SMEThermal 2011

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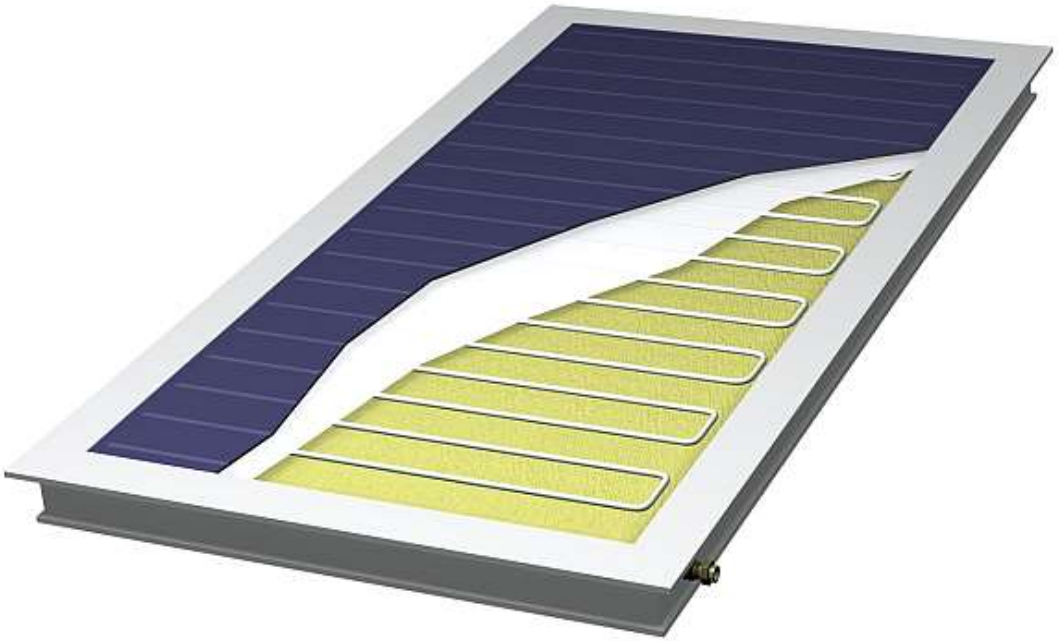
Berlin, Germany

Are aluminium absorbers market-ready?



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Werl / Germany

Standard-Metallwerke GmbH
Werl, Germany

Founded 1919, private ownership,
since April 1st 2009 part of
the Wilms Group

Specialised in precision drawn non-ferrous tubes and products

- Aluminium tubes (1000/2000/3000/5000/6000/7000 alloys)
- Copper & copper nickel tubes
- Brass tubes

Sales in Euro (Est. 2010):	63 Mio €
Employees:	320
Production area:	41.000 m²

Why a tube manufacturer answers questions about the design and production of absorbers

Standard-Metallwerke proposed the S-Life long life alloy to the solar thermal industry in 2007/2008

Questions came up on corrosion resistance but also regarding:

- brazing
- bending
- welding
- connecting
- fluid

The outcome of these discussion are summarized in this presentation.

Overview

- Aluminium for solar absorbers – What to learn from the Automotive Industry
- “Pipe layer” – Harp or Meander - Whatever you please
- “The heat is on” – Brazing of aluminium tubes possible?
- “Hunter and Seeker” – Laser or US that’s (not) the question
- “Transport” – Specialized fluids necessary?
- “Stay connected” – Fittings and Connecting pipes
- “The bill, please” – Realistic view on savings
- “Steeplechase” – Obstacles during the assembly
- “PISA for solar collectors” – Efficiency in comparison

What to learn from the Automotive Industry?

