

Contents

Introduction	V
1. Induction furnace technology	1
1.1 Basic principle and furnace types	2
1.1.1 Coreless furnace	2
1.1.2 Channel-type furnace.....	4
2. Design and equipment components	7
2.1 Coils / inductors	9
2.1.1 Coils.....	9
2.1.1.1 Strains and stresses.....	11
2.1.1.2 Basic types of induction coils	14
2.1.1.3 Optimizations	16
2.1.2 Inductors	20
2.2 Power supply	22
2.2.1 Power supply and electrical equipment.....	22
2.2.2 Power supply of the furnaces	25
2.2.3 Mains pollution	28
2.3 Water recooling system	31
2.4 Process control technology	36
2.5 Safety features	38
2.5.1 General systems.....	39
2.5.2 Crucible and coil monitoring	42
2.5.2.1 Earth fault monitoring.....	43
2.5.2.2 Analysis of electrical operating data.....	44
2.5.2.3 Temperature measurement.....	45
2.5.2.4 Measurement of remaining wall thickness.....	46
2.6 Refractory lining	48
2.7 Switchgear system rating and design.....	51
2.7.1 Frequency and power density.....	51
2.7.2 Special circuit configurations for coreless furnaces.....	55
3. Overall efficiency and energy efficiency	63
3.1 Energy efficiency of coreless furnaces	67
3.2 Energy efficiency of channel-type furnaces.....	73

4.	Furnace system design options	77
4.1	Coreless furnace	79
4.1.1	Variability	79
4.1.2	Special designs	79
4.1.2.1	Short-coil furnace.....	79
4.1.2.2	Hybrid furnaces.....	82
4.1.2.3	Separation of coil unit and crucible	83
4.1.2.4	Hot-swap crucible.....	86
4.1.2.5	Custom crucible material	87
4.1.2.6	Cold wall	88
4.1.2.7	Vacuum-tight furnace shell	88
4.1.2.8	Coreless furnaces with special pouring design options.....	88
4.2	Channel-type furnace.....	89
4.2.1	Variability	89
4.2.2	Special designs	89
4.2.2.1	Holding and melting.....	89
4.2.2.2	Combined coreless/channel-type melting furnace.....	91
4.2.2.3	Copper pouring furnace for a horizontal continuous caster.....	92
4.2.2.4	Low-pressure casting process.....	93
5.	Special applications of induction melting furnaces	95
5.1	Special charge materials.....	96
5.1.1	Fine-grained charge materials	96
5.1.1.1	Melting of chromium powder	96
5.1.1.2	Recycling of ferroalloy fines.....	97
5.1.1.3	Melting zink ash	99
5.1.2	Recycling.....	100
5.1.2.1	Melting of wet brass chips.....	100
5.1.2.2	Recycling of aluminium foil	101
5.1.2.3	Recycling of slab milling chips.....	102
5.1.2.4	Recycling of machining chips	103
5.2	Melting technologies for selected materials	104
5.2.1	Magnesium.....	105
5.2.1.1	Application focus	105
5.2.1.2	Furnace sizes and performance data	108
5.2.1.3	Typical applications.....	108

5.2.1.4	Innovative magnesium melting process.....	110
5.2.2	Zinc.....	111
5.2.2.1	Application focus	111
5.2.2.2	Furnace sizes and performance data	112
5.2.2.3	Steel strip coating	113
5.2.2.4	Typical concept of a strip galvanizing line.....	114
5.2.2.5	Batch galvanizing	115
5.2.2.6	Coreless furnace for superheating and pouring on an ingot casting machine	115
5.2.2.7	Coreless furnace for melting, holding and alloying of ZnAl alloys.....	116
5.2.3	Silicon.....	116
5.2.3.1	Application focus	116
5.2.4	Other metals and alloys	119
5.2.4.1	Ferromanganese	119
5.2.4.2	Cobalt alloys.....	119
5.2.4.3	Silver.....	119
5.3	Vacuum melting technology.....	120
5.3.1	Application overview and designs	120
5.3.2	Application examples.....	127
5.3.2.1	Distillation of zinc	127
5.3.2.2	Stainless steel casting	129
5.3.2.3	High-purity steel.....	131
6.	Furnaces for special technological tasks.....	135
6.1	Cast iron and steel	136
6.1.1	Storage of magnesium-treated cast iron in a channel furnace.....	136
6.1.2	Plant concept for melting, alloying and storing diverse cast iron materials.....	137
6.2	NF metals	138
6.2.1	Copper alloying furnace	138
6.2.2	Copper deslagging furnace.....	139
6.2.3	Vertical continuous caster for production of oxygen-free copper slabs.....	141
6.2.4	Production of aluminium master alloys.....	142
6.2.5	Alloying and melting furnace for a hypereutectic AlSi alloy	143

7.	Special pouring furnaces	147
7.1	Cast iron and steel	148
7.1.1	Special designs	149
7.1.2	Low-pressure pouring furnace for cast iron materials.....	155
7.2	NF metals	157
7.2.1	Finished casting products.....	157
7.2.1.1	Low-pressure die casting system	157
7.2.1.2	Low-pressure aluminium pouring furnace for sand casting application	159
7.2.1.3	Low-pressure copper pouring furnace for sand casting application	160
7.2.1.4	Pouring furnace as part of an overall plant for the manufacture of sanitary fittings	161
7.2.1.5	Metering furnace for aluminium die casting	162
7.2.2	Semi-finished casting products	163
7.2.2.1	Continuous caster for the production of copper tube blanks.....	163
7.2.2.2	Vertical continuous caster for production of high-precision tube	164
7.2.2.3	Production of rod by the upward casting technology	165
8.	Conclusion	169
	Literature	173
	Index	181