Table 1 *Properties and uses of aluminium*

Property	Example of use
Lightweight	Aeroplanes, boats and bicycles
Conducts electricity well	High-voltage power cables
Malleable	Boats, cooking foil
Doesn't corrode easily	Window frames

Casting

Aluminium can be used with other metals to form a range of alloys. These alloys are cast into a variety of useful and decorative objects which might be difficult to make by other means.

The White Eagle Foundry at Hurstpierpoint in Sussex casts aluminium into a range of products. In this foundry, ingots of aluminium (often containing other metals such as magnesium, iron, manganese, nickel, titanium and chromium) are melted using natural gas in refractory-lined ovens. Strontium, a group 2 metal, is often added in small amounts in order to cause small crystal grains to form when the metal solidifies. These small grains make the final product stronger.

Some hydrogen is absorbed into the molten metal as bubbles. This is because the molten aluminium reacts with moisture in the air. If the bubbles were left, they would cause a weakness in the final product. They are removed by blowing nitrogen gas through the mixture. Nitrogen absorbs the hydrogen and both gases are removed from the furnace. Aluminium oxide is also formed and floats to the surface. It is scraped off along with other impurities. If the impurities were left they would form impure lumps within the body of the cast object.

Preparing to blow nitrogen through the molten aluminium to remove traces of hydrogen dissolved in the metal

Stirring the furnace to ensure that the mixture is the same all the way through

Patterns and moulds

To make a casting mould a 'pattern' has to be made. This is an exact three-dimensional model of the object to be cast. It is made from wood, rubber or resin. The pattern is placed into a mould and sand is packed around it.

Several different types of sand are used. One commonly-used sand is Mansfield sand (also known as Greensand). This occurs naturally and was first discovered by the Romans. It is silica sand with 12–14% clay mixed in, which is bonded by water. It can be recycled by replacing the water lost as steam when the molten metal is poured into the mould. Other sands may have various resins and a catalyst added to them. The catalyst causes the resins in the sand to harden and so adopt the shape of the pattern.

An alloy is a substance made by mixing a metal with one or more other metals or non-metals. Alloys generally have different properties from their constituent elements.

• Can you write the equation for the reaction of aluminium with water to produce hydrogen? (Answer on page 18.)

Checking the mixture after the nitrogen blow

Right: *Pouring molten aluminium into a mould*

The finished object — ready to have excess metal trimmed off and then cleaned up

Right: *Shrinkage occurs as the aluminium cools in the mould*

Silica gel is a covalently bound network structure containing silicon and oxygen atoms.

The mould is made in two halves so that it can be separated and the pattern removed. This leaves a mould with the imprint of the object to be cast in it.

Channels are cut so that molten aluminium can be poured into the mould and to allow trapped air to escape. A reservoir is added so that when the molten metal contracts as it cools the mould can be topped up with molten metal (Box 2).

Aluminium shrinks by 6–7 % as it turns from liquid into a solid and then by a further 1.3% as the solid metal cools to room temperature. Patterns are therefore made larger by 1.3% to take into account any shrinkage. Often a ceramic filter is used in the mould to trap any remaining impurities and to stop them becoming part of the object being cast. Impurities weaken the structure.

• Find out more about the White Eagle Foundry on its website (www.wef.co.uk).

Box 2 Runners and risers

Channels which are added to allow metals to enter the mould are called **runners**. Extra shapes which may be added to feed the molten metal as it contracts are called **risers**.

Equation for reaction of aluminium with water:

$$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$$

Finishing the casting

Sometimes hollow objects may have to be cast, or shapes that cannot be cast from a single mould. If this is the case cores are used. These are special patterns which are made from a mixture of sand and silica gel. In order to get the silica gel to harden, carbon dioxide gas is blown over the pattern as it reacts with the silica gel.

Once the mould has been filled with molten aluminium alloy, it is allowed to cool. The sand is then knocked away from the cast object — this is usually with a sledge hammer! Any extraneous pieces of aluminium are sawn off — this is known as fettling — and the object is polished or treated prior to its use. Waste aluminium which has been cut off is returned to the melting furnace ready to be reused. The sand is crushed and screened to ensure that all the particles are of the correct size before being reused — this can be repeated many times before the sand finally becomes unworkable.

Finally

The casting process is labour intensive and so the objects produced are relatively expensive. This method is usually used when just a small number of items are made, or when items have a particularly complex shape. Countries such as China, where labour is cheaper, are now starting to compete for trade, with the inevitable closure of a number of foundries in the UK.

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