

INFACON 6

Volume 1
FERROALLOYS

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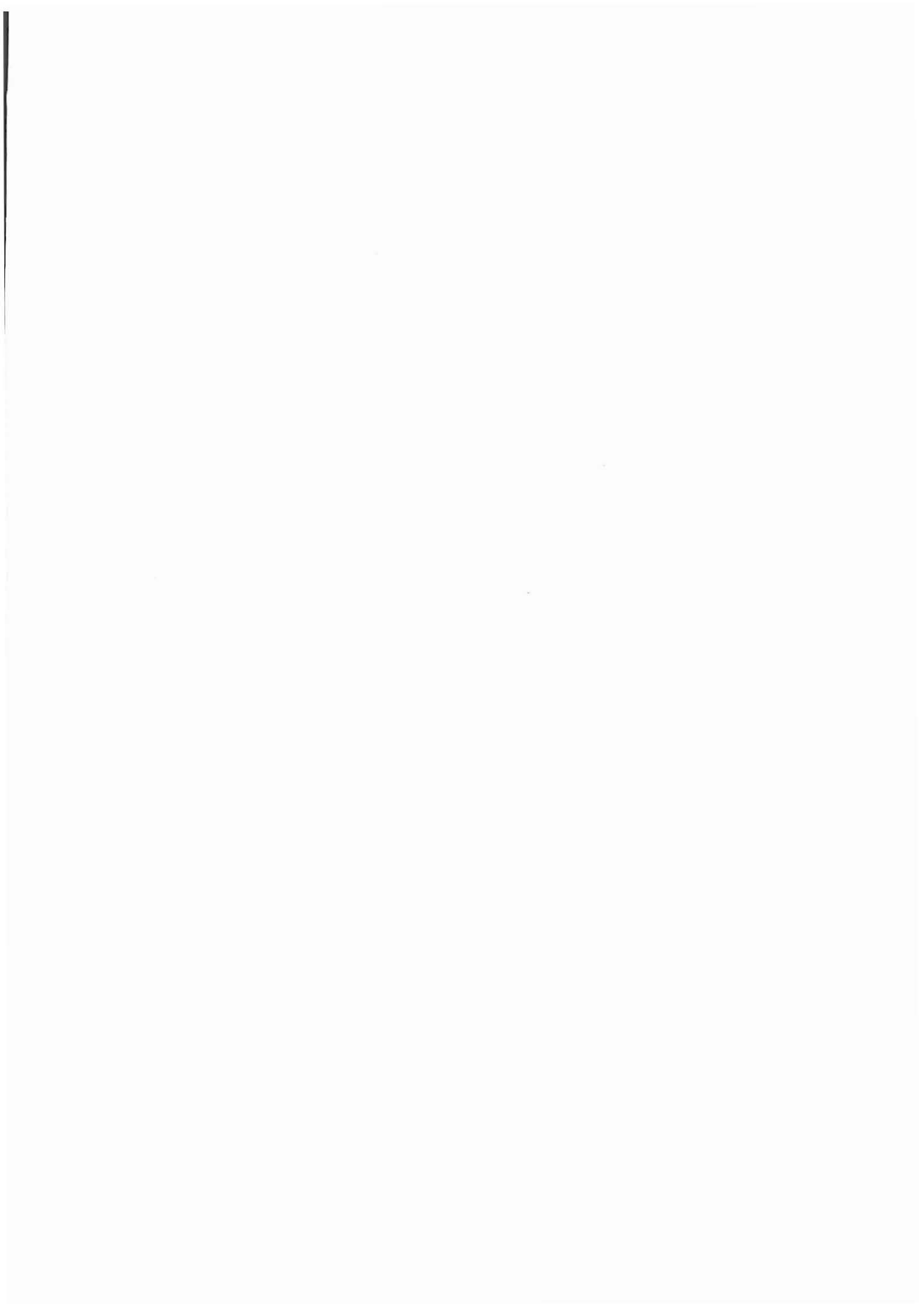
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THE SOUTH AFRICAN INSTITUTE OF MINING AND METALLURGY

SYMPOSIUM SERIES S11

INFACON 6

(Incorporating INCSAC 1)

Volume 1

FERROALLOYS

Edited by
H. W. GLEN

**The conference was organised by
The Council for Mineral Technology
The South African Institute of Mining and Metallurgy
and
The Ferro Alloy Producers' Association**

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Foreword

There are undoubtedly many people and organizations who still have on their bookshelves a copy of the Proceedings of the first INFACON, which was held in South Africa in 1974.

That first congress represented a big step forward for collaboration among ferroalloy industries around the world, and the papers presented demonstrated the value of the cross-fertilization that can arise in conferences of this type. Four other INFACONs have been held, and the International Committee has established INFACON as a much-respected feature of technical liaison.

These two volumes contain the papers that are to be presented at the 6th INFACON, which has introduced another innovative feature by combining the topics of chromium and stainless steel with that of ferroalloys. There is much of common interest in these topics, and we are sure that the combination will prove to be most interesting and valuable.

More importantly, as regards the challenges that lie ahead for the steel industries of the world, it is vital that the producers of raw materials, intermediate products, and final consumer products should form a coherent chain of collaboration, coordination, and cross-fertilization. INFACON helps to achieve this.

I sincerely hope that these proceedings will be the forerunner of many similar conferences in the future.

