HE Tubing Netherlands: an established producer of heat exchanger tubing

Alloy description, material data sheets and overview of available (flux) coatings.

Overview of alloys within HE Tubing Netherlands BV

Standard alloys for MPE and Round Tubing products

- *AA 1197*
- *EN AW 3102*
- *EN AW 3003*
- *EN AW 3110 (Nexcor™ C19E, Long Life alloy)*
- *EN AW 3026 (Nexcor™ C47B, Long Life alloy)*
- *Nexcor™ C47D (Nexcor™ C47D, Long Life alloy)*

Material Data Sheet

Chemical compositions of the applicable alloys:

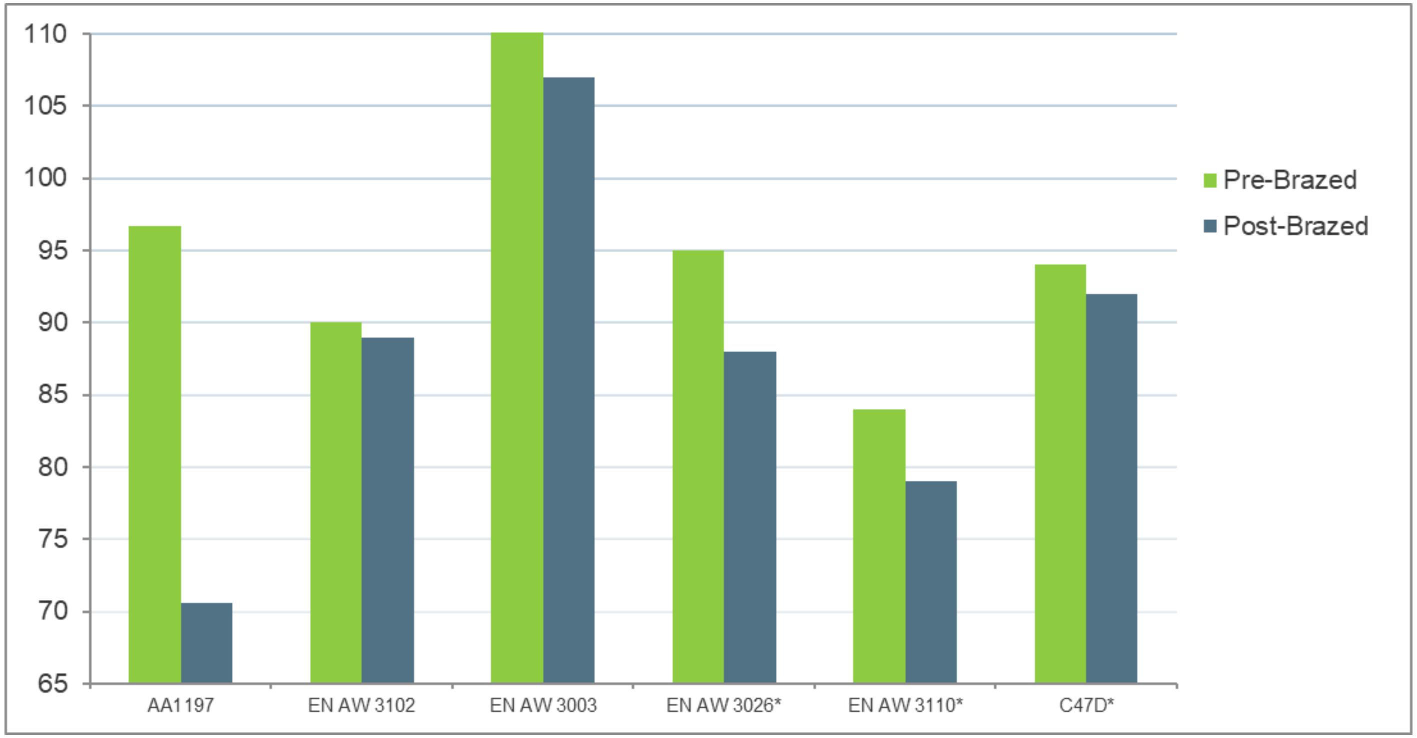
Designation	HET Code	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr
AA 1197	RTC001	0,15 max.	0,20 max.	0,40-0,55	0,10-0,20	0,03 max.	0,04 max.	0,03 max.	0,05 max.
EN AW-3102	3102	0,40 max.	0,70 max.	0,1 max.	0,05-0,40	-	0,30 max.	0,10 max.	-
EN AW-3003	3003	0,6 max.	0,7 max.	0,05-0,20	1, 0-1,5	-	0,1 max.	-	-
EN AW-3110*	Nexcor™ C19E*	0,25 max.	0,05-0,35	0,1 max.	0,30-0,70	0,1 max.	0,05 max.	0,05-0,30	0,05-0,25
EN AW-3026*	Nexcor™ C47B*	0,25 max.	0,10-0,40	0,1 max.	0,40-0,90	0,15 max.	0,05-0,30	0,05-0,30	0,05 max.
Nexcor™ C47D*	Nexcor™ C47D*	0,05-0,50	0,10-1,0	0,2 max.	1,0 max.	0,1 max.	0,06-1,0	0,05-0,35	0,03-0,50

