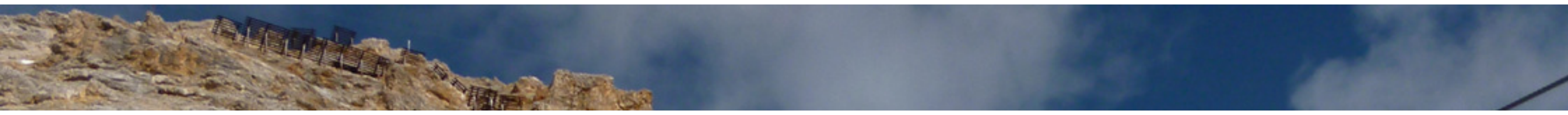
Accelerated Aging Tests for Adhesive Materials in Solar-Thermal Collectors Simulate 25 Years Real Load

INFO SHEET No. 02



Description	Adhesive materials in solar thermal collectors, service life time
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Project partners	Fraunhofer ISE (Coordinator), ITW TZS University Stuttgart, Alanod, Almeco Tinox, Arcelor Mittal, Bosch, Dow Corning, DSM, First Solar, Interfloat Kömmerling, Lorenz, Otto Chemie, Vaillant, Viessmann
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Download & further information	www.speedcoll2.de

*Speed*Coll and adhesive materials

The objectives of the *Speed*Coll2 project are the analysis of aging processes and the development of accelerated aging tests for solar thermal collectors and their components. The exposure of collectors and their components in extreme climatic conditions enables the verification of these procedures and the development of degradation models.

The aging effects occurring in solar collectors within the adhesive material component is by now not well examined. They are determined primarily by the temperature level in the collector. This temperature level has significantly increased during the last years due to the enhancement of the collector efficiency and the trend towards systems with higher solar fractions with resulting increase regarding stagnation time and temperature. Furthermore, durability analyses of new products on the market are needed, since only little is known about their long-term behavior.

The adhesive joint takes over multiple functions in the solar thermal collector, such as the mechanical holding of the transparent cover on the collector housing, as well as the sealing of the collector with respect to humidity, air and particle entry. Thus, it is a central component in a solar thermal collector.

The adhesive as well as the mechanical properties of the adhesives materials are determined by the use of small test specimens (H-PK, see figure 1). Representative material combinations were selected for this purpose. The collector manufacturers involved in the project provided the frame materials, which were then used as substrates for the H-PK in the three variants aluminum raw, aluminum powder coated and aluminum anodized.

The samples were exposed to outdoor weathering at tropical, maritime and moderate climatic conditions. The global weathering conditions and the respective micro climate inside the collector, including the temperature in the adhesive joint between glass cover and frame were monitored continuously.

RESULTS

In comparison to the other locations the alpine exposure site reaches the highest absorber temperature, which is consequently associated with a higher temperature within the collector and therefore the highest thermal load on the adhesive joint can be assumed in this case. An additional test combining high temperature and high humidity is not necessary, since this combined stress situation cannot be observed in solar collectors during operation conditions (Figure 1, left side).

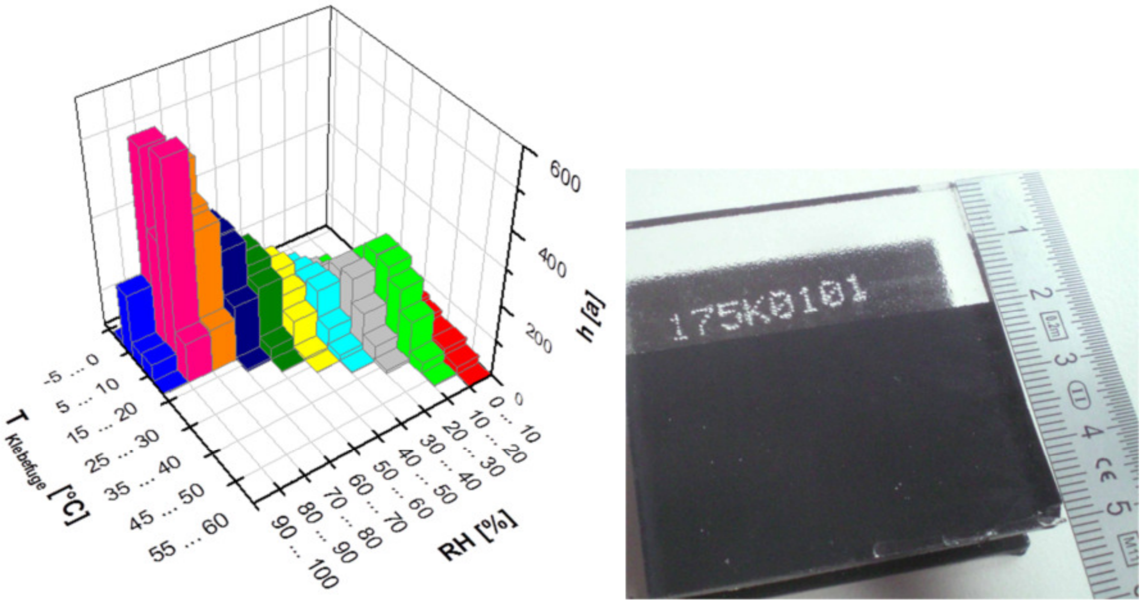

Figure 1: (left) Frequency [hours] in the period of (09/13 - 08/14) Rel. humidity inside the collector [%] - Adhesive joint temperature [°C]; (right) test specimen for outdoor exposure and indoor testing

For the definition of the test conditions the measured thermal load data were used. As a time transformation model for the accelerated aging the approach derived by Svante Arrhenius was chosen. The tests represent the measured load in the solar collector at the component adhesive joint to a calculated corresponding period of 25 years. The test sequence consists of three parts:

Part A Temperature stability T = 85 ° C, RH <10%
Part B Moisture stability = 40 ° C, RH = 95%
Part C Moisture stability + mechanical load, static T = 40 ° C, RH = 95% + 12.5% elongation

For an assumed activation energy of the dominant degradation process and a maximum test temperature of 85 °C, the calculated duration of the testing time is in the range of 600 h to 1000 h.

Performed tensile tests after an aging according to part A, B or C showed a 100% cohesive failure for all samples regardless of the chosen testing period up to 1000 h. Therefore the mechanical properties with respect to the adhesion of the transparent cover to the collector housing can be assumed to be ensured within the scope of the load depicted in the defined test cycle for more than 25 years. Compared to the reference values the tensile strength values after aging tests does not change significantly.

The results have been incorporated into the work of the Deutsche Institut für Bautechnik (DIBt) with regard to an approval "Verklebungen von Solarkollektoren"