Lightweight Design

Aluminum Rheocasting: Lighter and Recyclable

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Cast aluminum in semi-solid state: The so-called rheocasting process allows significantly lighter components which are also easier to recycle.

The decisive factor for the automotive industry in rheocasting is the design freedom of the corresponding components. *(Source: gemeinfrei / Pixabay)*

The thixotropy of lightweight melts: This sounds cryptic, but it is a rheological phenomenon that was discovered at the Massachusetts Institute of Technology back in the 1970s - and forms the basis for the so-called rheo process. "Thixotropy" is a property of molten metals: During solidification, they flow in the course of a stirring movement; at rest, however, they form a rigid doughy mass. A household example is ketchup, which becomes more liquid when you tap the bottle.

Aluminum Rheocasting: How the Process Works

Rheocasting has been continuously developed since the beginning of the millennium. The Salzburger Aluminium Group (SAG) has been using it on an industrial scale in Europe since 2016. In conventional casting processes, dendritically solidified α aluminum grains are

characteristic of the microstructure. During rheocasting, round grains, so-called globulites, are formed by controlled upstream cooling of the melt and a stirring movement. These favour flowability during mold filling and replenishment during solidification.

As the aluminum melt to be processed has already largely solidified before the mold is filled, solidification cavities and distortion can be minimised. The high viscosity of the melt also prevents turbulence and thus gas inclusions. As pores in conventional casting processes, these form the largest and most damaging proportion of casting defects. The partially liquid melt is processed in a cold chamber die-casting machine with high output. Widely used hypoeutectic aluminum alloys of the AlSiMg family are mainly used.

Potential for Lightweight Construction

The main advantages of the improved casting quality are increased strength and ductility. The low pore proportion also prevents the formation of bubbles in a downstream solution heat treatment process. As a result, the parts can be heat-treated in contrast to conventional T6 die casting. The possible mechanical parameters thus come close to those of iron castings or aluminum forgings. Compared with iron casting, this creates considerable potential for lightweight design, which corresponds approximately to the density advantage of aluminum, i.e. a weight saving of more than 60 %

The special feature here is that iron castings can even be replaced at no cost if all economic aspects such as material use, corrosion protection, mechanical processing and logistics are taken into account. Compared with aluminum forgings, rheocasting is therefore a cost-effective alternative for producing safety-relevant chassis parts. The low distortion and good surface quality allow tight tolerances to be maintained even without downstream mechanical processing - the corresponding process steps can be eliminated.

Variable and Weldable

However, the decisive factor for the automotive industry is the freedom of design of the corresponding components. The good mold filling and solidification properties allow thin-walled and thick-walled structures in one component. The material must only be used where it is important for the function of the component. This also leads to lighter components. The **improved casting quality and low pore proportion** also have a positive effect on the tightness and weldability of cast components. SAG therefore produces, for example, thin-walled, weldable cast components for pressure vessels of air suspension chassis which are helium pressure-tight. The application is also suitable for battery tanks, air-conditioning compressors and heat exchangers. For thermally stressed components, the rheocasting process means compared with die casting, they have a higher thermal conductivity.

Better Recycling through Rheocasting

However, the process does not only allow lighter components - these can also be better recycled. The use of secondary aluminum requires only about 5 % of the energy needed to produce primary aluminum. There is a wide range of raw materials that can be recycled: Scrap that arises locally during production and bought-in secondary material can be melted down - and with appropriate melt treatment can be processed into highly stressed components without any loss of quality.

An application example from the commercial vehicle industry shows just how resilient the components manufactured using this process are: SAG and Volvo Trucks jointly developed a cab holder that was to replace an existing cast iron component. The result: twelve kilograms less weight for two installed parts per truck.

Following the project, SAG received a corresponding series production order in 2016 - and the "Volvo Innovation Excellence Award". But this could only be the beginning: Similar applications can also be found in truck chassis, where cast iron currently still dominates. In the case of the classic two-axle semitrailer tractor, the process can save around 120 kilograms; in driving operation, this corresponds to a savings potential of 120 litres of fuel or 0.3 tonnes of CO_2 per truck per year. The payload of the truck increases in parallel. As a

result, fewer trips are required for the freight. Aluminum rheocasting can thus make a (light-)weighty contribution to lightweight design with classic materials.

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