SURFACE FINISHING FOR DIE CASTINGS

A guide to surface treatment systems for protection, decoration and improved performance of die cast product components

Many die cast products are put into use with no operations performed other than casting and trimming. A knowledge of recommended die casting surface finishing alternatives is important to the product engineer and specifier when a specific finish is required. However, to guide the casting alloy selection itself.

Surface treatment systems are generally applied to die castings for one or more of the following purposes:

- Provide a decorative finish
- Form a protective barrier against environmental or galvanic corrosion
- Achieve pressure tightness if interconnected subassembly parts are present
- Improve resistance to wear

Even when a die casting requires no further surface treatment to meet装饰性 surface requirements, or to provide improved performance, a delustering operation is almost always recommended. This step removes any flash, burrs, sharp or ragged edges that might remain after trimming, to facilitate handling and any further finishing treatments. Mechanical, chemical and thermal deburring techniques are available, with vibratory deburring the most common.

Surface Treatment Systems

Table finishing systems that offer the highest performance levels and are specified most frequently for die castings are discussed here and summarized in the table on page 2.

Decorative Finishes

Three types of decorative surface treatments are used on die castings: painting, plating, and bright finishing other than by plating. Decorative finish quality largely depends on casting surface quality. Bright chrome and paint systems that produce high luster or gloss require a high-quality surface. Systems that produce a textured finish are much less sensitive to surface quality. Therefore the die caster must know the precise surface quality and finish requirements to apply appropriate process controls, perform required die maintenance, and introduce secondary operations.

Bright finishes, such as chrome-plated hardware, usually require a buffing operation to develop a mirror-like surface to receive the plating and intermediate buffing during successive plating operations. Matt finishes, typically used for furniture and fixtures, are achieved by sand blasting, grit blasting or scratch brushing followed by a clear lacquer. Scratch brushing develops smooth fine textures in a satin finish. Textures such as stipple and grain can be cast into the surface (see illustrations on page 2), providing that the textured surface is generally oriented perpendicular to the direction of die draw.

Die castings that are to be electroplated must be designed to accommodate the electrical current density patterns that characterize the process. The complexity of the casting and the shape of features can affect current distribution and hence plate thickness. Good uniformity is achieved on gently curving convex surfaces. Corners, edges, fins, ribs and similar protruding textures concentrate current flow and receive more than the average deposition of plated metal. Recessed features, such as grooves, serrations, holes, cavities and deep recesses, receive less than average (see illustrations on page 2).

Electro-plating requires successive steps of immersion in plating solutions and rinsing. All casting features, particularly deep recesses, must be designed so that plating solutions will readily drain. The castings must also be designed so that they can be buffed and racked economically.

Process controls can help to equalize plate thickness. However, the most effective means of achieving good distribution at minimum cost is to follow recommended design procedures for configurations and orientation of features.

Die castings can be painted like ferrous and nonferrous wrought and sheet products. However, when exacting standards for a color-
Improved Design

The improved design uses
new materials and processes
to improve performance and
reduce costs. The key
features include:

1. Use of advanced
composite materials
for improved strength
and durability.

2. Implementation of
novel manufacturing
techniques to reduce
production time.

3. Integration of
sustainable
practices to minimize
environmental impact.

Conclusion

The improved design
provides significant
advantages over the
existing model. With
these enhancements,
we can expect a
substantial increase
in performance and
reduction in cost,
making it a viable
solution for future
applications.
Aluminum die castings manufactured by the cold-chamber process than with zinc, ZA5 and some magnesium die castings manufactured by the hot-chamber process. Porosity can be minimized in both processes by careful control of die-casting parameters; it may be virtually eliminated by employing one of several available proprietary systems.

Systems employing inorganic and methacrylates are currently employed when impregnation is specified to achieve 100% pressure tightness. These systems produce sound castings ready for pressure testing in 40 minutes at a yield of 98%, assuming average porosity.

1. Aluminum Alloys

Aluminum die castings exhibit good to excellent corrosion resistance, depending on alloy copper content. Alloys with restricted copper content exhibit improved corrosion resistance in atmospheric exposure. When corrosion protection is required beyond that afforded by the protective surface film, aluminum die castings can be chromated, painted, or anodized. Electroplating is less frequently used to produce a decorative surface.

Painting

Painting systems for aluminum die castings encounter few production problems. When they do occur, they are generally traced to processing factors which are readily corrected. When painting standards for zinc match with adjacent steel, steel must be nickel-plated, and paint formulation should be adjusted.

Available paint inimations for aluminum die castings penetrate the normally thin oxide coat and develop adhesion. When aluminum die castings have been stored in an extended period prior to painting, particularly in conditions of high humidity, the oxide layer accumulates, making it necessary to remove it by vibratory treatment in an abrasive medium or surface blasting it. In conditions where the component is subject to impacts, such as stone damage that can chip the paint, or in very corrosive atmospheres, paint adhesion can be improved by applying a conversion coating, such as chromating, or phosphating, as a paint base.

Anodizing

Anodizing is used to improve the natural corrosion resistance of aluminum die castings. Aluminum anodizing is an electrochemical process that converts aluminum into aluminum oxide at the surface of the casting.