- Need for cost (and weight) savings potentials
- Known manufacturing processes
- Durability and sustainable quality
- Investment return

Comparison S-LIFE vers aluminium alloy 3103

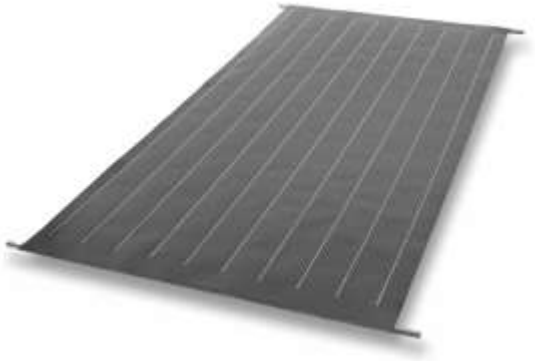
S-LIFE® after 80 days SWAAT-test

3103 after 80 days SWAAT-test

Resistance to corrosion is tremendously higher than for conventional AL 3003 or 3103
(tested with SWAAT test ASTM G85 A3)

Aluminium tubes tested in production of:

- ✔ Harp absorber
- ✔ Meander absorber



- Absorber tubes used
  - OD 8 to 10 mm
- Collector/Header tube
  - OD 18, 20 & 22 mm
- Positive feedback even if material changed “on the fly” for trial runs
- Optimization of bending process will be needed but seems minor
- Process adoptions for brazing needed

Aluminium tubes tested in production of:

- ✔ Harp absorber
- ✔ **Meander absorber**

e. g.
Reimann & Kahl have successfully manufactured meander with 10 x 0,8 mm S-Life aluminium tubes

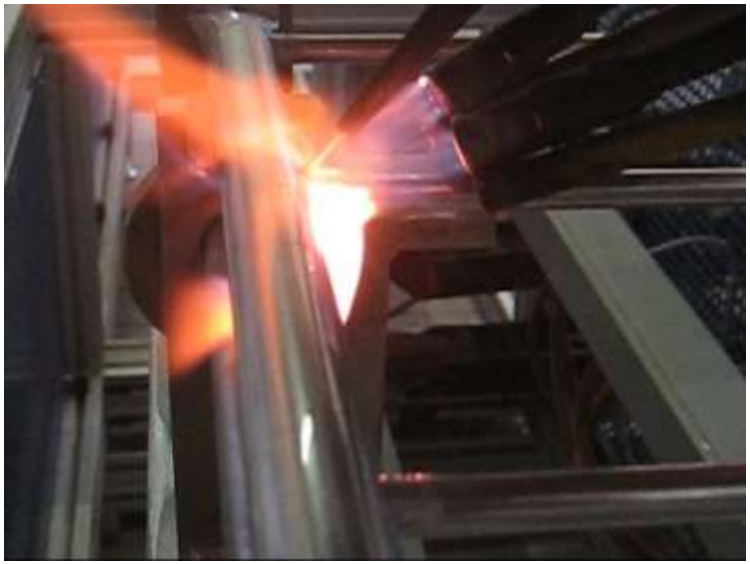
Several collector manufacturer have completed test runs

Aluminium tubes tested in production of:

✔ Brazing of aluminium under production conditions is possible

What’s different:

- Lower brazing temperature and smaller temperature “window”
- Different gas / oxygen mixture
- Special brazing torch



e. g. :

- Everwand & Fell
- Vermotec
- Sunrise

tested aluminium tubes on adopted brazing lines.

Brazing solder and flux by FLUX Schweiß- und Lötstoffe GmbH
Non-corrosive flux available to avoid cleaning process

Connecting absorber sheet to the tube

- ✔ Laser welding
- ✔ Ultrasonic welding

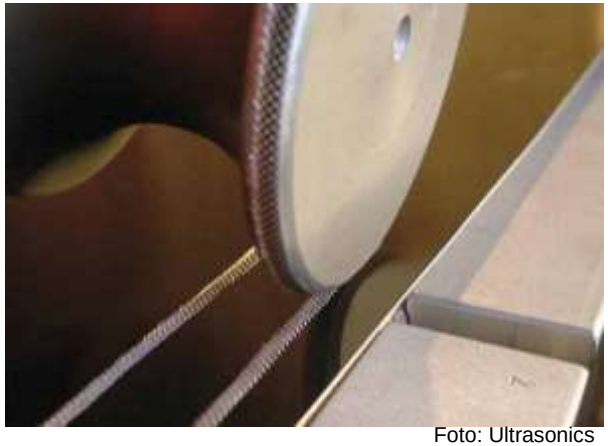


Foto: Ultrasonics

Foto: Sunlaser

Laser OR Ultrasonic

- Successful test runs laser welding
  - Sunlaser
  - several collector manufactures
- Successful test runs laser welding
  - Ultrasonics Steckmann
  - Schunk Sonosystems
  - several collector manufactures
- Not surprisingly gives the Al/Al US weld a very firm bond

