiese eienskappe, stollingsgedrag, eutektiese groef, pseudobrookiet, ewewig, onsuiverhede, titaandioksied

## LIST OF SYMBOLS

<u>Symbol</u>	<u>Description</u>	<u>Unit</u>
$\Sigma$	Foam index	s
$H_f$	Foam height	m
$v_s$	Superficial gas velocity	m/s
Q	Volumetric gas flow rate	ℓ/min
A	Unit area of cross section of container	m <sup>2</sup>
$\mu$	Gas viscosity	kg/m.s
$\sigma$	Surface tension	N/m
$\rho$	Gas density	kg/m <sup>3</sup>
g	Acceleration due to gravity	m/s <sup>2</sup>
d	Bubble diameter	$\mu$ m
$\eta_e$	Effective viscosity of the slag	kg/m.s
$\eta$	Viscosity of the molten slag	kg/m.s
$\Theta$	Volume fraction of precipitated solid phases	

## Abbreviations

SEM	Scanning Electron Microscope
XRD	X-Ray Powder Diffraction
XRF	X-Ray Fluorescence Spectroscopy

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## OBJECTIVES OF THIS INVESTIGATION

The aim of this investigation was to:

- Produce a literature survey on reason for slag foaming in the ilmenite smelter.
- Investigate the solidification behaviour of titania slags and the possible effect on slag foaming.
- Seek possible reasons for the single-phase solidification behaviour of titania slags.
- Investigate the interaction between the slag and freeze lining in the ilmenite smelter

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