Baknor Thermal

Liquid Cooling Application Note

Rev: 1

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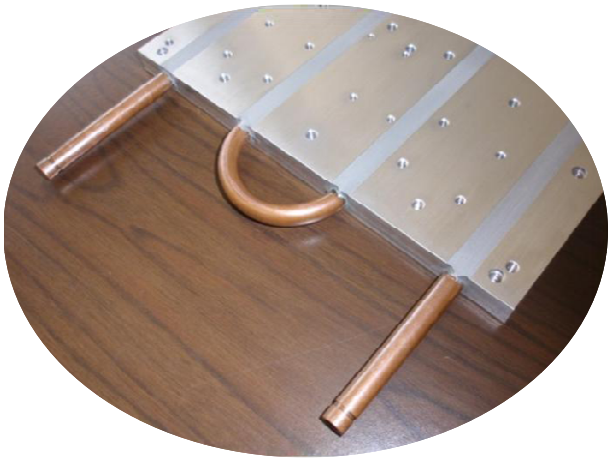
1.0 Cold Plate Manufacturing Capability



Tube Cold Plate

Brazed Cold Plate

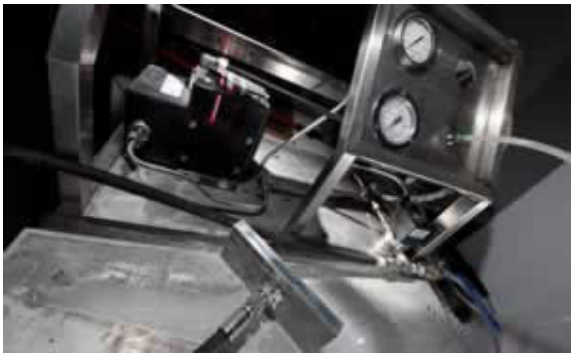
2.0 Product Line Summary

2.1 BT Tube: Tube Cold Plates

Max Dim	L: 58” x W: 28”
Base Material	Al 6061, 6063
Tube Material	Cu, Cupro-Ni, Al Seamless, Al Extruded & Cold Drawn SS
Min Bend Radius	2 x Pipe OD

2.2 BT Zed: CAB Brazed Cold Plate

Controlled Atmosphere Brazing (CAB), Nocolok® process, is the preferred process for manufacturing aluminum heat exchangers. This manufacturing technology is ideal for high performance LCP for electrically non isolated applications. The internal cooling path can be milled channels or lancet offset fins. Suitable for water, glycol or other cooling fluids.



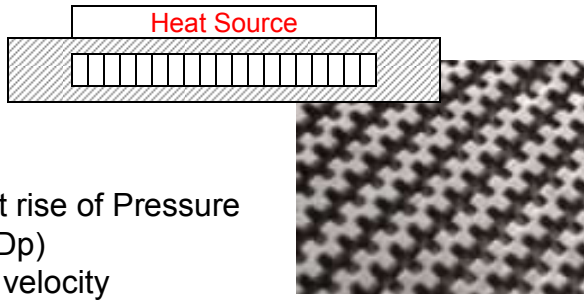
2.3 BT Flow: Vacuum Brazed Cold Plate

Vacuum brazing is a materials joining technique that offers significant advantages: extremely clean, superior, flux-free braze joints of high integrity and strength.

Channels: milled or offset lancet fins
Al base and stainless steel tubes

Vacuum brazing is suitable for electrically isolated devices in some traction and power transmission applications. This LCP is best suited for pure water in high voltage applications.

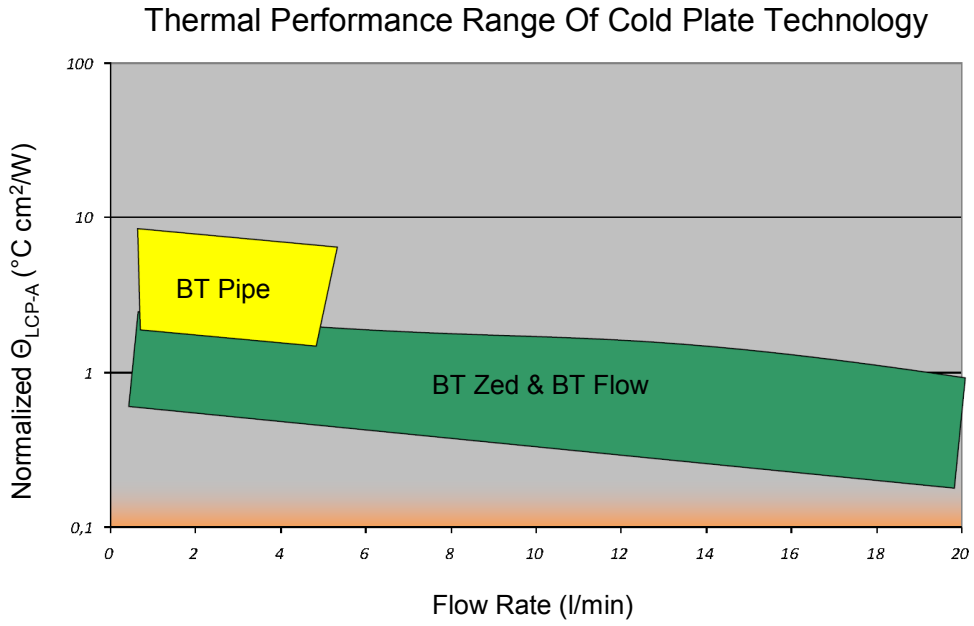
3. Improved Heat Transfer, Turbulators



For BT Zed and BT Flow LCPs performance can be improved by the addition of a turbulence generating fin structure, turbulator. Advantages include …

