
Physical Metallurgy of Cast Irons

José Antonio Pero-Sanz Elorz
Daniel Fernández González
Luis Felipe Verdeja

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José Antonio Pero-Sanz Elorz
Departamento de Ciencia de los Materiales e
Ingeniería Metalúrgica, Escuela de Minas,
Energía y Materiales
University of Oviedo
Oviedo, Asturias, Spain

Luis Felipe Verdeja
Departamento de Ciencia de los Materiales e
Ingeniería Metalúrgica, Escuela de Minas,
Energía y Materiales
University of Oviedo
Oviedo, Asturias, Spain

Daniel Fernández González
Departamento de Ciencia de los Materiales e
Ingeniería Metalúrgica, Escuela de Minas,
Energía y Materiales
University of Oviedo
Oviedo, Asturias, Spain

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This book is dedicated to the memory of José Antonio Pero-Sanz Elorz.

Endorsement

“The second half of the twentieth century was seeing casting processes gradually lifted from the art of crafts status to that of a science-engineers are complementing and supplementing the craftsman, and for the first time books are being published treating casting processes on the level of an advanced engineering or scientific subject; for contrary to the opinions of many, no other branch of industrial engineering will lend itself more responsively or rewardingly to scientific treatment and control, although the road will not be easy because the start has been slow and the numbers of scientist and engineers engaged in the process were relatively few”

“Cast iron is second only to steel in total tonnage produced. Cast iron has certain metallurgical and economic characteristic to the engineer; perhaps the most important is its cheapness”.

H. F. Taylor, M. C. Flemings and J. Wulff
*(Department of Metallurgy,
Massachusetts Institute of Technology (MIT), 1959).*

Preface

The possibility of obtaining metallic parts by simply solidification, without the subsequent processes of forging, justifies the interest of cast irons as structural materials. The economic advantages derived from this kind of manufacture, as well as some of their intrinsic properties, explain the strong demand of this product. Cast irons, with an annual production of 73.2 million tonnes in 2015, are, after steels, the metallic material most used worldwide. Cast irons are followed (regarding the production) in weight importance by aluminum and alloys (58.3 million tonnes in 2015).

The relation among the world production of cast irons and the total production of steel has decreased in the last years, being this relation 4.58% in 2015 (Fig. 1).

The industry of cast irons generates more employments than the steel industry, even when the investment for each position is only the seventh part of the equivalent in the steel industry. Nowadays, it is estimated that around 4.5 million people work (worldwide) in the steel industry, while around 3.5 million people work in the cast irons industry. However, one position in the cast irons industry generates, at

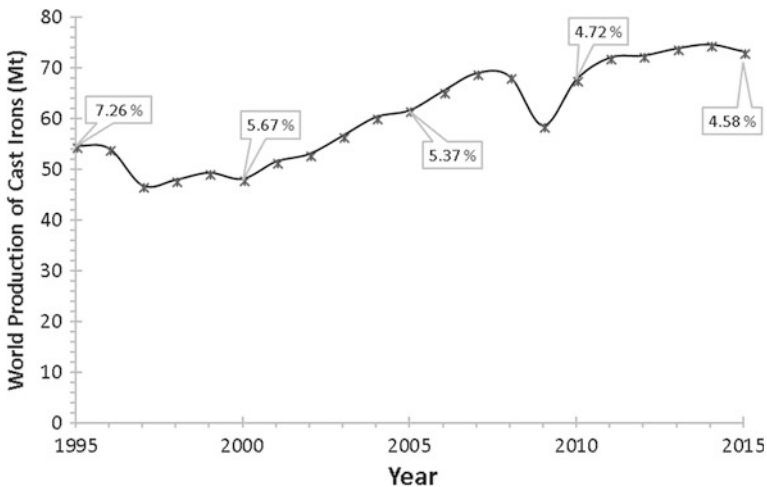


Fig. 1 World production of cast irons and their percentage in relation to steel production

least, other two or three in the metal mechanic industry. In short, the industry of cast irons has a strong impact in the horizontal integration of goods production.

The study of cast irons offers several facets: melting elaboration, physical chemistry of the equilibriums in liquid state, appropriate geometrical design of the parts, moulding technology, etc. Throughout the pages that compose this book, the physical metallurgy of cast irons is preferably studied with the objective of providing a criterion for the rational election of cast irons. That is, the relation between composition, metallographic structure derived from the composition and properties is studied, as well as the possibility of modifying the structure and properties by heat treatment.

