MATERIALS
Super Duplex Stainless Steel

Introduction

The term “Super Duplex” was introduced to denote highly alloyed, high-performance Duplex Steel with a pitting resistance equivalent greater than 40 (based on PRE = %Cr + 3.3x%Mo+ 16x%N). With its high content of Cr, these materials provide outstanding resistance to acids, acid chlorides, caustic solutions and other environments in several industries.
The chemical composition based on high contents of chromium, nickel and molybdenum improves inter granular and pitting corrosion resistance. Additions of nitrogen promote structural hardening by interstitial solid solution mechanism, which raises the yield strength and ultimate strength values without impairing toughness. Moreover, the two-phase microstructure guarantees higher resistance to pitting and stress corrosion cracking in comparison with conventional stainless steel.

Main Super Duplex Stainless Steel grades

From the long list of materials we produce, we give below some examples of the Supe Duplex Stainless Steel grades for which we have a long work experience.

ASTM	EN	%C	%Mn	%Cr	%Ni	%Mo	%N
A890 Gr5A (CE3MN)	EN 10213-4 GX2CrNiMoN26-7-4	<= 0.03	<= 1.5	24.0-26.0	6.0-8.0	4.0-5.0	0.10-0.30
A995 Gr4A (CD3MN)	EN 10213-4 GX2CrNiMoN 22-5-3	<= 0.03	<= 1.5	21.0-23.5	4.5-6.5	2.5-3.5	0.10-0.30
A995 Gr6A (CD3MWCuN)	EN 10283 GX2CrNiMoN25-7-3	<= 0.03	<= 1	24.0-26.0	6.0-8.5	3.0-4.0	0.20-0.30

Table 1 – Nominal composition of some Super Duplex Stainless Steel grades FERESPE produces

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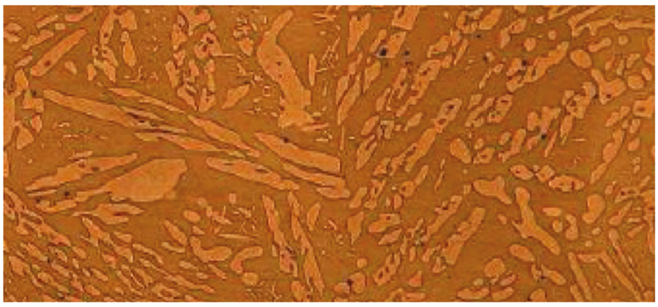
Typical microstructure
Material: A995 Gr4A (CD3MN)
Condition: Solution annealed
Etch: NaOH Electrolytic etch at 3V for 20s
Microstructure: Austenite + Ferrite (aprox. 50% and 50%, respectively)



Duplex Stainless Steel

Introduction

This material is a combination of Austenitic and Ferritic material, having higher strength and superior resistance to corrosion. It is usually fine-grained which improves strength and toughness. Duplex Stainless Steel is about twice as strong as conventional austenitic stainless steel and has significantly better toughness and ductility than ferritic grades, not reaching, however, the excellent values of the austenitic grades. As with all stainless steel grades, corrosion resistance depends mostly on the composition of the stainless steel and best practices of heat treatment. For chloride pitting and crevice corrosion resistance, improvements are achieved by the addition of Chromium, Molybdenum and Nitrogen.

Main Duplex Stainless Steel grades

From the long list of materials we produce, we give below some examples of the Duplex Stainless Steel grades for which we have a long work experience.

ASTM	EN	%C	%Mn	%Cr	%Ni	%Mo	%Cu	%N
-	EN 10213-4 G-X 2CrNiMoCuN25-6-3-3	<=0.03	<=1.5	24.5-26.5	5.0-7.0	2.5-3.5	2.75-3.50	0.12-0.22
A351 CD-4MCu	-	<=0.04	<=1	24.5-26.5	4.75-6.00	1.75-2.25	2.75-3.25	-
A743 CN7MS	-	<=0.06	<=1	24.0-27.0	4.0-6.0	1.75-2.50	-	0.15-0.25

Table 2 – Nominal composition of some Duplex Stainless Steel grades FERESPE produces

Typical microstructure
Material: EN 10213-4 G-X 2CrNiMoCuN 25-6-3-3
Condition: Solution annealed
Etch: NaOH Electrolytic etch at 3V for 20s
Microstructure: Austenite + Ferrite (aprox. 50% and 50%, respectively)

Austenitic Stainless Steel

Introduction

The most commonly used stainless steels are the austenitic grades. They contain 16% or more of Chromium, a ferrite stabilizing element and sufficient austenite-stabilizing elements, such as Carbon, Nitrogen, Nickel and Manganese to render austenite stable at room temperature. By adding elements such as Molybdenum, Titanium or Copper, the properties of steel can be modified. The addition of Mo greatly enhances corrosion resistance and increases elevated temperature strength. Ni or N additions will generate an austenitic structure, even at 18%Cr, and N significantly reduces the amount of necessary Ni to assure austenite. Most steels become brittle at low temperatures but Nickel in austenitic stainless makes it suited to low temperature or cryogenic applications. The “L” grades, indicating low carbon content, are used to provide extra corrosion resistance.

