

Die Casting

Conceptually, die casting is a manufacturing process and requires articulate calculations to create the required outputs. This process injects liquid material into different molds to solidify the mold. The amalgamation results in different fabricated parts. The primal benefit of casting process allows manufactures to create specific parts that are not economically feasible to create on the general assembly line. Million of parts that are made via die casting process could not have been achieved otherwise since the cost of producing certain items are not economical or even production possible.

any form of casting is a labor intensive process that requires a specific skill set. all processes from temperature building, quantity and quality of the liquid to be injected, form and shape of the mold, to the coolness technique of the output products all require specific skill sets. Without an accomplished team, it become very difficult for die casting manufactures to delivery quality products.

Die casting is a similar process in which molten metal is put under high pressure into the cavities of steel molds. The molds are called dies. The dies also come in different shapes and varieties in properties. Die casting process is heavily used in the automotive industry to create different body parts

"The earliest examples of die casting by pressure injection - as opposed to casting by gravity pressure - occurred in the mid-1800s. A patent was awarded to Stuges in 1849 for the first manually operated machine for casting printing type."(Brydson 31) The process was limited to printer's type for the next 20 years, but development of other shapes began to increase toward the end of the century. By 1892, commercial applications included parts for phonographs and cash registers, and mass production of many types of parts began in the early 1900s.

"The first die casting alloys were various compositions of tin and lead, but their use declined with the introduction of zinc and aluminum alloys in 1914."(Brydson 47) Magnesium and copper alloys quickly followed, and by the 1930s, many of the modern alloys still in use today became available.

The die casting process has evolved from the original low-pressure injection method to techniques including high-pressure casting -- at forces exceeding 4500 pounds per square inch -- squeeze casting and semi-solid die casting. These modern processes are capable of producing high integrity, near net-shape castings with excellent surface finishes.

There are several benefits of using lubricant in the process. The lubricant both helps control the temperature of the die and it also assists in the removal of the casting. Effective lubricant can be the differentiator factor of average versus customer centric products. Molten metal is then injected into the die under high pressure. "The high pressure assures a casting as precise and as smooth as the mold. This stage requires extreme caution in regarding to the pressure and checking of any defects in the mold. Once the cavity is filled then the pressure is maintained until the casting has become solid. (Bralla16)

There are also different ways of cooling the mold water cooling being one of them. It typically takes a lengthy amount of time to cool down the molds if left simply to nature. In order to expedite the end product, different cooling techniques are used. Finally, the die is opened and the casting is ejected. This is the entire process of the die casting procedures.

The clamping efficiency defines the quality of the machines that are used in the die casting manufacturing process. Typical sizes of the die casting machines range from 100 to 4,000 tons. along with the massive weights also comes a gigantic size associated with the machines "Majority of the machines can be as large as regular home sizes in any city of the world. Irrespective of size, there are primarily two types of categories of die casting machinery"(DeGarmo 19) One is the hot chamber

machines for zinc, magnesium and lower melting-point metals and the other is the cold chamber machines for aluminum and higher melting-point metals a die casting machine automatically opens and closes the mold and injects the liquid metal, all under high pressure and as rapidly as possible, in the case of zinc up to several hundred times an hour. This time line is also dependent upon the machinery features and the vendor. Extensive research and work has taken place to hone the die casting manufacturing machine features and make it more simple and cost effective both in terms of pricing and productivity.

Here are several key milestones that all die manufactures are looking anxiously to reduce. Time to produce the end product, minimize quantity of goods used in the entire process and enhance the overall skill set of individuals are all the key elements that need improvement. "The anticipated reduction is approximately 30% - 40%, but the overall reduction is around 20% and that too in the human resource department Engineers are now being trained on specialized avenues in die casting which helps in reducing the overall human resources required."(DeGarmo 27)

One of the ongoing challenges with die casting is detecting surface and sub surface defects within specific time lines Defects and variances in the final products are still on the high end. Due to the high number of defects and variance, a large amount of raw material is lost and put forth as waste Vendors have realized this gap in identifying the defects and variances during the process. Fully automatic machines are now being manufactured to cater to this ongoing challenge a fully automatic fault detecting machine named Cast vision has been produced and a prototype process is in place for extended in-plant on-line trials This is the third year of this project and it is giving good results. The result of algorithm which was designed and developed in 2nd year has been put to test now. By prototyping the Cast team had designed and developed a working system Cast vision. This can discriminate between good and defective parts

