

Materials for Advanced Heat Exchangers

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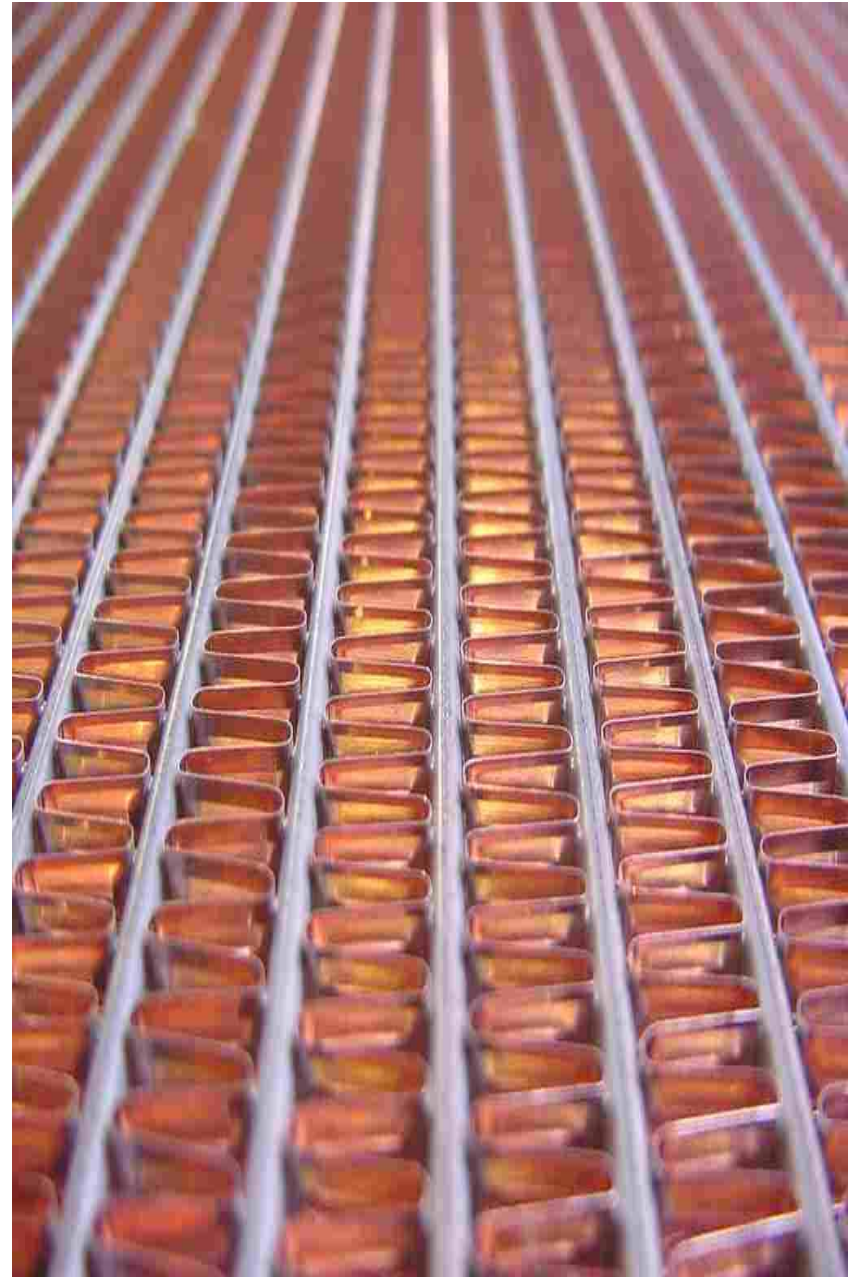
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The Dubai 2009 Special Technology Seminar: Advanced Heat Exchangers for Locomotives and Heavy Equipment

Contents

- Technology development
- What is *CuproBraze* (CB)?
- Process in brief
- CB vs Al and stainless steel
- Why special materials?
- Introduction to materials



Technology development



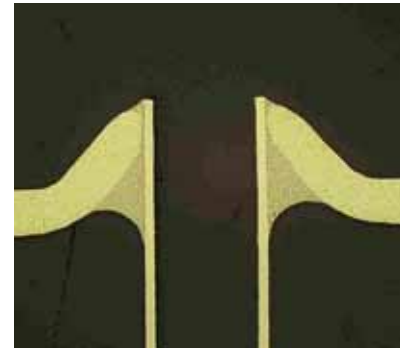
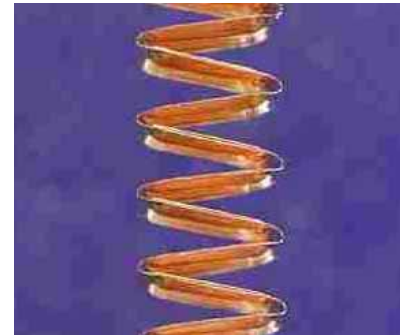
+ Stainless steel

What is *CuproBraz*e?

