METAL CASTING

Project Fact Sheet

DIE LIFE EXTENSION

BENEFITS

Extension of die life could result in annual savings of over $200 million (based on an annual U.S. die production of $1 billion). Already, the results of this research have saved over $1 million in die replacement costs.

Additional benefits of die life extension include reduced down-time associated with die production; and reduced energy consumption and emissions associated with die production.

APPLICATIONS

This project has resulted in heat treating and materials specifications that are available to the entire die casting industry. They can be applied in the design and development of die casting dies. Specifications have been published by the North American Die Casting Association and include:

- *Recommended Procedures: Premium Quality H-13 Acceptance Criteria* and
- *Heat Treatment of H-13 Tool Steel.*

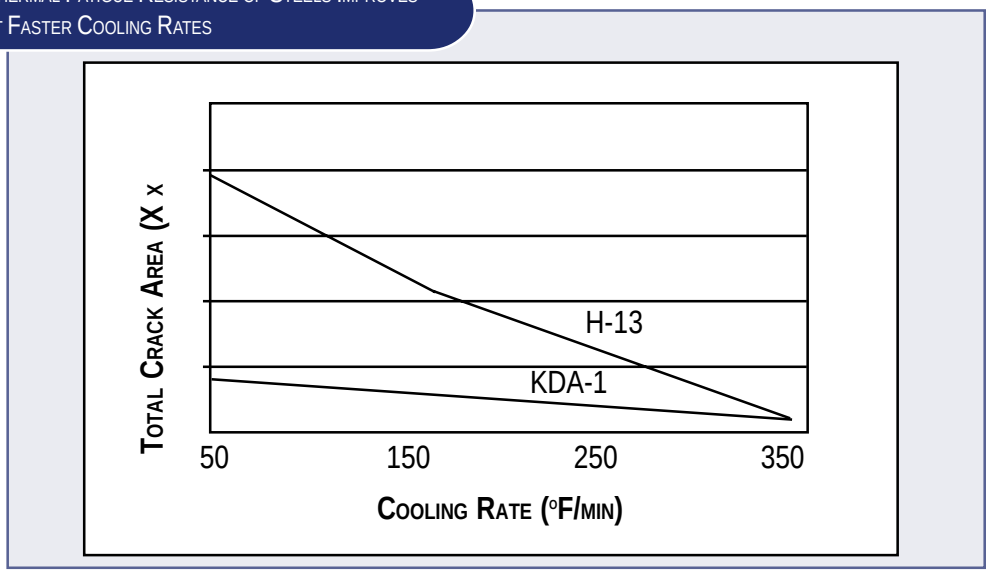
Moreover research findings have been applied by project partners from industry and are resulting in significant savings.

DIE LIFE EXTENSION RESEARCH LEADING TO SIGNIFICANT SAVINGS IN DIE REPLACEMENT COSTS

Die production is a significant cost for the die casting industry. This project seeks to extend the lifetime of dies for die casting by studying the effect of steel chemistry, heat treatment, and electro-discharge machining. It is resulting in important findings on the thermal fatigue and toughness of high performance steels including Premium Grade H-13, KDA-1 and H-11. These findings are leading to significant savings in die replacement costs and resulting in important energy and environmental benefits.

Researchers at Case Western Reserve University have demonstrated through immersion tests that the thermal fatigue resistance of KDA-1 steel is superior compared to Premium Grade H-13. This is a major accomplishment and an important breakthrough in die materials research. The test results obtained indicate that die life can be increased by 50%. The superior performance of KDA-1 is attributed to its lower silicon and vanadium and higher molybdenum content. This benchmarking study was initiated with the premise that modern '90s steelmaking technology may be able to produce hot die steels that are superior to the Premium Grade H-13 commonly used in the U.S. The results of the thermal cycling test demonstrate this to be true.

THERMAL FATIGUE RESISTANCE OF STEELS IMPROVES AT FASTER COOLING RATES



Plot depicts the effect of quenching cooling rate on crack area after 15,000 thermal cycles. Samples were austenitized at 1875°F and double tempered to 48-50 Rc. Graphic courtesy of Case Western Reserve University.

Project Description

Goal: *To identify measures for improving the average die life of a die casting die.* Specific tasks include: analyzing the effect of steel chemistry; analyzing the effect of austenitizing temperature and quenching rate; and analyzing the effect of electro-discharge machining.

Progress and Milestones

- Four different steels were evaluated. KDA-1 steel was identified as clearly superior to H-13 steel for thermal fatigue resistance. KDA-1 performance is attributed to the lower silicon and vanadium present in the steel.

- The optimum heat treatment processing has been determined for each steel with respect to austenitizing temperature (1875°F - 1925°F) and tempering conditions (double tempering for two hours at 1100°F).

- Thermal cycling samples were quenched under three cooling conditions:
  - Fast quench using an oil quench,
  - Medium quench using 5-bar, 7-bar and 10-bar nitrogen gas cooling, and
  - Slow quench using a 1-bar nitrogen cooling.

- Evaluating the effect of the quenching rate indicates that samples quenched at the fastest rates exhibit the best resistance to thermal fatigue.

- Charpy-V notch results confirm a significant increase in toughness with temperature for all steels; and higher toughness values for steels that were quenched in oil.

- Technology transfer is being coordinated through the Cast Metals Coalition and the North American Die Casting Association.

Project Partners

Alloy Tool Steel, Santa Fe Springs, CA

Case Western Reserve University, Cleveland, OH

Crucible Materials Group, Solvey, NY

DCD Technologies, Cleveland, OH

Euclid Heat Treating, Cleveland, OH

FPM Heat Treating, Chicago, IL

Lindberg Heat Treating, Solon, OH

North American Die Casting Association Rosemont, IL

Universal Heat Treating, Cleveland, OH

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