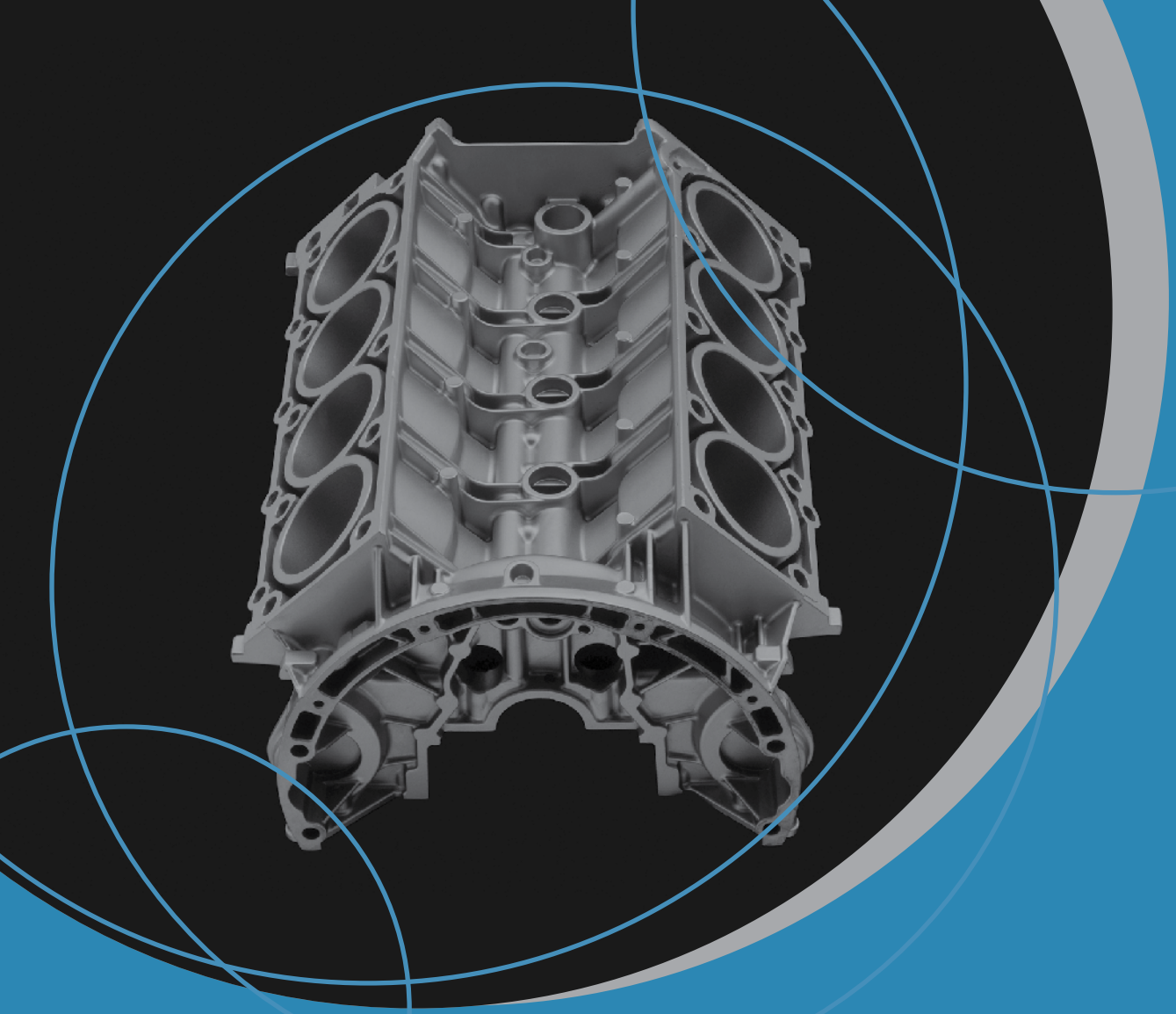

UK Aluminium Industry Fact Sheet 4

Aluminium Castings

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Introduction

Aluminium castings have the advantage of being produced to near net shape, maximising the yield and minimising further machining. They have many end uses but the transport industry is the predominant market.