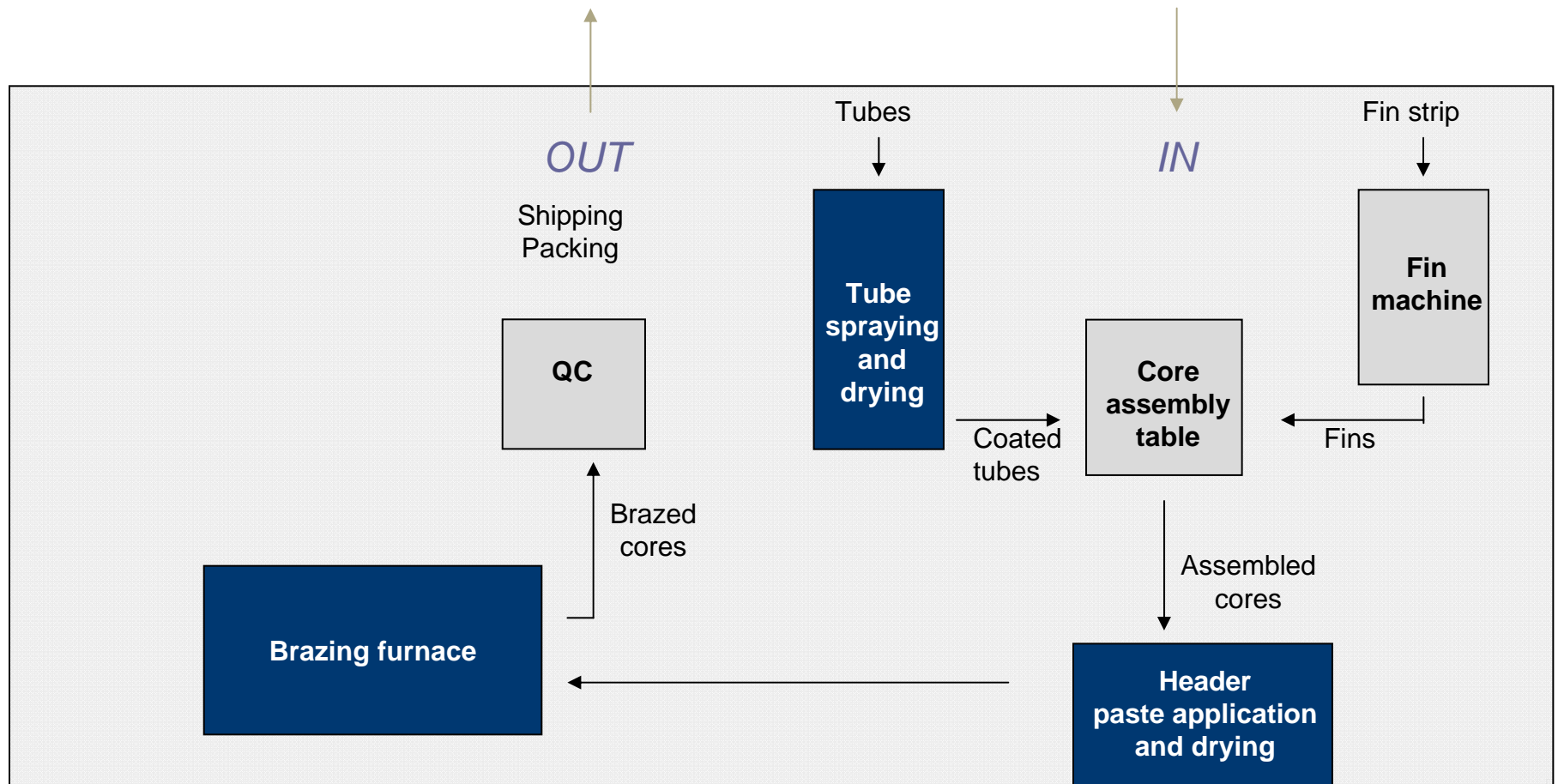
Copper is an outstanding heat conductor.

*CuproBraz*e is an industrial process to manufacture heat exchangers.

