In die casting, complex parts can be manufactured in large quantity with desired mechanical properties and near net shapes at relatively low cost. The design and performance of the steel die is critical in meeting these engineering requirements. It controls the dimensions, tolerances, and surface quality of final parts. The thermal stress to the die from constant heating and cooling ultimately leads to cracks in the die and die failure. A die can sometimes cost in excess of $1 million and take months to years to design, test, and produce. A significant amount of energy is used in each of these stages. Improvements in die life can significantly improve energy efficiency and cost competitiveness in die casting.

Case Western Reserve University has been conducting a program of research to extend the life of dies used for aluminum die castings. As part of that program, this project is studying compositional modifications and improved heat treatment procedures that will lead to a 50 percent improvement in the life of die casting dies.

Researchers will study the effect of steel composition on die life. The focus will be upon the relationship between thermal fatigue resistance and the steel chemistry. Specific elements are being evaluated in order to identify the best composition for extending the life of die steels. Researchers also will study the effect of the cooling rate for different steels. A step cooling process is being evaluated as a potential method for minimizing distortion and eliminating cracking.

Research has shown die life improvement through proper selection of die steel.
**Project Description**

**Goal:** The goal of this research is to extend the life of die materials utilized in aluminum die casting by 50 percent. The primary objectives are to 1) further evaluate the effect of controlled changes in steel chemistry on the resistance to heat checking, 2) develop a new fast interrupted oil-quenching cycle, and 3) verify the results of the laboratory tests with in-plant trials using production die casting machines.

This project is designed to incorporate all of the important findings, resulting from earlier research, that have been shown to improve die life, including:

- Proper selection of die steel including compositions that are preferable in service to premium grade H13.
- Use of rapid cooling of the die during heat treatment to improve its resistance to loss of both strength and thermal fatigue resistance.

DCD technologies has put these items to use and increased die life from 100,000 shots to 400,000 shots per die. Ford Motor Company has used both the new composition and heat treatment to at least double their die life. GM has also used both the steel selection and thermal treatments to at least double die life.

**Progress and Milestones**

This project began in January 2000. Specific milestones include:

- **Effect of Steel Composition** - Thermal fatigue testing and impact strength will be performed on die steel samples. Results will be analyzed and the relationship between properties and structure will be assessed.

- **Effect of Cooling Rate** - The effect of the cooling rate on die fatigue and cracking will be assessed. Alternative cooling procedures will be identified.

- **In-plant Trials** - Selected components will be tested by industry participants in some of the most demanding die casting applications. The performance of these components will be monitored and recorded for dissemination to industry.

- **Technology Transfer** - CWRU in conjunction with the North American Die Casting Association will conduct workshops and seminars to be presented to NADCA's local chapters in various locations throughout the country. Results also will be published in industry trade journals such as *Die Casting Engineer* and presented at NADCA's annual Die Casting Congress.

**PROJECT PARTNERS**

- Case Western Reserve University
- North American Die Casting Association
- Alloy Tool Steel
- Badger Metal Technologies
- Chem-Trend
- DCD Technologies
- FPM Heat Treatment
- Hayes Tech Center
- Latrobe Steel Company

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