EN NORMS FOR FOUNDRY ALUMINIUM ALLOYS

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Abstract. *Being light Al is a metal with an increasing usage in order to reduce energy consumption and limit the material thrown into landfills. In the metallurgy sector, aspects involving norms have greatly diversified the offer of foundry alloy and aluminium casting produced inside the European Community. EN norms for castings and EN 1676 for alloys are discussed in the paper for aluminium and its alloys together with technical tests that guarantee the correct performance of the castings.*
Keywords: *Aluminium alloys foundry; EN Norms.*

1. INTRODUCTION

Aluminium is a metal that is growing worldwide: new applications are being studied in order to reduce energy consumption and limit the materials thrown into landfills. Solutions are being sought using materials with a high rate of recovery and which are light enough to enable means of transport to save fuel.
The result is that the most interesting innovations studied by design engineers involve cars, rail transport, aeroplanes and nautical engineering. However, there are other sectors in which aluminium is creating an innovative presence, many of which involve solution using foundry products.

2. ALLOYS SYSTEMS

Aluminium casting alloys must contain, in addition to strengthening elements, sufficient amounts of eutectic-forming elements (usually silicon) in order to have adequate fluidity to feed the shrinkage that occurs in all but the simplest castings. Required amounts of eutectic formers depend in part on casting process. Alloys for sand casting generally are lower in eutectics than those for casting in metal molds, because sand molds can tolerate a degree of hot shortness that would lead to extensive cracking in nonyielding metal molds. The range of cooling rates characteristic of the casting process being used controls to some extent the distribution of alloying and impurity elements. For example, the extremely high cooling rates inherent in die casting result in fine dispersion of strengthening and eutectic-forming constituents, and reasonably good castings can be obtained in spite of impurity contents that would render sand or plaster-mold castings unacceptable. However, with these minor exceptions, most aluminium foundry alloys can be cast by all processes, and choice of casting technique usually is controlled by factors other than alloy composition.
A large number of aluminium alloys has been developed for casting, but most of them are varieties of six basic types: aluminium-copper, aluminium-copper-silicon, aluminium-silicon, aluminium-magnesium, aluminium-zinc-magnesium and aluminium-tin alloys.

3. ALUMINIUM PRODUCTION AND APPLICATIONS

Since 1997, when it overtook Germany, the historic leader in sector, the Italian industry is the leader of aluminium foundry alloys in Europe. At world level, only the USA and Japan produce more than Italy. In countries like France and Germany, end-uses in the transport in percentage terms are the highest (80% in Germany and almost 90% in France).
The transport industry absorbs 57% of production of aluminium foundry industry; 18% represents the production of aluminium heating radiators. The remaining percentages of end-uses are equally split among electrical apparatus, 8.5%, durables for domestic office use, 8.5% and mechanical engineering in general 8% (Figure 1).

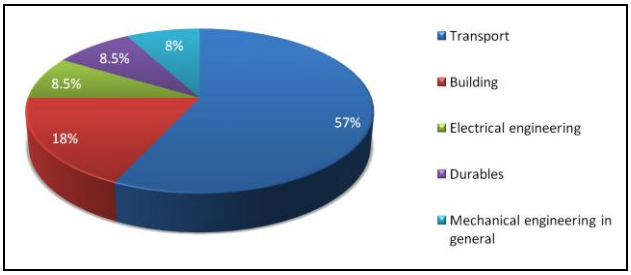

Figure 1. End use of aluminium alloy castings

4. NORMS [1]

In the metallurgy sector in particular, aspects involving norms are one of the elements that, from country to country have greatly diversified the offer of foundry alloys and aluminium castings produced inside European Community. Today it is a true harmonisation, and there is one set of norms for the whole of Europe.
The new EN norms are the fruit of a project that started within the CEN (European Norm Commission) about 18 years ago, in which all the sectors involved in all countries of the Community took part – users of castings, casting foundries and alloy procedures. The result is a compromise between the various needs and requirements of all operators involved, that will make it possible to use a single language, at least at norm level.

5. EN-NORMS FOR ALUMINIUM CASTINGS AND ALLOYS

En-Norms for castings are EN 1706 and for alloys are EN 1676 and describe:

- the type of alloy (AlSi, AlCu, AlMg etc.)
- their numerical designation EN AC or AB no. xxxxxx
- their designation using chemical symbols (AlSi11Cu2Fe)
- their chemical composition: Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn etc.
- the comparison of foundry characteristics, mechanical characteristics and other characteristics of the castings
- the mechanical characteristics of alloys for castings obtained from separately cast specimens

A significant aspect which should be constantly stressed is the responsibility of products if they are obtained using non standardised alloys.

The casting producer is obviously free to use any type of alloy, but if he uses non-standard alloys, he has to assume the responsibility for the necessary obligations to prove the product's quality. He must therefore supply technical tests that warrant the correct performance of the castings, affected before the casting is used.