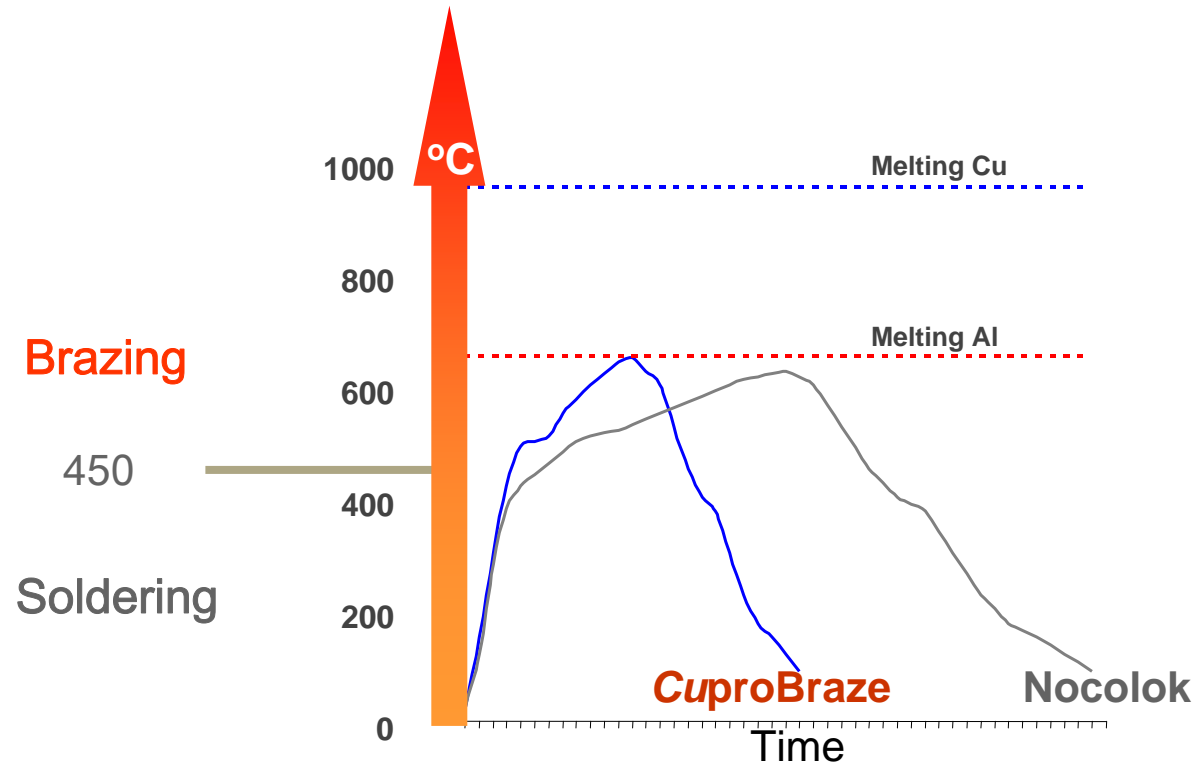
Durable heat exchangers with an environmentally friendly process.



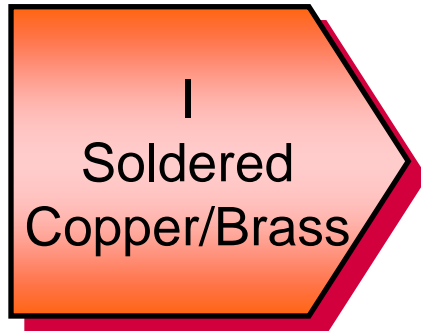
Plant layout for radiator for core manufacturing



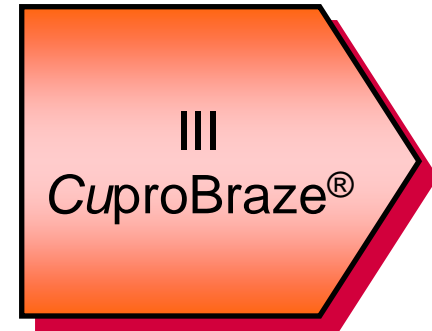
Brazing cycle



Benefits vs. soft soldering



- ✓ Stronger cores
- ✓ No lead
- ✓ Better corrosion resistance
- ✓ Cleaner process
- ✓ No fluxing stage
 - > No rinsing
 - > No waste water treatment
- ✓ Charge Air Cooler production possible



Note: Better tolerances on components required!

