

Reading:

Iron and Steel

The earth contains a *large number* of metals which are useful to man. One of the most important of these is iron. Modern industry needs *considerable quantities* of this metal, either in the form of iron or in the form of steel. A *certain number* of non-ferrous metals, including aluminium and zinc, are also important, but even today *the majority* of our engineering products are of iron or steel. Moreover, iron possesses magnetic properties, which have made the development of electrical power possible.

The iron ore which we find in the earth is not pure. It *contains* some impurities which we must remove by smelting. The process of smelting consists of heating the ore in a blast furnace with coke and limestone, and reducing it to metal. Blasts of hot air enter the furnace from the bottom and provide the oxygen which is necessary for the reduction of the ore. The ore becomes molten, and its oxides combine with carbon from the coke. The non-metallic constituents of the ore combine with the limestone to form a liquid slag. This floats on top of the molten iron, and passes out of the furnace through a tap. The metal which remains is pig-iron.

We can melt this down again in another furnace – a cupola – with more coke and limestone, and tap it out into a ladle or directly into moulds. This is cast-iron. Cast-iron does not have the strength of steel. It is brittle and may fracture under tension. But it possesses certain properties which make it very useful in the manufacture of machinery. In the molten state it is very fluid, and therefore it is easy to cast it into intricate shapes. Also it is easy to machine it. Cast-iron contains *small proportions* of other substances. These non-metallic constituents of cast-iron include carbon, silicon and sulphur, and the presence of these substances affects the behaviour of the metal. Iron which contains a *negligible quantity* of carbon, for example wrought-iron, behaves differently from iron which contains a lot of carbon.

The carbon in cast-iron is present partly as free graphite and partly as a chemical combination of iron and carbon which we call cementite. This is a very hard substance, and it makes the iron hard too. However, iron can only hold about 1½% of cementite. Any carbon content above that *percentage* is present in the form of a flaky graphite. Steel contains no free graphite, and its carbon content ranges from almost nothing to 1½%. We make wire and tubing from mild steel with a very low carbon content, and drills and cutting tools from high carbon steel.