R. E. ROBINSON
Chairman: INFACON 6
Organizing Committee

Preface

The papers published in this volume are grouped according to the technical sessions in which they were presented at INFACON 6. However, all the plenary and keynote papers are included in the first section. The main technical groupings are according to the major ferroalloy groups, namely ferrochromium, ferromanganese, silicon and silicon alloys, and vanadium and minor ferroalloys. The applications of ferroalloys in steel-making was chosen as a session topic in recognition of the new chromium steels and alloys. The papers dealing with chromium steels and alloys are published in the second volume of these proceedings.

The papers accepted for publication have been refereed and edited according to the customary criteria stipulated by the SAIMM. Apart from editorial changes, the papers are in the form in which they were finally submitted to INFACON 6. These Proceedings are the first produced on the SAIMM's new desktop publishing system. Although this system has many special features, the tight deadlines have resulted in some inconsistencies such as the use sometimes of decimal points, instead of the decimal commas that are standard South African practice. Other examples include the use of *weight per cent* instead of *mass per cent*, and *calories* or *BTUs* instead of *joules*.

I extend my thanks to Mr J.D. Austin (Publication Committee), Mr W.A. Gericke (Sub-Committee Chairman—Manganese), Mr B.R. Rohrmann (Sub-Committee Chairman—Silicon, Ferrosilicon, Vanadium, and Minor Ferroalloys), and Dr D. Slatter (Sub-Committee Chairman—Chromium), who served on the INFACON 6 Technical Programme Committee for ferroalloys, and to Mrs B. Watkins and Ms Y.M. Arnold (Secretariat). Mr H.F. Boshoff's assistance is acknowledged.

I give my sincere thanks to Dr H.W. Glen for the tremendous amount of work that she put in to ensure that these Proceedings were published on time. My thanks are also due to the many referees who assisted in vetting the papers; to Mr A.J. Cowey, Mr R. Stimson, Mrs C. Buys, and Ms M.M. Joubert for their sub-editing and proof-reading work; and to the staff of the SAIMM and Mintek for their efforts in preparing this publication. Gratitude is also expressed to the authors for contributing their papers to INFACON 6 and for their co-operation in meeting the stringent deadlines. Special thanks are due to Mrs Claire Kearney, Mrs Pam Smith and Mrs Susan Luddick, of the SAIMM, who co-ordinated the whole publishing task.

N. A. BARCZA

*Chairman: Technical Programme Committee
INFACON 6, 1992*

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Units and Ferroalloy Nomenclature

Throughout this volume, the use of the International Metric System (SI) units has been preferred.

Some of the relevant basic and derived SI units are as follows:

Basic SI units		
Quantity	Unit	Symbol
Electric current	ampere	A
Electric potential	voltage	V
Length	metre	m
Mass	kilogram	kg
	ton	1000 kg
Time	second	s
Luminous intensity	candela	cd
Temperature	kelvin	K
Amount of substance	mole	mol

Derived SI units			
Quantity	Unit	Symbol	Derivation
Force	newton	N	kg/m/s ²
Frequency	hertz	Hz	s ⁻¹
Pressure, stress	pascal	Pa	N/m ²
Work, energy, quantity of heat	joule (calorie)	J (cal)†	Nm
Capacitance	farad	F	m ⁻² kg ⁻¹ s ⁴ A ²
Electric potential	volt	V	m ² kg s ⁻¹ A ⁻¹
Impedance	ohm	Ω	m ² kg s ⁻¹ A ⁻²
Conductance	siemens	S	m ⁻² kg ⁻¹ s ³ A ²
Power	watt	W	m ² kg s ⁻¹
Quantity of electricity	coulomb	C	SA
Weight	newton	N	m kg s ⁻²
Restarting	ohm. metre	Ωm	
Resistance	ohm	Ω	
Temperature	(centigrade)	°C	
	(kelvin)	K	
Flow	(gas, liquids)	Nm ³	
where N means normal (i.e. STP)			
Feedrate	(solids)	kg/h or kg/min	
Annual production rate or capacity		Kt/a	
Emissivity		E	
Mean particle size		d ₅₀	
Atmosphere		atm	

† (1 cal = 4,1818J)

Since it is not practical to use only the basic and derived units of the accepted system, their decimal multiples and submultiples are formed by adding prefixes to the units. The prefixes are shown in the table below:

Multiples, Prefixes and Symbols		
Factor by which the unit is multiplied	Prefix	Symbol
10 ⁹	giga	G
10 ⁶	mega	M
10 ³	kilo	k
10 ⁻³	milli	m
10 ⁻⁶	micro	μ
10 ⁻⁹	nano	n
10 ⁻¹²	pico	p

Abbreviations/Nomenclature related to Ferroalloys		
Chromium alloys	FeCr	ferrochromium
	ChCr	charge chromium
	HCFerCr	high carbon ferrochromium
	FeCrSi or CrSi	ferrochromium silicide or silico chrome
Manganese alloys	FeMn	ferromanganese
	HCFerMn	high carbon ferromanganese
	FeMnSi or MnSi	ferromanganese silicide or silico manganese
Silicon alloys	FeSi, Si	ferrosilicon, silicon
	CaSi	calcium silicide
Minor ferroalloys (examples)	FeV	ferrovanadium
	FeTi	ferrotitanium
	FeB	ferroboron
Carbide	CaCr	calcium carbide

SECTION 1

Plenary and Keynote Addresses

Session Chairmen

A. M. Edwards

R. J. Dippenaar

P. A. Brink

N. Keys

H. J. Smith

