

The die casting process

The die casting process is a forming process in which molten metal is injected into the cavity of a steel die. The cavity is precision machined with tight tolerances into a block of heat resistant tool steel. Coupled with process control and the uniform shrinkage characteristics of zinc alloys, this gives the process and the resultant castings their exacting precision. In zinc alloy die casting, **the production cycle is the fastest of the metal casting processes** due to zinc's relatively low melting/solidification temperature (379-390 C, 715-734 F). Zinc die casting is used to produce parts from less than a gram in weight to a kilo or more.

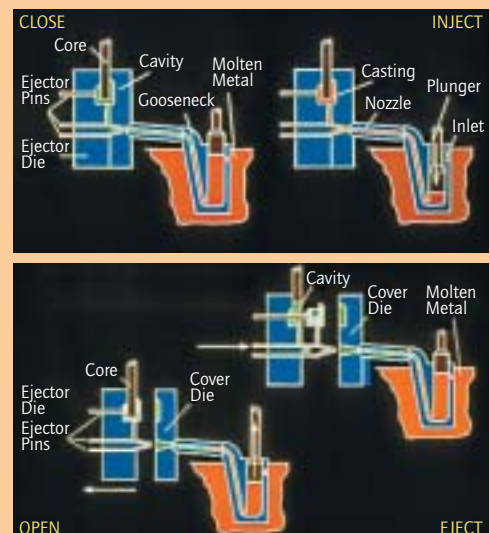
The die casting process, which can be described as "the fastest way from molten metal to finished part", begins with the closing and locking of the die under high pressure. Molten zinc alloy is then injected into the die. After a brief period, the metal solidifies, the die opens and the casting is ejected. The casting cycle then repeats itself. The process can often be as fast, or faster, as the time it took to read this sentence.

There are two types of machines used for zinc die casting—the conventional hot chamber machine with a two piece die and the high-speed, multi-slide machine. The conventional machine produces parts typically in excess of a two cm. envelope. The multi-slide machine is used to produce miniature parts. Both processes are capable of producing a net-shape component, incorporating openings, slots and threads.

The pressure die casting process has evolved to permit design of products to reduce metal content, lessening weight and cost. Zinc castings with walls less than .9mm in thickness are commonly produced with good structural integrity and excellent surfaces capable of being decoratively finished.

The process technology and quality systems available in die casting today provide designers and users of zinc die castings with consistent quality, the ability to design intricate configurations to net-shape and high quality surface finish. Coupled with the recyclability of zinc alloys, this results in **products which are truly consumer and environmentally friendly.**

Zinc Die Casting in a Hot Chamber Machine



THE UNSEEN BENEFITS OF ZINC DIE CASTINGS

MICHAEL BESS

Zinc is all around us in everyday life. For example, zinc provides the protective coating that prevents our automobiles from corroding. Zinc die castings are everywhere too. The finished products containing them are diverse but often hide the die castings themselves from sight. That does not mean they are not important to us, however. Zinc die castings provide us with safety, security, convenience and “decoration”, they improve our lives even as we go about our daily routines at home and at work.

Zinc component designs are truly impressive in their ability to make our lives safer and more enjoyable. They combine the precision and cost-effectiveness of the **die casting process** with the exceptional mechanical and physical properties of **zinc alloys**.

We tend to see only the surface of familiar objects: our household appliances, hand tools, telecommunication devices, computers, transportation vehicles. What is below the surface, providing the functionality of these objects, is often a marvel of engineering and design. Today’s manufacturers of both sophisticated and commonplace devices are constantly looking at many different materials and manufacturing processes to provide the function, aesthetics and reasonable cost that consumers demand.

Zinc Protects!

Let's explore some of the uses and benefits of zinc die castings across the routine of a typical day.

You awake on a sunny, bright morning. Although it's not warm enough to turn on the ceiling fan, you look up at its wide blades that are attached to the fan motor by zinc die cast support brackets. These brackets can be decorated in an array of colors and finishes while also providing the structural strength to prevent the blades from becoming flying missiles during operation.

As you walk towards the bathroom, you stop at the window to raise the blinds, letting in some welcome sunlight. Helping you do this is a zinc die cast cord lock, which is embedded in the blinds' header.

INTERZINC



The zinc material aids the cord to pass smoothly through while a zinc pin locks the cord when activated. In this design the zinc die casting replaced a multi-piece steel assembly, reducing the cost and improving the operation. Many blinds also incorporate a die cast zinc gearbox to activate the tilting of the blinds.

If you step in front of the bathroom mirror to shave, you may be using a high-tech

razor that utilizes a zinc die cast body to give it a sleek, sculptured look. The razor's designers specified the handle to be zinc die cast for its weight and feel, surface finishing properties and manufacturing economies.



