OEM Tech Brief

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Developing an Optimum Product Design

Capitalizing on Die Casting

Developing an optimum product design is similar, in most respects, for any material/process combination. In capitalizing on today's advanced die casting processes, however, specific attributes of die casting alloys and the die casting process offer opportunities for distinct product advantages and cost reductions that require somewhat different tactics. These should be applied when a totally new product is being developed, and are critical when an existing product made from another material or process is being redesigned for die casting.

When a design is started from a clean sheet of paper, the designer must disassociate the design constraints from the materials and processes traditionally employed. This is the path to the optimum cost-effective results. Three principles are helpful:

- Think function, before traditional form.
- Performance must be sufficient, not equal.
- Match material properties to performance specifications.

Function Before Traditional Form

In many cases form does not reflect function, but is instead determined by the traditional material and process employed. Therefore, it is essential to think of the function(s) that the component is to perform, and disregard the traditional or previous process form. For example:

- A powdered metal part may have relatively thick walls in structural areas, with through holes to remove excess material. A die casting typically achieves maximum structural properties by utilizing thin walls with corrugated sections or rib reinforcements.
- An injection molded plastic component may be attached with through bolts and nuts, which are required because the viscoelastic (relaxation) behavior of the plastic makes it necessary to apply only compression loads. Or it may utilize metal inserts. A die casting with superior creep and relaxation properties can employ tapped threads to an advantage.
- A billet machined part may have block like features to obtain functions, for example: square pockets, sharp edges, flat and cylindrical surfaces. The same part designed as a die casting may obtain function with smooth filleted pockets, generously radiused edges and contoured and shaped surfaces.

The function before traditional form principle can often be applied to die castings made a few years ago. In many cases, wall thicknesses have been dictated by the limitations of then existing casting technology, so that the component was over designed in terms of functional and structural criteria. Yesterday's die castings can often be redesigned and produced by today's advanced die casting technology with thinner walls, reduced draft, and closer tolerances that more nearly reflect the functional criteria.

It is important to note that the definition of form in "function before traditional form" is the traditional shape that is required by specific manufacturing processes. This is not to be confused with a purposely designed form or shape that may provide value or function to the product design. The die casting process easily produces complex design shapes that may be difficult, costly or impossible to produce with other manufacturing processes.

Performance Must Be Sufficient, Not Equal

Components are often over designed because the dimensions of structural features are governed by economics or manufacturing constrains, rather than design criteria. A die cast alternative must, of course, be designed to develop properties that clearly meet product standards. It is not necessarily required, however, that a die casting match the performance of an existing over designed component. For example:

- Cast iron was formerly the material of choice for automotive drivetrain components because of its strength and rigidity. Aluminum, magnesium and ZA die castings, employing carefully calculated wall thicknesses and rib reinforcements, are replacing cast iron at substantial weight reductions.

- Oil impregnated sintered bronze bushings, which offer good bearing properties, are often selected for bearing applications. However, die casting alloys, particularly the ZA group, are now being used for components that were redesigned to incorporate the bearing into the die casting itself, eliminating separately fabricated bearings.

Match Material Properties to Performance Specifications

The material properties apparently suggested by performance criteria are not always relevant. For example, a component required to withstand minor impacts without denting, such as gravel impingement, may seem to suggest a material with high impact strength. However, impact strength applies when the material is forced through the plastic range to rupture, whereas dent resistance implies minimal or no yielding.

Yield strength and modulus of elasticity are the properties critical to dent resistance. The moderate to high yield strength and relatively low modulus of die casting alloys often make die cast products equal or superior to products made from cast or wrought ferrous alloys when dent resistance is required.

A Procedure to Assess Alternatives

The following procedure will help the designer to assess the optimum material/process alternative.

- State objectives
- Review product constraints
- Configure for the material/process
- Involve the die caster early
- Verify the design
- Produce and Test

Reprinted from the North American Die Casting Association's *Design and Development Source Book, Product Design for Die Casting*.

This 122-page manual is available to purchase at a reduced rate by visiting CWM's DC^2 Design Center. This NADCA OEM Sourcebook covers all aspects of cost-effective design for manufacturing in Al, Mg, Zn & ZA alloys, from prototyping to die casting production, machining, plus surface finishing basics.

DC^2 "Die Cast Design Center"

CWM's Die Cast Design Center (DC^2) is a unique resource of die casting design guides, engineering bulletins and reference resources for OEM product designers, engineers and purchasing specialists. It contains over 70 documents that can be downloaded 24/7. Also available for instant viewing are 5- to 15-minute "Design for Die Casting" webinars. An on-site search engine now makes it easy to locate the specific subjects of value to visiting OEMs at the time this information is most needed, in the project planning stage. The Design Center was developed for OEM customers to provide useful information and data in order to assist designers and engineers who are involved in new product designs and redesigns.