The thickness of the anodized surface can be increased to develop a wear-resistant hard coat. As silicon content increases, aluminum alloys become more difficult to anodize. Anodizing is not generally used as a decorative coating on aluminum die castings.

2. Magnesium Alloys

During post-anodized environmental exposure, the natural film of corrosion on magnesium is formation of a surface film of hydroxide on exposure to water and formation of a surface coating of hydroxide-carbonate on exposure to the atmosphere. The coating thus formed offers some protection against further corrosion and is partially self-healing.

The atmospheric corrosion resistance of high-purity magnesium alloy is vastly superior to unmodified mild steel, somewhat superior to copper-modified mild steel, better than die cast 380 aluminum, and inferior to zinc and ZA alloys.

A wide variety of surface treatment systems has been developed for magnesium.

Short-term protection

A thin film of oil or wax is often applied to bare magnesium surfaces to provide protection during storage and shipping. These films are low in cost and applied by brush, spray, or dip. Oil coatings can be readily removed prior to machining or painting by vapor degreasing, alkaline cleaning, or solvent dipping followed by a final rinse in clean, unused solvent.

A number of chemical treatments (conversion coatings), both chemical and electrochemical, are used for short-term surface protection. The coatings replace the naturally alkali-hydroxide-carbonate film, which is more corrosion inhibiting and less alkali to slightly acid.

Painting

Paint systems that perform well on aluminum in zinc are generally satisfactory on magnesium die castings. Proper surface preparation and choice of painting materials are important, particularly under severe conditions, to ensure good contact between the primer and the metal surface. Surface preparation is often accomplished by applying one of several available chemical treatments that prevent oxides from forming in storage and shipment, forming a good paint base, and relining the natural alkali which forms at any point of damage on a painted magnesium alloy surface.

Chemical or electrochemical treatments improve adhesion and durability, but are not necessary for less severe applications.

Bright finishes

Polishing and buffing produce a bright metallic luster on magnesium die castings. Mechanical finishes require a gray film on atmospheric
be exposure; the luster must therefore be protected with a clear baked lacquer. This treatment is used for furniture and luggage. A ferric nitrate bright pickle chemical treatment is used to develop a semi-bright to bright silvery surface on magnesium die castings suitable for interior and mild exterior service. Typical uses include business machines, furniture, luggage trims, and tools. A more durable bright finish is obtained by a mild etch followed by a clear anodize.

Magnesium die castings can also be bright chrome-plated to produce a high-luster, durable surface. Service testing is recommended to determine the proper plating cycle for the conditions anticipated. Where increased wear resistance is required, heavy chrome plates may be applied.

Anodizing

Anodizing of magnesium alloys essentially follows the same procedure used on other metals. Surface cleaning, descaling, and anodize. Both alkaline and acid anodizes are available. However, anodizing on magnesium alloys do not lend themselves to dyeing. Color effects are achieved by bright pickles in combination with tinted or dyed clear lacquers. Alkaline anodize must be post-treated for paint adhesion, but is harder and more wear- and abrasion-resistant than acid anodizes. Acid anodizes are more flexible, less subject to spalling or chipping, and make excellent paint bases on magnesium die castings even under most severe conditions.

Other available processes include hard anodize, for improved resistance to wear, and an impregnation anodize process, which is applied where impregnation plus a protective or paint-base coating is required.

3. Zinc and ZA Alloys

Electroplating

The plating characteristics of the zinc (Zn) and ZA alloys have made them the prevailing choice for hardware applications, particularly where moderate to high strength is required. Zinc alloys readily accept a decorative bright chrome finish or a wear-resistant hard chrome finish. Chrome plating also improves corrosion resistance. High-quality polished surfaces can be maintained on zinc die castings in high-impact stress surfaces which do not require hardening prior to bright chrome plating.

ZA-8 can be plated using the same processes as the zinc alloys. ZA-8 is being used as an alternative to zinc in applications where bright chrome plating combined with higher strength or improved crack resistance is required. ZA-12, with higher aluminum content, requires some plating process modifications. ZA-27 is not chrome plated.

Painting

The zinc alloys are readily and economically painted. Color match with steel is excellent. Zinc die castings painted in the same operation as contiguous steel members meet the exacting standards for adhesion and color match of the automotive and home appliance industries. Primers and topcoats are specified to improve adhesion and durability in severe conditions.

ZA alloys are also readily painted. There is, however, less experience with these alloys, particularly color-matching with steel.

Chromate treatments

Chromate treatments are applied to the zinc alloys to develop a decorative finish, a base for paint, and corrosion protection. Chromate treatments combined with chemical polishing solutions have replaced more expensive finishing operations for zinc die castings.

ZA-8 and ZA-12 accept chromate finishes. Chromating ZA-27 requires some process modification. Zinc plating prior to chromating produces a decorative, economical finish.

Anodizing

Aside from the name, zinc anodizing bears no resemblance to aluminum and magnesium anodizing. Zinc alloys ZA-8 and ZA-12 can be anodized using one basic process, ZA-27 requires some process modification. Although proven in severe operating environments, the cost of anodizing is high relative to other processes, and it is not currently in wide use.