Benefits vs. brazed aluminium



Materials

- ✓ Conductivity
- ✓ Thermal expansion
- ✓ Antimicrobial
- ✓ Specific heat
- ✓ Strength at elevated temperatures

Process

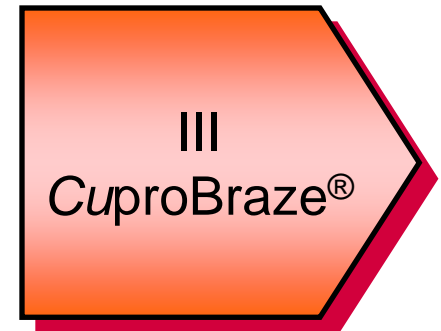
- ✓ Mixed production
- ✓ No fluxing stage
 - >No rinsing
 - >No water treatment
- ✓ Smaller investment

Field service

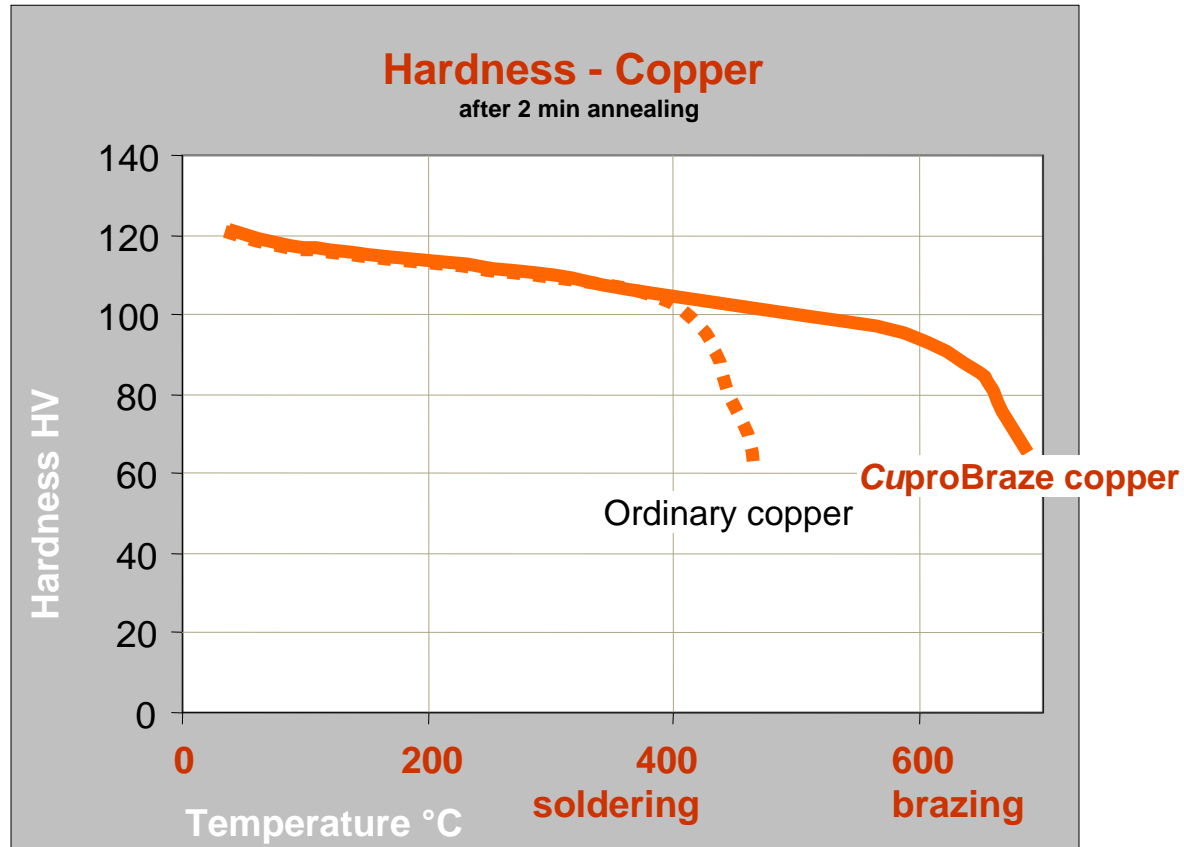
- ✓ **Durability**
- ✓ Spring-back
- ✓ Corrosion resistance
- ✓ Repairability
- ✓ Less fan noise and energy