As you reach for the faucet to turn on the water, you see your reflection in the highly decorative die cast zinc spout. Tub and sink faucets have evolved from purely functional to highly decorative objects. In the days when faucets were strictly functional, they were machined out of brass bar stock. To accomplish today's style demands, faucet shells and bodies are made from zinc die castings. By utilizing the die casting process, engineers fashion the sleek, smooth designs that enable faucets to highlight a bathroom. Another property of zinc is its ability to take a highly decorative finish. With the latest advances in coatings, zinc is given a high luster coating that will last a lifetime.



INTERZINC

After showering, you pick up the hairdryer but do not pay attention to the fact that hidden under the plastic exterior is a small electric motor, which drives the blower. This motor provides multi-speed air moving capability. Integral to this motor are two zinc die castings functioning as the motor end supports. These supports also function as bearings against which the fan shaft turns. The unique combination of zinc alloy bearing properties and the precision available through the die casting process satisfy the design and performance requirements of an electrical home appliance.

On the way back to the bedroom, you pause to adjust the temperature on the wall thermostat. In doing so, you are engaging a zinc die casting. Many thermostats and humidstats utilize a zinc die casting for the switch mechanism. The casting is the gateway for the electrical contact which controls the operation of the furnace or humidifier.

Now in the kitchen to prepare breakfast, you may need to warm up a dish taken from the refrigerator. As you turn on the stove and set the temperature, you activate a thermostat and a control shaft consisting of zinc die castings. The thermostat used by many stove manufacturers makes use of a zinc die cast base that replaced a multi-component assembly, reducing cost and improving reliability.

The control shaft is also a zinc die casting which replaces a machined steel component, again improving cost and performance.

As you close the cabinet door after taking out a coffee cup, you may notice the cabinet hardware. The door pulls and hinges in your kitchen are probably made from zinc die castings. Cabinet manufacturers worldwide make use of the strength and excellent finishing characteristics of zinc alloys to provide their hardware with the look and durability required in today's homes.

Sitting idle on the kitchen counter is a robust kitchen mixer incorporating numerous zinc die cast structural parts.



Zinc die castings comprise all the outer components of this stand mixer including the base, neck and motor housing. In addition to strength, the zinc die castings neutralize the vibrations created by the mixing action.



Setting off for work, you close and lock the door. Keeping everything secure are zinc die castings, which form the lock casing and the bolt latch of the dead bolt



lock. Zinc alloy's strength, density and decorative finishing makes it an ideal material for door lock components.



With the simple act of unlocking your car door, sitting in the driver's seat and putting the key in the ignition to start the engine, you are relying on the precision and durability of zinc die castings to provide the security and dependability you take for granted. The door lock housing is a zinc die casting, which provides the precise dimensions that allow a lock to perform dependably and predictably over the vehicle's lifetime. The locks are strong too, standing up to normal, and sometimes abnormal, conditions.

Before venturing onto the street, you buckle your seatbelt. This simple safety act brings to bear the design and performance of zinc die castings. In the seatbelt retractor system there is typically a system of gears, counterweights and pawls to lock the seatbelt in place in one direction while

allowing simple adjustment in length in the other direction. The pawls, inertia disks, retractor gears and pulleys in this assembly are high-strength zinc die castings that provide the unique combination of mechanical and physical properties (strength, ductility and weight) to insure that this system

performs as designed. Zinc provides the ability to create the complex design and geometry required for the seat belt system to function. The consistency of the die casting process yields part-to-part dimensional uniformity down to less than a tenth of a millimeter. In the event that this restraint system has to work, such as a sudden stop or collision, a device called the seat belt pretensioner uses a pyrotechnic charge to take up slack and lock the seatbelt in the earliest stages of an impact. The pretensioner housing is also a zinc die casting. Although not seen universally, such safety devices are being deployed in more and more vehicles throughout the world.

Perhaps you wish to adjust your power seat. What used to be a luxury has now almost become a standard feature. Power seats are available in many makes and models of automobile. They are easy to take for granted but they constitute an intricate system of motors and flexible drives. Housing this system is a precision zinc die casting. Typically there are three



motor drives, up and down, back and forth, and tilt. The one-piece housing contains the motors and incorporates an outer gear housing for each, and the attachment for the three flexible drives.



