Standard-Metallwerke

Test Specifications SWW-2010-12

Solar Simulator Test

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Testing solar heat transfer fluids and absorber tubes

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Task definition

At the present time collectors used in solar thermal systems are primarily manufactured with absorber tubes made of copper. As a consequence of continuously increasing prices for raw materials aluminium is progressively becoming the focus of interest as an alternative material for these tubes. Aluminium absorber tubes manufactured using the Rollbond method were used in solar thermal collectors as far back as the 1980s. Problems with corrosion arose for a variety of reasons in conjunction with those systems, which prevented a greater take-up of this type of collector. With the beginning of the renaissance of solar thermal technology in the 1990s copper became the exclusive material of choice for marketable flat plate and vacuum tube collectors. The composition of the solar heat transfer fluid(s) were modified in part accordingly.

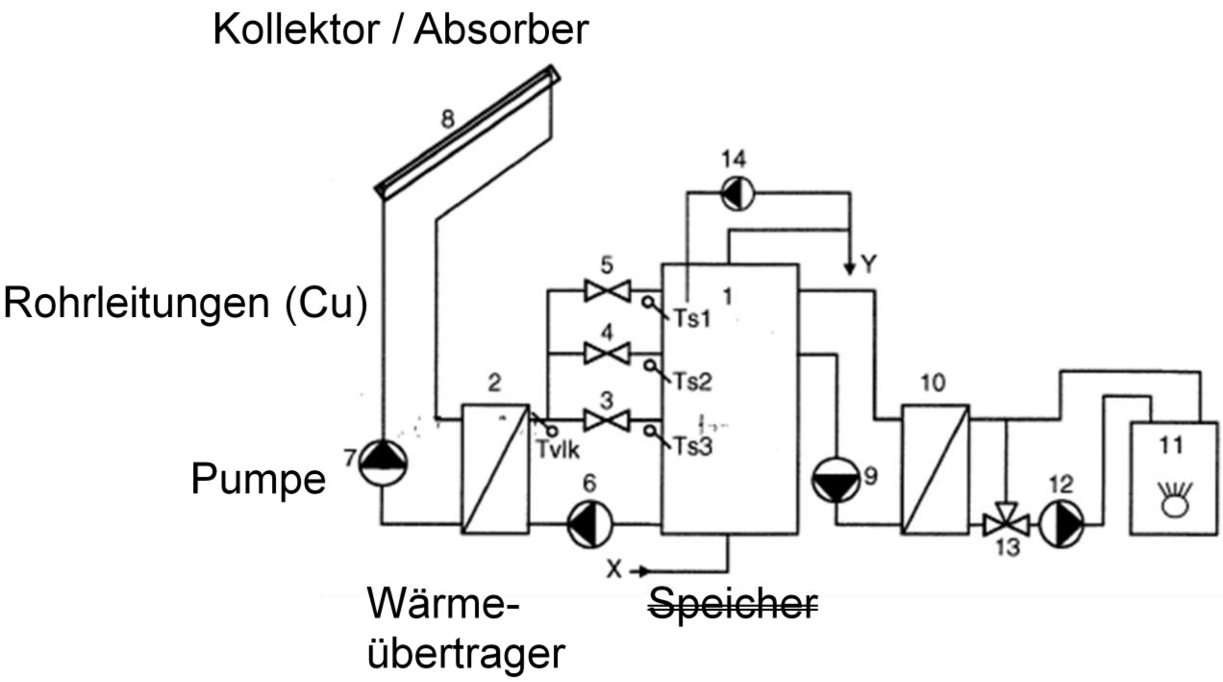
Continually increasing prices for conventional materials is the driving force behind the use of alternative materials, a fact that applies in particular to absorbers. Following the introduction of absorber plates made of aluminium, the possibility was examined to produce absorber tubes from other materials as well. And because aluminium tubes have become widely used in motor vehicles the idea of applying the experiences gained to other sectors of industry was not too far-fetched. In practice, it quickly proves to be the case that there are no standards specifying corrosion tests for the absorber tubes themselves. Consequently, it proved difficult to develop a test sequence with which it is possible to examine the durability of absorber tubes and characterize the service life of a collector by means of a shortened test routine. Incidentally, the same also applies to solar heat transfer fluids. It is true there are laboratory tests to determine material compatibility based on corrosion rates; however, to date there are no representative and at the same time internationally standardized test procedures for collector circuits.

With headquarters in Rapperswil, Switzerland, SPF suggested a test scenario based on the assumption that as far as the solar heat transfer fluid is concerned, and as such the absorber tube itself, the stagnation condition is the critical application condition. It is for this reason that the test cycle brings an absorber and the fluid within it to the vapour phase and subsequently cools it down again in a controlled manner.

