INDUSTRY DEVELOPMENTS:

DIE CAST HEAT SINKS

Die casting was developed almost two centuries ago. One of its first applications was for making movable letter type for more efficient printing. Today, die casting remains a reliable process for producing accurately dimensioned, sharply defined, smooth or textured-surface metal parts.

In simple terms, die casting is the forcing of molten metals into a die cavity to create reproducible three-dimensional parts. It can quickly yield complex, precise, rigid cast parts with smooth surfaces that don't need intense secondary machining. Most metals used for die cast parts are non-ferrous, while the die molds are typically steel. Common materials include copper and aluminum which are the most widely metals used for heat sinks.

The die cast process has been refined over the years, including advanced process controls to maintain consistent castings part after part. Today, with forced die filling, fast cooling, multi-part cavities and automated ejection, die casting is a practical way to produce high volumes of precision parts. High density die casting is bringing even more capabilities to the industry.

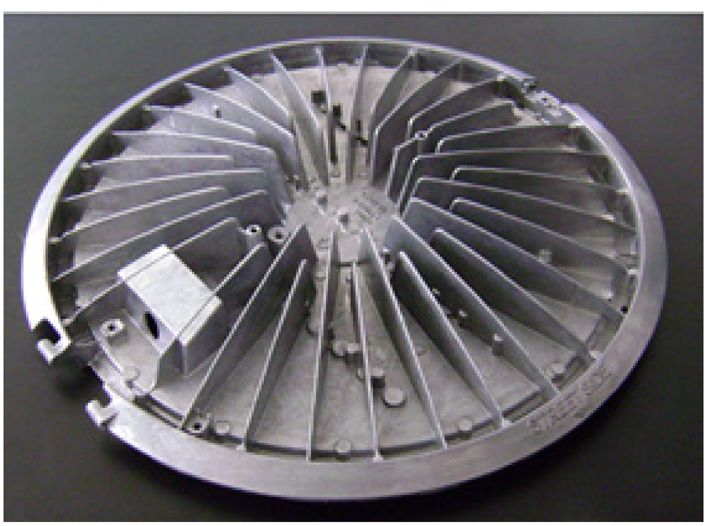

Figure 1. Aluminum Die Cast Heat Sink Used for Cooling LED-based Street Lights [1]

For heat sink manufacturing the above qualities along with better cooling performance makes die casting an option for many applications.

The solid, one-part nature of cast heat sinks provides application-suitable cooling performance, and parts can be cast to mate intimately with irregularly shaped hot surfaces. Fins and pins are not bonded on, but are an integral part of the cast metal base. Die cast heat sinks are thus a practical means to cool different electronic components and devices. These include circuit boards, LED fixtures, automotive, communication and military electronics.

With advanced die casting processes, larger heat sinks can be cast to bring thermal management to cool modern electronics. In one example, die casting was used to create the heat sink structures used on LED-based city street lights. Another application of a large die cast sink is on an LED canopy lighting system for retrofitting the existing lighting systems. Requirements for this heat sink include proper function with the presence of hornet nests.

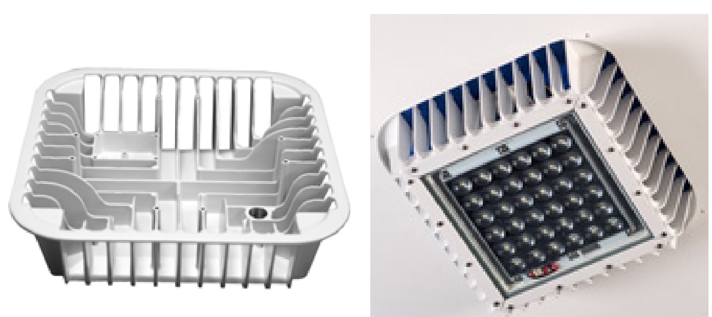

Figure 2. Die Cast Heat Sink Cools LEDs on a Canopy Light [2]

Another die cast sink model was used to cool the LED stadium lighting at the last Super Bowl. The University of Phoenix Stadium was the first NFL field to be lit using only LEDs. The new lights draw approximately 310 kilowatts of energy compared with the 1,240 kilowatts required by the old system, a savings of about 75%. To realize these benefits, the LEDs needed a thermal management solution that could meet the cooling needs of the lighting as well as perform in the high heat of Arizona. [3]

The solution was a die cast aluminum heat sink fabricated by Advanced Thermal Solutions to fit the stadium's modern design look while providing the essential cooling solution. Die casting allowed the heat sink to meet exacting tolerances required in the lighting design.