You check the traffic in your side view mirror. Once almost exclusively produced as zinc die castings, the exterior mirror shells today are produced from a variety of materials. Prestige and luxury vehicles whose mirror shells are finished in bright chromium still depend upon the excellent surface finish of zinc die castings to provide the substrate for the electroplated finish. The strength of the shell and internal complexity also provides the ability to fix the internal components of the mirror. No matter what the shell may be made from, the internal workings of the mirror, whether manually or electrically adjustable, depend on zinc die castings to support the adjustment mechanism. Pushing an electrical switch or moving a lever inside the vehicle sets in motion a complex mechanism containing zinc die castings to move the mirror.

As you proceed to work, you spot an emergency vehicle ahead. Emergency and municipal vehicles flash their rooftop warning lights by rotating a parabolic reflector at high speed around a high-intensity bulb. Supporting the bulb, reflector and rotator gear on many

emergency vehicles is a one-piece zinc die cast rotator base. The design of the rotator base incorporates specific geometry and proportion. It requires precision and balance to prevent problems in the gear meshing geometry. Zinc die casting provides the precision and balance so when an emergency vehicle needs to respond, you see the warning.



With traffic delays, you use a cell phone to let co-workers know you will be late. This phone happens to be a model that contains a thin zinc die cast frame supporting the enclosed electronics. The zinc frame not only provides rigidity and strength, but zinc protects the electronics in another way as well.



Electronics can emit and must be shielded from electromagnetic interference (EMI). Zinc is a natural barrier to this interference, enhancing the performance of the phone.

Imagine that you need to have the oil changed in your car's engine. The hood of the car is opened, the oil cap removed and an electronic oil-metering assembly is inserted. The main component of the metering assembly is a 25 cm-long zinc die cast housing. The housing functions as a conduit for the oil, and integrates a shut-off valve and metering gears. When the correct amount of oil is pumped into the engine the meter shuts off and the attendant readies your car for departure.



INTERZINC

Do you play golf? Maybe you own a new pair of golf shoes that are outfitted with the latest cleat system. This system features interlocking tri-lobes. One half of the system is a plastic cleat and the other half is a die cast zinc receptacle. This quick change system allows you to quickly

change cleats depending on the course conditions. The zinc alloy provides the cleat system with superior corrosion resistance and strength.



INTERZINC

During the day, you may well walk over to a vending machine to get a cold drink. The note changer that is now a part of the vending machine incorporates a

number of zinc die castings, one that can be seen, and several behind the scenes. The casting that you can see is the note changer face plate, which is typically finished in a black epoxy coating.

The other zinc die castings in this changer are the top and bottom sensor plates.



INTERZINC

The casting process has eliminated multiple part assembly, improved quality of fit, provides improved guidance of the notes, and forms a tight seal keeping dirt and dust out of the mechanism.

Arriving home, you receive a package from a parcel delivery service. The delivery person scans the bar code on the package for tracking purposes.

The portable bar code scanner used is a marvel of mechanical and electrical design. In the scanning mechanism small, precisely positioned mirrors direct light to similarly precisely positioned sensors. Zinc die castings provide the physical attachment points and supports for these critical elements of the design. The part-to-part consistency and long term



SYMBOL TECHNOLOGIES

dimensional stability of zinc die castings helps contribute to the dependability built into this scanner.

Setting the package down, you notice that the lights in the living room are not working, the breaker in the power box must have been tripped. Here too, zinc die castings are hard at work for you. Without die cast conduit connectors, cable clamps, elbows and other electrical fittings, your electrical wiring system would be that much more difficult and expensive for the initial installation and subsequent maintenance. Approved by governing boards around the world such as UL and CSA¹, zinc die cast electrical fittings help create the infrastructure that you and your neighbors depend on. Opening the electrical distribution panel that safeguards your home, you can find more zinc die castings in the form of ground clamps and internal components of the circuit breakers.

In the utility room, you may well have some power tools. Tool manufacturers take advantage of zinc alloy's strength to make low cost power tools available for home use. For example, the die cast zinc gear case of a battery-powered driver provides the outer gear race and houses the drive gear assembly. Zinc alloy has the toughness needed by the gear teeth and the bearing properties for smooth operation, as well as offering good aesthetics.

Another likely tool on the workbench is a hand stapler. New stapler designs utilize zinc castings for the stapler body.

Two zinc cast body halves replace multiple parts and eliminate secondary machining and additional assembly. Zinc alloy also provides a damping effect, reducing the shock of the spring recoil after the staple is shot.



Another tool on the table may be a retractable rule. The steel rule is housed in a chrome plated zinc die cast case. The reflective housing is attractive while also having the internal complexity, strength and precision to permit the tool to perform for many years to come.

Back in the family room, the home entertainment console contains an abundance of zinc die castings. The amplifier and receiver contain zinc die cast electronic chassis components, heat sinks and wire wrap terminals. These zinc alloy components provide the precision, strength, and thermal properties that insure proper functioning of printed circuit boards and semiconductor devices.

