Infratron®
GmbH · Produktion und Vertrieb

The Thermal Management

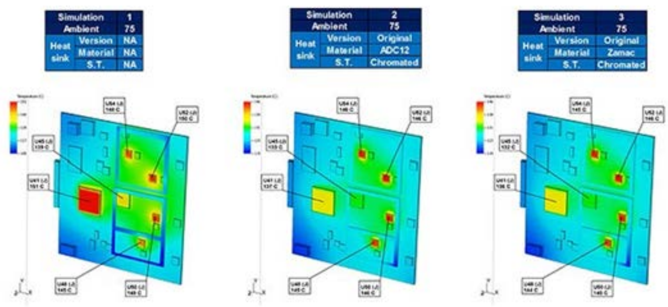
Thermal Analysis

When a required thermal solution is complex Columbia-Staver begin by fully understanding the customers challenge.

This not only requires a detailed understanding of the mechanical and thermal requirements but also the working environment, the components safe working parameters and of course the commercial constraints.

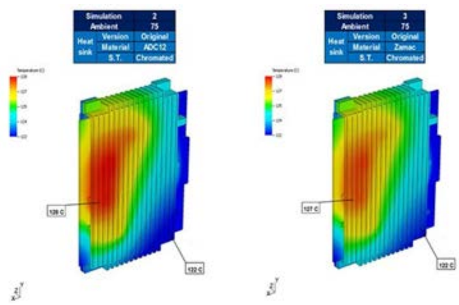
Reaching the optimum mechanical, thermal and commercial solution in the shortest possible time then often requires thermal analysis using analytical and Computational Fluid Dynamics (CFD) techniques This approach will almost certainly shorten product development times and reduce development costs ensuring increased revenue and profitability.

Once the data has been entered into the software, time can be saved by performing multiple visualisations and simulations changing parameters each time in order to optimise a potential design solution prior to prototype manufacture and empirical testing.



Typical temperature results from three separate analysis runs:

- Base line (Board with no solution fitted)
- With Aluminium casting material
- With Zinc casting material



Typical XY Temperature plot

Infratron GmbH Produktion und Vertrieb · Am Schnepfenweg 34 · D-80995 München
Tel.: 089/158 126-0 · Fax: 089/158 126-99 · www.infratron.de · e-mail: info@infratron.de

Liquid Cooling

Liquid Cold Plates
When compared with more traditional air cooled solutions, Liquid cold plates offer significant performance advantages particularly in high power and high heat flux applications. Columbia-Staver are the go to experts in liquid cooling and offer a comprehensive range of cold plates.

Tube in Plate
The simplest form of cold plate where a joint free tube is embedded into a copper or aluminium carrier plate. The tube can be copper or stainless steel and can be a simple mechanical (dry) press fit, press fit with a thermal epoxy boundary or soldered in place for maximum thermal performance.

Gun-Drilled
A gun-drilled cold plate is manufactured by drilling a matrix of holes through the length of the x and y axis. Liquid is then directed through the desired bath by mechanically blocking unwanted paths. These cold plates have the advantage that there are no thermal boundaries and the carrier plate has had no thermal stress during the manufacturing process.

Die Cast
When complex surface shapes are needed on a cold plate and CNC machining would be cost prohibitive. Then one or even both halves can be die cast. These die cast parts can then be joined together by structural epoxy or as pioneered by Columbia-Staver Friction stir welded FSW.

Multi-Part Cold Plates
When higher performance is required, cold plates can be made from multiple parts (two or more). This enables additional thermal features to be added into the liquid flow path. Once made the separate pieces need to be joined. The joint needs to be leak free and able to withstand the working pressure.

FSW Friction Stir Welded
This is a welding technique that uses friction to locally heat and join the metal. It is fast, clean, and flexible and requires no filler material. Additional benefit final plate does not need re-tempering.

Structural Epoxy Bonding
This is a method to bond cold plate components together using a high strength structural epoxy. The Joint is strong and reliable and final plate does not need re-tempering.

Brazing (vacuum or controlled atmosphere brazing)
This kind of joining gives a very clean cold plate, it would requires a braze foil and will thermally stress the entire plate requiring re-hardening. Must be done in batches

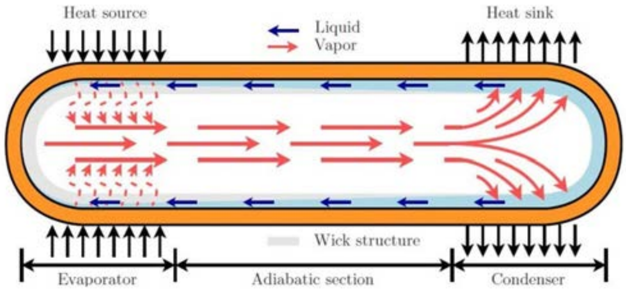
Dip Brazing
With this method the plates are held together by tabs and then immersed in a bath of molten rock salt until the braze foil is diffused into the pieces to be joined. The plate will need flushing clean be thermally stressed and will require re hardening

Heat Pipes

Heat Pipe

A heat pipe is a heat-transfer device that moves heat from a heat source to an area where the heat can be dissipated.