The test facility in use today at Standard-Metallwerke GmbH was developed by SPF in Rapperswil, and is oriented towards the real-life structure of many solar thermal systems. Following optimization carried out with the aid of the Fraunhofer Institute for Solar Energy Systems ISE, based in Freiburg, Germany, the test facility has been in use since 2007 with tests focusing on aluminium absorber tubes.

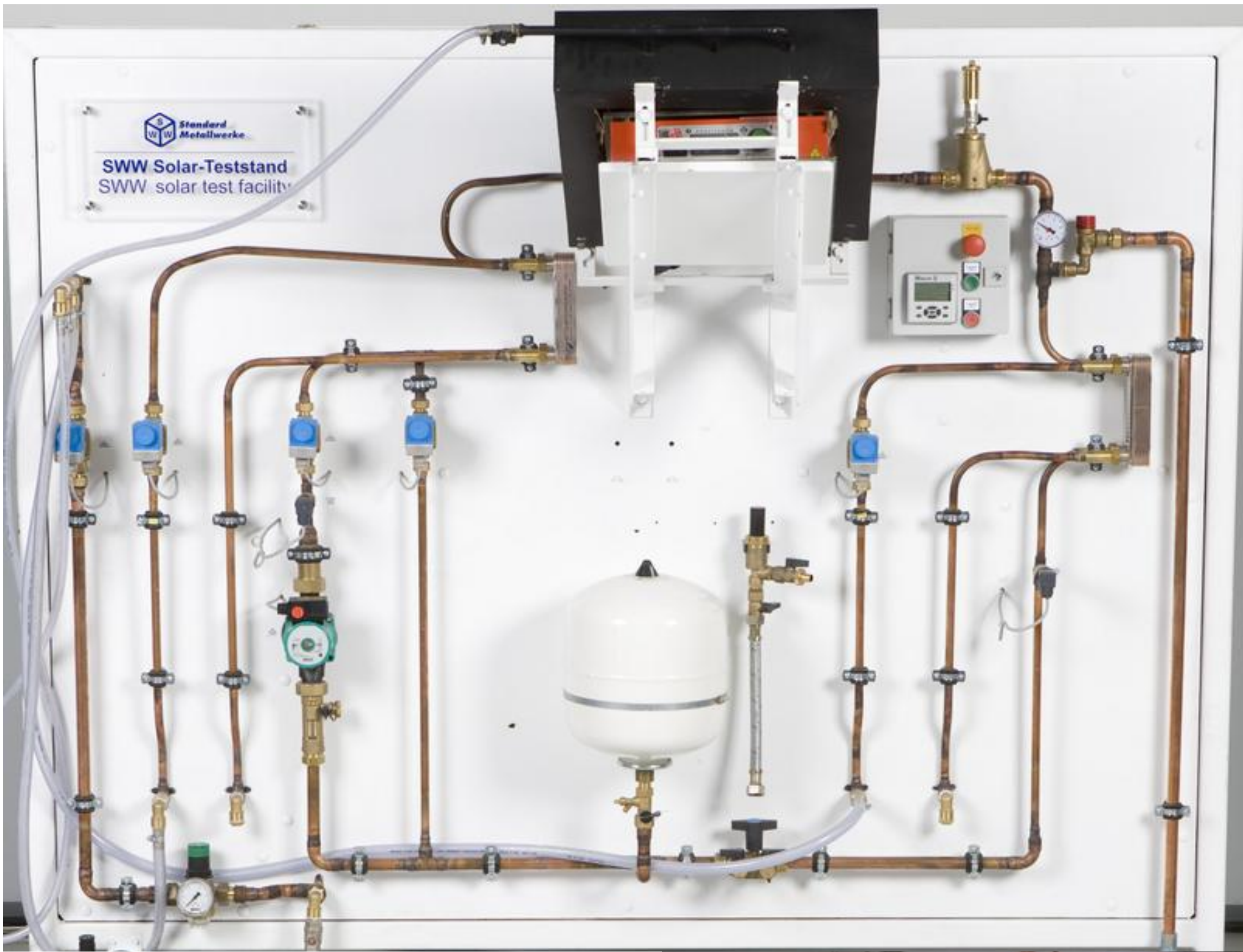
Standard-Metallwerke Solar Thermal Technology Simulator

