



Heat Exchanger Material

Facts & Figures

Aurubis Heat Exchanger Material

- 2,800** • different **heat exchanger designs** are included in the **Aurubis Technical Center's database**.
- 50** • years is how long the **Aurubis Technical Center** has been in **operation**.
- 31** • is the number of times that the amount of **radiator strip** annually supplied by Aurubis could be wound **around the world**.



> 290 °C
> 554 °F

is the extremely high inlet temperature that CuproBraz® charge air coolers (CACs) can withstand.









Production of Heat Exchanger Material

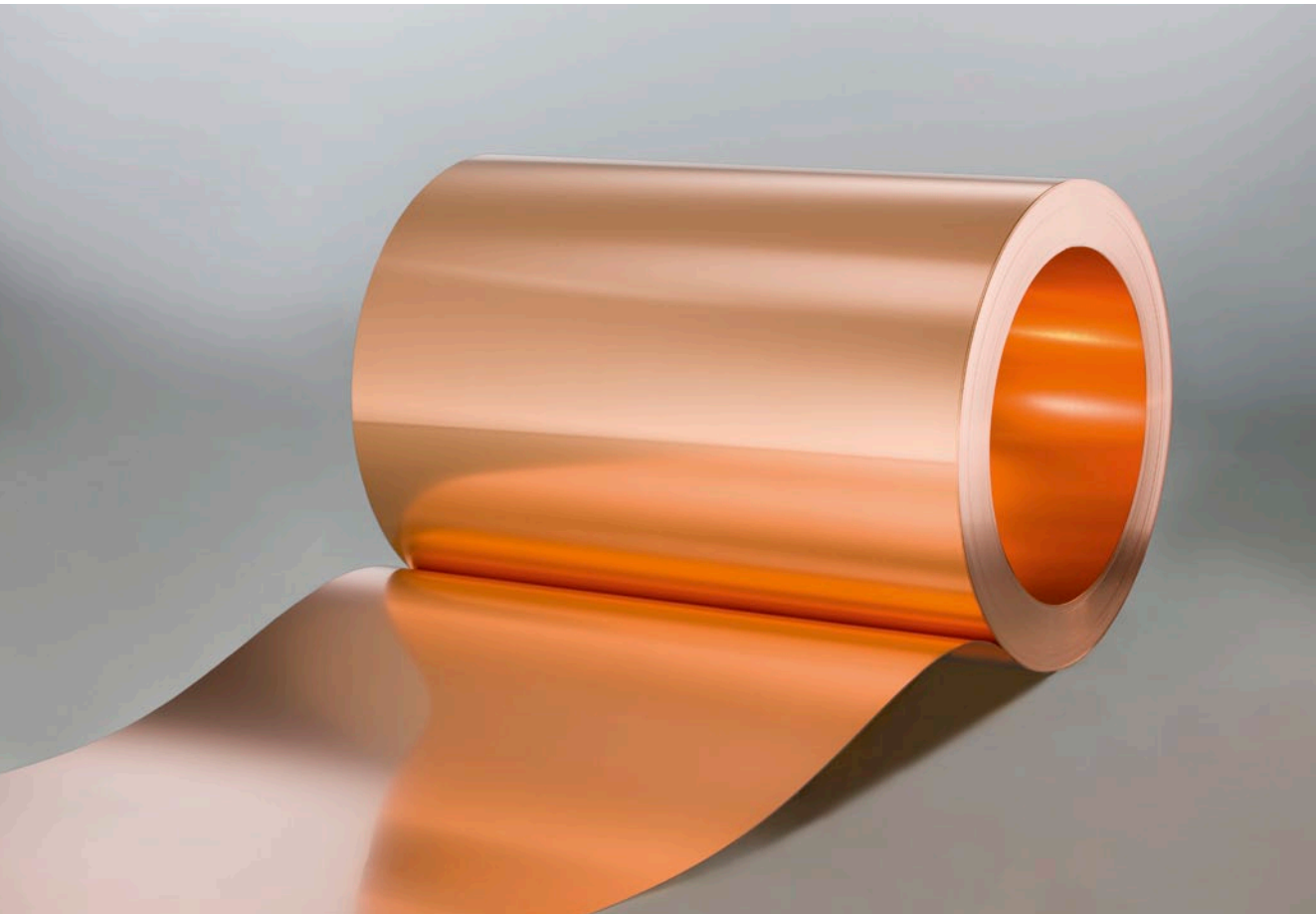
- Chicago (USA)**
- Buffalo (USA)**
- Avellino (Italy)**
- Mortara (Italy)**
- Lyon (France)**
- Madrid (Spain)**

- Emmerich (Germany)**
- Fehrbellin (Germany)**
- Hamburg (Germany)**
Group headquarters
- Lünen (Germany)**
- Röthenbach (Germany)**
- Stolberg (Germany)**
- Strass (Germany)**

- Zutphen (Netherlands)**
- Brussels (Belgium)**
- Olen (Belgium)**
- Birmingham (United Kingdom)**

- Pori (Finland)**
- Västerås (Sweden)**
- St. Petersburg (Russia)**
- Dolný Kubín (Slovakia)**
- Pirdop (Bulgaria)**
- Istanbul (Turkey)**
- Prague (Czech Republic)**
- Dubai (UAE)**
- Bangkok (Thailand)**
- Ho Chi Minh City (Vietnam)**
- Singapore (Singapore)**
- Seoul (Korea)**
- Tokyo (Japan)**
- Taipei (Taiwan)**
- Shanghai (China)**
- Hong Kong (China)**

