Diecast Forums - Bulletin Board – Diecast Zone

Posted By: **William Hadfield**
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Message:

I came across some information on Wikepedia about the dreaded disintegration of our

beloved little cars. It is known as Intergranular Corrosion caused by impurities in the Zinc Alloys that are used to make our diecast models. It seems that despite regulated standards imposed for the composition of ZAMAK since 1960, these impurities have still managed to creep into the mixture at some of the Chinese factories that produce diecast models, as evidenced by many early Franklin Mint models which are affected from 1996-2000. It's too bad all of these affected models weren't recalled, or replaced by Franklin Mint. IMHO.

Zinc pest, (from German Zinkpest), is a destructive, intercrystalline corrosion process of zinc alloys of poor purity. This corrosive process is not the same thing as metal fatigue caused by externally applied forces.

Zinc pest affects primarily die-cast zinc articles that were manufactured during the 1930s, 1940s, and early 1950s. In Germany, articles made from ZAMAK, a zinc alloy that also contains aluminum, magnesium, and copper, may be affected when produced during World War II and several years thereafter. Purer alloys were not available to the manufacturers as they were used for the war effort, or were just not on the market after the war. While impurities of the alloy seem to be the cause of the problem, environmental conditions such as warm humidity (greater than 65%) may accelerate the process. Also, significant temperature changes can be damaging.

Affected objects may show surface irregularities such as blisters or pitting. They expand, curl, buckle, tear, and in the end, crumble. The irreversible process will eventually destroy the object. Due to the expansion process, attached normal material may be damaged secondarily. Zinc pest is different from a superficial white oxidation process (“Weissrost”) that may affect some zinc articles.

Zinc pest is dreaded by collectors of old model trains, toys, or radios where the zinc die-cast process was used. Valuable items are rendered worthless but for their residual parts. Also parts of engines of older vehicles or airplanes and military medals may be affected. Fortunately many articles of the time period at risk show no signs of zinc pest and seem to be stable.

Articles made after 1960 are generally considered free of the risk of zinc pest. Use of purer materials and more controlled manufacturing conditions make it unlikely that modern zinc articles will encounter degradation by zinc pest.

Zinc pest is not related to tin pest.

ZAMAK, also known as ZAMAC, was the trademarked name covering a family of zinc alloys, with a base metal of zinc and alloying elements of aluminum, magnesium and copper. ZAMAK alloys are part of the zinc aluminum alloy family; they are distinguished from the other ZA alloys because of their constant 4% aluminum composition. The name ZAMAK is an acronym of the German names for the metals of which the alloys are composed: Z for Zink (zinc), A for Aluminium (aluminum), MA for magnesium and K for Kupfer (copper). The New Jersey Zinc Company first developed the ZAMAK alloys in 1929. ZAMAK may also be referred to as pot metal, or white metal.

Zinc-aluminum alloys, more commonly referred to as ZA, are named as such because the main constituents are zinc and aluminum. Other alloying elements include magnesium and copper. The numbers associated with the name represent the amount of aluminum in the alloy (i.e. ZA8 has 8% aluminum). ZAMAK goes by many different names based on standard and/or country. The most common ZAMAK alloy is ZAMAK 3, but ZAMAK 2, ZAMAK 5, and ZAMAK 7 are still commercially used. These alloys are most commonly die cast. ZAMAK alloys (particularly #3 and #5) are frequently used in the spin casting industry.

In the early 1930s Morris Ashby in Britain had licensed the New Jersey ZAMAK alloy. The high-purity refluxer zinc was not available in Britain and so they acquired the right to manufacture this alloy using a locally available electrolytically refined zinc of 99.95% purity. This was given the name Mazak, partly to distinguish it from ZAMAK and partly from the initials of Morris Ashby. In 1933 National Smelting licensed the refluxer patent with the intent of using it to produce 99.99% zinc in their plant at Avonmouth.

A large problem with early zinc die casting materials was zinc pest, owing to impurities in the alloys. ZAMAK avoided this by the use of 99.99% pure zinc metal, produced by New Jersey's use of a refluxer as part of the smelting process.

All ZAMAK castings have additional amounts of various impurities which are regulated, and controlled, supposedly, to fall within specified guidlines. These elements are Lead(Pb), Cadmium(Cd), Iron(Fe), Nickel(Ni), Tin(Sn), Silicon(Si), Indium(In), and Titanium(Ti).

ZINC ALLOY APPLICATIONS:

ZA2 Industrial hardware, automotive parts, and sporting equipment.

ZA3 Having excellent balance of desirable physical, mechanical, and superb castability. Almost suitable for any die-casting component .

ZA4 Ceiling fans, electronics, and electrical.

ZA5 Toys, bathroom hardware, domestic hardware, gas regulators, electronics, and electrical.

ZA8 Industrial hardware, sporting equipment (golf clubs, fishing reels), and automotive parts.

ZAMAK 2 and ZAMAK 3 have the same composition, except ZAMAK 2 also has the addition of 3% copper in order to increase strength by 20%, but this also increases the price. ZAMAK 2 has the greatest strength out of all the ZAMAK alloys. Over time it retains it's strength and hardness better than the other alloys, however, it becomes more brittle, shrinks, and is less elastic.

ZAMAK 2 is also known as Kirksite when gravity cast as for use as a die. It was originally designed for low volume sheet metal dies. It later gained popularity for making short run injection molding dies. It is also less commonly used for non-sparking tools and mandrels for metal spinning.

The KS alloy was developed for spin casting decorative parts. It has the same composition as ZAMAK 2, except with more magnesium in order to produce finer grains and reduce the orange peel effect.

ZAMAK 3 is the de facto standard for the ZAMAK series of zinc alloys; all other zinc alloys are compared to this. ZAMAK 3 has the base composition for the ZAMAK alloys (96% zinc, 4% aluminum). It has excellent castablity and long term dimensional stability. More than 70% of all North American zinc die castings are made from ZAMAK 3.

ZAMAK 4 was developed for the Asian markets to reduce the effects of die soldering while maintaining the ductility of ZAMAK 3. This was achieved by using half the amount of copper from the ZAMAK 5 composition.

ZAMAK 5 has the same composition as ZAMAK 3 with the addition of 1% copper in order to increase strength (by approximately 10%), hardness and corrosive resistance, but reduces ductility. It also has less dimensional accuracy. ZAMAK 5 is more commonly used in Europe.

ZAMAK 7 has less magnesium than ZAMAK 3 to increase fluidity and ductility, which is especially useful when casting thin wall components. In order to reduce inter-granular corrosion a small amount of nickel is added and impurities are more strictly controlled.

All types of Zamak are used in China and Asia. I would guess that ZA5, or ZA3 is the type used to cast our models, but I'm not sure. I couldn't find any definitive information to back this up, except one mention in a link that most diecast toys are made from ZA5. 

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Message thread:

Thanks, George. I had a feeling it was the ZA3, but it's nice to have it comfirmed by someone in the by **William Hadfield** #22198.1.3

It's certainly not the white room at NASA. by **George Bojaciuk** #22198.1.3.1