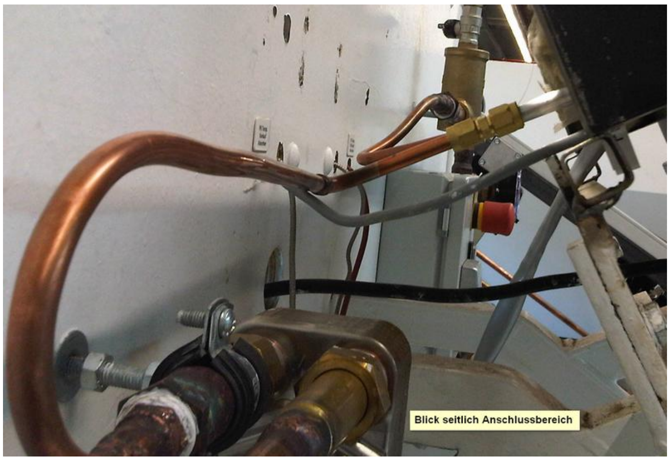
Verification of durability in a solar collector system!

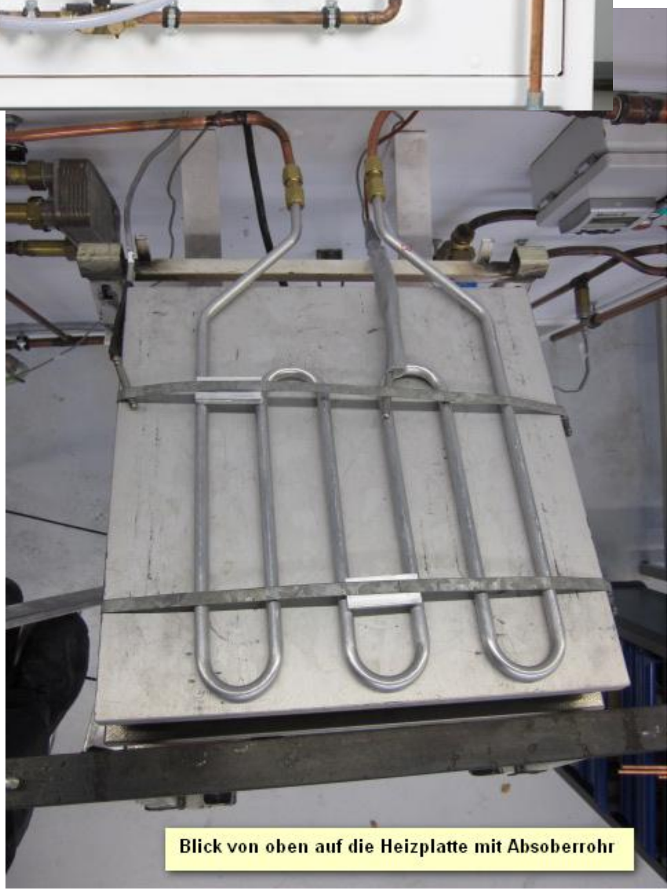


Test facility setup to simulate stagnation events. Assuming **30 stagnation events** per annum and a simulated service life of 20 years the result is 600 cycles.