<p>Raw materials</p> <p>Concentrates and recycling materials are the raw materials from which copper is produced.</p> <p> </p> <p>Concentrates Recycling material</p>	<p>Products</p> <p>The copper is processed into products. Some products are already the result of copper production.</p> <table border="0"> <tr> <td> Cathodes</td> <td> Continuous cast shapes</td> <td> Wire rod</td> </tr> <tr> <td> Strips/foils</td> <td> Specialty rod/profiles, shaped wire</td> <td> Precious metals</td> </tr> <tr> <td> Other metals</td> <td> Sulfuric acid</td> <td> Iron silicate</td> </tr> </table>	 Cathodes	 Continuous cast shapes	 Wire rod	 Strips/foils	 Specialty rod/profiles, shaped wire	 Precious metals	 Other metals	 Sulfuric acid	 Iron silicate	<p>Slitting Centers</p> <p>Service Centers located near our customers cut strips to the desired dimensions.</p> <p></p>	<p>Sales and distribution</p> <p>An international sales and distribution network markets our products.</p> <p></p>
 Cathodes	 Continuous cast shapes	 Wire rod										
 Strips/foils	 Specialty rod/profiles, shaped wire	 Precious metals										
 Other metals	 Sulfuric acid	 Iron silicate										

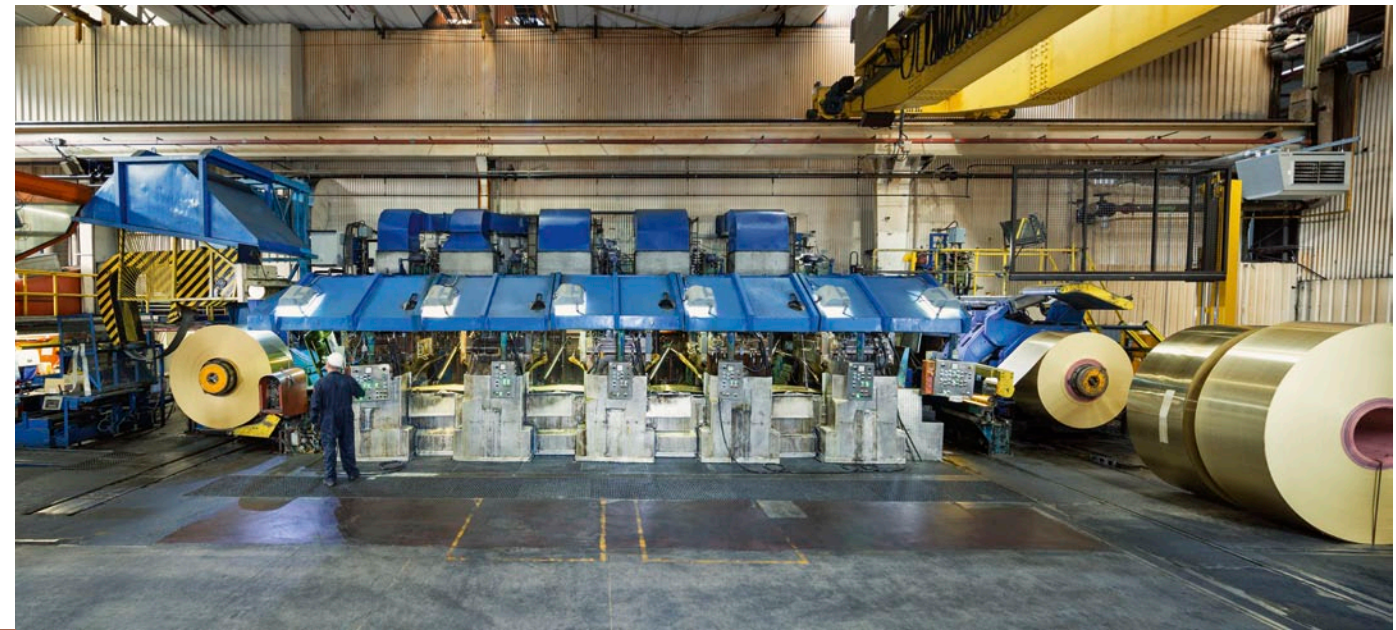


Contents

THE GROUP	Aurubis Group	4
	Aurubis Heat Exchanger Material	5
THE PRODUCTS	Alloys	6
	Dimensions	7
	Mechanical properties: Tempers	8
SPECIALTY PRODUCTS	Brazed plate and finned tube heat exchangers	11
	CuproBraz® technology	12
	Technical Center	16
	Outstanding service	18
	Contact	

Aurubis Group

Our Copper for your Life



As a fully integrated global copper company, Aurubis is a leader in smelting, fabricating, refining and recycling copper.

With about 6,400 employees at production sites in Europe and the US and sales offices all over the world, the Aurubis Group

has a leading global position in the copper industry.

Aurubis stands for innovative processes, cutting-edge technology, exemplary environmental protection, customer value and high profitability.



Aurubis

Heat Exchanger Material

Aurubis is the world's leading supplier of thin gauge copper and copper alloy strip for the heat exchanger industry, serving engine cooling customers around the world.

Customers benefit from the high quality, productivity, process efficiency and innovation Aurubis provides. They trust Aurubis' proprietary processes and technology, and appreciate that the majority of thin strip manufacturing equipment and processes have been developed and built by Aurubis itself.

