# Comparing Metal Injection Molding (MIM) with EZAC® Die Casting Components

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## Introduction

The Metal Injection Molding process is a net shape process that forms and sinters metal powder to create high strength components. It is a cost effective process when components are in need of high strength and wear characteristics that other processes are not able to achieve.

Although both the MIM and die casting processes consist of injecting metal into a die, this is where the similarity ends. Die casting has several economic advantages, which in the right circumstance and component, may offer large cost savings opportunities for the component designer. This article briefly touches on some of these advantages.

## Property Comparison

There are many different types of MIM alloys. The most common alloys are stainless steels, titanium, nickel, tungsten, copper and other various combinations. Figure 1 shows a list of many of these alloys with respect to yield strength. The highest strength MIM alloys are extremely strong, reaching 1600 MPa (232 ksi). However there is quite a range with the lower strength alloys at approximately 200 MPa (29 ksi). Included in this graph is a reference to Eastern Alloys' new EZAC® alloy. As shown, the strength of this alloy is approximately 400 MPa (57 ksi).

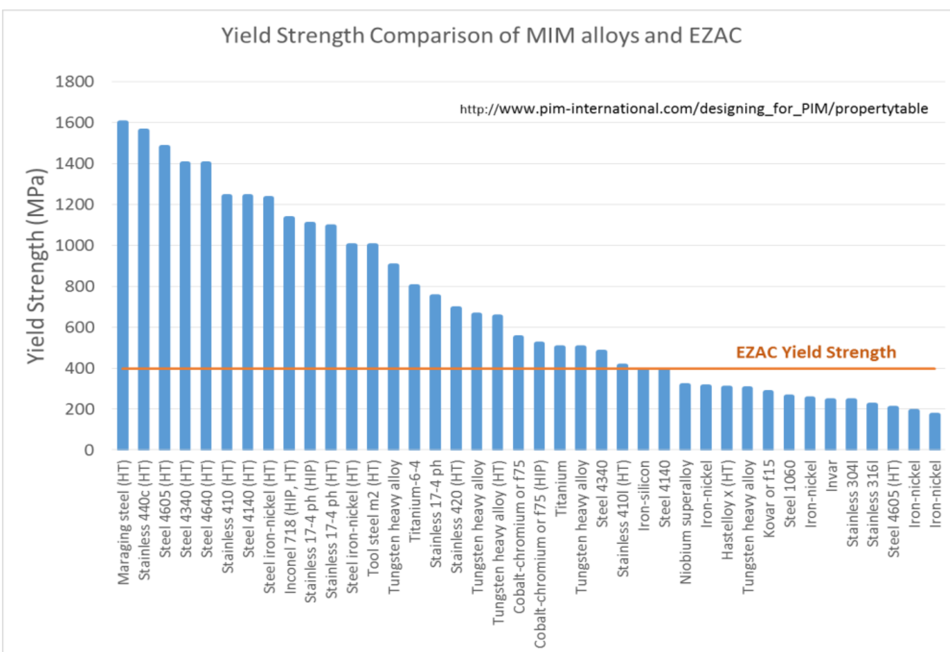



*Figure 1: Yield strength comparison of common MIM alloys compared to EZAC.*

Although EZAC is not as strong as many of the MIM alloys, it is stronger than about 1/3 of those alloys shown in this fairly extensive list. It appears to be stronger than most of the "Iron-Nickel" alloys, L-grade stainless steels, and several others.

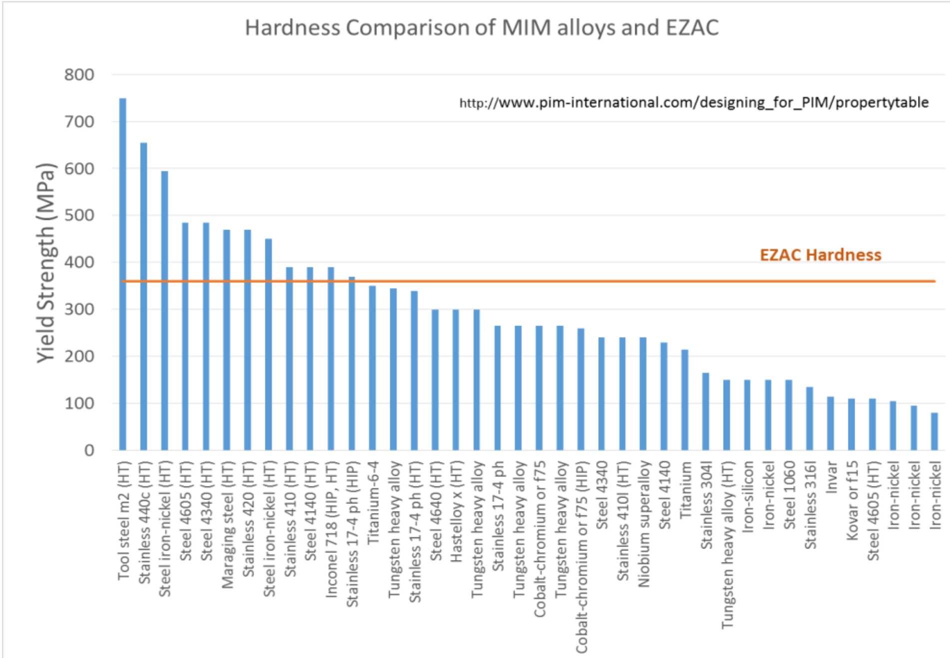



*Figure 2: Hardness comparison of common MIM alloys compared to EZAC.*
*(Note: EZAC's VHN hardness was converted from a Rockwell B value of 68.4)*

EZAC®'s hardness value was tested using the Rockwell B scale, with a result of 68.4. The closest conversion of this value to a Vickers value is 354. As shown in Figure 2, EZAC® appears to have a greater hardness value than more than half of the MIM alloys represented here, including the same L-grade stainless steels, iron-nickel alloys, and even some of the heat treated alloys.