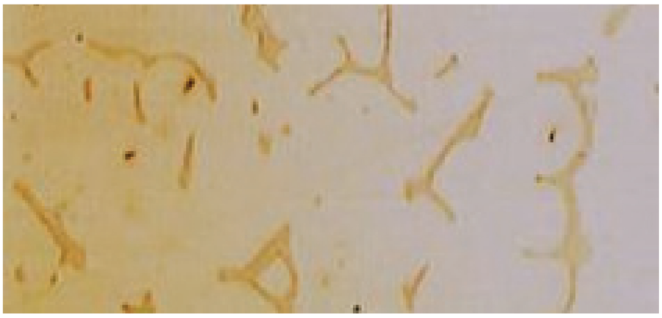
Main Austenitic Stainless Steel grades

From the long list of material we produce, we give below some examples of the Austenitic Stainless Steel grades for which we have a long work experience.

ASTM	EN	%C	%Si	%Mn	%Cr	%Ni	%Mo	%Nb
A351 CF-8	EN 10213-4 GX5CrNi19-10	<=0.08	<=2	<=1.5	18.0-21.0	8.0-11.0	-	-
A351 CF-3	EN 10213-4 GX2CrNi19-11	<=0.03	<=2	<=1.5	17.0-21.0	8.0-12.0	0.5	-
A351 CF-3M	EN 10213-4 GX2CrNiMo19-11-2	<=0.03	<=1.5	<=1.5	17.0-21.0	9.0-13.0	2.0-3.0	-
A351 CF-8C	EN 10213-4 GX5 CrNiNb 19-11	<=0.08	<=2	<=1.5	18.0-21.0	9.0-12.0	0.5	0.64-1.0
A743 CF-8M	EN10213-4 GX5CrNiMo19-11-2	<=0.08	<=2	<=1.5	18.0-21.0	9.0-12.0	2.0-3.0	-
-	EN10213-4 G-X5CrNiMoNb19-11-2	<=0.07	<=1.5	<=1.5	18.0-20.0	9.0-12.0	2.0-2.5	0.56-1.0

Table 3 – Nominal composition of some Austenitic Stainless Steel grades FERESPE produces

Typical microstructure
Material: A351 CF-3M
Condition: Solution annealed
Magnification: 200x
Etch: NaOH Electrolytic etch at 3V for 20s
Microstructure: Austenite + Ferrite (5-10%)



Martensitic Stainless Steel

Introduction

Martensitic grades were developed in order to provide a group of stainless alloys that would be corrosion resistant and hardened by heat treating. They are magnetic and are mainly used where hardness, strength and wear resistance are required. They contain more than 10.5%Cr plus other austenite stabilizing elements such as carbon, nitrogen, nickel and manganese to expand the austenite phase field and improve welding. The composition must be carefully balanced to prevent delta-ferrite formation and attain best mechanical properties.

Main Martensitic Stainless Steel grades

From the long list of material we produce, we give below some examples of the Martensitic Stainless Steel grades for which we have a long work experience.

ASTM	EN	%C	%Mn	%Cr	%Ni	%Mo
A743 CA-15	EN10283 GX12Cr12	<=0.15	<=1.00	11.5-14.00	<=1.0	-
A487 CA-6NM	EN10283 GX4CrNi13-4	<=0.06	<=1.00	11.5-14.00	3.5-4.5	0.4-1.0

***Table 4** – Nominal composition of some Martensitic Stainless Steel grades FERESPE produces*

Typical microstructure
Material: A487 CA-6NM
Condition: Heat Treated
Etch: Ralph's agent
Microstructure: Martensite

Heat Resistant Steel

Introduction

Castings are classified as Heat Resistant if they are capable of sustained operation while exposed, either continuously or intermittently, to operating temperatures that result in metal temperatures in excess of 650ºC. These materials are hard wearing and offer a resistance to large variations in temperature. Their main characteristics include corrosive resistance, creep resistance, oxidation resistance and hydrogen brittleness all under extremely high temperatures.

The three principal categories of this type of steels, based on composition are: Iron-chromium alloys; Iron-chromium-nickel alloys and Iron-nickel-chromium alloys. In terms of stainless steel structures may be austenitic, ferritic, martensitic or duplex.

Main Heat Resistant Steels grades

From the long list of material we produce, we give below some examples of the Heat Resistant Steels for which we have a long work experience.

