Objet Geometries

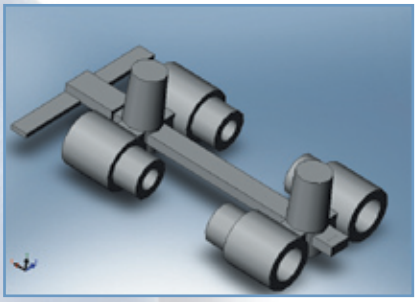
Sand Casting Applications

Overview

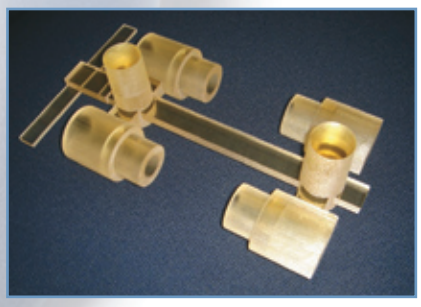
Skill Level Time Cost

Sand casting is an economical process for creating rough metal parts. Raw castings are then machined to produce finished products or components. Sand casting is the least expensive of all casting processes, including die and investment casting. Sand casting may require a longer lead time for production at high output rates (1–20 pieces/hour/mold), but is unsurpassed for large-part production. Sand has almost no upper limit on part weight and minimum part weight ranges from 0.075–0.1 kg. The sand is bonded together using clays or chemical binders. In most operations, the sand can be recycled many times, requiring the addition of only small amounts of sand each time.

Preparation of the sand mold is fast but requires a pattern that can "stamp" out the casting template. Typically, sand casting is used for processing low-temperature metals, such as iron, copper, aluminum, magnesium, and nickel alloys. It can also be used for high-temperature metals where other means would be impractical. Sand casting is by far the oldest and best understood of all techniques. As such, automation can easily be adapted to the production process, although somewhat less easily to the design and preparation of forms.



Picture 1. CAD design for a pattern.



Picture 2. Printing the pattern.

The Sand Casting Process

In the sand casting process, a pattern is made in the shape of the desired part. The pattern can easily be made using PolyJet™ models. A single piece or solid pattern is used for simple designs. Patterns that are more complex are made in two parts, and are called split patterns. This can also be designed in the CAD level, and printed by Objet systems. The upper part of a split pattern is called a cope, while the bottom section is called a drag. Where the cope and drag separate is known as the parting line. Both solid and split patterns can have cores inserted to complete the final part shape. When making a pattern, it is necessary to taper the edges so the pattern can be removed without breaking the mold.

Application Tip: *Sand castings generally have a rough surface, sometimes with surface impurities and surface variations. A machining finish allowance is made for correcting these kinds of imperfections.*

Forming the Cavity

The pattern is housed in a box called the flask, and then packed with sand. A binder helps harden the sand into a semi-permanent shape.

OBJET

Once the sand mold is cured, the pattern is removed. This leaves a hollow space in the sand in the shape of the desired part. The pattern is made larger than the cast to allow for shrinkage during cooling. Sand cores can then be inserted in the mold to create holes and improve the casting's overall shape. Simple patterns are usually open on top, allowing molten metal to be poured into them. Two-piece molds are clamped together. Molten metal is poured into a pouring cup from where it travels down a sprue and into the gating system. Vent holes are created to allow hot gases to escape during the pour. Ideally, the pouring temperature of the molten metal should be a few hundred degrees higher than the melting point, assuring good fluidity. The temperature difference also prevents premature cooling and the resulting voids and porosity. After the metal cools, the sand mold is removed and the metal part is ready for additional operations, such as cutoff and grinding.

Picture 3. The sand casting mold – forming the cavity.

Picture 4. The pattern is removed from the flask.

Picture 5. The desired bronze cast model.

Sprues and Runners

The molten material is poured into the pouring cup, which is part of the gating system that supplies the molten material to the mold cavity. The vertical part of the gating system that is connected connected to the pouring cup is the sprue, and the horizontal portions are called the runners. The multiple points where the material is introduced to the mold cavity are called the gates. Additionally there are extensions to the gating system, called vents, that provide the path for the built-up gases and the displaced air to vent to the atmosphere.

The cavity is usually made oversized to allow for metal contraction as it cools down to room temperature. This is achieved by making the pattern oversized. To allow for shrinking, the pattern must be oversized according to certain averaged factors. There are linear factors that apply in each direction. These shrinkage allowances are only approximate because the exact allowance is determined by the shape and size of the casting. In addition, different parts of the casting might require a different shrinkage allowance.

Disclaimer

Objet Geometries Ltd. is not responsible for misuse of our products or their use in conjunction with unsafe or improperly maintained equipment or for uses other than intended as specified in this application note.

Reference: Erie Bronze & Aluminum Company. www.eriebronze.com

Objet Geometries Ltd.
Headquarters
2 Holzman St., Science Park
P.O.Box 2496,
Rehovot 76124, Israel
Tel: +972-8-931-4314
Fax: +972-8-931-4315

Objet Geometries Ltd.
Europe
Leuvensesteenweg 388
1932 Sint-Stevens-Woluwe
Belgium
Tel: +32-2-717-6502
Fax: +32-2-717-6500

Objet Geometries Inc.
North America
5 Fortune Drive
Billerica, MA 01821
USA
Tel: 1-877-489-9449
Fax: 1-866-676-1533

Objet Geometries
AP Limited
13 Floor, Unit 52A, HITEC
1 Trademart Drive
Kowloon Bay, Hong Kong
Tel: +852-2174-0111
Fax: +852-2174-0555

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