Environmental

- ✓ Recyclability
- ✓ No waste waters
- ✓ Energy savings

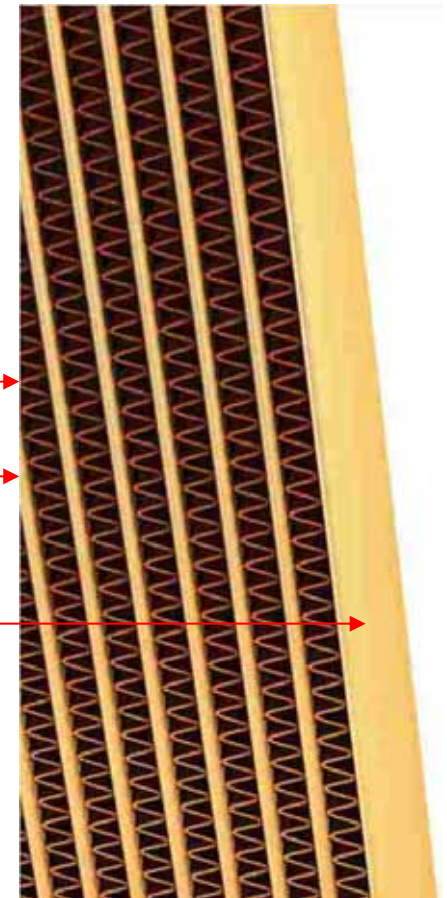


Special materials retain their strength at brazing temperature



Material compositions (%)

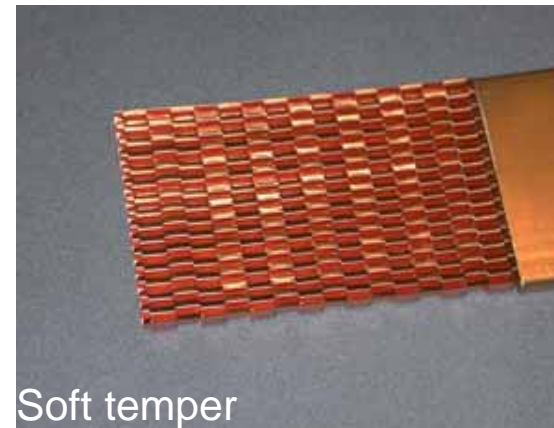
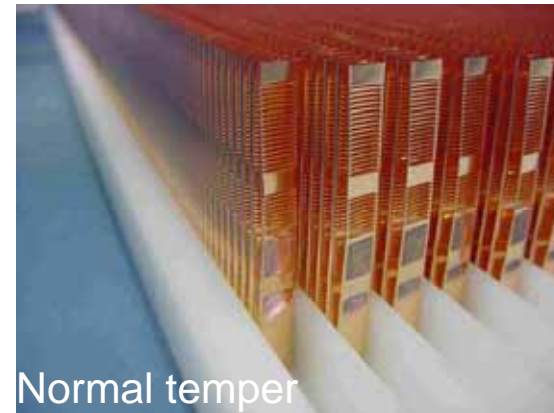
	Cu	Zn	Additional elements	Delivery form
Fins	99.8	-	Cr 0.2	Thin strip
Tubes	85	14	Fe 1	Thin strip
Headers Side supports Tanks	64	33	Ni 3	Strip, sheet
Joints	74.9	-	Ni 4.2, Sn 15.6, P 5.3	Paste
	77.2	-	Ni 7.0, Sn 9.3, P 6.5	Foil



Copper for fins – SM0502

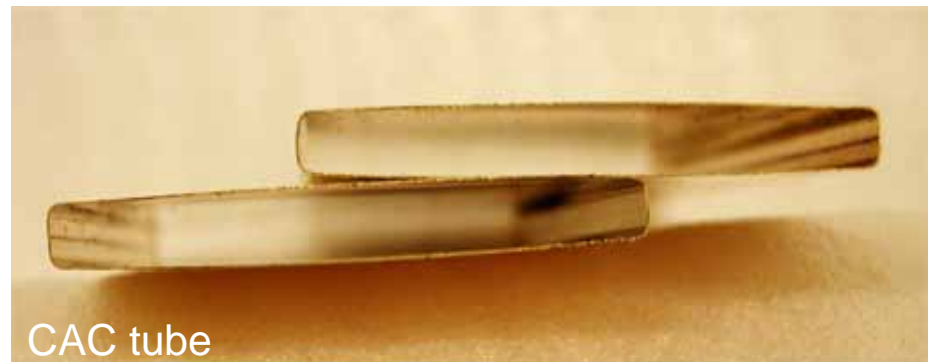
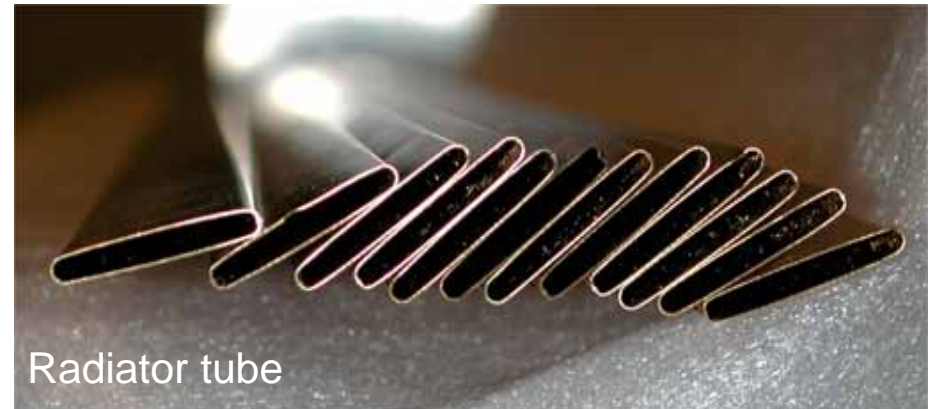
- Copper with 0.2% Cr.
- Precipitation hardening.
- Finely dispersed CuCr particles prevent softening (recrystallization)
- Particle size 2 nm