## Process Comparison

The Zinc die casting process is the fastest and most economical way to form high volumes of net-shape components. The zinc alloying process consists of mixing zinc with essential elements such as aluminum, copper and magnesium into an ingot which is then shipped to the die casting facility. At the die casting plant, the ingot is melted either at the die casting machine or in a central furnace and transported to the die casting machine. During the "hot chamber" die casting process, the pump (which is immersed in the molten alloy) pushes the alloy through the die casting machine and into a die. Cycle times are dependent on the size of the component, but can range from a second, up to approximately 30 seconds.

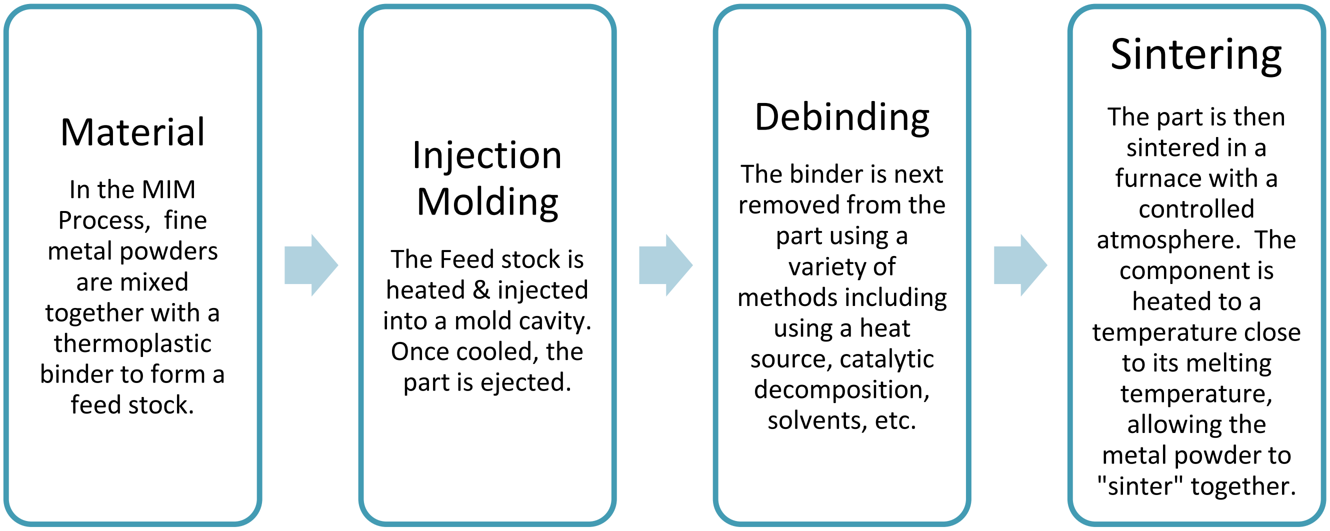
**Material**

In the Zinc die casting process, zinc alloys are produced by alloying zinc with other essential ingredients such as Aluminum, Copper and Magnesium.

**Die Casting**

At the die casting facility, the zinc alloy is melted and cast into a net shape component.

The MIM process is a more demanding process. In this process, the metal alloy is first formed into a fine powder and then mixed with a thermoplastic binder to form a feed stock. The feed stock is shipped from the supplier to the injection molding plant where it is heated, injected into a mold, cooled and finally ejected from the mold. The next step is a de-binding process where a catalyst is used to remove the binder. This is followed by a sintering process where the part is put into an oven at a temperature close to the melting temperature of the metal allowing the fine metal powder to sinter together, leaving a strong net-shape component.




Although the MIM Process can produce higher strength components than die casting, the process is been found to be much more costly than the die casting process. This cost differential depends on the type of alloys chosen, but our experience is that the die casting process has been found to be <u>at least</u> 30% less expensive. In addition, it is published that the typical die life for MIM alloys is about 150k – 300k shots (depending on size and shape of component). The zinc die casting process reports a typical die life of over one million shots. So, in addition to standard material and processing costs, additional costs in die life can be achieved with the zinc die casting process.

Also, during the debinding and sintering stage up to 30% shrinkage can occur in the MIM process. The patternmaker's shrinkage for zinc die casting is approximately 0.007" per inch. This isotropic shrinkage that occurs in die casting eliminates some of the MIM related tool making challenges and costs. There are also many other component design advantages to the zinc die casting process over MIM including linear tolerance, draft, size limitations, isotropic shrinkage, etc. These may be discussed in detail in a subsequent articles.

## Summary

The MIM process is a very interesting and cost effective method to create high strength, net-shape components. It is less expensive than many alternative processing techniques such as machining. It is however, much more expensive than the zinc die casting process. Although many of the MIM alloys are stronger and harder than most of the zinc die casting alloys, Eastern Alloys' new EZAC® alloy appears to be stronger than about a third of the alloys commonly listed as MIM alloys and harder than more than half of the MIM alloys listed. Therefore, there appears to be many cost saving opportunities to convert some of these lower strength less hard MIM alloys to an EZAC® die casting component.

*Please visit our website www.eazall.com, or contact Ryan Winter via email at rwinter@eazall.com or phone 845-427-2151 to discuss additional advantages of zinc die casting or the die casting process.*