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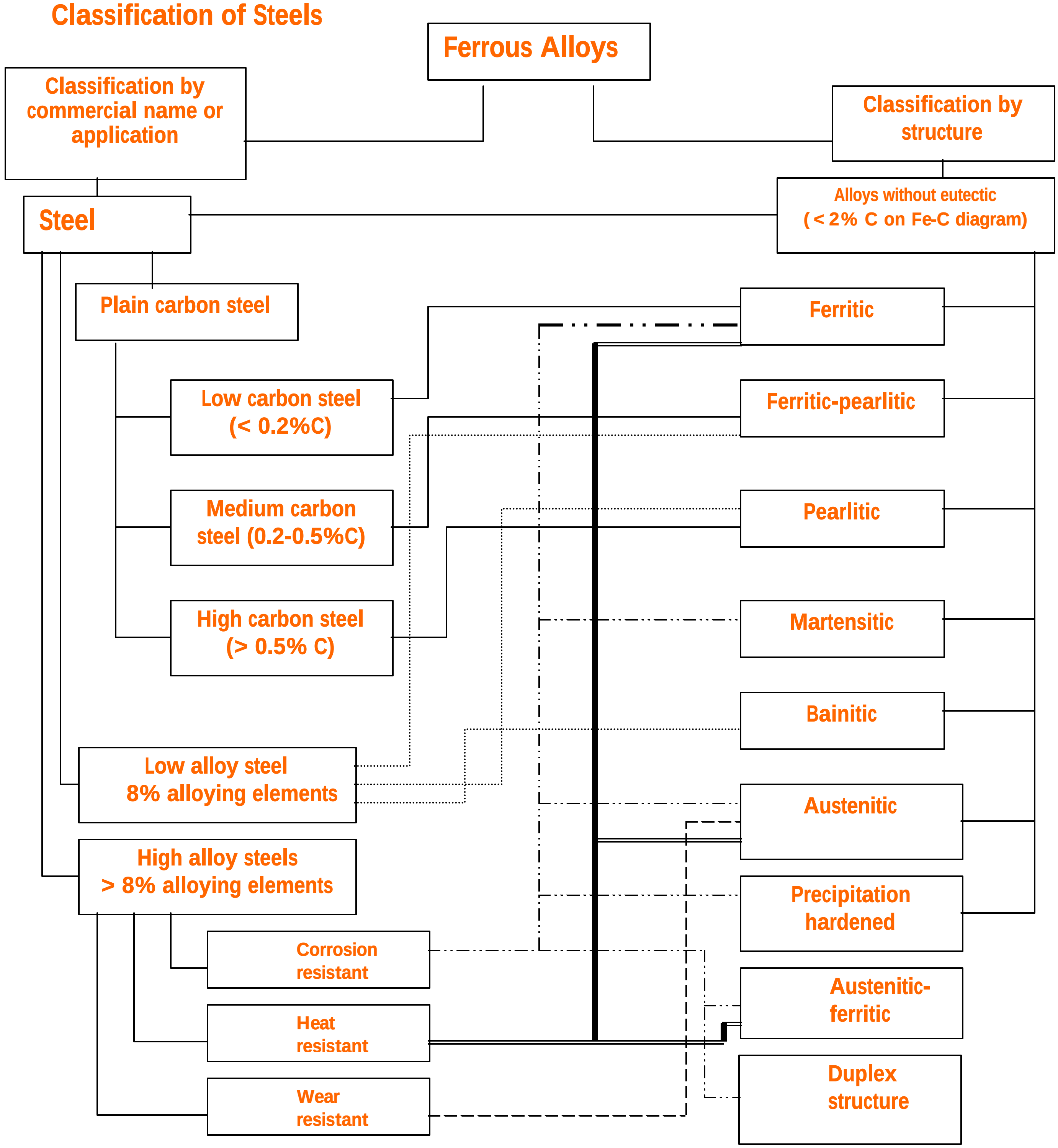
Products | Alloys | Carbon & Low Alloy Steels

Classification of Steels



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Plain carbon steels are satisfactory materials where strength and other requirements are not so severe. They are also used successfully at ordinary service temperatures and in atmospheres that are not highly corrosive, but their relatively low hardenability, limits the strength that can be obtained except in fairly thin sections.

What are the limitations of plain-carbon steels?

Although plain-carbon steels can be produced in a great range of strengths at relatively low cost, their properties are not always adequate for all engineering applications of steel. In general, plain carbon steels have the following limitations

1. They cannot be strengthened beyond 100,000 pounds per square inch (psi) without significant loss in toughness (impact resistance) and ductility.
2. Large sections cannot be made with a martensitic structure throughout, and they aren't deep-hardenable.
3. Rapid quenching rates are necessary for full hardening in medium-carbon plain carbon steels to produce a martensitic structure. The rapid quenching leads to part geometry/shape distortion and often cracking of heat-treated steel.
4. Plain carbon steels have poor impact strength at low temperatures.
5. Plain carbon steels have poor corrosion resistance for many engineering environments.
6. One significant constraint with plain carbon steels is that they readily oxidize at elevated temperatures.

