

Entrepreneur India

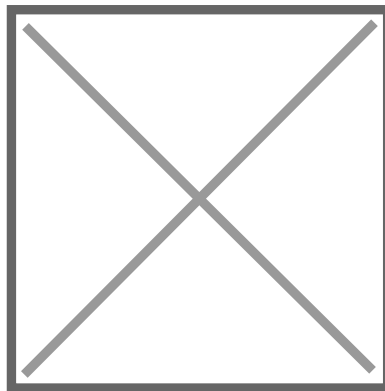
106-E, Kamla Nagar, New Delhi-110007, India.

Tel: 91-11-23843955, +91 9097075054

Mobile: +91-9097075054

Email: npcs.ei@gmail.com, info@entrepreneurindia.co

Website: www.entrepreneurIndia.co



The Complete Book on Ferroalloys (Ferro Manganese, Ferro Molybdenum, Ferro Niobium, Ferro Boron, Ferro Titanium, Ferro Tungsten, Ferro Silicon, Ferro Nickel, Ferro Chrome)

Code	NI258
Format	paperback
Indian Price	₹2775
US Price	\$250
Pages	480
ISBN	9789381039298
Publisher	NIIR PROJECT CONSULTANCY SERVICES

Description

The Complete Book on Ferroalloys

(Ferro Manganese, Ferro Molybdenum, Ferro Niobium, Ferro Boron, Ferro Titanium, Ferro Tungsten, Ferro Silicon, Ferro Nickel, Ferro Chrome)

An alloy is a mixture or solid solution composed of metals. Similarly, Ferroalloys are the mixture of Iron with high proportion of other elements like manganese, aluminium or silicon. Alloying improves the physical properties like density, reactivity, Young's modulus, electrical and thermal conductivity etc. Ferroalloys thus show different properties as mixture of different metals in different proportion exhibit a wide range of properties. Also, Alloying is done to alter the mechanical properties of the base metal, to induce hardness, toughness, ductility etc.

The main demand of ferroalloys, nowadays is continuously increasing as the major use of such products are in the field of civil construction; decorative items; automobile; steel industry; electronic appliances. The book provides a wide idea to readers about the usage of appropriate raw material and the treatment involved in the processing of raw material to final produce, safety, uses and properties of raw material involved in the processes.

This book concisely presents the core principles and varied details involved in processing of ferroalloys. The work includes detailed coverage of the major products like ferroaluminium, ferrosilicon, ferronickel, ferromolybdenum, ferrotungsten, ferrovanadium, ferromanganese and lesser known minor ferroalloys.

Progress in thermodynamics and physico-chemical factors in ferroalloy production has developed rapidly during the past twenty-five years or so. The book presents the principles and current knowledge of processes in the production of various ferroalloys. The production of a particular ferroalloy involves a number of processes to be followed in order to give the alloy desired physical and mechanical properties. The slight difference in the temperature or heating or composition can lead to entirely different alloy with different properties. This book is not only confined to the different processes followed in the production of ferroalloys but also describes the processes used and other information related to product, which are necessary for the manufacturer's knowledge. Also, the book gives the reader appropriate knowledge regarding the selection the best of available raw materials.