It is assumed that the reader is familiarized with the constituents of the alloys, simples (solid solutions, intermetallic compounds, etc.) or compounds (eutectics, eutectoids); and that the reader knows and interprets the equilibrium diagrams. To study the previous fundamentals, as well as to know the fundamentals of solidification and transformations in solid state, the book of José Antonio Pero-Sanz Elorz, María José Quintana Hernández and Luis Felipe Verdeja González entitled *Solidification and Solid-state Transformation of Metals and Alloys* (Elsevier, 2017, first edition) is available for the readers.

From Chaps. 1 to 5, the metallographic structures of cast irons are studied. These chapters concern low and medium-alloyed cast irons, although the notions developed in these chapters will reach other types of cast irons. Chapter 5 is dedicated to the general properties resulted from the structure of grey cast irons.

Chapters 6 and 7 are devoted to malleable and ductile irons, while Chaps. 8 and 9 deal with the high-alloy cast irons. Chapter 8 is dedicated to the diagram Fe–C–Cr with the purpose of justifying several types of cast irons with corrosion resistance. White cast irons are first studied in Chap. 9 as an introduction to the alloyed cast irons used in applications where abrasion resistance is required. Chapter 9 continues with the explanation of high-alloy cast irons characterized by abrasion, corrosion or heat resistances.

Chapter 10 comprises exercises, problems and case-studies. This chapter could be of special interest for the readers after studying the book. Different situations, some of them real case-studies, will help the reader in the full understanding of the cast irons applications, with problems of moulding practice as well as exercises for studying the mechanical properties of cast iron parts. Finally, Chap. 11 is dedicated to the manufacture of cast irons in cupola furnace.

Oviedo, Asturias, Spain

José Antonio Pero-Sanz Elorz
Daniel Fernández González
Luis Felipe Verdeja

Acknowledgements

Nearly 30 years after the first edition in Spanish (new revised edition in 2018) of the book of Prof. José Antonio Pero-Sanz Elorz, that was entitled *Materiales para la Ingeniería. Fundiciones Férrreas*, the new edition of the book, this time in English, is published as a small tribute to him. With the idea of reaching a larger public, the original book was translated into English, and more than 50 solved exercises were included with the purpose of facilitating the understanding of the document. The book, now entitled *Physical Metallurgy of Cast Irons*, will be a support for professors in the fields of metallurgy and materials science, but also will be interesting for industrial professionals and researchers.

In this new edition of the book, several people have collaborated, and we want to express our sincere gratitude for their support. We thank José Ignacio Verdeja González of the University of Oviedo (Oviedo, Asturias, Spain), and María José Quintana Hernández and Roberto González Ojeda of the Panamerican University (México City, Mexico) for their advices and support. We cannot forget the invaluable help of José Ovidio García García, we thank him for the micrographs and good attitude towards work. Moreover, we express our gratitude for the valuable collaboration, help and support to the companies Arcelor Mittal Spain and Fundyser (www.fundyser.com/, Gijón, Asturias, Spain).

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Oviedo, Asturias, Spain

Contents

1	Fe–C System. Stable and Metastable Equilibrium Diagrams	1
1.1	Fe–C Equilibrium Diagram	1
1.2	Graphitizing Elements	9
1.3	Inoculant Elements	9
1.4	Carburigenous Elements	9
1.5	The Influence of Silicon in Cast Irons	10
2	Stable Eutectic—Graphite Morphologies	19
2.1	Stable Eutectic	19
2.2	Lamellar Graphite Morphologies	25
3	Compromise Between Stable and Metastable Solidifications	33
3.1	Composition and Massivity Factor (Section Sensitivity or Volume/Area Ratio)	33
3.2	Superheating	41
3.3	A Eutectic of Iron Phosphide (Fe_3P), Steadite	44
4	Stable and Metastable Cooling Compromise in Solid State	47
4.1	Introduction	47
4.2	Cooling of Grey Cast Irons in Solid State: Matrix Structures	51
4.3	Non-equilibrium Transformations. Low and Medium Alloy Elements	53
4.4	High Alloying and Transformations During the Cooling	54
4.5	Transformations by Heating	55
4.5.1	Indirect Ferritizing Due to Heat Treatment	55
4.5.2	Cementite Graphitization at 450 °C	60
5	General Properties of Non-alloyed Grey Cast Irons (or Low Alloy) and Flake Graphite	65
5.1	Properties of Grey Cast Irons	65
6	Malleable Irons	91
6.1	Malleable Cast Irons	91
6.2	White Heart Malleable Cast Iron	92