By 1855 investment and sand castings were being produced from the newly discovered aluminium metal. By the turn of the century the cost of refining aluminium had dropped so dramatically that by the 1920's aluminium was extensively being alloyed with copper, magnesium, silicon and other elements and made into foundry ingots to provide the modern world with light, durable and versatile aluminium castings.

The Process

One of the oldest methods of producing a shape in metal is that of casting. Casting involves the melting of the metal in a furnace or ladle and pouring this molten metal into a hollow mould, usually made in sand, or in another suitable material. A sand mould is used once and a metal mould, known as a chill mould or die, may be used many times, reproducing the same shape of casting.

Aluminium may be cast by all of the processes used for casting metal. These processes, in decreasing order of amount of aluminium cast in the UK are pressure diecasting, permanent mould casting, sand casting, plaster casting and investment casting.

Pressure Diecasting

The pressure diecasting processes consume almost twice as many tonnes of aluminium alloys as all other casting processes combined. These processes are especially suited to the production of large quantities of relatively small parts. Aluminium diecast parts may weigh up to around 5 kilograms.

High Pressure Diecasting

High pressure diecastings are made by injecting molten aluminium alloy into a metal mould under substantial pressure. Rapid injection and rapid solidification under high pressure combine to produce a dense, fine grained surface structure, which results in excellent wear and fatigue properties. Diecastings maintain close tolerances and produce good surface finishes.

Diecastings are not easily welded or heat treated because of entrapped gases. Special techniques, such as vacuum diecasting may reduce these entrapped gases. Aluminium alloy diecastings are not usually heat treated to improve mechanical properties, but may be treated to improve dimensional and metallurgical stability.

Approximately 85% of aluminium alloy diecastings are produced in aluminium-silicon-copper alloys. This family of alloys provides a good combination of strength and castability at reasonable cost.

Low Pressure Diecasting

Molten metal is introduced into metal moulds at pressures up to 170 kPa. Thinner walls can be cast by low pressure diecasting than can be cast by permanent mould castings. This process can be highly automated.

Gravity Diecasting, Permanent Mould Casting

Permanent mould castings are suited to high production runs, and are normally larger than pressure diecastings, the maximum weight of these castings is usually about 10 kilograms. Tooling costs are high, but less than those for pressure diecasting. Destructible cores may be used and internal cavities can be fairly complex.

Permanent mould castings are gravity fed with a relatively low pouring rate, either by hand or by robot. The metal mould produces rapid solidification. Castings produced by the permanent mould method have excellent mechanical properties, are generally sound and hold good dimensional tolerances. Permanent mould castings may be heat treated, which further enhances their mechanical properties. For maximum properties the full heat treatment cycle of a solution treatment, followed by a quench, and natural or artificial ageing is used.

Sand Casting

Moulds are formed by ramming sand onto a pattern. The pattern is removed leaving a cavity in the sand. Internal cavities for the casting may be made with sand cores. Molten metal is poured into the mould and after it has solidified the mould is broken to remove the casting. Sand casting is a versatile and low cost process using a wide range of alloy types. Sand castings do not have the dimensional accuracy of other casting processes and have a relatively poor surface finish. They have the advantage of flexibility of numbers of castings produced, it may be very few or many.

Shell Mould Casting

A mould is made of a resin-bonded sand, in the form of a shell from 10 – 20mm thick, much thinner than the massive moulds used in sand casting. Shell mould castings produce finer surface finishes than sand casting and give greater dimensional accuracy. Equipment and production costs are relatively high and the size and complexity of the castings are limited.

Plaster Casting

In this process the moulds are made of plaster. The plaster slurry is poured around a pattern, the plaster is baked, and the pattern removed leaving a mould cavity. Plaster moulds have high reproducibility, permitting castings to be made with fine detail and close tolerances. The surface finish of plaster casting is good. Although the costs for basic equipment for plaster casting are low, the operating costs are high.

Investment Casting

This process uses refractory moulds formed over expendable wax or thermoplastic patterns. A refractory slurry is invested around an arrangement of patterns and the refractory is dried and the pattern is melted out, leaving a cavity. The molten metal is then cast into the fired mould.