- Normal temper for corrugated fins and soft temper for turbulators
- Brazing cycle brings up the conductivity



Brass for tubes – SM2385 (C6640)

- CuZn15 with Fe
 - no dezincification
 - no stress corrosion
- Precipitation hardening
- Finely dispersed Fe particles prevent softening (recrystallisation)
- Particle size 0.2 μm
- Tubes made by HF welding

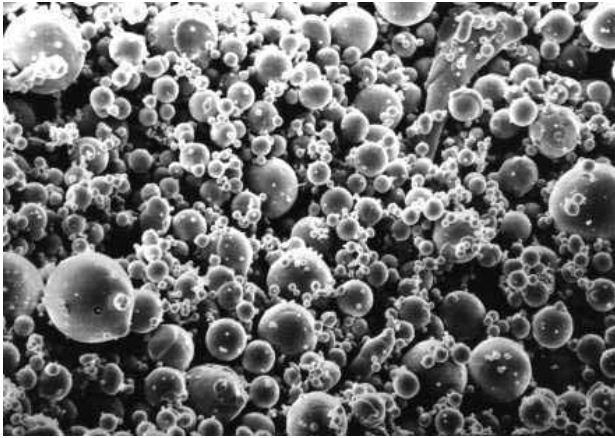


Brass for headers, tanks and side supports – SM 2464 (C74400, CuZn36Ni3)

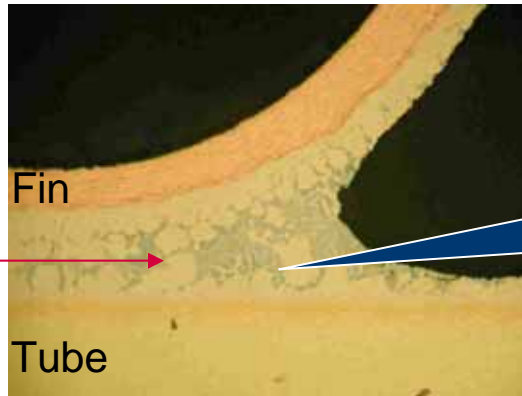


Excellent formability!

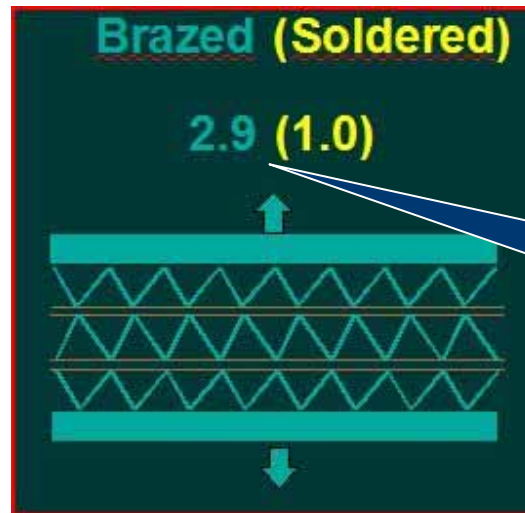
Brazing filler alloy OKC 600 powder



The powder is mixed to paste



As noble as brass >
No galvanic corrosion.