More visible, but usually not recognized, are die castings located on the rear panels of your electronics such as the chassis connectors for antenna cables (commonly called type "F" connectors.) The shells of these externally threaded connectors are produced to net shape by the die casting



INTERZINC

INTERZINC

¹ UL: Underwriters' Laboratory
CSA: Canadian Standards Association

process, without any machining. That even includes the threads. This is due to zinc's good fluidity during the casting process and the tool makers' ability to capture intricate detail in die cast tooling. The castings are then electroplated for enhanced conductivity, assembled with the internal insulator and contact (by simply deforming the casting to

capture these other pieces of the assembly) and it is ready for use. The mating cable connectors are also usually zinc die castings.

Throughout a typical day, zinc die castings are all around us, as the engineered components that provide safety, security, convenience and decoration for all of us.

Zinc and the humble zipper

One of the most widespread applications of zinc die casting is around us on an everyday basis. Whether you are getting dressed, packing luggage for a journey, putting books and other items into a backpack, or getting your laptop out of its carrying case, you are very likely using a zipper. Yes, zippers are a significant benefactor of the capabilities of zinc die casting. The zipper slider and pull are commonly produced from zinc die casting, and even the teeth are often zinc die castings. Precise dimensions insure easy operation and gripping power. The strength and stability of zinc alloy provide long life. From miniature applications in delicate garments through heavy-duty usage in commercial closures, zinc die castings are holding things together for us.



Sustainability

Zinc is natural, recyclable and inherently part of our environment. It is the 17th most common element in the earth's crust and an essential element for man, animals and plants. Specifying zinc for die casting is an environmentally responsible choice, in line with today's need for sustainable materials. Zinc die cast parts are durable and fully recyclable. At the end of their product life, zinc die castings can re-enter the materials stream via an established recycling industry, often finding their way into new products produced by the steel, rubber, agricultural and pharmaceutical industries. Furthermore, zinc enables the production of precision parts to net shape that requires no extra machining, thus contributing to energy savings. For more information about zinc and sustainable development, please visit www.zincworld.org.

Zinc pressure die casting alloys

Originally developed in the 1930's, zinc casting alloys are made from high purity zinc, combined with small amounts of aluminum, magnesium, and sometimes, copper. These small amounts of alloying materials transform zinc, which in its pure form is a brittle, low-strength metal, into an engineering material, with high strength and hardness, good ductility and excellent castability. The physical and mechanical properties of zinc alloys can be negatively affected by impurities, so international specifications have been developed for zinc die casting alloys, insuring consistent chemical quality.

Zinc casting alloys were originally used in decorative and non-structural applications, but over the last several decades have gained acceptance as a material for engineered components and structures. The castability and strength of zinc alloys provide excellent design flexibility, expanding the capabilities of the die casting process.

Mechanical properties (strength and ductility) are comparable, or even superior, to many other cast materials such as aluminum, magnesium, brass and cast iron. Zinc alloys have good bearing and wear resistance; performing like traditional bronze bearing alloys in both dry and lubricated conditions. Zinc alloys perform exceptionally well under conditions of moderate, continuous loading (like threaded connections) or short term, high stresses. These alloys are typically not used in applications where high continuous stresses or elevated temperatures are encountered.

Zinc alloys are corrosion resistant under normal atmospheric conditions, in neutral to alkaline pH aqueous solutions and in contact with petroleum products. Like many other metals, the use of chromate or phosphate dip coatings enhances corrosion resistance.

The commonly used zinc alloys (normally referred to as #3, #5, or #7) have a unique combination of properties that allow for rapid, cost-effective production of strong, durable and accurate components. In comparison to other non-zinc die casting alloys (such as aluminum and magnesium), they are more easily cast, require less finishing, can be held to tighter tolerances, are cast in thinner sections and are generally superior in strength and hardness. Zinc alloy die castings are stronger, tougher and more dimensionally stable than injection molded plastics. The development of a family of high strength (ZA) zinc alloys in the 1970's created the opportunity for expanded zinc pressure die casting use in higher performance applications, replacing cast iron, brass and bronze.

Zinc alloys are environmentally sound. They require less energy to convert from ore to ingot to finished product than most competing materials. When properly handled, zinc alloys do not create airborne pollutants or toxic waste products. An infrastructure is actively in place to recycle zinc by-products and cast zinc alloy products at the end of their useful life.

Zinc *Protects!*

www.dezign.org
contains over 150 case studies demonstrating the
versatility of zinc in die cast applications as well as
detailed technical information on designing with zinc.

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