Content

1. INTRODUCTION

Theory

Terminology

Interstitial Alloy

Classification of Alloys

2. FERROALLOYS

Ferroalloys

Ferro Aluminium

Ferro Boron

Ferro Chromium

Ferro Manganese

Ferro Molybdenum/Molybdic Oxide

Ferro Molybdenum

Molybdic Oxide

Ferro Niobium

Ferro Phosphorus

Ferro Selenium

Ferro Silicon

Ferro Silico Manganese

Ferro Silicon Magnesium

Ferro Silicon Zirconium

Ferrous Sulphide

Ferro Titanium

Ferro Vanadium

Calcium Silicon Manganese

Calcium Silicon

Ferro Tungsten

Iron

3. PRODUCTION OF FERROALLOYS

Primary Processes

Secondary Processes

Applied Processes and Techniques

Ferro-chrome

Raw Materials

Pre-treatment Techniques

Production of Ferro-chrome and Silico-chromium

High-carbon Ferro-chrome

4. PRODUCTION OF FERRO MANGANESE

Raw Materials

Pre-treatment Techniques

Production of Ferro-manganese and Silico-manganese

High-carbon Ferro-manganese
Medium-carbon Ferro-manganese
Low-carbon Ferro-manganese
Silico-manganese
Types of Ferromanganese
Production of Ferromanganese
Production of High Carbon Ferromanganese
Blast Furnace Production
Electric Furnace Production
High Manganese Slag Practice
Discard Slag Practice
Production of Medium-Carbon Ferromanganese
Silicothermic Production of Medium-Carbon Ferro-manganese
Production of Medium-Carbon Ferromanganese by Oxygen Refining of High-Carbon Ferromanganese
Production of Low-Carbon Ferromanganese
Thermodynamics of Reduction of Manganese Oxides
High Carbon Ferromanganese Slags
Refining of Ferro Manganese
Introduction
The Sintering Pilot Facility
Preparation of the Sinter Mix
Sintering
Characterization
Performances
Eramet Research Mn Alloys Smelting Pilots
Background
Pilot Campaign Approach
Transfer of the Pilot Results to the Plants
The New Pyrometallurgy Piloting Facility
Constraints and Stakes for the New Facility
Definition of the Power Supply Characteristics
Design of the New Power Supply
Design of the Furnace
Furnace Diameter
Furnace Height
Side Wall Furnace Lining
Hearth Lining and Bottom Electrode
5. PRODUCTION OF FERRO MOLYBDENUM
Production of Ferro-molybdenum
Raw Materials

Carbo-thermic Production of Ferro-molybdenum
Metallo-thermic Production of Ferro-molybdenum

6. PRODUCTION OF FERRO NIOBIUM

Introduction

Basic Technology of FeNb Manufacturing

The Evolution of Ferro-niobium Manufacturing

Recent Developments in Ferro-niobium Manufacturing

Pyrometallurgical Refining of Concentrate

Sintering

Electric Arc Furnace Smelting

Ferro-Niobium Production

Crushirm and Packaging

Future Developments in Ferro-niobium Manufacturing

7. PRODUCTION OF FERRO BORON

Ferro-niobium

Production of Ferroalloys from Secondary Raw Material

Raw Material and Raw Material Preparation

8. PRODUCTION OF FERRO TITANIUM

Transferred-arc Plasma Furnaces

The Reduction of TiO₂

Enthalpy Considerations

Constitution of the Charge

Choice of Raw Material

Reasons for the Choice of a d.c. Transferred-arc Plasma Furnace

Small-scale Batch Tests in a 50 kVA Water-cooled Furnace

Equipment and Procedures

Objectives of the Experimental Work

Interpretation of Results of the Small-scale Tests

Large-scale Continuous Tests

Further Experimental Work

Melting Point of the Alloy

The Addition of Iron to the Charge

Further Furnace Modifications

Small-scale Sealed Furnace

9. PRODUCTION OF FERRO TUNGSTEN

Production of Ferro-tungsten and Tungsten Melting Base

Tungsten Melting Base (TMB)

Ferro-titanium

10. PRODUCTION PROCESS OF FERRO SILICON

Raw Materials

Production of Ferro-silicon, Silicon Metal and Silico-calcium

Ferro-manganese and Manganese Alloys

Refining of Ferro-silicon

Introduction

Processes for the Refining of Ferro-silicon

Solid/Liquid Oxide Method

Oxidising Treatment with Gaseous Oxygen/Enriched Air

Refining with Chlorine Gas

Purification by Carbon Dioxide Injection Method

Typical Results from Studies on the Refining of Ferrosilicon Carried Out at NML

The Chlorine Donor Method

The Carbon Dioxide Injection Method

The Oxygen Injection Method

Conclusions

Ferro Silicon Operation at IMFA—A Critical Analysis

Introduction

Quality Norms of Raw Materials at IMFA

Quality Deviations Experienced By IMFA

Ferro Silicon Process Description

Formation of Slags in Ferro Silicon

Types of Slag

Characteristics of Different Kinds of Slags

Incompletely converted charge (Slagging)