Solar fluids for S-Life Aluminium tubes

Solar fluids released for the temperature range of flat panel collectors and with inhibitors for the use with aluminium

Test conducted with:

- *Tyfocor L*
  - Lab test at Tyforop Chemie, Hamburg
  - Solar thermal simulator at SPF, Rapperswill
  - SWW simulator
  - SWW outdoor test
- *Fragol Ucotherm W-PGA*
  - SWW simulator
- *Antifrogen L*
  - *Customer outdoor test setup*

Specialized fluids necessary?

No, *the requirements are*

- Fluid suitable for solar absorbers especially for the temperature range!
- Fluid with inhibitors suitable for aluminium

Latest results of a 2 seasons test run at Standard-Metallwerke under special conditions: No circulation during daytime

Days / peak temperature			
Peak	**2009**	**2010**	***Total***
<= 140°C	172	209	*381*
> 140°C	**134**	**126**	***260***
Total	306	335	*641*

Fittings and Connecting pipes

Materials tested on SWW outdoor test

- ✔ Stainless steel
- ✔ Brass
- ✔ Brass nickel plated
- (✔) Aluminium

  (not released for +150°C applications)

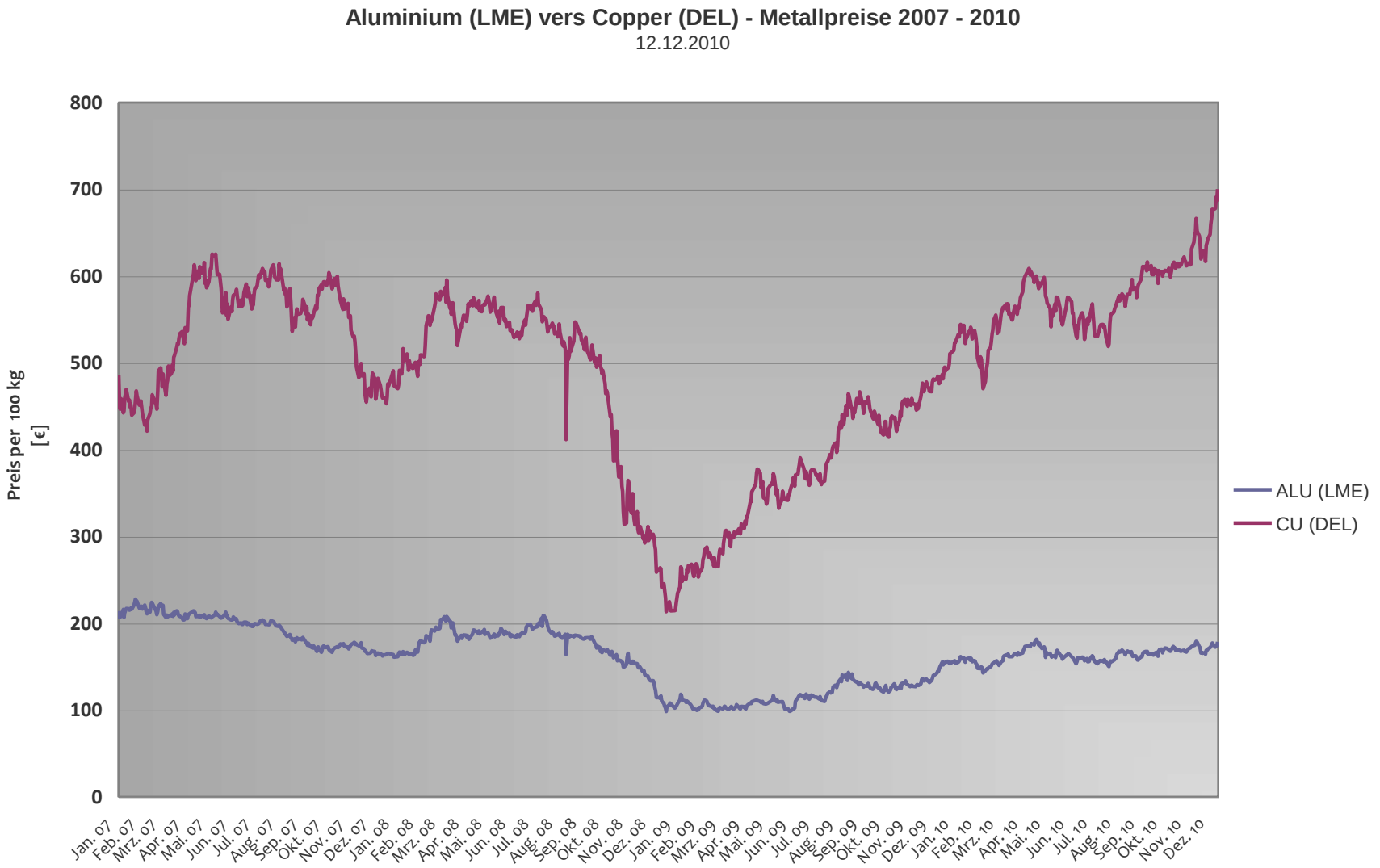
Assembly

- ✔ e.g. SERTO 18 & 22 mm

After 20 months on an outside test setup SERTO confirmed that S-Life aluminium tubes can be very well used in combination with SERTO fittings
Smaller diameter need slightly less force

Swagelok and Lokring used on outdoor test

“The bill, please”

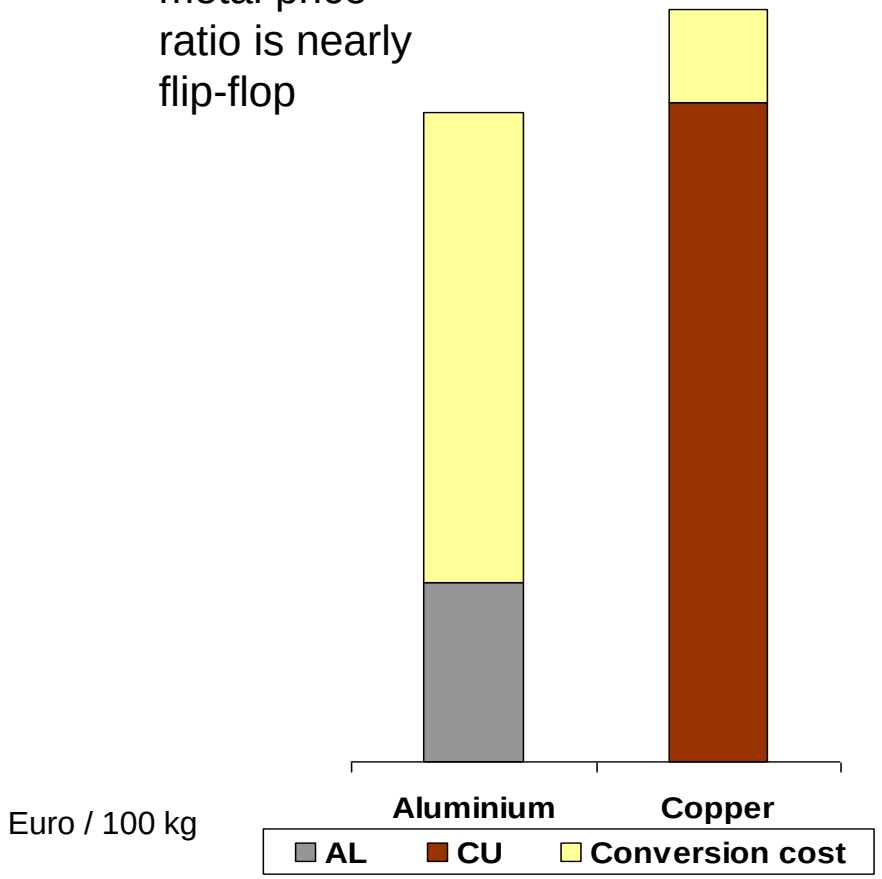


Metal price development & total cost

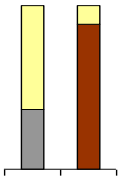
For the absorber tubes often a slightly thicker wall is selected to compensate for lower strenght of the aluminium material e.g.:

Copper		Alumiunium
8 x 0,5	>	8 x 0,6 or 0,7 mm
10 x 0,5	>	10 x 0,7 or 0,8 mm

Conversion to metal price ratio is nearly flip-flop

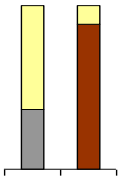


Realistic view on savings - assuming <u>equal total</u> price of 790 € per 100kg



S-Life Solar						Copper				Possible Saving	
AD in mm	Wall in mm	Length in mm	Desc.	Weight kg/m	Total €/m or pc	AD in mm	Wall in mm	Weight kg/m	Total €/m or pc	€/pcs.	%
8,00	***0,70***	*Coil*		0,04383	**0,35 €**	**8,00**	**0,50**	0,10485	0,83 €	**- 0,48 €**	**-58,2%**
		14.000,0	Modell 1	**per piece**	**4,85 €**			**per piece**	11,60 €	**- 6,75 €**	**-58,2%**
		15.000,0	Modell 2	**per piece**	**5,19 €**			**per piece**	12,42 €	**- 7,23 €**	**-58,2%**
		23.000,0	Modell 3	**per piece**	**7,96 €**			**per piece**	19,05 €	**- 11,09 €**	**-58,2%**
		21.000,0	Modell 4	**per piece**	**7,27 €**			**per piece**	17,39 €	**- 10,12 €**	**-58,2%**
22,00	***0,80***	*5-6m*		0,14546	**1,15 €**	**22,00**	**0,80**	0,47420	3,75 €	**- 2,60 €**	**-69,3%**
		1.100,0	Modell 1	**per piece**	**1,26 €**			**per piece**	4,12 €	**- 2,86 €**	**-69,3%**
		1.700,0	Modell 2	**per piece**	**1,95 €**			**per piece**	6,37 €	**- 4,42 €**	**-69,3%**
		2.200,0	Modell 3	**per piece**	**2,53 €**			**per piece**	8,24 €	**- 5,71 €**	**-69,3%**
		2.100,0	Modell 4	**per piece**	**2,41 €**			**per piece**	7,87 €	**- 5,45 €**	**-69,3%**

Realistic view on savings - assuming equal total price of 790 € per 100kg



	Header tube length	Meander tube length	S-Life Solar	Copper	Cost difference per collector	Cost difference per collector
	mm	mm	total*	total*	per pc	in %
Modell 1	1.100	14.000	7,38 €	19,84 €	12,46 €	62,8%
Modell 2	1.700	15.000	9,10 €	25,16 €	16,06 €	63,8%
Modell 3	2.200	23.000	13,02 €	35,53 €	22,52 €	63,4%
Modell 4	2.100	21.000	12,10 €	33,13 €	21,03 €	63,5%

2 x header + 1 x meander tube(s)

Obstacles to watch during the assembly

“Think aluminium”

Nearly all productions steps can be adopted for aluminium, but expect different behaviour when

- de-coiling
- bending
- cutting
- punching

- Equip welding & brazing lines with suitable components
  (talk to the known machine manufacturer)
- Avoid cutting of copper and aluminium tubes on the same cutting machines at the same time
- Avoid chips and burr especially of copper in the tubes

Foto: Rotex

Obstacles to watch during the installation

A good indication is given in the imprint:

i.160 “Die fachgerechte Installation von thermischen Solaranlagen“ published 2006 by the „Deutsches Kupferinstitut“:

- “After installation clean and rinse the circuit thoroughly”
- “Fill system with ready mixed solar fluid” *
- “Release air from circuit”
- “Check annually for pressure drop”
- “Check every two years the condition of the solar liquid if Ph value drops below 7 replace liquid.”

Page 19ff: 6. Setup and maintenance of a solar thermal system

Foto: wikipedia

* what needs to be added:

Solar fluid suitable for the use with aluminium

Efficiency in comparison

For a cross-validation, we had the ISFH examine two structurally identical solar collectors in a shortened performance test.

