Heat treatment process supplies stronger die cast parts

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A display of three test castings, which, from left to right, are: 1. As cast (left), 2. Conventional heat treatment (middle), 3. Heat treated using the new procedure (right). Credit: CSIRO

Car components with doubled mechanical strength, higher fatigue resistance and improved energy absorption are the result of a revolutionary CSIRO heat treatment process for high pressure die casting (HPDC) of aluminium.

“Our heat treatment methods offer major improvements in tensile mechanical properties and enhancement of a range of other material properties for HPDC components,” says metallurgist Dr Roger Lumley of the Light Metals Flagship.

“Components treated with the new process do not show surface blistering or dimensional changes, they retain an as-cast appearance.”

Surprisingly, fatigue resistance of aluminium HPDC components heat-treated with the new process can be as high as for some wrought aluminium products, tending towards limiting behaviour usually observed in steel.

The new procedures may also substantially raise energy absorption during fracture, which has significant implications for crash-sensitive structural components made by high pressure die-casting.

For example, one common secondary alloy almost doubles in energy absorption, when heat treated specifically for this purpose.

“We envisage that this will make it possible to use HPDC components more widely in load carrying structural and safety applications,” Dr Lumley says.

Additionally, treated parts exhibit thermal conductivity about 20 per cent above their as-cast status, meaning that for engine or transmission applications heat can be transferred or removed more efficiently and quickly.

Potentially, since heat extraction operates more effectively, heat-treated HPDC parts could operate with lower amounts of fluid in cooling and lubrications systems.

The heat treatment process can easily be implemented in existing manufacturing facilities using conventional heat treatment equipment such as continuous belt furnaces, fluidised beds or furnace systems designed specifically for rapid heat treatment.

“It’s an attractive option because the HPDC process is more cost-effective than other manufacturing methods in mass production, and the net increase in design strength post-treatment may allow castings to be made using up to 30 per cent less metal. As a result, there is significant potential for cost reduction per part,” Dr Lumley says.

The researchers have also recently discovered a range of HPDC aluminium alloy compositions that display extraordinarily rapid strengthening behaviour, which has major cost and energy usage implications in manufacturing.

These alloys can be heat treated to high strength levels during a total cycle time of only 30 minutes and develop properties superior to conventional

aluminium casting alloys requiring heat treatment in thermal cycles of up to 24 hours.

The CSIRO-led Light Metals Flagship is now seeking partners for a published case study.

“Following our success with evaluations conducted on HPDC parts up to more than 30kg, we would like to hear from OEM or Tier 1 suppliers who would be interested in submitting a component for heat treatment, and jointly publishing the results as a case study,” Dr Lumley said.

Technical data sheets, providing test results after treatment with the new process for a range of aluminum alloys under various tempering conditions, are available at: www.csiro.au/science/ps1f1.html

Source: CSIRO Australia

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