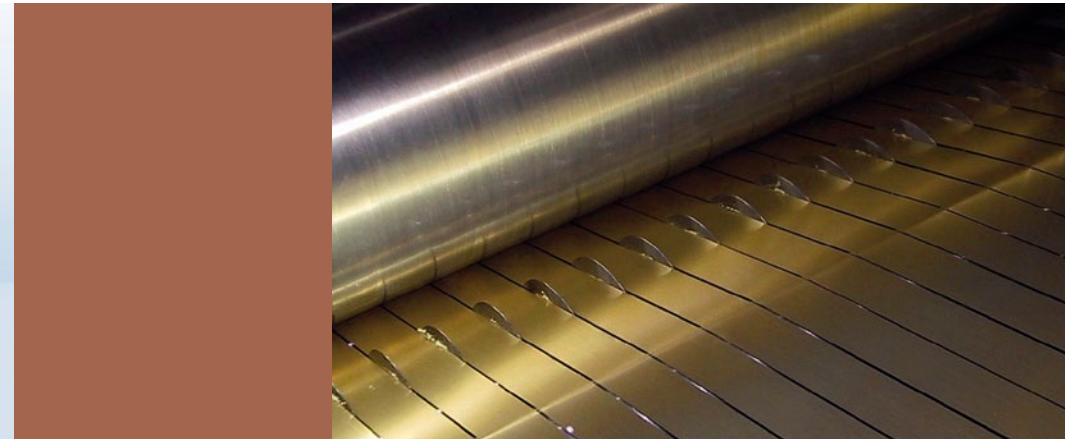
Long-term customer relationships stand for reliability and confidence.

The different types of heat exchanger designs that are produced by Aurubis using copper and brass alloys are nearly unlimited: radiators, charge air coolers (CACs), brazed plate heat exchangers, heaters and AC systems.

At its two production sites for heat exchanger material in Buffalo (USA) and Zutphen (Netherlands), Aurubis manufactures a large selection of fin

copper, tube brass and brazing foil of high uniform quality, with tight dimensional tolerances and precise mechanical properties.

The Aurubis Technical Center continuously works on the further development of materials and manufacturing processes for its customers' applications. See page 16 for additional information.



**THE BENCHMARK FOR
EDGE QUALITY**
Leading manufacturers for
high frequency (HF) welded
tube mills require Aurubis
strip to commission their
equipment.

Alloys

COPPER AND LOW-ALLOYED COPPER						Main applications
ISO	UNS	EN	JIS	Buffalo	Zutphen	
Cu-HCP (SE-Cu-57)	C10300	CW021A		C103	SM0013	Brazed plate heat exchangers
Cu-XLP / Cu-PHC (SE-Cu-58)	C10300	CW020A		C103	SM0011	Brazed plate heat exchangers
Cu-DHP (SF-Cu)	C12200	CW024A		C122		Brazed plate heat exchangers
CuTe0.02Sn0.02	C14530			C1453	SM0300	Fins
CuSn0.04					SM0700	Fins; brazed plate heat exchangers
CuSn0.09					SM0701	Fins
CuSn0.15	C14415	CW117C		C14415	SM0702	Fins
BRASS						Main applications
ISO	UNS	EN	JIS	Buffalo	Zutphen	
CuZn15	C23000	CW502L	C2300	C230	SM1085	Tubes
CuZn30	C26000	CW505L	C2600	C260	SM1070	Tubes; tanks and headers
CuZn30As	C26130	CW707L			SM2870	Tubes
CuZn33	C26800	CW506L	C2680	C268	SM1067	Tanks and headers
CuZn35	C26800		C2680		SM1065	Tubes; tanks and headers
CuZn35P					SM2965	Tubes
CuZn36	C27000	CW507L		C270	SM1064	Tubes; tanks and headers
CuZn37	C27200	CW508L	C2720	C272/C274	SM1063	Tubes
CuproBraz® ALLOYS						Main applications
ISO	UNS	EN	JIS	Buffalo	Zutphen	
CuZn15Fe0.8	C66420				SM2385	Tubes
Cu64ZnNi3	C74400				SM2464	Tanks and headers
CuCr0.2					SM0502	Fins

Aurubis provides alloys specially developed to meet the requirements of the heat exchanger industry.

Dimensions

THICKNESS				
Product	Thickness range (mm)	Thickness tolerance (mm)	Thickness range (inches)	Thickness tolerance (inches)
Fin material*	0.035 – 0.050	± 0.002	0.0014 – 0.0020	± 0.0001
	> 0.050 – 0.100	± 0.003	> 0.0020 – 0.0039	± 0.0001
	> 0.100 – 0.150	± 0.005	> 0.0039 – 0.0059	± 0.0002
Tube strip	< 0.300	± 0.005	< 0.0118	± 0.0002
	> 0.300 – 0.500	± 2 %	> 0.0118 – 0.0197	± 2 %
Tank and header strip	0.300 – 1.600	± 2 %	0.0118 – 0.0630	± 2 %
Brazing foil**	0.035 – 0.050	± 0.002	0.0014 – 0.0020	± 0.0001
	> 0.050 – 0.100	± 0.003	> 0.0020 – 0.0039	± 0.0001
	> 0.100 – 0.150	± 0.005	> 0.0039 – 0.0059	± 0.0002
	> 0.150 – 0.200	± 0.007	> 0.0059 – 0.0079	± 0.0003

