

# The Complete Book on Ferrous, Non-Ferrous Metals with Casting and Forging Technology

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The Casting and Forging product is playing a greater role in our everyday lives and is essential than it has ever been. The Casting and Forging industry fortunes is largely dependent on the level of activity within the construction (building and non-building) and automotive sectors. Ferrous and non ferrous metals and its alloys accounts for a large portion of all metal production. Metal ingots and billets are formed by a casting process. The Casting process has traversed a long path and impacted human civilization for nearly five millennia. For any metal casting process, selection of right alloy, size, shape, thickness, tolerance, texture, and weight is very vital. Casting process involves melting the metal to be used, pouring it into a mould, letting it cool and then knocking out the casting. On the other hand, forging is one of the oldest known metal working processes. Forging technology occupies a very important place among all the manufacturing processes as it produces parts with excellent properties and with minimal wastage. Forging involves the use of machinery with a hammering or pressing action to convert basic shapes into a pre-determined form. Forging has the capacity to refine the grain structure and improve the physical properties of the metal. Forging products are consistent, without the defects of porosity, inclusion or voids, and finishing operations like machining, coining, sizing, straightening or surface treatments can also be easily done. This handbook gives a concise description of the fascinating on the state-of-the-art technology of the casting and forging process of metals and metal alloys. This book contains precise details on production of ferrous and non ferrous metals, its casting and forging process along with their alloys. It is hoped that this book will find very helpful to all its readers who are just beginners in this field and will also find useful for existing industries, technocrats, technical institutions, etc.

## CHAPTER 1

Production of Ferrous Metals

Production of Pig Iron

Blast Furnace

Direct Reduction

Furnaces for Steel making and Iron making

Basic Oxygen Furnace

Electric Furnace

Open-Hearth Furnace

Cupola

Steel Ingots and Strand Casting

Refining Furnaces and Vessels

Crucible  
Induction  
Melting in a Vacuum and Special Atmospheres  
AOD Process  
Energy Referred for Melting  
Ferrous Metals  
Wrought Iron  
Steel  
Carbon Steel  
Alloy Steel  
Stainless Steels  
Cast Iron  
Effects of chemical elements on cast iron  
Carbon  
Silicon  
Manganese  
Sulfur  
Phosphorus

## CHAPTER 2

Casting Design, Materials and Economics  
Introduction  
Design Considerations  
Designing for expendable-mold casting  
Corners, angles, and section thickness  
Flat areas  
Shrinkage  
Parting line  
Draft  
Tolerances  
Machining allowance  
Residual stress  
Designing for permanent-mold casting  
Casting Alloys  
Nonferrous casting alloys  
Ferrous casting alloys  
Economics of casting

## CHAPTER 3

Production of Non-Ferrous Metals  
Properties  
Non-Ferrous Metals  
Smelting  
Furnaces for Non-Ferrous Smelting  
Production of Aluminium  
Production of Magnesium  
Production of Copper  
Production of Lead  
Casting Non-Ferrous Materials  
Wrought Alloys  
Aluminium Alloys  
Copper Alloys  
Magnesium Alloys

Die-Casting Alloys  
Zinc Base Alloys  
Aluminium Base Alloys  
Copper Base Alloys  
Lead Base Alloys  
Tin Base Alloys  
Continuous Casting of Aluminium

#### CHAPTER 4

Welding and Joining Processes  
Fundamentals of a Welding System  
Design fundamental of welded joints  
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Carbon Electrode Welding  
Metal Electrode Welding  
Electrode coating  
Atomic Hydrogen Arc Welding  
Inert-Gas Shielded-Arc Welding  
Arc spot Welding  
Submerged Arc Welding  
Stud Arc Welding  
Electroslag Welding  
Resistance Welding Processes  
Spot Welding  
Projection Welding  
Seam Welding  
Butt Welding  
Flash Welding  
Percussion Welding  
    High-Frequency Resistance Welding  
Oxyfuel Gas Welding Processes  
Oxyacetylene Welding  
Oxyhydrogen Welding  
Air Acetylene Welding  
Pressure Gas Welding  
Solid-State Welding processes  
Cold Welding  
Ultrasonic Welding  
Explosive Welding  
Diffusion Welding  
Forge Welding  
Friction Welding  
Special Welding Process  
Induction Welding  
Electron Beam Welding  
Laser Welding  
Flow Welding  
Welding Quality and Safety  
Other Joining Processes  
Soldering  
Brazing  
Adhesive Bonding  
Allied Processes

Oxyacetylene Torch Cutting  
Transferred-Arc Cuttings

## CHAPTER 5

Finish Processes  
Mechanical Surface Preparation  
Blast Finishing  
Process control  
Chemical Surface Preparation  
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Drain  
Dragout  
Concentration in the Tank  
Concentration in the Rinse.  
Flow  
Equilibrium and Effectivity  
Multiple Rinsing  
Plating Procedure  
Automatic Control  
Brush Plating  
Metalizing Nonconductors  
Metalizing Processes  
Catalytic Deposition  
Metal Deposition Design Considerations  
Time and Tank Capacity Determination  
Thickness Testing  
Other Metallic Coatings  
Electroplating  
Chrome Plating  
Galvanizing  
Tin Coating  
Other Plating Metals  
Parkerizing  
Anodizing  
Colorizing  
Hard Surfacing