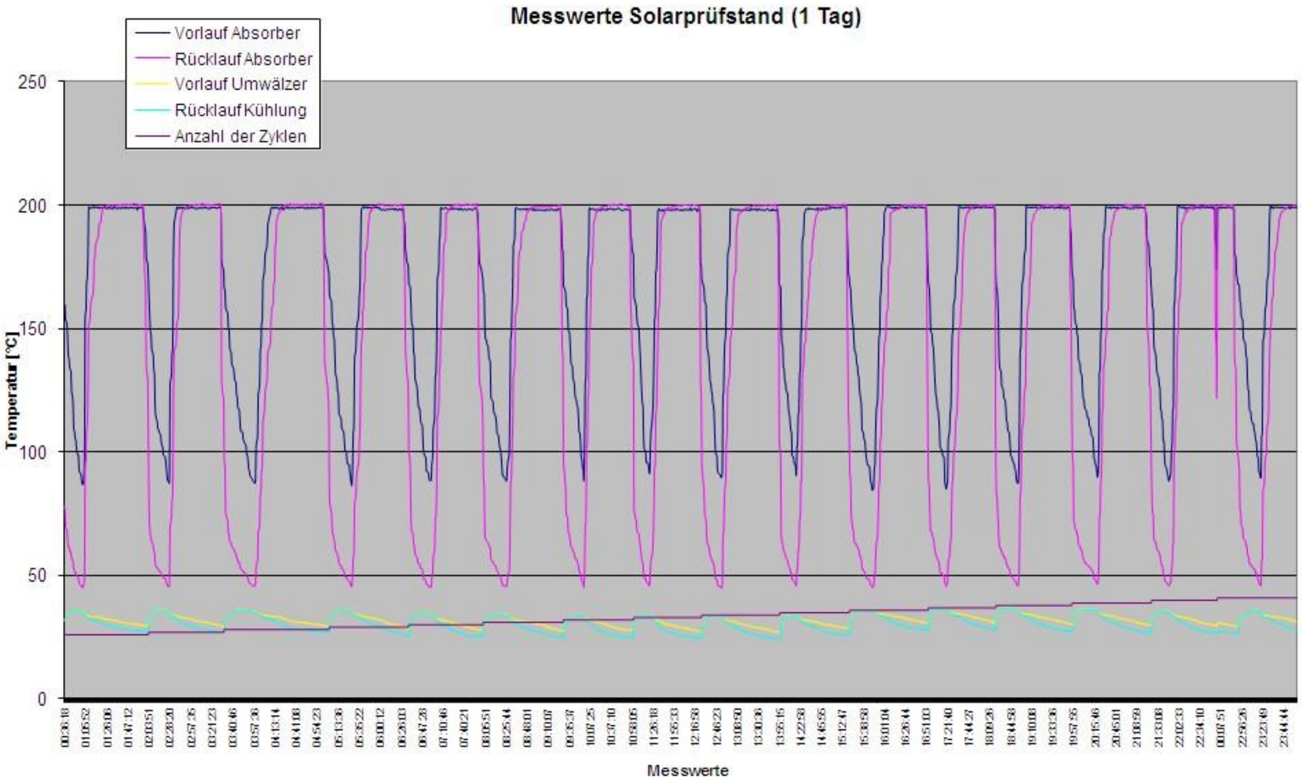
The setup corresponds to a conventional solar system available on the market. The entire pipework is made of copper – with traditional connections made primarily of brass or stainless steel.




Blick seitlich Anschlussbereich


Blick von oben auf die Heizplatte mit Absoberrohr

Test sequence



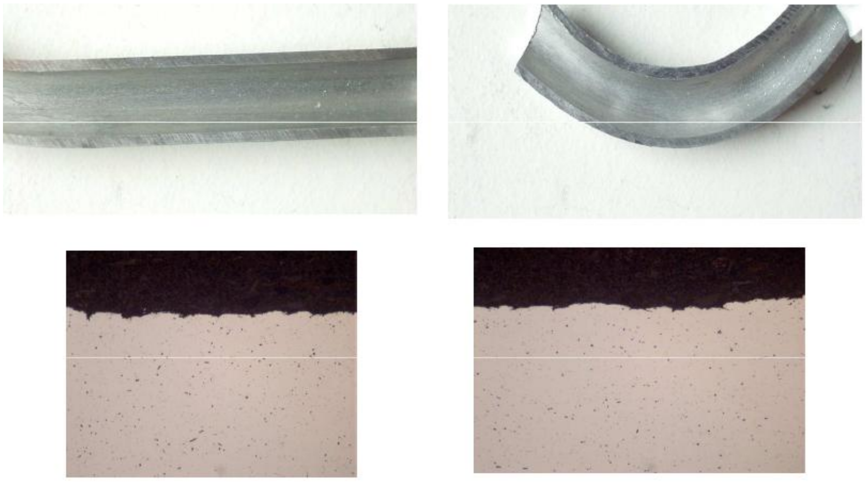
Cycle

- Heat absorber on heating plate to 210 °C
- Min. temperature of absorber tube: 190 °C
- Maintain temperature for 45 minutes
- Use air to cool down the absorber
- Temperature falls to 100 °C
- Heat transfer fluid circuit with coolant starts
- Temperature falls to 45 °C
- Begin cycle again

<u>Number of cycles: at least 600</u>

Designed and built by
SPF Solartechnik Prüfung Forschung
and assessed by
Fraunhofer ISE

Test result



Example
photos

Absorber tubes and connections are subjected to a visual inspection at the end of the test.

In addition, the absorber tubes are cut open lengthwise and all areas of the inside surface are subjected to a microscopic examination (example photos).

The solar heat transfer fluid is chemically tested in accordance with the manufacturer's specifications.

Test criteria

The test is considered as having been successfully passed after 600 cycles when ....

- The fluid in the chemical analysis fulfils the manufacturer's requirements, in particular with regard to material removal, reserve alkalinity, pH value and so forth.
- **No** leaks have occurred to the absorber tube or its connections.
- **No** pitting corrosion has occurred.
- **No** corrosion is detected during the visual inspection.
- There are **no** easily detachable deposits in the tube.

Allowed are ….

- Surface discolourations, in particular in hot area.
- Grain boundary damage in the material to a depth of 200 µm, visible only under a microscope.

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