WIDTH				
Product	Width range (mm)	Width tolerance (mm)	Width range (inches)	Width tolerance (inches)
Fin material*	20 – 100	± 0.075	0.7874 – 3.9370	± 0.0030
	> 100 – 200	± 0.100	> 3.9370 – 7.8740	± 0.0040
	> 200 – 300	± 0.150	> 7.8740 – 11.8110	± 0.0059
Tube strip	6 – 50	± 0.050	0.2362 – 1.9685	± 0.0020
Tank and header strip	< 200	± 0.100	< 7.8740	± 0.0040
	> 200 – 350	± 0.150	> 7.8740 – 13.7795	± 0.0059
	> 350 – 620	± 0.200	> 13.7795 – 24.4094	± 0.0079
Brazing foil**	5 – 100	± 0.075	0.1968 – 3.9370	± 0.0030
	> 100 – 200	± 0.100	> 3.9370 – 7.8740	± 0.0040
	> 200 – 600	± 0.150	> 7.8740 – 23.6220	± 0.0059

* Thinner gauges available on request.

** For brazing foil thickness < 0.047 mm (0.0019 inch), the max. width is 320 mm (12.6 inches).

Mechanical properties

Optimize your production process

Uniform mechanical properties have a strong influence on further processing. Choose the properties for optimizing your production process together with our experts.

TEMPERS: AURUBIS STANDARDS FOR FIN MATERIAL, TUBE STRIP AND TANK AND HEADER STRIP

Copper and brass strip for heat exchanger applications from Aurubis can be produced for all known international standards. Due to our extensive experi-

ence in the production of heat exchanger materials, we have been developing internal tempers specifically for those types of applications.

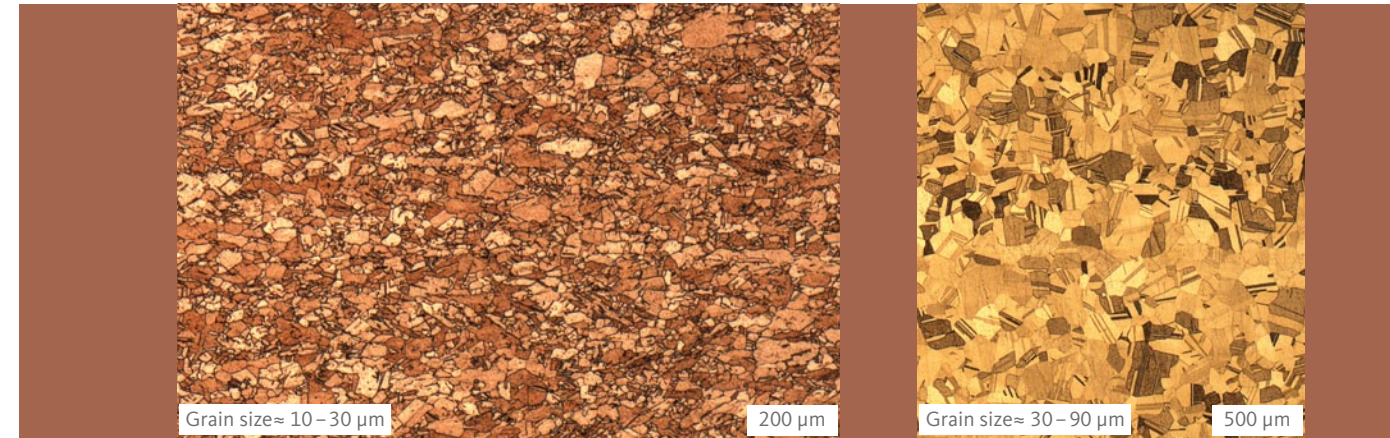
FIN MATERIAL IN ALLOYS CuTe0.02Sn0.02 AND CuSn0.04

Temper	Tensile strength (MPa)	Hardness (HV')
79	220 – 275	53 – 65
81	230 – 290	63 – 75
82	240 – 300	67 – 85
83	255 – 315	80 – 100
845	260 – 330	85 – 110
867	280 – 360	95 – 120
889	330 – 410	105 – 130
901	355 – 435	115 – 140
923	390 – 475	125 – 150
95	520 – 590	140 – 160

FIN MATERIAL IN CuproBraz® ALLOY CuCr0.2

Temper	Tensile strength (MPa)	Hardness (HV')
47B	330 – 410	110 – 130
79B	255 – 315	65 – 85

* For reference only.
Other tempers available on request.



TUBE STRIP IN ALLOYS CuZn30, CuZn30As, CuZn35 AND CuZn35P

PREFERRED TEMPER FOR ANNEALED-TO-TEMPER CONDITION

Temper	Tensile strength (MPa)	Hardness (HV)	Grain size (μm)
77	380 – 460	96 – 124	Max. 10
79	410 – 480	115 – 145	Max. 10

PREFERRED TEMPER FOR ROLLED-TO-TEMPER CONDITION

Temper	Tensile strength (MPa)	Hardness (HV)	Grain size (μm)
86B	390 – 480	118 – 148	Max. 15

TUBE STRIP IN CuproBraz® ALLOY CuZn15Fe0.8

ANNEALED-TO-TEMPER CONDITION

Temper	Tensile strength (MPa)	Hardness (HV)	Grain size (μm)
79B	386 – 455	115 – 145	Max. 10

TUBE STRIP IN ALLOY CuZn15

ANNEALED-TO-TEMPER CONDITION

Temper	Tensile strength (MPa)	Hardness (HV)	Grain size (μm)
851	300 – 370	80 – 100	Max. 15

Other tempers available on request.

TANKS MADE OF CuZn30, CuZn33 AND CuZn35

The material hardness is in the range of HV 55 – 75.