**AA3026 (C47B), C47D and AA3110 (C19E) are part of the Nexcor™ family of alloys and patented products (US 6503466, US 6458224, US 6602363 and US 6656296).*

HE Tubing Netherlands BV uses the alloys of the Nexcor™ family under sublicense from SAPA AS and Alcoa Inc.

Mechanical Properties

Tensile strength:



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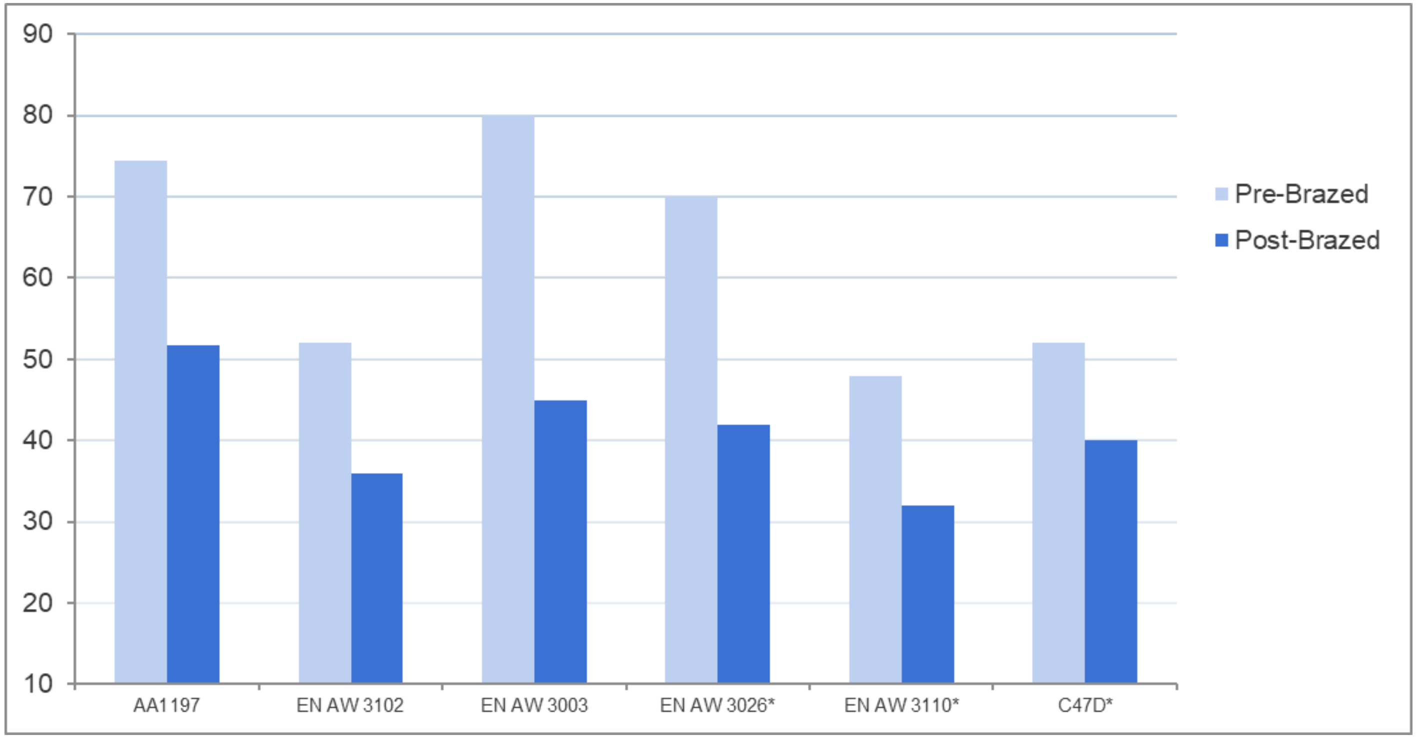
The data in the chart is determined from tensile tests performed on MPE tubes (in H111 condition).

The data is not for design purposes.

Mechanical Properties

Yield strength:



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Properties MPE products based on 3xxx alloys

General:

HE Tubing's alloy palette contains the most important alloys for thin wall aluminium MPE. The alloys have been widely adopted and have been in use for a variety of applications for decades. While all of the mentioned alloys are suitable for heat exchanger applications, the specific alloy selection will be arrived at through careful matching of an alloy's capabilities and limitations to the requirements of the set of functional requirements of the intended application. Consideration of performance factors like extrudability and/or corrosion resistance are in most cases determining which alloy should be used.