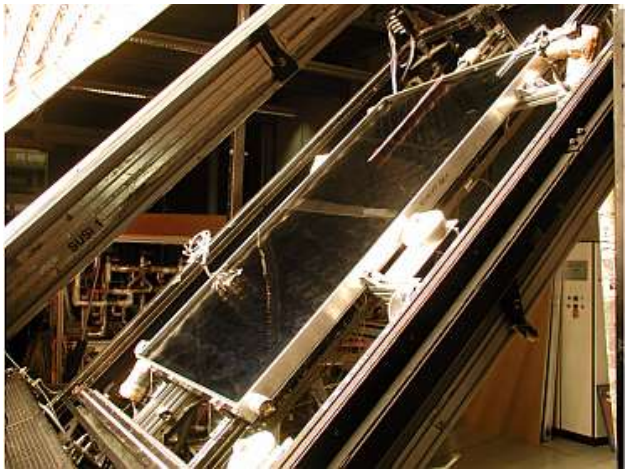
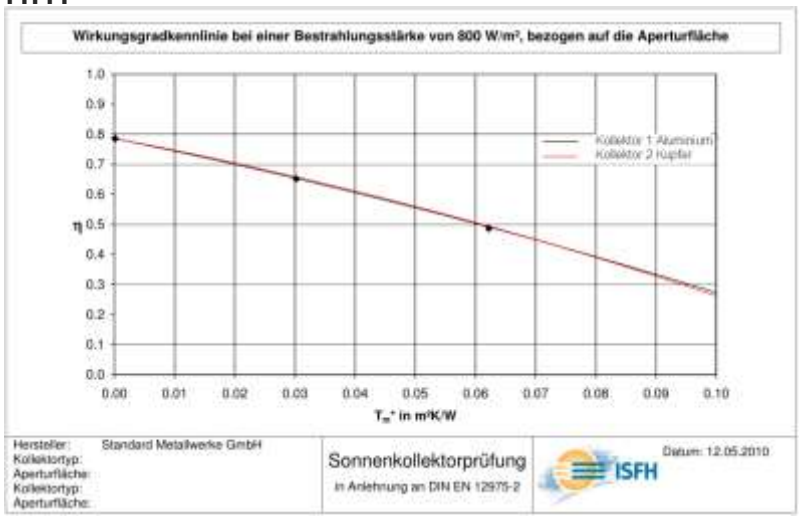


Foto: ISFH

Size approx. 1820 x 1140 mm
Absorber sheet: Alanod Miro-Therm 0.4mm
Absorber harp: 12 absorber tubes, laser welded
Material of fluid tubes:

- Collector 1: S-Life®-Solar Aluminium 8 x 0.7 mm
- Collector 2:´Copper tube 8 x 0.4 mm



The efficiency differences between the copper/aluminium and an aluminium/aluminium absorber are very small.

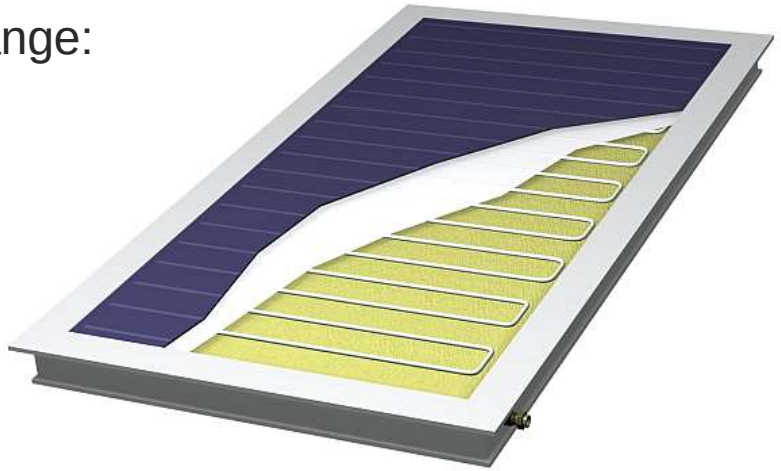
"… the differences being negligible within the scope of process accuracy.“

Are aluminium absorbers market-ready?

✔ Yes, they are!

The three main factors for a successful change:

1. The solar fluid
2. Think aluminium
3. Maintenance



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Talk to your bending/brazing/punching/welding machine manufacturer

Thank You!

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