WHITE PAPER

For Efficient Manufacturing, Look to Die Casting

NADCA
North American Die Casting Association
The ecological impact of modern society has become a major issue in today’s world. Buzzwords like green jobs, renewable energy, greenhouse gases, and more are taught in schools, discussed in business, and used in political speeches. Many of these concepts are built on the idea of sustaining modern society with renewable energy sources, foods, and products. In manufacturing, process efficiency is the best way to reduce the impact on the environment and sustain production. Die casting sustainably produces cast products with recyclable materials, while conserving energy, and creating a small carbon footprint. In addition, the die casting supply base in the US is continually improving its efficiency making it an increasingly sustainable process.

Recyclable Materials

Aluminum, magnesium, and zinc are the three most common die casting materials. All three elements are in the top 25 most abundant elements in the earth’s crust. Magnesium for example is the 8th most abundant element on Earth, and aluminum is the 3rd most abundant element. The dies for die casting are made of steel. The primary element in steel is iron which is the 4th most abundant element. This means there is a large and readily available supply of the materials used in die casting. The data shows the size of the world zinc reserves compared to the zinc demand. The most recent data in 2007 indicates that the reserves contain enough material to satisfy over 50 years of demand without recycling any zinc products.

Energy Conserving

Since the molds are reusable and it is a high production rate process die casting lends itself to efficient use of energy. Other casting processes utilize expendable molds of sand. Creating these molds can use up to 7% of the tacit energy for producing castings. In die castings the dies can be used to produce over 100,000 castings. This makes the energy use for tooling small in die castings. Die casting is the most energy efficient casting process for producing non-ferrous metal castings. This fact is shown in Table 1. Less energy is consumed producing an aluminum die castings than using the permanent mold, sand, and lost foam casting processes. This implies that the most efficient way to produce aluminum castings is with the die casting process.

<table>
<thead>
<tr>
<th>Casting Process</th>
<th>Tacit Energy (10^3 Btu/lb)</th>
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</thead>
<tbody>
<tr>
<td>Al Die Casting</td>
<td>27.5</td>
</tr>
<tr>
<td>Mg Die Casting</td>
<td>30.8</td>
</tr>
<tr>
<td>Zn Die Casting</td>
<td>10.6</td>
</tr>
<tr>
<td>Al Permanent Mold/Sand</td>
<td>45.2</td>
</tr>
<tr>
<td>Al Lost Foam</td>
<td>37.2</td>
</tr>
<tr>
<td>Copper-Base: Sand</td>
<td>17.0</td>
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</tbody>
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The data also shows there is an opportunity for further refinement to reduce the energy use in die casting facilities. For example new furnace technologies have effectively doubled the melting efficiency in many facilities. Modern die cast-
ing furnaces can now melt with a thermal efficiency of 45% utilizing natural gas. Electrical furnaces are now achieving demonstrated efficiencies as high as 70%. The next generation of furnace technology will utilize electricity and have efficiency of 90% or higher. The transition to electrical energy will be critical for maintaining the sustainability of die castings. This is because the electricity can be utilized from renewable power sources. This cannot be said for natural gas.

**Carbon Footprint**

Another powerful way to understand the efficiency of die casting is to look at carbon footprints. A small survey was conducted in 2009 that examined the carbon footprint of the die casting industry (Monroe, 2010). The respondents accounted for approximately 10% of the industry and the results are presented in Figure 2. The survey found that over half the industry produced less than 4 pounds of CO\(_2\) for each pound of die casting shipped. The more important figure was the industry best practices. The best practices, defined as the top 10%, achieved a carbon footprint of 1.14 pound of CO\(_2\) per pound shipped.

To put the best practice carbon footprint in perspective it can be compared to the carbon footprint of producing a plastic component. A full life cycle analysis of a plastic component compared to aluminum and magnesium die castings was completed in 2008. This found that the carbon footprint of producing an injected molded plastic component was 1.6 pounds of CO\(_2\) per pound shipped. This means that the best practices in die casting produces less carbon emissions than a similar plastic component. As the industry moves to electrical forms of melting, there is an opportunity to completely eliminate the carbon footprint of die castings.

**Continually Improving**

As an industry, the die casting process is continually being improved. Some of these improvements have been listed above. Others include increasing the die life, which reduces further the energy and carbon footprint of the process. Also, castings are being optimized to improve yields. This has a dramatic effect on the energy savings with it being 30% in some cases. These types of improvements are shown most clearly by the productivity enhancements in the industry over the last ten years, Figure 3. This graph shows that die casters have improved their productivity by over 20% when compared to the year 2000. This dramatic improvement is the result of increased efficiency and use of technology throughout the industry.

Productivity enhancements are not the only continuously improving portion of the industry. High performance die casting alloys have been developed and they are continually being refined. These alloys can achieve superior performance while maintaining their recyclability. Most high performance alloys cannot be recycled because of purity issues. This means that the recycled high performance alloy will not achieve equivalent properties to the virgin alloy. The high performance die casting alloys have the opportunity to replace the energy inefficient alloys being used today.

**Conclusions**

Die casting remains the most efficient process for producing aluminum, zinc, and magnesium castings on a moderate to large scale. As the industry utilizes recently developed furnace technologies, its already high energy efficiency will be further improved while its carbon footprint is reduced and possibly eliminated. Technology continues to drive these efficiency gains through dramatic improvements in productivity.

The industry continues to be committed to finding cost effective and sustainable process improvements. These efforts are largely led by NADCA’s research and development efforts. NADCA will continue to support the development of technologies that will keep die casting as the most efficient and sustainable metal casting process.

**Works Cited**