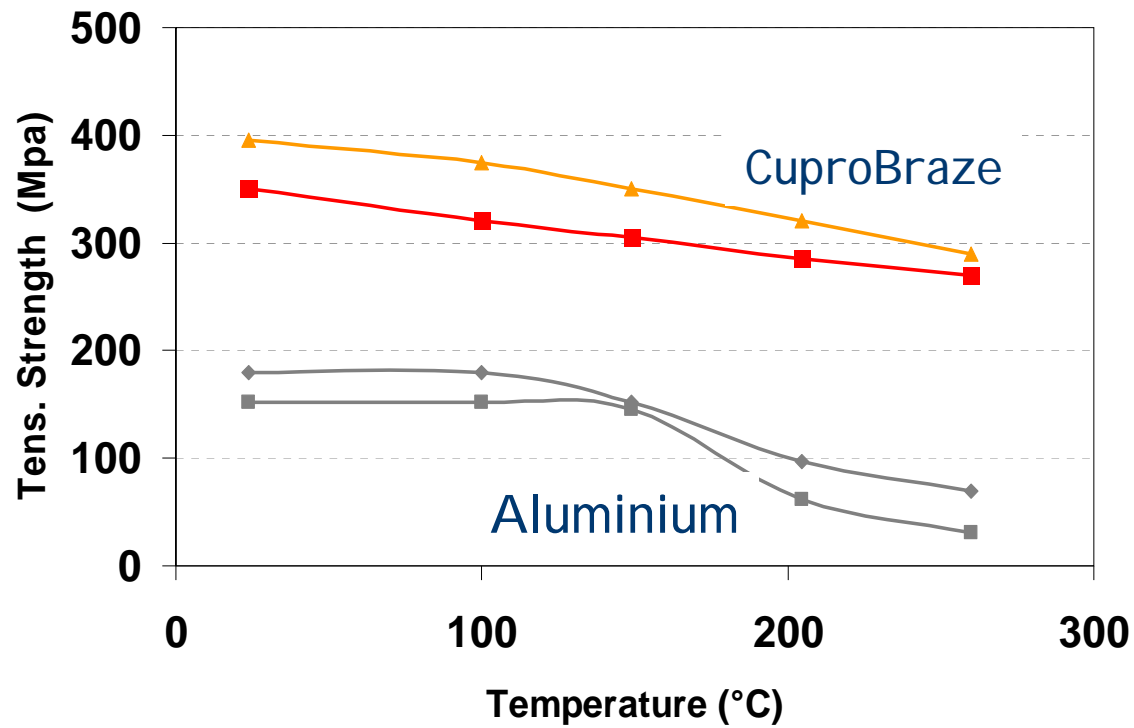


About 3 times stronger
than soldered joints.

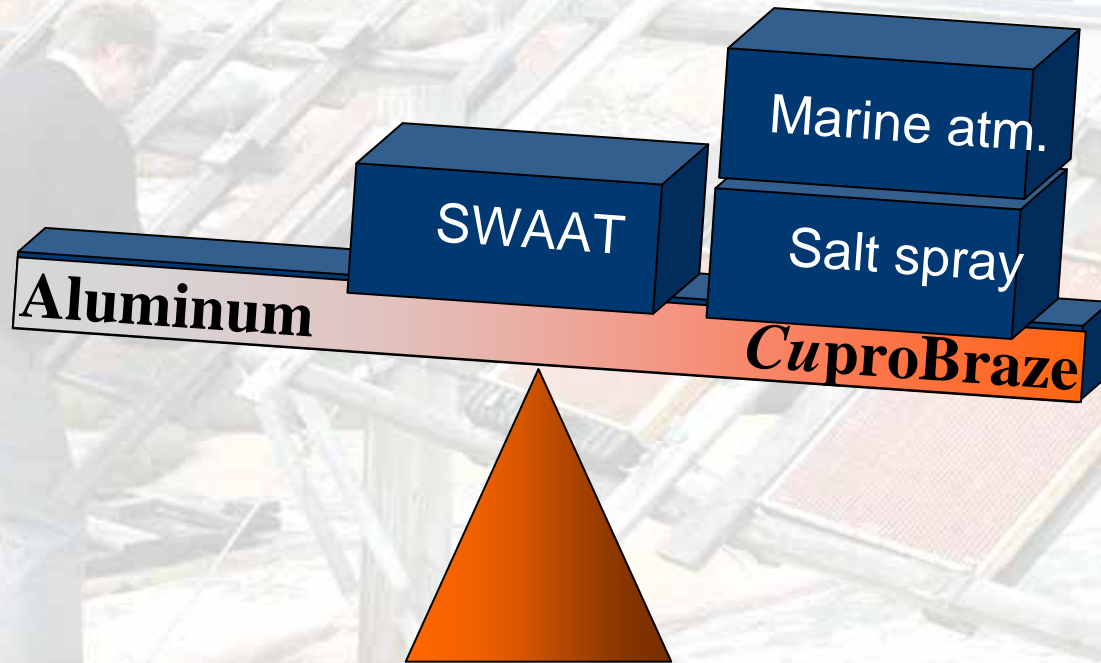
Material comparison

Property	Unit	Cu fin	Brass tube	Al fin	Al tube	Stainless Steel
Density	g/cm ³	8.95	8.53	2.75		7.8 - 8
Thermal conductivity	W/m °C	377	(120)	222	(160)	3 - 24
Tensile strength at room temperature	MPa	330	435	40	145	> 485
Tensile strength at elevated temperature 260°C	MPa	270	290	31	69	> 475
Thermal expansion	µm/m°C	16.5	19.9	23.6		11 - 19
Specific heat	J/kg °K	377		963		500
Melting temperature	°C	1083	915	643		> 1400
Safety margin in brazing operation against core melting	°C	300		30		350