Investment casting produces components that require almost no further machining. The advantages of the process, to produce thin walls, good tolerances and fine surface finishes, lend it to the production of precision engineered parts.

Centrifugal Casting

The centrifugal casting method forces metal into spinning multiple moulds arranged around a central pouring sprue. Mould materials may be of steel, baked sand, plaster, cast iron or graphite. Cores may be used in these moulds.

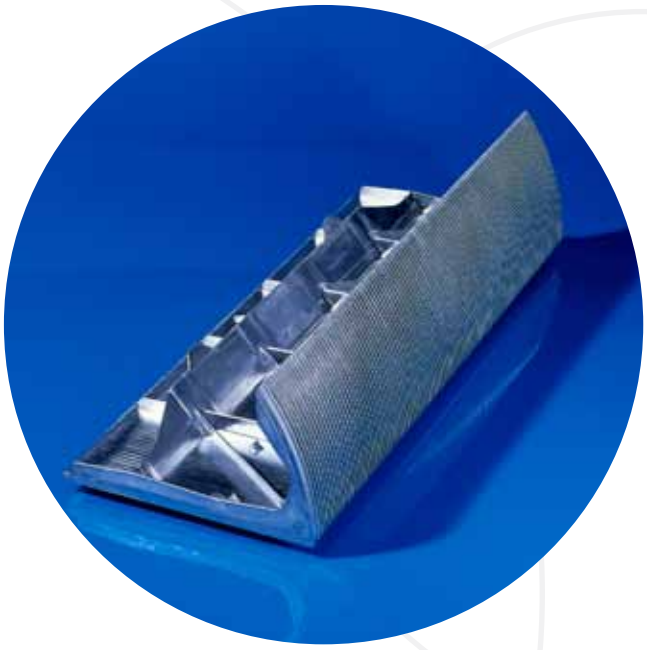
There is a limitation on the shape and size of the castings available by this method and the casting cost is high, though the integrity of the castings comes closer to that of wrought products and equates well with permanent mould castings.

The Products

Without aluminium castings the world we live in today would be very different. Aluminium castings are found in most vehicles in use today from cars, buses, trains, to ships, aircraft and spacecraft. The wide variety of aluminium casting alloys available, allows the selection of materials with good strength and good corrosion resistance and other special properties. In this age of energy conservation the advantages of lightweight aluminium outweighs the initial cost of the material, particularly in transport applications where light weight equals less fuel. During the working life of transport vehicles the total fuel consumption is lowered when the overall weight of the vehicle is reduced by the use of aluminium castings rather than, for example, cast iron. Over 70% of aluminium castings in Western Europe are used in transport applications.

General engineering products and processes utilise the corrosion resistance, strength and versatility of aluminium castings. In the home aluminium castings form parts used in cooking pots, washing machines, refrigerators, chairs and tables etc. In offices castings are used in furniture, computers and other small lightweight high technology equipment. Together, these engineering, office and domestic applications account for up to 20% of aluminium castings used.

Architects design private houses or public buildings using aluminium casting alloys to enhance the appearance of these structures. Aluminium casting alloys can be anodised to provide a very corrosion resistant surface with coloured finishes to complement any structure. Around 8% of aluminium castings are used in the building and construction industry.



The Structure of the UK Industry

The United Kingdom uses around 140,000 tonnes of aluminium foundry alloys for the production of castings for the transport industries, general engineering and electrical engineering industries, in the buildings and construction industry, and for domestic and office equipment.

British Standard BS EN 1706 provides information on the chemical composition and mechanical properties of the main aluminium casting alloys in use today.

The United Kingdom's foundry industry is made up of major international companies as well as small entrepreneurial foundries. Over the last few decades the total number of foundries in the UK has decreased although, as market niches are found, small foundries continue to flourish.

Further information specific to casting is also available via the Cast Metals Federation http://www.castmetalsfederation.com/casting01.asp

Further information about aluminium and aluminium alloys, their production, fabrication and end use can be obtained from:

(1) European Aluminium Association in Brussels **www.eaa.net**

(2) International Aluminium Institute in London **www.world-aluminium.org**