ANNEALED-TO-TEMPER CONDITION			
Temper	Thickness range (mm)	Thickness range (inches)	Grain size (μm)
TB4	0.425 – 0.570	0.0167 – 0.0224	50 – 75
TB5	0.571 – 0.670	0.0225 – 0.0264	55 – 80
TB6	0.671 – 0.750	0.0264 – 0.0295	60 – 85
TB7	0.751 – 0.850	0.0296 – 0.0335	65 – 90
TB8	0.851 – 1.050	0.0335 – 0.0413	70 – 100
TB0	1.051 – 1.600	0.0414 – 0.0630	75 – 110

HEADERS IN ALLOYS CuZn30, CuZn33 AND CuZn35

The material hardness is in the range of HV 60 – 85.

ANNEALED-TO-TEMPER CONDITION			
Temper	Thickness range (mm)	Thickness range (inches)	Grain size (μm)
HP4	0.425 – 0.630	0.0167 – 0.0248	35 – 55
HP6	0.631 – 0.850	0.0248 – 0.0335	40 – 65
HP8	0.851 – 0.950	0.0335 – 0.0374	45 – 75
HP9	0.951 – 1.250	0.0374 – 0.0492	50 – 80
HP0	1.251 – 1.600	0.0493 – 0.0630	50 – 90

Other tempers available on request.

Brazed plate and finned tube heat exchangers

Aurubis offers high-performance foil and strip of the finest quality and with the tightest tolerances for industrial heat exchangers.

COPPER FROM AURUBIS IS THE PREFERRED CHOICE FOR BRAZED PLATE AND FINNED TUBE HEAT EXCHANGERS DUE TO ITS:

- » Excellent thermal conductivity
- » High corrosion resistance
- » High pressure resistance
- » Smooth brazeability

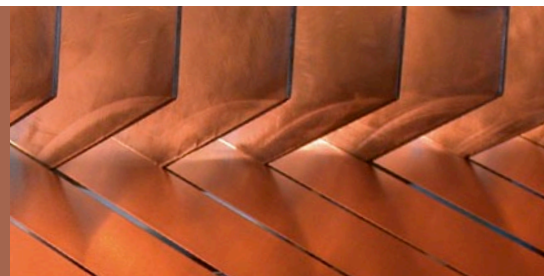
APPLICATIONS:

- » HVACR (heating, ventilation, air conditioning and refrigeration)
- » Oil cooling
- » Others



QUALITY ASSURANCE

The production operations of heat exchanger material at Aurubis are certified to the highest standards: ISO/TS 16949, DIN EN ISO 9001 and environmental management standard DIN EN ISO 14001.



SLITTING CENTERS

Aurubis has established a network of slitting and distribution centers in Europe (Italy, Slovakia, Netherlands, United Kingdom) and Asia and cooperates with partners worldwide.

TIGHT TOLERANCES

Aurubis' capability to produce thin gauge copper strip in combination with the tightest tolerances offers customers substantial savings potential without compromising the product's mechanical performance.

FORMABILITY

Uniform mechanical properties have a strong influence on further processing. Mechanical properties tailored to customers' requirements ensure excellent formability and process optimization.

CORROSION RESISTANCE

The ability to withstand harsh conditions can be further improved by Aurubis' state-of-the-art surface coatings. We offer in-house surface coatings (hot-dip tinning and electroplating) as well as additional surface coatings via service partners.

Aurubis offers a wide range of Cu+ alloys in thin gauges with antimicrobial properties for use in air conditioning (AC).

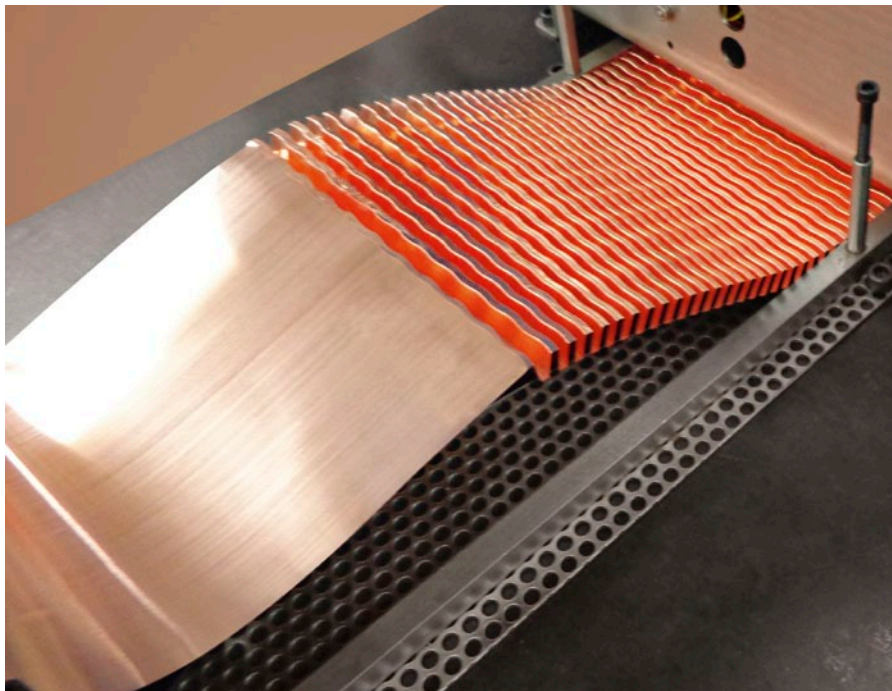
CuproBraze®

Perfect heat transfer

CuproBraze® technology is a manufacturing process for brazing copper/brass heat exchangers, utilizing anneal-resistant alloys developed by Aurubis.