The technical tests involve: [2]

- fluidity
- resistance to cracking due to shrinkage
- pressure seal
- corrosion resistance
- attitude to polishing
- linear thermal expansion
- electrical conductivity
- thermal conductivity
- resistance to various temperatures
- impact resistance
- ductility or fatigue strength
- tensile strength
- elongation
- Brinell hardness
- designation of metallurgical state

Foundries are obliged to satisfy all these specifications, especially those operating under a quality certification regime. Only alloys corresponding to norms posses all these indispensable detailed analyses.

Table 2. Comparison between the percentages of EN foundry alloys and those of the main similar alloys

Type of alloy	Norm EN-AB	Denomination	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb	Sn	Ti	Others total
AlCu	21000	AlCu4TiMg	0.15 (0.20)	0.30 (0.35)	4.2-5.0	0.10	0.20-0.35 (0.15-0.35)		0.05	0.10	0.05	0.05	0.15-0.25 (0.15-0.30)	0.10
	21100	AlCu4Ti	0.15 (0.18)	0.15 (0.19)	4.2-5.0	0.55				0.07			0.15-0.25 (0.15-0.30)	0.10
AlSiMgTi	41000	AlSi12MgTi	1.6-2.4	0.50 (0.60)	0.08 (0.10)	0.30-0.50	0.50-0.65 (0.45-0.65)		0.05	0.10	0.05	0.05	0.07-0.15 (0.05-0.20)	0.15
AlSi7Mg	42000	AlSi7Mg	6.5-7.5	0.45 (0.55)	0.15 (0.20)	0.35	0.25-0.65 (0.20-0.65)		0.15	0.15	0.15	0.05	0.05-0.20 (0.05-0.25)	0.15
	42100	AlSi7Mg0.3	6.5-7.5	0.15 (0.19)	0.03 (0.05)	0.10	0.30-0.45 (0.25-0.45)			0.07			0.10-0.18 (0.08-0.25)	0.10
	42200	AlSi7Mg0.6	6.5-7.5	0.15 (0.19)	0.03 (0.05)	0.10	0.50-0.70 (0.45-0.70)			0.07			0.10-0.18 (0.08-0.25)	0.10
AlSi10Mg	43000	AlSi10Mg	9.0-11.0	0.40 (0.55)	0.03 (0.05)	0.45	0.30-0.45 (0.25-0.45)		0.05	0.10	0.05	0.05	0.15	0.15
	43100	AlSi10Mg	9.0-11.0	0.45 (0.55)	0.08 (0.10)	0.45	0.30-0.45 (0.25-0.45)		0.05	0.10	0.05	0.05	0.15	0.15
	43200	AlSi10Mg(Cu)	9.0-11.0	0.55 (0.65)	0.30 (0.35)	0.55	0.20-0.45 (0.20-0.45)		0.15	0.35	0.10		0.15 (0.20)	0.15
	43300	AlSi9Mg	9.0-10.0	0.15 (0.19)	0.03 (0.05)	0.10	0.30-0.45 (0.25-0.45)			0.07			0.15	0.10
	43400	AlSi10Mg(Fe)	9.0-11.0	0.45-0.9 (1.0)	0.08 (0.10)	0.55	0.25-0.50 (0.20-0.50)		0.15	0.15	0.05		0.15 (0.20)	0.15
	44000	AlSi11	10.0-11.8	0.15 (0.19)	0.03 (0.05)	0.10	0.45			0.07			0.15	0.10
	44100	AlSi12	10.5-13.5	0.55 (0.65)	0.10 (0.15)	0.55	0.10		0.10	0.15	0.10		0.15 (0.20)	0.15
AlSi	44200	AlSi12	10.5-13.5	0.40 (0.55)	0.03 (0.05)	0.35				0.10			0.15	0.15
	44300	AlSi12(Fe)	10.5-13.5	0.45-0.9 (1.0)	0.08 (0.10)	0.55				0.15			0.15	0.15
	44400	AlSi9	8.0-11.0	0.55 (0.65)	0.08 (0.10)	0.50	0.10		0.05	0.15	0.05	0.05	0.15	0.15
AlSi5Cu	45000	AlSi6Cu4	5.0-7.0	0.9 (1.0)	3.0-5.0	0.20-0.65	0.55	0.15	0.45	2.0	0.30	0.15	0.20 (0.25)	0.35
	45100	AlSi5Cu3Mg	4.5-6.0	0.50 (0.60)	2.6-3.6	0.55	0.20-0.65 (0.15-0.45)		0.10	0.20	0.10	0.05	0.20 (0.25)	0.15
	45200	AlSi5Cu3Mg	4.5-6.0	0.7 (0.8)	2.5-4.0	0.20-0.55	0.40		0.30	0.55	0.20	0.10	0.15 (0.20)	0.25
	45300	AlSi5Cu1Mg	4.5-5.5	0.55 (0.65)	1.0-1.5	0.55	0.40-0.65 (0.35-0.65)		0.25	0.15	0.15	0.05	0.05-0.20 (0.05-0.25)	0.15
	45400	AlSi5Cu3	4.5-6.0	0.50	2.6-3.6	0.55	0.05		0.10	0.20	0.10	0.05	0.20	0.15

