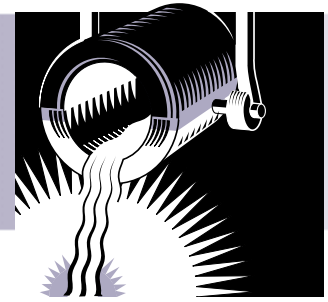


# METAL CASTING

## Project Fact Sheet



## DIE LIFE EXTENSION: MATERIALS FOR CRITICAL APPLICATIONS & INCREASED PRODUCTION RATES

### BENEFITS

Researchers anticipate a variety of benefits including energy savings associated with the increased production of die castings made from secondary aluminum versus virgin aluminum used in other casting methods. One million Btus are required to melt one ton of secondary aluminum whereas 20 million Btus are required to melt the same amount of virgin aluminum. Additional benefits include the lower process energy consumption and productivity gains associated with shorter production cycles. These gains will result in higher casting yield further reducing melting requirements. In addition, significant cost savings will occur due to a reduction in die replacement costs and associated downtime. Together, these benefits are estimated to result in annual energy savings of 6.4 trillion Btu by 2020.

### APPLICATIONS

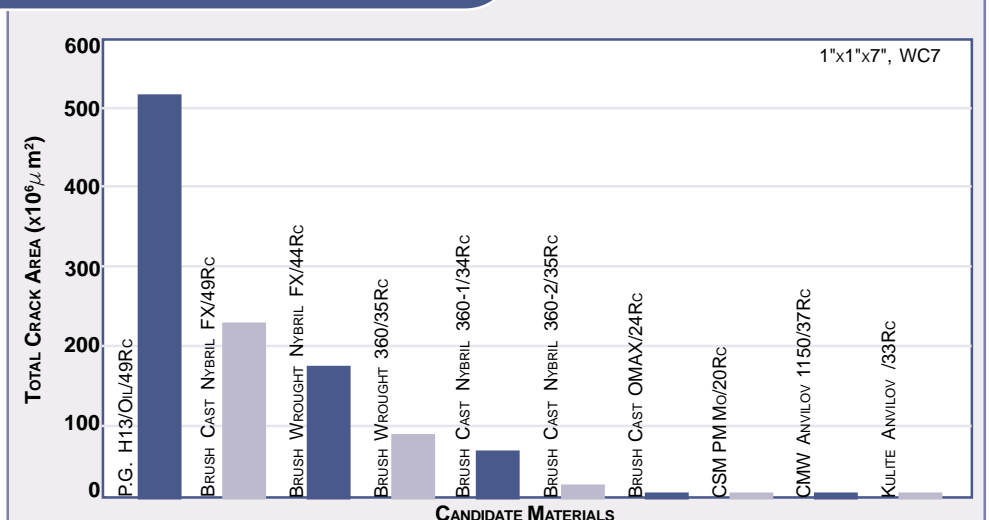
The results of this research can be applied throughout the die casting industry. They will address important industry concerns in extending the life of die casting dies.

## MATERIALS BEING IDENTIFIED TO DOUBLE THE LIFE OF DIE CASTING INSERTS

In die casting, parts can be manufactured in large quantity with desired mechanical properties and near net shapes at relatively low cost. Very complex shapes ranging in size from less than one inch, to fifty inches or more, can be made out of aluminum, magnesium, zinc, and copper with no additional machining. The design and performance of the steel die is critical in meeting the engineering requirements of the final casting. It controls not only the dimensions and tolerances of the final part but also the surface quality of the products. Many dies end their useful life when tiny cracks develop on the surface, leading to unacceptable marks on the cast part. Improvement in the die steel has a major impact on the dimensional stability, reproducibility, and surface quality of the product.

Case Western Reserve University, in conjunction with the North American Die Casting Association, has been conducting a program of research to extend the life of die casting dies. This project is designed to show how the proper selection of die materials by composition and processing can improve die life. As part of that program, this project is seeking to double the life of die casting inserts exposed to the most severe die casting conditions. This will be accomplished by testing and comparative analysis of: high alloy tool steels; refractory and other non-ferrous high temperature die materials; and diffusion coatings. At the conclusion of the research, guidelines for the selective use of each will be provided.

### PERFORMANCE OF NONFERROUS DIE MATERIALS



Proper selection of die materials by composition and processing can improve die life.



## Project Description

**Goal:** The goal of this research is to double the life of die casting inserts exposed to the most severe die casting conditions by testing, comparing, and providing guidelines for selective use of: high-alloy tool steels; refractory and other non-ferrous high temperature die materials; and diffusion coatings.

## Progress and Milestones

Prior work conducted by Case Western Reserve demonstrated that dies produced from chromium-molybdenum-vanadium steels with about 0.40% carbon, a minimum of inclusions and segregation, and heat treated to a Rockwell C range of 45-50, provide good thermal fatigue resistance. With appropriate composition, optimized austenitizing temperature, and a fast cooling rate, these studies show that improved die life can be expected in most applications. However, under certain conditions and in specific locations these good quality tool steels are prone to early failure. The use of special inserts or cores can extend die life in severe conditions.

Researchers will study the behavior of these materials from a basic microstructure standpoint and evaluate the relative behavior of candidate materials. Testing will require a thermal fatigue test that is more severe than has been used so far. Specific elements of the study will include:

- the effect of increased alloy content;
- an evaluation of non-ferrous high temperature die materials;
- the effect of diffusion coatings; and
- productivity improvements.

Some of the alloys being tested include:

- Allvac IN718, a nickel-base alloy
- Carpenter SS464, a ferritic stainless steel
- Brush Wellman QMAX, a beryllium-copper alloy

This project was awarded in 1999 and a paper on this research was presented at the 1999 NADCA International Die Casting Congress. In addition, the results of this work were presented to the Die Materials Committee of NADCA. Several members have tried the new materials on the applications that 1) improve both die life by avoiding soldering and allow higher production rates by at least 50% by solidifying the metal more rapidly, 2) avoid die damage, and 3) increase the rate of production of the machines by 50%.



## PROJECT PARTNERS

Case Western Reserve University  
Cleveland, OH

North American Die Casting Association  
Rosemont, IL

A. Finkle & Sons, Chicago, IL

Alloy Tool Steel, Santa Fe Springs, CA

Badger Metal Technologies, Menomonee Falls, WI

Brush Wellman, Cleveland, OH

Chem-Trend, Howell, MI

CSM Industries, Cleveland, OH

DCD Technologies, Cleveland, OH

FPM Heat Treatment, Elk Grove Village, IL

Hayes Lemmerz - CMI, Ferndale, MI

Latrobe Steel Company, Latrobe, PA

## FOR ADDITIONAL INFORMATION,

### PLEASE CONTACT:

Harvey Wong  
Office of Industrial Technologies  
Phone: (202) 586-9235  
Fax: (202) 586-6507  
Harvey.Wong@ee.doe.gov  
<http://www.oit.doe.gov/IOF/metalcast/>

Please send any comments,  
questions, or suggestions to  
[webmaster.oit@ee.doe.gov](mailto:webmaster.oit@ee.doe.gov).

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Office of Industrial Technologies  
Energy Efficiency  
and Renewable Energy  
U.S. Department of Energy  
Washington, D.C. 20585



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