- Device foot print is uniformly cooled
- Wet area is increased (at the same time slight rise of Pressure Drop) for a better performance (↑↑Surface + ↑Dp)
- High thermal performance even with low flow velocity (turbulator ↑Re)

4. Technology Cooling Spectrum



5. Cold Plate Selection Criteria

		Thermal Performance	Component Mounting Flexibility	$/cm2
Medium Power Density	SS BT Pipe			
	Cu BT Pipe			
High Power Density	BT Zed			
	BT Zed w Turbulators			
	BT Flow			
	BT Flow w Turbulators			

6. Cold Plate Fluid Compatibility

		Water	Water + Glycol	De-ionized Water	Oil	Special Fluids
Medium Power Density	SS BT Pipe					
	Cu BT Pipe					
High Power Density	BT Zed					
	BT Zed w Turbulators					
	BT Flow					
	BT Flow w Turbulators					

7. Corrosion/Erosion Concerns

7.1 Water pH

• Aluminum in pure water will form a self protecting hydroxide layer, in equilibrium with itself.

• This layer is stable in water with a pH range from 4.5 to 8.5.

Natural Waters both surface waters (river water, spring water) and seawater	Typical Municipal Water	Distilled Water
pH close to neutral	6.5 to 7.5 pH	6 to 6.5 pH

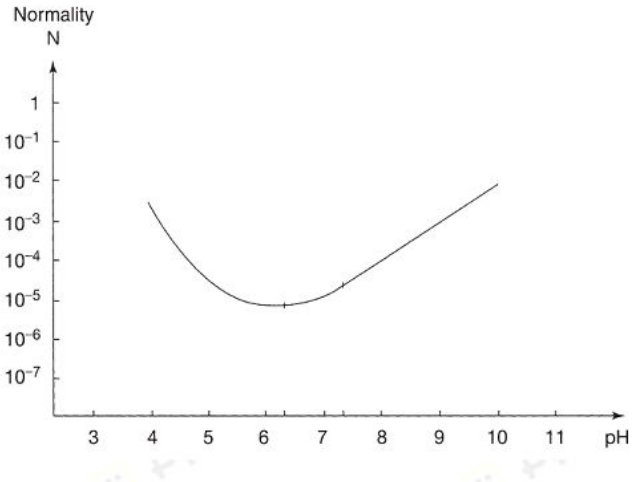


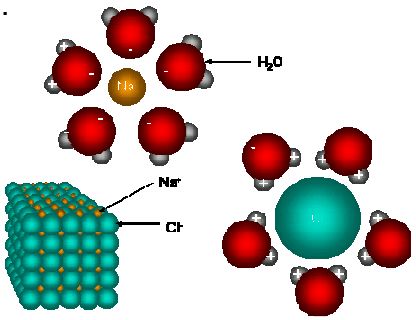
Figure D.2. Solubility of alumina in water as a function of pH.

7.2 Ions solved in water

Among all anions, chloride ions have the highest power of penetration into natural oxide film, because they are small and very mobile.

Chlorides (Cl-), as well as fluorides (F-), bromides (Br-) and iodides (I-) belong to the anions that activate corrosion of aluminum in water, while sulfates (SO2-4), nitrates (NO-3) and phosphates (PO3-4) hardly activate it or do not activate it at all.

Chlorides may substitute oxygen atoms in the alumina network. This leads to a decrease in the protective layer's resistivity.



• Dow Chemical suggests to use water with Cl-< 80 ppm (recommended< 35 ppm)

7.3 Galvanic Corrosion

The galvanic corrosion severity depends on the electrical potential between two metals in the same circuit. Avoid placing two materials with very different electrochemical voltage together (e.g. Copper and Aluminum)

Galvanic corrosion requires 3 conditions:

- Two electrochemically dissimilar metals
- An electrically conductive path between the two metals
- An electrolyte (fluid) to allow the flow of metal ions.

Metal	Electrochemical Voltage (V)
Li	-3,02
Na	-2,72
Mg	-1,80
Al	-1,45
Zn	-0,77
Ni	-0,20
Sn	-0,14
Pb	-0,13
H	0,0
Cu	+0,35
Ag	+0,80
Au	+1,5

7.4 Corrosion Inhibitors

Typically all anti-freeze substances (e.g. ANTIFROGEN–N by Clariant) based on glycol have corrosion inhibitors inside which reduce the corrosion phenomena. See product declarations by the manufacturers for specific performance benefits.

7.5 Corrosion Conclusions

Considering all the parameters affecting the corrosion of aluminum, Baknor has chosen the best solution available in terms of material (aluminum alloys) in order to produce devices guaranteed for a life span in the tens of years under controlled operating conditions:

1. Water quality
2. Correct coupling of materials
3. Use of corrosion inhibitor

8.0 Fittings

PT Pipe: Tube endings can be straight or beaded. Sealing is achieved with PTFE or brass ring

PT Zed & PT Flow: Brazed directly to the plate
Or mechanically fastened

Recommended Vendors
Parker – Industrial Fittings
Swagelok - Fittings

9.0 Lab Test internal Capabilities

Baknor's line of liquid cold plates are manufactured to high quality standards. The internal channels are cleaned with de-ionized water and dried with nitrogen.

Baknor provides the following test capabilities to guarantee product quality:

- Sealing test > 8 bar with air
- Pressure drop measurement
  - Flow rate up to 15 l/min
- Life tests
  - Cycling
  - Stress (up to 45 bar)
- Under preparation:
  - Thermal and mechanical measurement equipments