				(0.60)									(0.25)	
	46000	AlSi9Cu3(Fe)	8.0-11.0	0.6-1.1 (1.3)	2.0-4.0	0.55	0.15-0.55 (0.05-0.55)	0.15	0.55	1.2	0.35	0.25	0.20 (0.25)	0.25
	46100	AlSI11Cu2(Fe)	10.0-12.0	0.45-1.0 (1.1)	1.5-2.5	0.55	0.30	0.15	0.45	1.7	0.25	0.25	0.20 (0.25)	0.25
	46200	AlSi8Cu3	7.5-9.5	0.7 (0.8)	2.0-3.5	0.15-0.65	0.15-0.55 (0.05-0.55)	0.15	0.35	1.2	0.25	0.15	0.20 (0.25)	0.25
	46300	AlSi7Cu3Mg	6.5-8.0	0.7 (0.8)	3.0-4.0	0.20-0.65	0.35-0.60 (0.30-0.60)		0.30	0.65	0.15	0.10	0.20 (0.25)	0.25
	46400	AlSi9Cu3Mg	8.3-9.7	0.7 (0.8)	0.8-1.3	0.15-0.55	0.30-0.65 (0.25-0.65)		0.20	0.8	0.10	0.10	0.10-0.18 (0.10-0.20)	0.25
	46500	AlSi9Cu3(Fe)(Zn)	8.0-11.0	0.6-1.2 (1.3)	2.0-4.0	0.55	0.15-0.55 (0.05-0.55)	0.15	0.55	3.0	0.35	0.25	0.20 (0.25)	0.25
	46600	AlSi7Cu2	6.0-8.0	0.7 (0.8)	1.5-2.5	0.15-0.65	0.35		0.35	1.0	0.25	0.15	0.20 (0.25)	0.15
	47000	AlSi12(Cu)	10.5-13.5	0.7 (0.8)	0.9 (1.0)	0.05-0.55	0.35	0.10	0.30	0.55	0.20	0.10	0.15 (0.20)	0.25
	47100	AlSi12Cu1(Fe)	10.5-13.5	0.6-1.1 (1.3)	0.7-1.2	0.55	0.35	0.10	0.30	0.55	0.20	0.10	0.15 (0.20)	0.3
	48000	AlSi12CuNiMg	10.5-13.5	0.6 (0.7)	0.8-1.5	0.35	0.9-1.5 (0.8-1.5)		0.7-1.3	0.35				0.15
AlMg	51000	AlMg3	0.45 (0.55)	0.45 (0.55)	0.08 (0.10)	0.45	2.7-3.5 (2.5-3.5)			0.10			0.15 (0.20)	0.5
	51100	AlMg3	0.45 (0.55)	0.40 (0.55)	0.03 (0.05)	0.45	2.7-3.5 (2.5-3.5)			0.10			0.20 (0.15)	0.15
	51200	AlMg9	2.5	0.45-0.9 (1.0)	0.08 (0.10)	0.55	8.0-10.0		0.10	0.25	0.10	0.10	0.15 (0.20)	0.15
	51300	AlMg5	0.35 (0.55)	0.45 (0.55)	0.05 (0.10)	0.45	4.8-6.5 (4.5-6.5)			0.10			0.15 (0.20)	0.15
	51400	AlMg5(Si)	1.3 (1.5)	0.45 (0.55)	0.03 (0.05)	0.45	4.8-6.5 (4.5-6.5)			0.10			0.15 (0.20)	0.15
AlZnMg	71000	AlZn5Mg	0.25 (0.30)	0.70 (0.80)	0.15-0.35	0.40	0.45-0.70 (0.40-0.70)	0.15 (0.60)	0.05	4.5-6.0	0.05	0.05	0.12-0.20 (0.10-0.25)	0.15

6. CONCLUSIONS. EUROPE BEFORE EN NORMS

Table 1 illustrates a number of names according to national norms of similar alloys before the introduction of EN Norms.

Although they correspond to the application level there is no similar correspondence in terms of composition. The new alloys have meant more or less significant variations in their analytical content.

The table 2 shows details of the comparison between the percentage composition of EN foundry alloys and of those of the main similar alloys. The content referring to the castings is shown in brackets.

Table 1. Correspondence between DIN, AFNOR and BS Norms; similar or equivalent alloys

• DIN 226 • AFNOR AS 9 U • BS LM 24	• DIN 231 • AFNOR AS 12 U • BS LM 2

REFERENCES

[1] *** European Norms on Aluminium Foundry Alloys and Products for similar or equivalent aluminium alloys

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