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Die Casting

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Die casting is a metal casting process that is characterized by forcing molten metal under high pressure into a mold cavity. The mold cavity is created using two hardened tool steel dies which have been machined into shape and work similarly to an injection mold during the process. Most die castings are made from non-ferrous metals, specifically zinc, copper, aluminium, magnesium, lead, pewter, and tin-based alloys. Depending on the type of metal being cast, a hot- or cold-chamber machine is used. Die casting equipment was invented in 1838 for the purpose of producing movable type for the printing industry. The first die casting-related patent was granted in 1849 for a small hand-operated machine for the purpose of mechanized printing type production. In 1885 Otto Mergenthaler invented the Linotype machine, an automated type-casting device which became the prominent type of equipment in the publishing industry. The Soss die-casting machine, manufactured in Brooklyn, NY, was the first machine to be sold in the open market in North America [1].

Other applications grew rapidly, with die casting facilitating the growth of consumer goods and appliances by making affordable the production of intricate parts in high volumes. In 1966, General Motors released the Acurad process [2]. The main die casting alloys are: zinc, aluminium, magnesium, copper, lead, and tin; although uncommon, ferrous die casting is also possible [3]. The Aluminum Association (AA) standards: AA 380, AA 384, AA 386, AA 390; and

AZ91D magnesium [4]. The following is a summary of the advantages of each alloy [5].

Zinc: the easiest metal to cast; high ductility; high impact strength; easily plated; economical for small parts; promotes long die life. Aluminium: lightweight; high dimensional stability for complex shapes and thin walls; good corrosion resistance; good mechanical properties; high thermal and electrical conductivity; retains strength at high temperatures.

Magnesium: the easiest metal to machine; excellent strength-to-weight ratio; lightest alloy commonly die cast. Copper: high hardness; high corrosion resistance; highest mechanical properties of alloys die cast; excellent wear resistance; excellent dimensional stability; strength approaching that of steel parts. Silicon tombac: high-strength alloy made of copper, zinc and silicon. Often used as an alternative for investment cast steel parts. Lead and tin: high density; extremely close dimensional accuracy; used for special forms of corrosion resistance. Such alloys are not used in foodservice applications for public health reasons. Maximum weight limits for aluminium, brass, magnesium, and zinc castings are approximately 70 pounds (32 kg), 10 lb (4.5 kg), 44 lb (20 kg), and 75 lb (34 kg), respectively [6]. The material used defines the minimum section thickness and minimum draft required for a casting. The thickest section should be less than 13 mm (0.5 in), but can be greater [3]. There are a number of geometric features to be considered when creating a parametric model of a die casting: Draft is the amount of slope or taper given to cores or other parts of the die cavity to allow for easy ejection of the casting from the die. All die cast surfaces that are parallel to the opening direction of the die require draft for the proper ejection of the casting from the die. Die castings that feature proper draft are easier to remove from the die and result in high-quality surfaces and more precise finished product. Fillet is the curved juncture of two surfaces

that would have otherwise met at a sharp corner or edge. Simply, fillets can be added to a die casting to remove undesirable edges and corners. Parting line represents the point at which two different sides of a mold come together. The location of the parting line defines which side of the die is the cover and which is the ejector. Bosses are added to die castings to serve as stand-offs and mounting points for parts that will need to be mounted. For maximum integrity and strength of the die casting, bosses must have universal wall thickness. Ribs are added to a die casting to provide added support for designs that require maximum strength without increased wall thickness. Holes and windows require special consideration when die casting because the perimeters of these features will grip to the die steel during solidification. To counteract this effect, generous draft should be added to hole and window features.

There are two basic types of die casting machines: hot-chamber machines and cold-chamber machines [3]. These are rated by how much clamping force they can apply. Typical ratings are between 400 and 4,000 st (2,500 and 25,400 kg) [5].

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