Heat pipes themselves do not dissipate any heat so they need to be incorporated into an assembly to facilitate the heat dissipation or spreading.



Embedded Heat Pipes

The performance of aluminium heat sinks can be improved by embedding heat pipes into the base plate of the heat sink. The high thermal conductivity of the heat pipe effectively changes the thermal conductivity of the base.

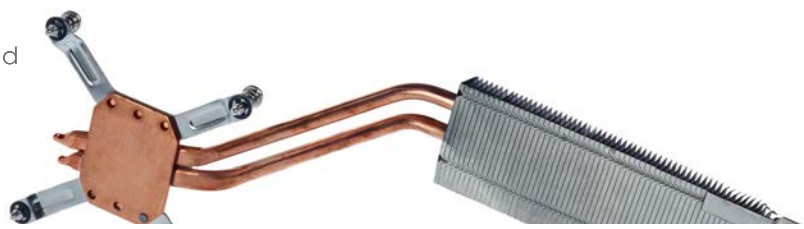
High Heat flux in concentrated areas can be spread across a heat sink by placing the hot spot over one end of the heat pipe which becomes the 'evaporator' and the heat is transferred to the cooler part of the heat sink where it condenses, releasing the heat to the heat sink.

The Dissipation Area

At the other end of the heat pipe from the evaporator is the condenser section, this can be a simple spreader plate or the wall of an enclosure but is more commonly a set of fins designed to increase the surface area for dissipation.

The number and size of the fins depends on the system requirements and the available airflow if any. These fins can be extruded, stamped, skived, machined and can be attached in similar ways to the evaporator i.e. Interference fit, epoxy glued, soldered or even expanded.

By changing the scale of the design i.e. size and number of Heat pipes, the size and number of fins & the design of the evaporator, Heat pipe fin stacks can be designed to carry a few watts or kilo watts of power.



Heat Sinks

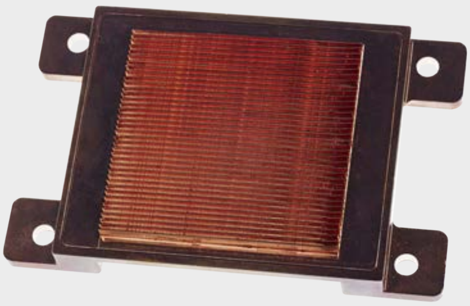
Whatever your Heat-Sink requirement Columbia-Staver can provide the optimum technical and commercial solution.

Extruded Heat Sinks

Extruded heat sinks are the most common heat sinks, used in both natural and forced convection. The extrusion process, allows for innumerable complex shapes to be manufactured. Columbia-Staver can supply standard profiles or engineer a heat-sink shape to achieve optimal performance in the space available. After cooling and aging the material is cut to the final Heat-sink length and any additional features such as holes or pockets can be added.

Cold Forging

Cold Forging is a cold working process. Aluminium is squeezed by a press into the closed die the resultant Heat sink taking on the shape of the void in the die. This process is also known as Cold Heading. Cold forged heat-sinks often have high performance compared with other technologies. The fins can be formed into an elliptical or circular shape enabling airflow from any direction a big advantage in some applications.

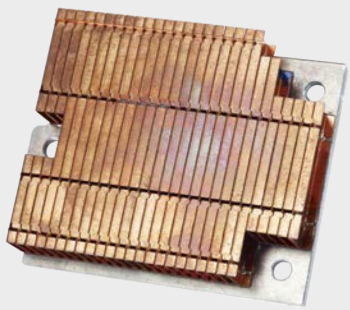


Skived Heat Sinks

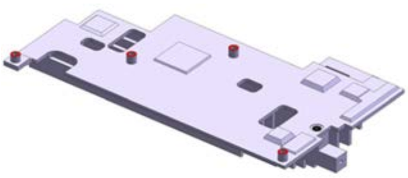
Skived Fin heat-sinks can be used when looking for a fin density which can't be achieved by extrusion technology. Skived heat-sinks usually have 0.5mm thick fins, although fins as thin as 0.2mm are achievable. In this manufacturing technology the Heat-Sink fins are literally carved out of the base of the Heat-sink, the fins are then folded vertically and aligned with the previous fin. As the fins and base are the same block of material, skived fin heat-sinks give excellent thermal conductivity between fin and base.

Stacked, Zipper, folded fin Heat Sink

Stacked or Zipper Fin heat-sinks can be an alternative to extruded and skived when looking for high density fin structure. Unlike the skived fin heat-sink, a zipper fin heat sink is an assembly of a base and a separate fin stack. The fin stack is created using a set of individually stamped fins, these fins are stacked or zipped together into a block of fins. The finished fin stack is then soldered or bonded to the base.



Die-Cast Heat Sinks



Made by injecting liquid metal under high pressure into a high precision mould, created using two hardened tool steel dies. One of the big advantage of Die Casting is forming complex shapes of high tolerance with little need for post moulding machining. Mounting holes, slots, pins etc can be added with little cost penalty. Heat-sinks can be die-cast in both aluminium and zinc materials however the thermal conductivity, of the Die Cast material, is not as good as that used in Extruded Heat-Sinks and Die Casting tooling is generally more expensive than extrusion tooling.