SiC with Si at the Bottom

Crusts of Sintered Charge Materials in the Upper Parts of the Furnace

Description of the Furnace

Operating conditions of the Furnace

Problems in the Furnace

Observations on the Deteriorating Conditions

Introduction of Lime Stone in the Burden

Variation in the Slag Properties

Operating Data

Improvements in the Furnace Performance

Comparison of Output Alloy Analysis

Detrimental Effects of CaO in the Burden Charge

Overcoming the Problem of Alloy Disintegration

Remarks and Conclusion

Controlled solidification of Ferrosilicon

Introduction

Experimental Work

Equipment

Casting

Investigation

Results and Discussion

Primary Silicon Grains

Eutectic

Distribution of Aluminium and Calcium

Cracking

Porosity

Conclusions

11. PRODUCTION OF FERRO NICKEL

Raw Materials

Production of Ferro-Nickel from Primary Raw Material

Production of Ferro-Nickel from Secondary Raw Material

“Ferronickel Ladle Furnace Refining Process”

Introduction

Process Description

Equipment

Process Theory

Oxidation

Desulfurization

Development

Oxidation

Desulfurization

Observation

Conclusions

Design of a Modern Large Capacity FeNi Smelting Plant

History, Applications and Trends

Experiences in FeNi-Smelters and Rectangular Furnaces

General Trends in the FeNi-production; Industry Demand

Design Principles of Large Scale FeNi-smelters

Calcine Transport System

Submerged Arc Furnace (SAF)

Principle of Submerged Arc Furnaces

Design Principle of a Large-Scale Rectangular FeNi-smelter

Process and Furnace Dimensioning

3-D Fluid Dynamic Codelling

Control and Operation

Furnace Integrity and Cooling

Further Application of Side Wall Copper Cooling for Rectangular Furnace

Additional Technological Highlights

SMS DEMAG Tapping Machines

Off-gas System

Plant Start Up
Refining of FeNi
Conclusions and Outlook
12. PRODUCTION PROCESS OF FERRO CHROME
Medium-Carbon Ferro-Chrome
Low-Carbon Ferro-Chrome
Silico-Chromium
Ferro-Silicon and Silicon Alloys
Various Techniques to Produce Low Carbon Ferrochrome
Introduction
Problems of Carbon
Decarburization
Decarburization Techniques
Conventional Techniques
Refining of Ferrochrome by Chromium Ore
Refining of Ferrochrome by Blowing Oxygen
Refining of Ferrochrome with the Presence of Silica
Silicothermic Process for the Production of Low Carbon Ferrochrome
Production of Carbon Free Ferrochrome by Aluminothermic Method
Non Conventional Techniques
Decarburization of Solid Ferrochrome
Decarburization using Oxidizing Gas Mixture
Production of Low Carbon Ferrochrome from Chromite Ore
Khalafala's Method
Other Methods
Conclusion
Modern Practices of Post Taphole Operation in Ferro Chrome Production and its
Advantages
Introduction
Mechanized Flow Sheet for Handling High Carbon Ferro Chrome Metal 62000 T/Y and
Corresponding Slag
Post Taphole Concept
Taphole Installation
Conventional and Freeze Lining Concept
Taphole Configuration
Taphole Lining
Taphole Operation
Temperature Monitor and Control
Important Aspect for Effective Taphole Operation
Movable Tapping Platform
Receptacles