Figure 3. Large Die Cast Heat Sinks for High Power LED Stadium Lights [3]

As mentioned, die casting allows the use of embedded inserts that become part of the ultimate part. The process yields a strong mechanical bond with almost no interfacial gap or porosity. For example, the base of a heat sink can be die cast around an array of thin, stamped metal fins or pins. The continuity between the fins/pins and the base eliminates the impact of any interface resistance. This hybrid manufacturing process can allow the manufacturing of higher aspect ratios with tightly spaced fins for more heat absorbing capabilities.

A more recent development in this kind of manufacturing is high density die casting, or HDDC. The process involves a pressurization step of the liquid metal, which allows the use of higher thermal conductivity metals, including wrought aluminum AL 6063 and Al 1070. This process can produce heat sinks that provide better heat dissipation efficiencies than common die cast heat sinks. These sinks are also much less porous and have higher strength due to the high pressure process. [5]

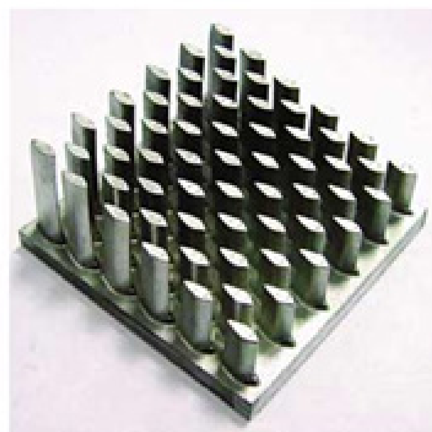

Figure 4. Aerofoil-shaped Pins Inserted in a Die Cast Heat Sink Base [4]

The high density casting method also allows a wider variety of fin designs and features. Fins can be cast thinner and with higher aspect ratios. Redesigned fin fields can lower airflow resistance and enhance turbulence for improved thermal performance. HDDC enables tighter fin to fin spacing and fin angles. The pore-free structure of aluminum HDDC heat sinks allows them to be finished using wet electrochemical processes like anodizing. With the HDDC process, aluminum, copper, graphite or other solids with lower CTEs than aluminum can be embedded directly into the part. The process yields a strong mechanical bond with almost no interfacial gap or porosity.

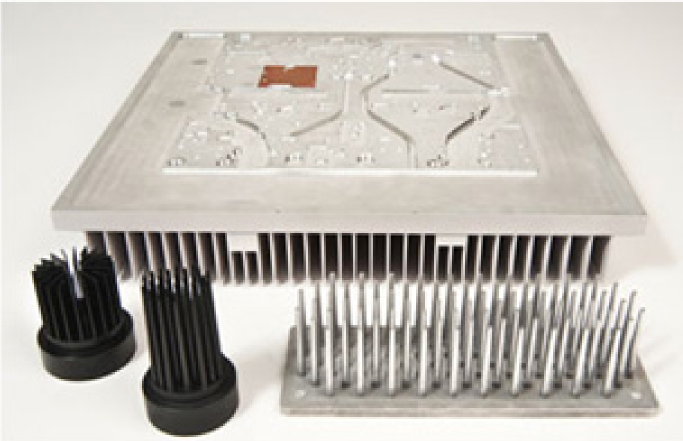

Figure 5. High Density Die Cast [6]

CONCLUSION

Die casting is an older but proven technology, sometimes called the shortest distance between raw materials and finished parts. For many applications this is still true, and today's die cast parts can provide performance and price points that other processes can't match. With a high demand for customization in commercial electronics, such as LED lighting, die cast heat sinks can quickly bring practical cooling solutions that other methods can't achieve.

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