Metal stamping is the process of cutting and shaping metal alloys into specific forms, especially to be used as components for large machinery or structures. Metal sheets can be molded into different pre-determined shapes for use as regular products like pans and cans The most common alloys that are used in metal stamping are steel, zinc, nickel, aluminum and titanium Metal stamping is a very cost-effective and productive way of producing many kinds of metal products on a large scale

In metal stamping, the metal sheets are placed in a die or a press tool that has a specially designed cavity that gives the preferred shape to the metal sheet. The upper part of the die connects to the press slide while the lower component connects to the press bed. "a specific component known as the punch pushes the metal sheet through the die, thus performing the actual shaping operation"(Kalpakjian 1997) after pressing, the metal is plated with gold, palladium, nickel or tin to prevent corrosion.

Plating also increases the wearability and solderable nature of the product. Sometimes, the sheet is also pre-plated before the stamping process, and then the product is cleaned to remove excess metal stamping oils and films. The product is then heat treated to make it stronger since it is still in the soft state after stamping The product is then subjected to the deburring process for removing the sharp corners. This is done by using chemicals or abrasives "Metal stamping also involves other metalworking processes like piercing, blanking, forming and drawing on the same machines "(Kalpakjian 1997)

Stamping presses have specific force, speed and precision for giving a specific shape to the metal There are two types of metal stamping presses: Mechanical and hydraulic These are available in an extensive range of capacities, sizes, stroke lengths and operating speeds.

Metal stamping is slowly replacing other metal forming processes like die casting, forging, fabricating and machining One reason for this is the very low costs involved in metal stamping The dies

used for metal stamping cost less than those used in forging and casting also, the metals used in metal stamping can be harder than those used in other processes, thus making the end product stronger. The cost of the secondary processes, like cleaning and plating are also considerably reduced.

"Moreover, there are certain products that have to be produced only through metal stamping: Base weights, brackets, balance clamps, brake flanges, conveyer flights, bushing seats, engine bases, flywheel shrouds and friction plates."(Doyle 50)

There are also different kinds of metal stamping including: Deep drawn stamping, electronic stamping, Fourslide stamping, medical stamping, and progressive die stamping and short run stamping. The most commonly used type is the progressive die drawing wherein a metal sheet is drawn through a series of dies and stamping is done by all the dies simultaneously, thus considerably reducing the time it takes.

Progressive die stamping refers to a stamping operation whereas many operations are performed with a single progressive die. Progressive stamping is one of the most common, fastest means of producing piece parts. "Unlike in a single-station operation, all of the stations in a progressive-stamping line needed to cut and form the piece part are mounted on a single common die set. These stations are properly timed and sequenced so that the piece part can be fed ahead of a given constant distance."(Doyle 66) This distance is called the progression, or pitch. as the strip or coil advances through the die in the press, each station cuts and forms the part in a given sequence. Each stage of the part remains in the original strip or coil and is "tied together" using a portion of the strip or coil called a strip carrier. Many different stages of a part--even left-handed and right-handed halves of a part--are stamped with a single stroke of the press.

a progressive die has stations that progressively perform operations on the part, for example blanking, forming, and piercing. Progressive stamping produces precision formed parts at a very high production rate. Progressive stamping is common in the electronics and automotive industries. Progressive stamping dies are built by tool and die shops. Though die types are many, they can be broken into two basic types--cutting and forming. "Many dies perform both cutting and forming.

Cutting is perhaps the most common operation a stamping die performs. Cutting operations are blanking, shearing, trimming, piercing, and notching."(Kutz 1986)

The sheet metal, positioned between two dies, is severed as the die cutting edges move past each other. The dies have a small gap between them, called the cutting clearance. Clearances change, depending on the type of cutting operation, metal properties, and the desired edge condition. The cutting clearance often is expressed as a percentage of the metal thickness. "In most cutting operations, the metal is stressed to the point of failure, producing a cut edge that has a shiny portion referred to as the cut band or shear, and a portion of the edge called the fracture zone or break line."(Kutz 1986) There are numerous types of forming dies. Some of the most common forming die types are bending, stretching, flanging, drawing, coining, extruding, and ironing.