Skimming System

Casting, Crushing, Screening & Handling of Finished Product

Liquid Slag Handling and Disposal

Granulation Process

Recovery of Entrapped Metal from the Slag

13. PRODUCTION OF FERROALLOY FROM SECONDARY RAW MATERIALS

Raw Material and Raw Material Preparation

Preprocessing

Mixing and Drying (Plasma Dust Process only)

Submerged arc Furnace Process

Plasmadust Process

14. PRODUCTION TECHNIQUES OF FERROALLOYS

General

Process Description

Submerged Electric Arc Process

Exothermic (Metallothermic) Process

Electrolytic Processes

Emissions and Controls

Aluminothermic Reduction of Oxides with Liquid Start
Description

Innovative Aspect and Main Advantages

Areas of Application

Atomisation of Ferroalloys

The Atomisation Process

Why Atomise (or Granulate)?

To Produce a Saleable, Dust-free Brittle Product

To Produce a Small-sized Ductile Product

To Produce a Reactive Intermediate Product

To Produce a "Rapidly Solidified" Product

To Produce Special Powder Products

Atomisation Processes

Water Atomisation

Gas/Air Atomisation

Centrifugal Atomisation

Atomised Products and Their Markets

Ferrosilicon 15% Dense Medium

Ferrosilicon 45% for the Welding Industry

Ferromanganese for the Welding Industry

Injectables

Higher Melting Alloys
Silicon
Process Selection
The Improvements to Copper Casting Machine for Ferroalloys
Brief Description of Casting Machine
Artificial Vision System
Monitoring of Main Parameters of the Casting
New Improvements of the Casting Machine
Advantages of the Casting Machine
From the Metal Quality Point of View
From the Economical Point of View
Application of Fluid Bed in Ferroalloy Industry
Introduction
Particle Characterization and Flow Regimes
Fluidized Beds in the Ferroalloy Industry
Ferrochromium Production
Ferronickel Production
Ferromanganese Production
Conclusions
Low Cost Ferroalloy Extraction in DC-ARC Furnace at Middleburg Ferrochrome
Introduction
The Process Principle of Ferroalloy Recovery
Description of Electrical System in Place
Designing the Electrical System According the Process' Need
Keeping the Arc under Control
Advantage of the DC-arc for Ferroalloy Recovery
The Furnace' Conductive Bottom
The Merits of the DC-arc
Optimized Furnace Design
Refractory Lifetime and General Maintenance
Power Quality Considerations
System Overview
What is Flicker?
Flicker Calculation and Measurements
Harmonics
Power Factor
DC Reactor Size
Flicker Mitigation
Production Increase
Thermodynamics Applied to Ferroalloys Smelting
Introduction

Thermodynamic Data
Chromium
Titanium
Niobium
Vanadium
Thermodynamic Slag Models and Computer Software
Regular Solution Models
Sublattice Models
Quasi-chemical Models
Other Models
Optical Basicity
Industrial Applications
Dephosphorization of Ferromanganese Alloys
Effect of Slag Composition
Effect of Ferroalloy Composition
Effect of Temperature
Dephosphorization under Reducing Conditions
Titanium Behavior Description in Silico-manganese Alloys
Thermodynamic Modeling
Industrial Application
Conclusions
Techno Economics of Recovering Ferroalloys from Dust and Slag
Introduction
Technology
Metal Recovery from Slags
Metal Separation
Metal Fines Remelting/Refining
Metal Recovery from EAF Dust
Hydrometallurgical Processes
Pyrometallurgical Processes
Carbon Steel Dusts
Stainless Steel Dusts
Metal Fines Remelting/Refining
Metal Recovery from EAF Dusts
Pyrometallurgical Processes
Carbon Steel Dusts
Stainless Steel Dusts
Conclusion
Atomisation of Ferroalloys
The Atomisation Process
Why Atomise (or Granulate)?