6.3	Blackheart Malleable Cast Iron	97
6.3.1	Ferritic Blackheart Malleable Cast Iron	98
6.3.2	Blackheart Malleable Cast Iron of Pearlitic Matrix.	100
7	Spheroidal Graphite Cast Irons (or Ductile Cast Iron)	105
7.1	Chemical Composition	105
7.2	General Properties of Ductile Cast Irons	111
7.3	Heat Treatments with Continuous Cooling	125
7.3.1	Ferritizing Treatments	128
7.3.2	Heat Treatments for Pearlitic Matrix	129
7.3.3	Treatments for Achieving a Matrix of Tempered Martensite	130
7.3.4	Other Treatments for Austenitic Cast Irons: Stress Relieving and Hyperquenching	131
7.4	Isothermal Treatments. Austempered Cast Irons, ADI (Austempered Ductile Iron)	135
8	Fe–C–Cr System	141
8.1	Binary Diagrams	141
8.2	Solidification Reactions in the Fe–C–Cr System	142
8.3	Austenite with Chromium: Composition Limits and Temperature	146
8.3.1	Gamma Iron Constituents in the Fe–Cr System	146
8.3.2	Limits of the Gamma Iron Constituent in the Fe–C–Cr Diagram	147
9	Composition, Structure and Properties of High-Alloy Cast Irons	153
9.1	Introduction to High-Alloy Cast Irons	153
9.1.1	Non-alloyed White Cast Irons	156
9.2	High-Alloy Cast Irons for Wear Resistance Applications	159
9.2.1	Ni-Hard Cast Irons	160
9.2.2	Martensitic Cast Irons and K_C Carbides Eutectic (15–28% Cr)	167
9.3	Corrosion-Resistant Cast Irons	177
9.3.1	High-Silicon Cast Irons	177
9.3.2	Ferritic Cast Irons with More Than 28% Chromium	179
9.3.3	High-Nickel Cast Irons (15–35% Ni)	180
9.4	Heat-Resistant Cast Irons	184
10	Exercises, Problems and Case Studies	191
10.1	Introduction	191
10.2	Thermal Analysis. Carbon Solubility in the Metastable and Stable System	192

10.3	Thermodynamics of the Fe–C–Si Ternary System. Interaction Coefficients. Carburizing and Graphitizing Elements	195
10.4	Magnesium Effect. Pig Iron Desulphurization	201
10.5	Solidification Times. Chvorinov Equation	203
10.6	Risering. Equations of Caine and Adams–Taylor. Exothermic Isolation. Solidification Defects	205
10.6.1	Introduction to Caine’s Equation	205
10.6.2	Risering in Grey Irons	212
10.6.3	Rail Aluminothermic Welding (Applicable to Exothermic Risers)	221
10.6.4	Gases in Cast Metals	224
10.6.5	Pressure Tightness	225
10.7	Mould Filling Times. Gating Design. Downhill Casting and Bottom Casting	228
10.7.1	Aspiration of Gases	231
10.8	Superheating. Fluidity. Castability	242
10.9	Mechanical Properties. Reliability (Weibull Statistics)	249
10.10	Creep: Stress Relieving	257
10.10.1	Measurement of Residual Stresses	257
10.10.2	Stress Relieving	259
10.11	Thermal Shock Resistance. Damping Capacity	262
10.11.1	Thermal Shock Resistance	262
10.11.2	Damping Effect	264
10.12	Fatigue	267
10.13	Heat Treatments	270
10.14	Fe–C–Cr System	272
11	Fundamentals of the Cupola Furnace: Applications—Mass and Energy Balances	313
11.1	Cast Iron Production in Cupola Furnace	313
11.2	Sulphur and Phosphorus in the Cupola Furnace	330
	Bibliography	335
	Index	341