One of the most common methods of shaping plastic resins is a process called injection molding. Injection molding is a manufacturing technique for making parts from both thermoplastic and thermosetting plastic materials in production.

"Molten plastic is injected at high pressure into a mold, which is the inverse of the product's shape. after a product is designed, usually by an industrial designer or an engineer, molds are made by a moldmaker (or toolmaker) from metal, usually either steel or aluminum, and precision-machined to form the features of the desired part."(Leong 36) Injection molding is widely used for manufacturing a variety

of parts, from the smallest component to entire body panels of cars.

"In 1868 John Wesley Hyatt became the first to inject hot celluloid into a mold, producing billiard balls. He and his brother Isaiah patented an injection molding machine that used a plunger in 1872, and the process remained more or less the same until 1946, when James Hendry built the first screw injection molding machine, revolutionizing the plastics industry."(Oberg 17) Roughly 95% of all molding machines now use screws to efficiently heat, mix, and inject plastic into molds.

Molds are built through two main methods: standard machining and EDM machining. Standard Machining, in its conventional form, has historically been the method of building injection molds. With technological development, CNC machining became the predominant means of making more complex molds with more accurate mold details in less time than traditional methods.

"The electrical discharge machining or spark erosion process has become widely used in mold making. as well as allowing the formation of shapes which are difficult to machine, the process allows pre-hardened molds to be shaped so that no heat treatment is required."(Technical Staff 1997) Changes to a hardened mold by conventional drilling and milling normally require annealing to soften the steel, followed by heat treatment to harden it again.

"EDM is a simple process in which a shaped electrode, usually made of copper or graphite, is very slowly lowered onto the mold surface (over a period of many hours), which is immersed in paraffin oil."(Oberg 70) A voltage applied between tool and mold causes erosion of the mold surface in the inverse shape of the electrode.

Injection molding is accomplished by large machines called injection molding machines. Resin is fed to the machine through the hopper. Colorants are usually fed to the machine directly after the hopper. The resins enter the injection barrel by gravity through the feed throat. Upon entrance into the barrel, the resin is heated to the appropriate melting temperature.

The resin is injected into the mold by a reciprocating screw or a ram injector. The reciprocating screw apparatus is shown above. The reciprocating screw offers the advantage of being able to inject a smaller percentage of the total shot (amount of melted resin in the barrel). The ram injector must typically inject at least 20% of the total shot while a screw injector can inject as little as 5% of the total shot. Essentially, the screw injector is better suited for producing smaller parts.

The mold is the part of the machine that receives the plastic and shapes it appropriately. The mold is cooled constantly to a temperature that allows the resin to solidify and be cool to the touch. The mold plates are held together by hydraulic or mechanical force. "The clamping force is defined as the injection pressure multiplied by the total cavity projected area. Typically molds are overdesigned depending on the resin to be used. Each resin has a calculated shrinkage value associated with it."(Chua 1998)

The most commonly used thermoplastic materials are polystyrene (low cost, lacking the strength and longevity of other materials), ABS or acrylonitrile butadiene styrene (a ter-polymer or mixture of compounds used for everything from Lego parts to electronics housings), polyamide (chemically resistant, heat resistant, tough and flexible - used for combs), polypropylene (tough and flexible - used for containers), polyethylene, and polyvinyl chloride or PVC (more common in extrusions as used for pipes, window frames, or as the insulation on wiring where it is rendered flexible by the inclusion of a high proportion of plasticiser)

"Injection molding can also be used to manufacture parts from aluminum or brass. The melting

points of these metals are much higher than those of plastics; this makes for substantially shorter mold lifetimes despite the use of specialized steels. Nonetheless, the costs compare quite favorably to sand casting, particularly for smaller parts."(Tres 44)

Injection molding machines, also known as presses, hold the molds in which the components are shaped. Presses are rated by tonnage, which expresses the amount of clamping force that the machine can generate. This pressure keeps the mold closed during the injection process. Tonnage can vary from less than 5 tons to 6000 tons, with the higher figures used in comparatively few manufacturing operations.