To Produce a Saleable, Dust-free Brittle Product
To Produce a Small-sized Ductile Product
To Produce a Reactive Intermediate Product
To Produce a “Rapidly Solidified” Product
To Produce Special Powder Products
Atomisation Processes
Water Atomisation
Gas/Air Atomisation
Centrifugal Atomisation
Atomised Products and Their Markets
Ferrosilicon 15% Dense Medium
Ferrosilicon 45% for the Welding Industry
Ferromanganese for the Welding Industry
Injectables
Higher Melting Alloys
Silicon
Some considerations of future developments in ferroalloy furnaces
Introduction
Present Constraints on the Scale up of Submerged-arc Furnaces
Scale up of the Electrical Circuit
Scale up of the Electrodes
The Supply of Electrical Energy
The Smart Grid
Some Possible Ways for the Ferroalloy Industry to Adapt to Changes
Submerged-arc Furnaces
Plasma Furnaces
Constraints on Electrodes
Swinging the Load
A Larger Furnace
Conclusions
SHS-Technology of Ferroalloys Nitriding
Introduction
Ferrosilicon Nitride Synthesis
Combustion Temperature
Filtration Combustion
The Phase Composition and the Structure of the Products
The Industrial Production
Conclusions
Changing Requirements of Ferroalloys for Flat Products
Introduction
Manganese (MN) Ferroalloys

Vanadium (V) Ferroalloy
Other Ferroalloys
Ti Sponge & Low Al Fe-Ti
Fe-Al lump
Fe-Nb lump
Plasma Technology in Ferroalloy Processing
Introduction
Plasma - A Basic Definition
Plasma Furnaces for Ferroalloys Smelting
Process Chemistry Consideration
Thermodynamics
Kinetics and Mechanisms
Slag Chemistry
Energy Related Issues
Power Input and Furnace Type
Energy Requirement and Distribution
Energy Efficiency
Advantages over Conventional Process
Relevance in the Indian Context
Application of Magnesite Ramming Material in Ferroalloy Refining Furnace
Introduction
Development of Ramming Material
Characteristics of Ramming Material in Ferroalloy Furnace
High Smelting Temperature
Good Sintering Property
Homogeneous and Rational Structure
Mineral Compositions and Effect of C2F
Mineral Composition
The Effect of C2F
Furnace Dissection Analysis
Analyses of Erosion Mechanism of Furnace Bottom
Conclusions
15. POLLUTION CONTROL IN FERROALLOY PRODUCTION
Introduction
Pollution in Ferroalloys Production
Assessment of Pollution
Selection of a Pollution Control Device
Equipments Employed for Pollution Control in Ferroalloy Production
Process of Pollution Control in Ferroalloys Production
Illustrations of Stack emissions from a Few Ferroalloy Plants
Emissions of Particulates and Dust from Ferroalloy Furnaces

Illustrations of Pollution Control Systems in Ferroalloys Production

Two Stage Venturi Scrubbing System for Air Pollution Control from Closed Ferroalloy Furnace

Conclusions and Remarks

About Niir

NIIR Project Consultancy Services (NPCS) is a reliable name in the industrial world for offering integrated technical consultancy services. Its various services are: Pre-feasibility study, New Project Identification, Project Feasibility and Market Study, Identification of Profitable Industrial Project Opportunities, Preparation of Project Profiles and Pre-Investment and Pre-Feasibility Studies, Market Surveys and Studies, Preparation of Techno-Economic Feasibility Reports, Identification and Selection of Plant and Machinery, Manufacturing Process and/or Equipment required, General Guidance, Technical and Commercial Counseling for setting up new industrial projects and industry. NPCS also publishes various technology books, directories, databases, detailed project reports, market survey reports on various industries and profit making business. Besides being used by manufacturers, industrialists, and entrepreneurs, our publications are also used by Indian and overseas professionals including project engineers, information services bureaus, consultants and consultancy firms as one of the inputs in their research.