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What are alloy steels?

To combat problems mentioned above and for other significant reasons (discussion of which is beyond the scope of this technical literature), alloy steels have been developed, which although cost more, yet are more economical for many uses. In some applications, alloy steels are the only materials that are able to meet certain specific engineering requirements.

Alloy steel may be defined as one whose characteristic properties are due to some element other than carbon. Although all plain carbon steels contain moderate amounts of manganese (up to about 0.90%) and silicon (up to about 0.30%), they are not considered alloy steels because of the principal function of the manganese and silicon as deoxidisers. They combine with oxygen and sulphur to reduce the harmful effect of those elements. The principal elements that are added to make alloy steels are nickel, chromium, molybdenum, manganese, silicon and vanadium. Sometimes other elements like cobalt, copper and lead are also added.

What is the purpose of alloying elements in alloy steels?

Alloying elements are added to plain carbon steels for many purposes. Some of the most important of these are:

1. Increase the depth of hardenability
2. Improve strength at ordinary temperatures
3. Improve mechanical properties at either high or low temperatures
4. Improve toughness at any minimum hardness or strength
5. Increase wear and abrasion resistance
6. Increase corrosion resistance
7. Improve magnetic properties

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By increasing the depth of hardening of plain carbon steels, larger sections and bigger parts can be made martensitic throughout, and thus the strength and toughness advantage of a tempered martensitic structure can be obtained. Another significant advantage by increasing the depth of hardening in steel, a slower quench rate can be used, thus the cooling stresses can be reduced. Eventually, distortion of the component can be controlled during quenching. Oil or air quenching reduces thermal gradient, which can lead to distortion and cracking of steel.

By increasing the resistance to softening during tempering, the alloy steels are able to resist softening (ductility) at elevated temperatures. A lower carbon content may therefore, be used to obtain same tempered hardness as in a higher-carbon-containing plain carbon steel. Since in a steel with a lower carbon content is in general tougher than one containing more carbon, the lower-carbon alloy steel will have increased toughness. Similarly, the toughness of alloy steel can be increased to that of a plain carbon steel of the same carbon content by tempering at a higher temperature, which allows greater relieving of stresses while maintaining the same hardness.

Material Specifications for Carbon & Alloy Cast Steels

The material to be used to produce the part must be identified in the order. Should you need Acme Alloys to review the material for your application, please do not hesitate to ask us. Material for steel castings are generally ordered to the more popular, The American Society of Testing Materials (ASTM) standards, although we welcome to work with other standard specifications like DIN, BIS and the ISO.

The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code makes extensive use of the ASTM specifications with slight modifications. The American Iron and Steel Institute (AISI) and the Society of Automotive Engineers (SAE) have developed a four number wrought alloy designation system, which is extensively used.

These steels have been identified in the AISI classification by a numerical index system that is particularly descriptive of the composition.

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AISI Classification System

Series Designation	Type
10xx	Non-resulphurized carbon steel grades
11xx	Resulphurized carbon steel grades
12xx	Rephosphorized and resulpurized carbon steel grades
13xx	Manganese 1.75%
15xx	Manganese over 1.00 to 1.65%
23xx	Nickel 3.50%
25xx	Nickel 5.00%
31xx	Nickel 1.25%-Chromium 0.65%
33xx	Nickel 3.50%-Chromium 1.55%
40xx	Molybdenum 0.25%
41xx	Chromium 0.50 or 0.95% - Molybdenum 0.12 or 0.20%
43xx	Nickel 1.80%-Chromium 0.50 to 0.80%-Molybdenum 0.25%
44xx	Molybdenum 0.40 or 0.53%
46xx	Nickel 1.55 05 1.80% - Molybdenum 0.20 or 0.25%
47xx	Nickel 1.05% - Chromium 0.45% - Molybdenum 0.20%
48xx	Nickel 3.50% - Molybdenum 0.25%
50xx	Chromium 0.28 or 0.40%
51xx	Chromium 0.80, 0.90, 0.95, 1.00 or 1.05%
5xxx	Carbon 1.00%-Chromium 0.50, 1.00 or 1.45%
61xx	Chromium 0.80 or 0.95- Vanadium 0.10% or 0.15% min.
81xx	Nickel 0.30-Chromium 0.40-Molybdenum 0.12
86xx	Nickel 0.55%-Chromium 0.50 Or 0.65%-Molybdenum 0.20%
87xx	Nickel 0.55%-Chromium 0.50%-Molybdenum 0.25%
88xx	Nickel 0.55%-Chromium 0.50%-Molybdenum 0.35%
92xx	Manganese 0.85%-Silcon 2.00%
93xx	Nickel 3.25%-Chromium 1.20%-Molybdenum 0.12%
B	Denotes boron steels (e.g. 51B60)
BV	Denotes boron-vanadium steel (e.g. TS 43BV12 or TS43BV14)
L	Denotes leaded steel (e.g. 10L18)