It is an environmentally friendly technology, eliminating any fluxing stage for brazing and free of lead and other toxic chemicals.

Stronger joints combined with an increased durability, heat transfer rate and corrosion resistance – CuproBraze® ideally combines the benefits of brazed aluminum and soft-soldered brass technologies and fulfills all current and near-future requirements.



CuproBraze® is the production method of choice for off-road vehicles that must withstand an extremely challenging environment with harsh conditions, e.g. high and low temperatures, humidity and vibration loads that call for superior heat transfer together with efficient use of space and that require high durability, strength, fatigue resistance and excellent corrosion resistance.



AREAS OF APPLICATION:

- » Industrial heat exchangers
- » Radiators
- » Heaters
- » Charge air coolers (CACs)
- » Oil coolers
- » CPU coolers
- » Inverter coolers in hybrid vehicles
- » Climate control systems / cooling systems

CuproBraze® TECHNOLOGY IS PERFECT FOR HEAT TRANSFER SYSTEMS IN VEHICLES AND EQUIPMENT SUCH AS:

- » On / off-highway trucks
- » Mining vehicles
- » Construction and agricultural equipment
- » Gensets
- » Industrial engines
- » Locomotives
- » Other off-road diesel engines



CuproBraze®

Efficient, durable, sustainable

THERMAL PERFORMANCE AND SIZE REDUCTION

CuproBraze® offers a great deal of cooling capacity and high heat transfer efficiency in a compact size. For example, charge air coolers (CACs) do not need a pre-cooler. The pressure drop advantage due to thinner fin and tube materials means an improved thermal performance and/or smaller core size. Decreased air pressure drops compared to aluminum allow for a smaller fan to be used, meaning less energy consumption and consequently less fuel usage.

DURABILITY

Brazed copper/brass charge air coolers (CACs) have stronger, tougher joints and can withstand inlet temperatures of more than 290 °C (554 °F) while retaining their strength and avoiding metal fatigue.

EXCELLENT CORROSION RESISTANCE

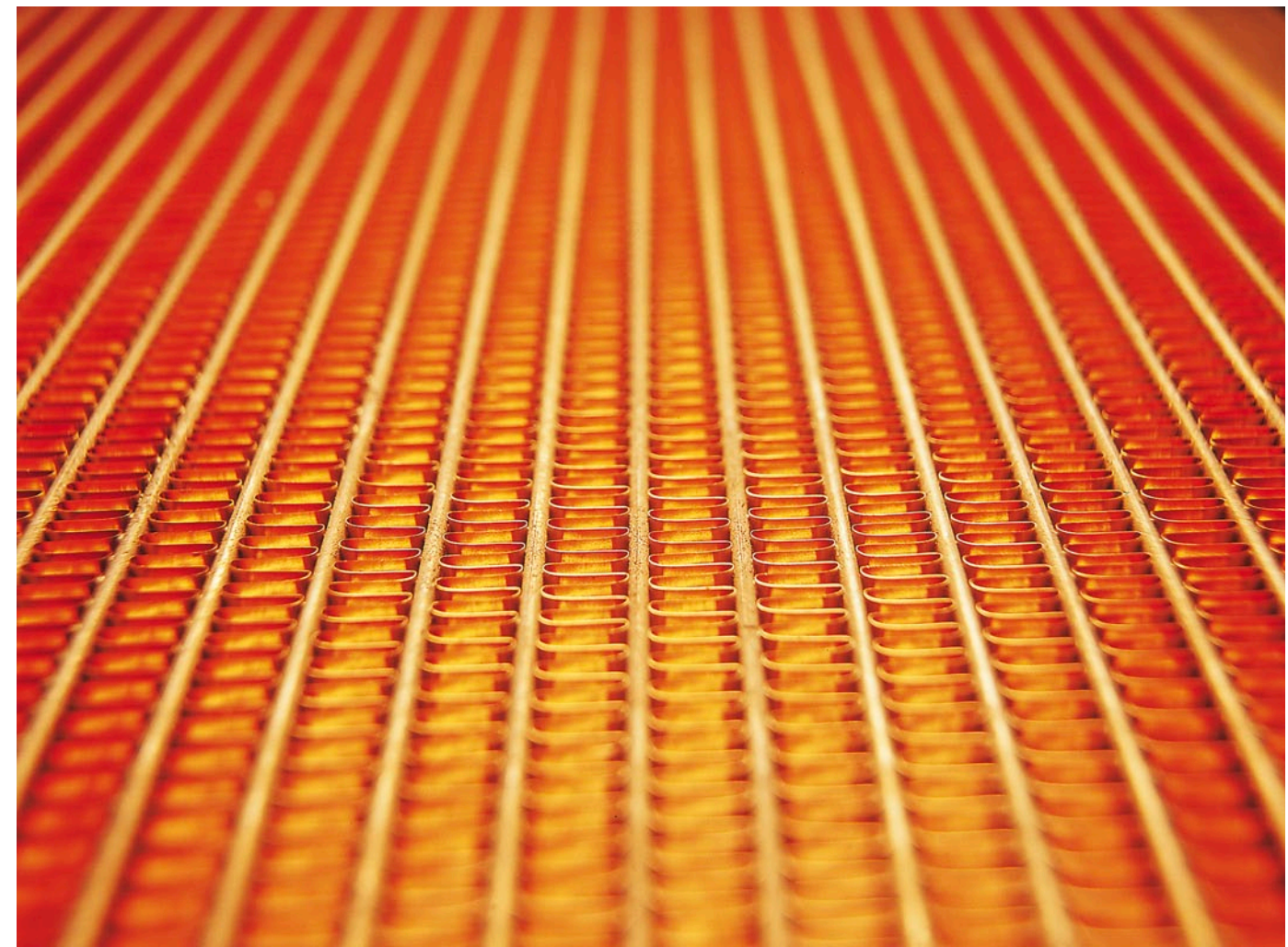
Based on the results from four different types of accelerated and globally recognized corrosion tests, the external corrosion resistance of CuproBraze® radiators is clearly better than that of brazed aluminum radiators and copper/brass radiators, particularly in marine conditions. High-performance coatings can be used to improve the strength and resistance against humidity, sand erosion and stone impingement on copper.