## CHAPTER 6

The Crystalline Structure of Metals  
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Atomic Planes  
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Dendrite Growth  
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Astm Grain Size  
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Three Kinds of Stress  
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Engineering Strain and True Strain  
Engineering Stress strain Diagrams  
True Stress-strain Diagram  
Idealized Stress-Strain Diagrams  
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Strain Rate  
Compression Test  
Tension Test  
Combined Deformation Tests  
Hardness Tests  
Hardness Versus Strength  
Hardenability Test  
Dynamic Impact Test  
Toughness  
Heat Resistance  
Thermal Conductivity  
Specific Heat  
Density  
Thermal Diffusivity  
Thermal Expansion  
Thermal Emissivity  
Corrosion Resistance  
Electrical Resistivity  
Magnetic Properties  
Malleability and Machinability  
Wear Resistance  
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Major Classifications and Specifications  
Unified Numbering System  
AISI-SAE Designation System  
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Electrical Sheet Steels  
Heat Resisting Alloys

## CHAPTER 7

Conditioning Semi-Finished Products  
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Ingot Defects  
Surface Defects Originating in Soaking Pits  
Defects Resulting From Hot-Rolling  
Practices  
The Classification of Surface Defects for Conditioning  
Method of Surface-Defect Detection  
The Mechanical Removal of Surface Defects  
Conditioning by Scarfing

## CHAPTER 8

### Structural Mills

#### Introduction

#### The Evaluation of Structural Mills

#### Universal Beam Mills

#### Modern Structural Mills for Rolling Large Beams

#### Modern Mills for Medium Sections

## CHAPTER 9

### The Reheating of Ingots

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#### The General Layout and Design of Soaking-Pit Facilities

#### Gaseous Fuels and Burners used in Soaking Pits

#### The Use of Oil for Heating Soaking Pits

#### Heat Recovery in Soaking -Pit Operations

#### Two-Way Fired Soaking Pits

#### One Way Fired Soaking Pits

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#### Circular Pits

#### Electric Soaking Pits

#### Pit Covers and Seals

#### Automatic Controls for Soaking Pits

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### Forging

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#### Cogging

#### Precision Forging

#### Forging Force

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#### Related Forging Operations

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#### Piercing

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#### Forging-Die Design

#### Die Material and Lubrication Forgeability

#### Forging Machines

#### Presses

#### Mechanical Presses

#### Screw Presses

#### Hammers

#### Counterblow Hammers

#### High-Energy-Rate Machines

#### Selection of Forging Machines

#### Forging Practice and Process Capabilities

#### Automation in Forging

#### Economics of Forging

## CHAPTER 11

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Types of Sand Molds  
Patterns  
Cores  
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Expandable pattern casting (lost Foam)  
Plaster Mold casting  
Ceramic Mold Casting  
Investment Casting  
Vacuum Casting  
Permanent Mold Casting  
Slush Casting  
Pressure Casting  
Die Casting  
Hot Chamber process  
Cold chamber process  
Process capabilities and machines selection  
Centrifugal Casting  
Squeeze Casting and Semisolid Metal Forming  
Squeeze casting  
Semisolid metal forming  
Casting Technique for Single Crystal component  
Rapid solidification (Amorphous alloys)  
Inspection of castings  
Melting practice and furnaces

## CHAPTER 12

Foundry Processes  
Sand casting and Molding procedures  
Green Sand Mold  
Loam Mold  
Furfuryl Alcohol Binder Molds  
CO<sub>2</sub> Molds  
Skin Dried Molds  
Dry Sand Molds  
Metals and Special Molds  
Gating System and Solidification Characteristics  
Patterns  
Allowances  
Removable patterns  
Sand Technology  
Mold and Core Hardness Test  
Fineness  
Test for moisture Content  
Clay content Test  
Permeability Test

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## CHAPTER 13

Tube Mills  
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Typical Skelp Mill  
The production of continuous butt-welded pipe  
The production of electric-resistance-welded tubing and electric-welded large-diameter pipe  
The production of seamless shells or Bottles by Direct Punching  
Rotary Piercing machines  
Rotary Rolling Mills  
The Plug Rolling Mill  
Reeling  
The Mandrel Mill  
Sizing and Stretch Mills  
The Pilger Mill  
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The Diescher Mill  
Modern Seamless Tube-Making Facilities

## CHAPTER 14

The cooling of Mill Rolls  
Introduction  
Heat Conduction equations  
Solution to Transient Heat Conduction Problems  
Mathematical Models Pertaining to Transient Heat Flow in Work Rolls  
Measured One-Dimensional Temperature Patterns in Mill Rolls  
Predicating the Roll Surface Temperature Rise in The Roll Gap  
The Water Cooling of Rolls and Measurement of Heat Transfer Coefficients  
Sprays and Their Placement for Optimum Roll Cooling

## CHAPTER 15

Extrusion and Drawing  
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Extrusion Force  
Metal Flow in Extrusion  
Extrusion Practice  
Hot Extrusion  
Die Design and Materials  
Lubrication  
Cold Extrusion



Impact Extrusion  
Extrusion Defects  
Surface cracking  
Pipe  
Internal Cracking  
Extrusion Equipment  
The Drawing Process  
Drawing Practice  
Die design  
Die Materials  
Lubrication  
Defects and Residual Stresses  
Drawing Equipment

## About NIIR

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Our Detailed Project report aims at providing all the critical data required by any entrepreneur vying to venture into Project. While expanding a current business or while venturing into new business, entrepreneurs are often faced with the dilemma of zeroing in on a suitable product/line.

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