

Steel

Carbon steels

This extract from an article in an engineering journal is about different types of steel.



Steel is the most widely used engineering material. Technically, though, this well-known alloy of **iron** and **carbon** is not as simple as one might think. Steel comes in a huge range of different **grades**, each with different characteristics. For the inexperienced, it can be difficult to know where to begin.

A good place to start is with the two main types of steel. The first, **carbon steels**, consist of iron and carbon, and contain no significant quantities of other metals. Carbon steels can be divided into three main grades:

- **Mild steel** – the most widely used grade – is a low carbon steel which contains up to approximately 0.3% carbon.
- **Medium carbon steel** contains between approximately 0.3% and 0.6% carbon.
- **High carbon steel** contains between approximately 0.6% and 1.4% carbon.

Note: The chemical symbol for iron = Fe, and carbon = C.

Alloy steels

The article goes on to look at **alloy steels**.

The second main category of steel is alloy steels, which consist of iron, carbon and one or more alloying metals. Specific grades of alloy steel include:

- **low alloy steels**, which contain 90% or more iron, and up to approximately 10% of alloying metals such as **chromium**, **nickel**, **manganese**, **molybdenum** and **vanadium**
- **high strength low alloy steels (HSLA)**, which contain smaller quantities of the above metals (typically less than 2%)
- **stainless steels**, which contain chromium as well as other metals – such as nickel – and which do not **rust**.
- **tool steels**, which are extremely hard, and are used in cutting tools. They contain **tungsten** and/or **cobalt**. A widely used grade of tool steel is **high-speed steel**, which is used in cutting tools that operate at high temperatures, such as drill bits.

Notes: The terms **carbon steel** and **alloy steel** can cause confusion, as carbon steels are also alloys, and alloy steels also contain carbon.

The chemical symbol for chromium = Cr, cobalt = Co, nickel = Ni, manganese = Mn, molybdenum = Mo, tungsten = W, and vanadium = V.

Corrosion

One weakness of mild steel is that it **corrodes** – its surface progressively deteriorates due to a chemical reaction. This reaction takes place between the iron in the steel and the oxygen (O₂) in the air, to form **iron oxide**. When iron corrodes, we say that it **rusts**. In some metals, such as aluminium (Al), the presence of **corrosion** is not a problem, as the layer of **oxide** around the metal remains hard, which prevents it from **oxidizing** any further. However, when mild steel **goes rusty**, the **rust** on the surface comes off continuously, and a new **rusty** layer forms, progressively ‘eating into’ the metal.



- .1 Decide whether the sentences below are true or false, and correct the false sentences. Look at A and B opposite to help you.

- 1 Steel is an alloy of iron and carbon.
- 2 Mild steel is a high carbon steel.
- 3 Alloy steels contain carbon.
- 4 Chromium and nickel are used as alloying metals in steel.
- 5 Low alloy steels contain more chromium than iron.
- 6 Stainless steel is an alloy steel.
- 7 Tungsten is added to steel to make it softer.
- 8 High-speed steel is suitable for making cutting tools that get very hot.

- .2 Complete the table with words related to *corrode*, *oxide* and *rust*. Then use the words to complete the sentences below. There is more than one possible answer. Look at C opposite to help you.

Verb	Noun	Adjective
		corroded
		oxidized
/ go rusty		

- 1 When steel is exposed to air and water, it
- 2 A brown/red material on the surface of steel is called
- 3 The strength of steel is reduced if it is

- .3 Complete the article about a special type of steel, using words from A, B and C opposite.

Weathering steel

The perennial problem with mild (1) is that it (2) when exposed to air and water. Generally, the only solution is either to apply a protective coating, or to use another (3) of steel that is resistant to the (4) process – the most well-known being (5) steel, which contains significant quantities of (6) and, often, nickel.

There is, however, an alternative solution. So-called weathering steel is a special alloy suitable for outdoor use. But rather than being completely protected from corrosion, the surface of the steel is allowed to go (7) Once a layer of (8) has formed on the surface, it stabilizes and forms a hard protective layer. This layer differs from ordinary (9) oxide, as it does not continue to eat into the metal. While not everyone may like the 'rusty look', weathering steel has been widely used in architectural applications and outdoor sculptures.