CuproBraze® allows for more durable products and the use of thinner materials and space-saving designs at the same time. The relative strength advantage becomes more pronounced with increasing

The internal surfaces of CuproBraze® heat exchangers are less sensitive to bad coolant and pitting corrosion than aluminum.

operating temperatures. For example, brass tube is three times stronger than aluminum tube at room temperature, but more than four times stronger at 260 °C (500 °F).

PROPERTY / MATERIAL	DENSITY (g/cm³)	THERMAL CONDUCTIVITY (W/m°C)	TENSILE STRENGTH AT ROOM TEMPERATURE (MPa)	TENSILE STRENGTH AT ELEVATED TEMPERATURE 260 °C (500 °F) (MPa)
Cu fin	8.95	377	330	270
Brass tube	8.53	(120)	435	290
Aluminum fin	2.75	222	40	31
Aluminum tube	2.75	(160)	145	69



Aurubis is the world leader in copper and brass strip for heat exchanger applications, utilizing soft solder and CuproBraze® technology.

MAINTAINABILITY

In order to minimize unplanned downtime for expensive equipment, CuproBraze® can be easily repaired with soft-soldered or common silver-bearing brazing alloys. This is a crucial parameter for commercial vehicles and gensets operating at remote locations without a functional service network.

ENVIRONMENT AND EMISSIONS

Gradually tightening emission regulations for the off-road segment, e.g. nitrogen oxides (NOx) and particulate matter (PM), in addition to the associated use of turbocharging technology call for highly efficient and durable charge air coolers (CACs) with increased heat

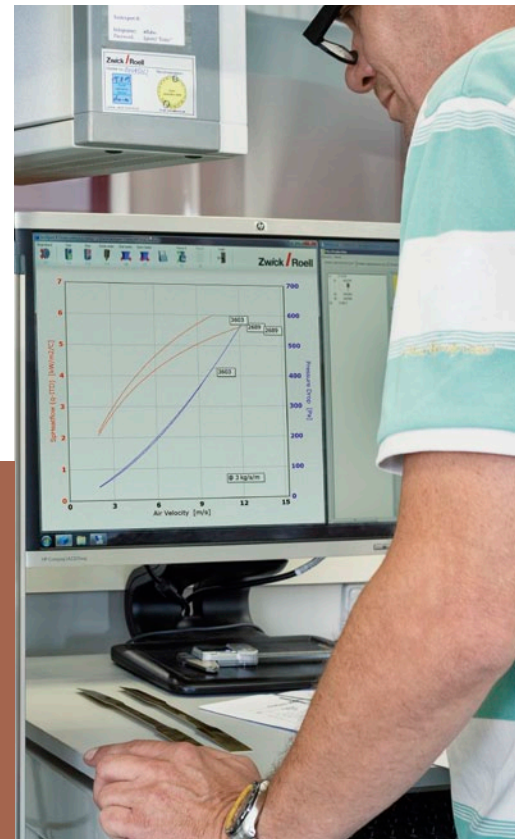
resistance. Aurubis delivers the superior material to fulfill the corresponding demand for higher pressure and increased process temperatures. Copper and brass are 100 % recyclable.

Technical Center

Your partner in the field of thermal management

To ensure its customers' competitiveness, Aurubis is the only supplier offering a comprehensive range of training programs, theoretical instructions and customer workshops in the field of thermal management.

At its Technical Center, Aurubis has uniquely combined a brazing and technical center to continuously work on heat exchanger designs for optimal performance. We produce full-scale prototypes using these facilities.



THE AURUBIS TECHNICAL CENTER OFFERS CUSTOMERS VARIOUS SERVICES, E.G.:

- » Wind tunnel tests
- » Heat exchanger design
- » Prototype heat exchangers
- » Pressure pulsation tests
- » Corrosion tests
- » Furnace profile tracking
- » New processes
- » Modernization
- » Problem solving
- » Training programs
- » Cost-cutting programs
- » Plant project support

One of the proprietary developments by the Aurubis Technical Center is the Compact Core, or splitter fin design. It enables

the use of 25 micron (0.025 mm, 0.001 inch) copper strip in the fins of a heat exchanger core and does not only provide a

way to reduce the weight of the cores but also to reduce the pressure drop and material cost.