ASTM	EN	%C	%Si	%Mn	%Cr	%Ni	%Mo
A297 HH	17465 G-X 40CrNiSi 25 12	0.20-0.50	<=2.0	<=2.0	24.0-28.0	11.0-14.0	<=0.5
A 297 HK	17465 G-X 40CrNiSi 25 20	0.20-0.60	<=2.0	<=2.0	24.0-28.0	18.0-22.0	<=0.5
A 297 HE		0.20-0.50	<=2.0	<=2.0	26.0-30.0	8.0-11.0	<=0.5
A 297 HU	EN 10295 GX40NiCrSi38-19	0.35-0.75	<=2.5	<=2.0	17.0-21.0	37.0-41.0	<=0.5
A 297 HD	EN 10295 GX40CrNiSi27-4	0.20-0.50	<=2	<=1.5	26.0-30.0	4.0-7.0	<=0.5

Table 5 – Nominal composition of some Heat Resistant Steel grades FERESPE produces

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Typical microstructure
Material: EN 10295 GX40CrNiSi27-4
Condition: As-Cast
Magnification: 100x
Etch: NaOH Electrolytic etch at 3V
Microstructure: Ferrite + Austenite with Cr Carbides

Wear Resistant Steel

Introduction

Steel casting parts are successfully used in many applications requiring resistance to wear while at the same time demanding adequate toughness so that the components will be dependable under severe service conditions. An important consideration many times overlooked in wear situations is the consideration of metal toughness and ultimately the consideration of resistance to breakage. Shock loading and stress concentration can be of paramount importance in selecting wear materials. In fact, this consideration that often dictates a wear-resistant steel being used preferentially over a wear-resistant cast iron. Lower carbon grades can be used in light-duty gears and for plow implements, but usually are surface hardened. Alloyed steels are of growing importance in wear resistant applications. Wear, mechanical and impact properties must be blended to optimize service.

Main Wear Resistant Carbon Steels grades

	ASTM	DIN / EN	%C	%Si	%Mn	%Cr	%Ni	%Mo	Hardness (HRC)
Carbon Steels	A148 80-40	DIN 168 GS-60 / EN 10293 GE600							160-200 HB
	-	DIN 168 GS-70	0.3-0.4	0.4-0.6	0.2-0.5	-	-	-	180-230 HB
Medium Alloyed Steels	-	EN 10293 G25CrMo4 QT1 / QT2	0.22-0.29	<=0.6	0.5-0.8	0.8-1.2	-	0.15-0.3	160-220 HB
	-	EN 10293 G34CrMo4	0.3-0.37	<=0.6	0.5-0.8	0.8-1.2	-	0.15-0.3	200-300 HB
	-	EN 10293 G32NiCrMo 8-5-4	0.28-0.35	<=0.6	0.6-1	1-1.4	1.6-2.1	0.3-0.5	270-300 HB
	-	-	0.28-0.33	1.05-1.2	1.05-1.15	1.4-1.7	0.7.-11.00	0.25-0.5	47-49 HRC

***Table 6** – Nominal composition of some Wear Resistant Steel grades FERESPE produces*

Typical microstructure
Material: EN 10293 G34CrMo4
Condition: Normalized and Tempered
Magnification: 200x
Etch: Nital 4%
Microstructure: Ferrite + Perlite / Hardness: 240 HB

Wear Resistant Cast Iron

Introduction

Abrasion resistant cast iron materials are white, carbide-solidified cast iron materials which contain a high level of hard particles in the form of iron or chromium carbides. The carbides are held by a hard matrix. Generally, the matrix is martensitic but there are also cases of an austenitic matrix as well, which only becomes more solid during the wear process associated with strain hardening. The hardness can be increased with the elements nickel, copper, molybdenum and manganese. Chromium provides improved resistance to corrosion, to such an extent that high chromium levels can achieve a performance to match that of the lower limits of stainless steels. In some grades the desired microstructure can be achieved in the as-cast condition. Others require additional heat treatment to remove unwanted microstructure portions and achieve the desired properties. Optimum service properties for these materials are not generally achieved in the as-cast condition. Nevertheless, they are certainly used for occasional applications in this condition, partly for reasons of cost but also to avoid the risk of cracking during heat treatment.

Main Wear Resistant White Cast Iron grades

ASTM	DIN / EN	%C	%Si	%Mn	%Cr	%Ni	%Mo	%Cu	Hardness (HRC)
A532 II B	EN 12513 EN-GJN-HV600 (xCr14) AC	2.0 - 3.3	<=1.5	<=2.0	14.0 - 18.0	<=2.5	<=3.0	<=1.2	**60-65**
A532 III A	-	2.0 - 3.3	<=1.5	<=2.0	23.0 - 30.0	<=2.5	<=3.0	<=1.2	>**50**
A532 II D	EN 12513 EN-GJN-HV600 (xCr18) MC	2.0 - 3.3	1.0 – 2.2	<=2.0	18.0 - 23.0	<=2.5	<=3.0	<=1.2	**60-65**
A532 IB NiCr LC	EN 12513 EN-GJN-HV520	2.4 - 3.0	<=0.80	<=2.0	1.4 - 4.0	3.0 - 5.5	<=3.0	-	> **60**
A532 IA	DIN 1695 G-X 330 NiCr42	2.8 – 3.6	<=0.80	0.20-0.80	1.5 - 2.5	3.3 - 5.0	<=0.5	-	**>55**
A532 IID	-	2.5 – 3.6	<=2.0	<=2.0	7.0-11.0	4.5-7.0	<=1.5	-	**>55**

Table 7 – Nominal composition of some wear resistant white cast iron grades FERESPE produces

Typical microstructure
Material: EN 12513 EN-GJN-HV600 (xCr14) AC
Condition: As-Cast
Magnification: 1000x
Etch: Nital 4%
Microstructure: Martensite + Carbides