APPLICATION BRIEF:

FDM for Sand Casting

Overview

Sand casting is the process of metal casting using sand as the mold material. When creating a sand cast mold, sand is packed around the pattern. The resulting mold cavity is then used to create finished metal parts. If voids are required within the mold cavity, core boxes are used to create sand cores.

Sand casting is a cost-effective, efficient process for small-lot production or high-volume manufacturing when used in conjunction with automated equipment.

There are three common types of sand casting patterns:

- Loose patterns are simply replicas of the cast piece.
- Split patterns are made in two or more pieces and doweled together to permit separate removal.
- Matchplates are similar to split patterns except the cope and drag sides are combined into a single piece.

BENEFITS OF FDM

Average lead time savings:
- 30% - 70%

Average cost savings:
- 60% - 80%

Greater efficiency:
- Reduce burden on pattern shop
- Automate pattern production
- Keep pattern work in-house

Greater design freedom:
- Redesign parts / patterns
- Redesign gates / runners
- Optional use of interchangeable components

FDM IS A BEST FIT

Quantity:
- Low to moderate-volume (5,000+ castings)
- Prototype, pilot runs and production

Strength:
- Compaction pressure
  < 20.7 MPa (3,000 psi)

Design:
- Moderate to high complexity

Size (XYZ):
- < Build envelope of FDM system

Finishing:
- Features accessible for finishing.

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Matchplate with FDM insert in molding machine.

Sand mold created from FDM pattern.

Pouring molten metal.

Shakeout removes sand from casting.

Application outline

The production of sand molds and cast metal parts is relatively straightforward and suitable for automated methods. However, fabrication of the patterns used to produce the sand molds is often difficult, time-consuming and expensive.

The most common approach is to produce patterns using computer numerical control (CNC) machining, but the production costs are high and the lead time is substantial. Problems like incorrect shrink compensation and design flaws generally require that the pattern be reworked which adds to the expense and lead time.

Gate and runner systems are typically cut from Ren board or a similar material, hand-carved and then sanded to the finished shape. This also adds additional expense and lead time. Because of these problems, foundries have turned to additive manufacturing (AM).

To replace the machined pattern, AM patterns must withstand the ramming forces that are applied to pack the sand, be abrasion-resistant, and be unaffected by the chemicals in the sand binders and mold release. Most additive manufacturing technologies have been unable to meet these challenges. However, Fused

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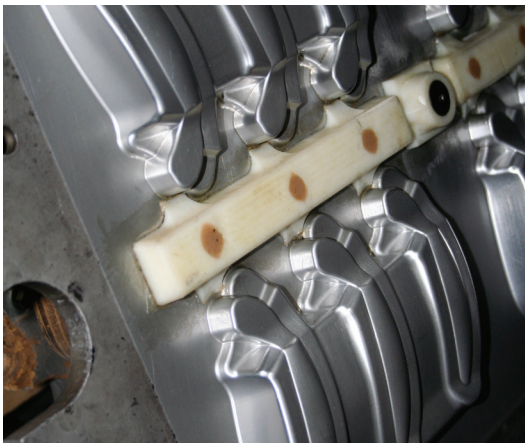

A matchplate with an interchangeable FDM gate and runner system.

Deposition Modeling™ (FDM®) with materials offered by Stratasys® like acrylonitrile butadiene styrene (ABS), polycarbonate (PC), PC-ABS and ULTEM 9085™ thermoplastic resin meet all of these requirements.

FDM is an AM process that builds plastic parts layer by layer, using data from computer-aided design (CAD) files. FDM parts have the compressive strength needed for use as a sand casting pattern. The surface finish of FDM created parts meets all the requirements of sand casting patterns when post-processed. Post processing also seals the molding surface which prevents release agents from penetrating and sand from sticking. Finally, FDM Technology™ is also being used in both green and no-bake operations for pattern and core box production.

Process overview: Matchplates

The first step in pattern design is to modify the cast part's geometry to accommodate metal shrinkage and metal removal in the finishing operations. Then a parting line is created and a draft angle is applied to allow the pattern to be removed from the cope and drag. Next, the size and configuration are designed to fit the automatic molding machine. The part file is separated along the parting line and the two halves are bolted to a matchplate blank. The half that forms the cope side of the tool is joined to the top face of the matchplate while the drag side is placed on the bottom face. If the runners, gates, risers and wells are not already integrated into the FDM pattern, they are now added.

Customer story

Melron Corporation is a manufacturer of window and door hardware using traditional sand casting techniques and modern foundry practices. As a means of becoming more competitive in the global marketplace, the company began focusing on the production of high-margin, low-volume items for the residential and restoration markets.

In the past, Melron had engaged a subcontractor to machine matchplates from aluminum at a cost

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Cast handles.

of approximately $5,000 each, plus three - four weeks for delivery. However, the matchplates often required design changes. As a result, Melron began to consider rapid prototyping technologies only to learn that most were not able to withstand the ramming forces necessary to pack sand. Furthermore, they lacked abrasion and chemical resistance.

Melron then decided to investigate FDM. They started on a small scale by ordering an FDM matchplate from a service bureau. Then, because it worked so well, the company ordered a Stratasys® FDM printer and began producing matchplates that combined pre-fabricated aluminum blanks with FDM inserts.

Thanks to FDM Technology the cost of producing matchplates is now approximately $2,000 — a 60% reduction from CNC machining. Additionally, lead times have been reduced to one and a half weeks from the standard three weeks previously needed — a reduction of 50% or more. Melron also uses its FDM machine to create a gate and runner system which also saves an estimated six hours of hand work per matchplate.

“FDM is facilitating our transition to new markets by enabling us to produce matchplates at a lower cost and in less time than ever before,” said Dan Schaupp, Melron engineer.

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HOW DOES FDM COMPARE TO TRADITIONAL METHODS FOR MELRON?

METHOD	PRODUCTION TIME	COST
CNC	3 weeks	$5,000
FDM	1.5 weeks	$2,000
SAVINGS	1.5 weeks (50%)	$3,000 (60%)

Application compatibility:

(0 – N/A, 1 – Low, 5 – High)

- FDM: Idea (1), Design (2), Production (4)
- PolyJet™: Design (3)

Companion and reference materials:

- Technical application guide
  - Document
- Application brief
  - Document
- Video
  - Commercial
  - Success story
  - How It's Used
- Referenced processes
  - Sparse fill
  - Metal inserts
  - Section large parts
  - Insight custom groups
  - Finishing techniques
  - Optimizing seam location
  - Orientation for smooth part
  - Part dipping

CUSTOMER PROFILE

Forward-thinking manufacturers, foundries and pattern shops that produce sand cast patterns for:

Reference industries:

- Aerospace
- Agricultural equipment
- Automotive
- Consumer goods
- Defense
- Industrial equipment

Applications:

- Low to mid-volume production / prototyping (5,000+ castings)
- Use matchplates or split patterns
- Frequently adjust gates / runner systems

Traditional technology obstacles:

- Labor intensive; long lead times.
- Skilled patternmakers are disappearing.
- Complex patterns are difficult to create.

REFERENCE COMPANIES

MELRON

Danko Arlington Since 1920

ROCK ISLAND ARSENAL

BRADKEN

SST BEARING CORPORATION

BASSLER

CONTACT:

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