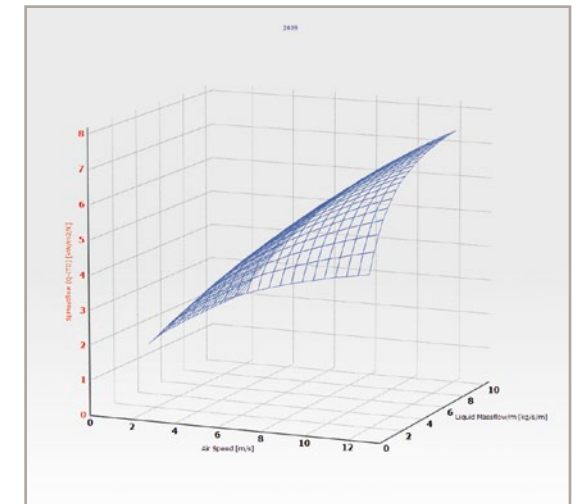
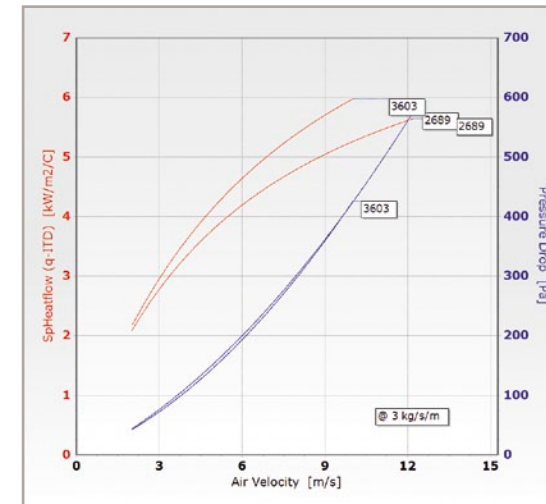
The application engineering makes Aurubis your preferred supplier.

At our Technical Center, radiators, heaters, charge air coolers (CACs) and oil coolers designed by our customers and their competitors undergo performance testing in the calorimetric

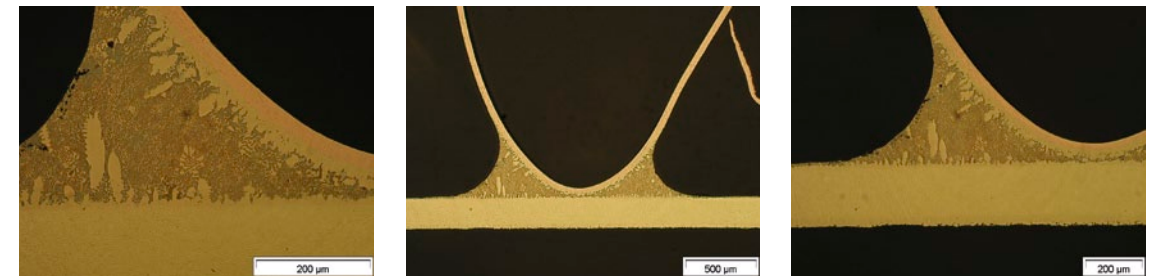
test rig. With the help of our database, which includes around 2,800 tested heat exchangers, results can be compared and benchmarked.

In a theoretical calculation application, design parameters can be changed to show the impacts

on heat exchanger performance. The utilization of virtual engineering for product development enables customers to save time, material and process costs. The creation of prototypes and wind tunnel testing ensure that the re-design goals are reached.



Comparison of customer's product and Aurubis prototype: Wind tunnel testing enables highly accurate performance evaluation



The geometry and microstructure of the joint determine the heat flow and durability



Aurubis is the only copper and brass supplier for the heat exchanger industry that offers comprehensive technical service and design support, assisting customers in achieving modern and cost-effective designs.

Outstanding service

COMMERCIAL SERVICES

- » Leading actor on the global copper market for decades
- » Integrated, strong and financially healthy long-term copper supply
- » Worldwide availability due to the international sales network: Operating globally – acting locally
- » Hedging advice and support
- » As a leader in the recycling industry, we assist our customers in increasing economic efficiency using recycling concepts

TECHNICAL SERVICES

- » Customer advisory service on all aspects of processing semi-finished products at their production site, from dimensions to surface quality
- » Aurubis values precision. We achieve the tightest dimensional and property tolerances by using computer-controlled equipment designed and built in-house
- » Aurubis assists customers by developing prototypes using full-scale production equipment
- » The technical parameters of the strip, coil weight and inner and outer diameters are tailor-made to follow the customers' individual production processes and the requirements of their equipment

LOGISTICS

- » Our global, flexible logistics framework makes it possible for us to respond to individual requirements
- » We work with our customers to optimize the supply chain
- » Our production units on two continents combined with our local service centers give us a global reach
- » Maximum reliability of supply and flexibility thanks to integrated copper supply



CONTACT FOR HEAT EXCHANGER MATERIAL (HX)

Aurubis Engine Cooling
info-hx@aurubis.com

Production sites

Aurubis Netherlands B.V. (NL)
Phone: +31 575 594594

Aurubis Buffalo Inc. (US)
Phone: +1 716 879 6700

Sales Offices

Aurubis Chicago (US)
Phone: +1 630 980 8400

Aurubis Dubai (AE)
Phone: +971 55 7592103

Aurubis Shanghai (CN)
Phone: +86 186 21387861
Phone: +86 136 81628369

Aurubis Singapore (SG)
Phone: +65 9758 2482

Imprint

Editor

Aurubis AG
Hovestrass 50
20539 Hamburg
Germany
Phone: +49 40 7883-0
Fax: +49 40 7883-2255
www.aurubis.com



Status:
November 2013

Photos:
istockphoto: p. 13
all others: PR Aurubis AG

Our Copper for your Life

www.aurubis.com