Extrudability:

All mentioned alloys can be used for thin wall aluminium MPE extrusions with the exception of EN AW 3003. The overall industrial experience leads to the conclusion that for thin wall extruded tube, EN AW 3003 is less than optimal. Due to its chemical composition, EN AW 3003 is more difficult to extrude compared to the other 3xxx alloys mentioned in this document, resulting in lower extrusion process productivity, and therefore higher production cost.

Corrosion resistance:

EN AW 3110, EN AW 3026* and Nexcor™ C47D* are designed and developed as "Long Life Alloys". These alloys show, under comparable test conditions, a better resistance to corrosion attack.*

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Coatings for aluminium (CAB) brazing – HE Tubing Netherlands BV

- *Filler metal generating coatings*
- *Flux based coatings*

Filler metal generating coatings;

This type of coating comprises all components needed to generate the braze filler metal during the Controlled Atmosphere Brazing (CAB) process used to braze aluminium heat exchangers. The coatings, which include (in most cases) flux and a metal source, react with the aluminium substrate during brazing to produce filler metal in place. These coatings can be divided into two groups:

a) Silicon based coatings and

b) $AlSi_{12}$ based coatings.

Overview of (flux) Coatings within HE Tubing Netherlands BV

Filler metal generating coatings (continued);

Current recipes of HE Tubing:

a) Silicon based coatings:

SilFlux (Si, $K_{1-3}AlF_{4-6}$, binder)

SilZnFlux + ZnFlux (Si, $K_{1-3}AlF_{4-6}$, $KZnF_3$, binder)

SilZnFlux + Zn (Si, $K_{1-3}AlF_{4-6}$, Zn, binder)

b) $AlSi_{12}$ based coatings:

Alloy Coating ($AlSi_{12}$, $K_{1-3}AlF_{4-6}$, binder)

Alloy Coating + ZnFlux ($AlSi_{12}$, $KZnF_3$, binder)

Alloy Coating + Zn ($AlSi_{12}$, K1-3AlF_{4-6} , Zn, binder)

Metal Coating ($AlSi_{12}$, binder)

$AlSi_{12}$ Arc Spray (applied in line during the extrusion process)

$AlSi_{xx}Zn_{xx}$ Arc Spray (applied in line during the extrusion process)

The average coating weight that must be applied for functional Si-containing coatings are ~ 12-18 grams/m2 and 20-35 grams/m2 for the AlSi12 containing coatings.

With the right choice of materials, high performance can be expected in SWAAT testing

- *up to approx. 1.000 hours with the Si-containing coatings and*
- *up to 2.000 hours with the AlSi12 containing coatings.*

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Flux based coatings:

This type of coating contains only a the CAB Flux and a binder. A binder in the coating is used as a temporary carrier of the flux components. In most cases, the needed filler metal will come from the clad layer of one or more of the aluminium components during the (CAB) brazing process.

Coatings of this type can be divided in two different groups:

a) Potassium based coatings and

b) Zinc Flux based coatings.

Note: The Zinc component is added to the coating in order to enhance the corrosion resistance.

Flux based coatings (continued):

Current recipes of HE Tubing:

a) Potassium based coatings:

Flux Coating (K1-3AlF4-6 , binder)

b) Zinc Flux based coatings:

Zinc Flux ($KZnF_3$, binder)

Flux + Zn ($K_{1-3}AlF_{4-6}$, Zn, binder)

Zinc Arc Spray (applied in line during the extrusion process)

The typical coating weight applied for functional flux coating is ~ 3 - 18 grams/m^2.

With the right choice of materials SWAAT-test results up to approx. 2.000+ hours can be obtained.

This result was achieved through the use of EN AW 3110 in combination with Zinc Flux 10 grams/m^2 (3 grams/m^2 Zinc).

Alternatives for the use of Potassium trifluorozincate ($KZnF_3$)

Ongoing R&D at HE Tubing has identified alternatives to $KZnF_3$. Testing of functional coatings containing elemental Zn shows similar or better SWAAT performance can be achieved (less fin debonding) compared to functional coatings containing $KZnF_3$.

Duplex coatings, e.g. Zinc Arc Spray + Alloy Coating provide yet another path to eliminate the use of $KZnF_3$.

General notes:

HE Tubing sources raw materials of the highest available quality to use as components of the functional coatings discussed herein.

Silicon powder must meet stringent specifications for the chemical composition and Particle Size Distribution.

The AlSi12 powder component has been under development since 2006 with reference to the chemical composition and Particle Size Distribution. Current specifications have been developed and optimized to give consistent coating application and braze process quality result.

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