Strength at elevated temperatures

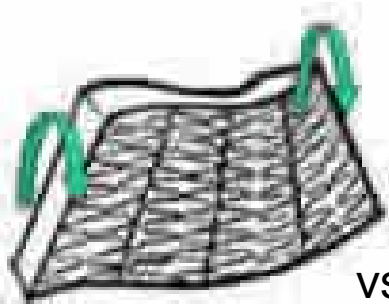


Corrosion testing



Ref: SAE 2001-01-1718

The core has spring-back

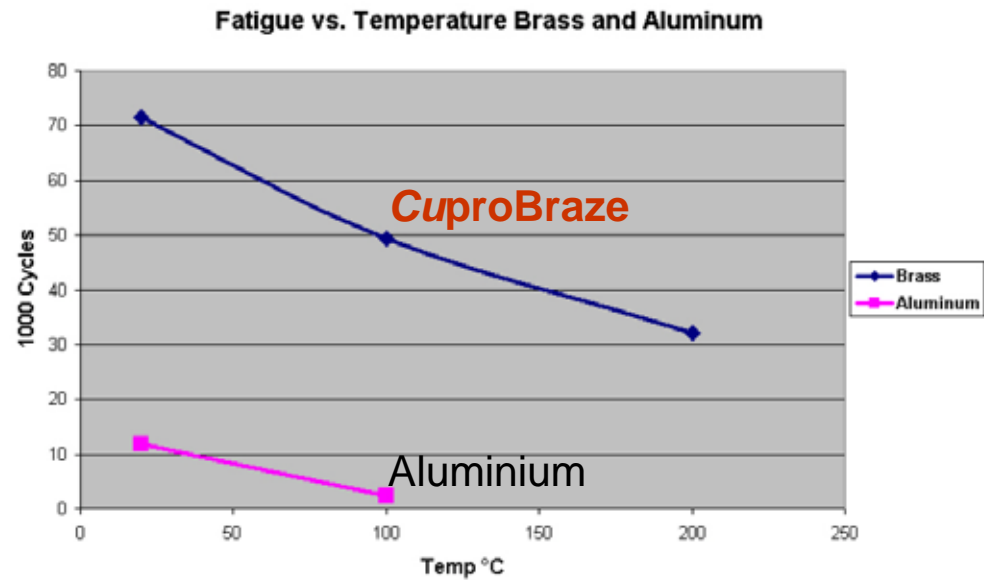
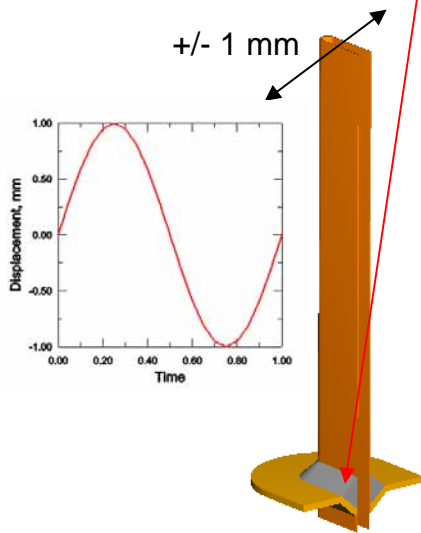
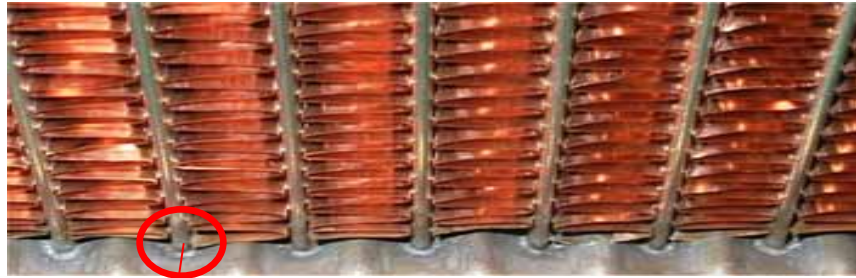


2.6 x

vs. soft soldered

AI stays in twisted position

Fatigue resistance of single tube/header joint



Summary

**The new materials
provide a sound basis for building
durable heat exchangers!**

More info:

www.cuprobraze.com

www.luvata.com

Luvata's *CuproBraze* Brazing Handbook
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LUVATA