Institut für Solarforschung

Accelerated Aging Testing of Parabolic Trough Receivers at DLR

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Introduction

The performance of a parabolic trough receiver is best described by optical efficiency and heat loss power. Their constancy over the lifetime are tested with accelerated aging at DLR. Tests are performed on entire receivers and on small glass samples, where aging of the AR-coating is investigated. Before and after the aging the samples are tested for performance, compare Figure 1.

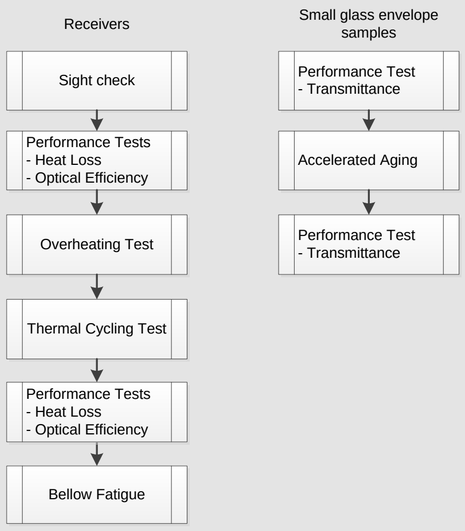

Figure 1: Measurement sequence

Performance Measurement of Receivers

Performance measurement of parabolic trough receivers consists of optical efficiency testing in the linear focus solar simulator (Figure 2) and heat loss testing. Figure 3 shows a typical heat loss curve.

Figure 2: Linear focus solar simulator

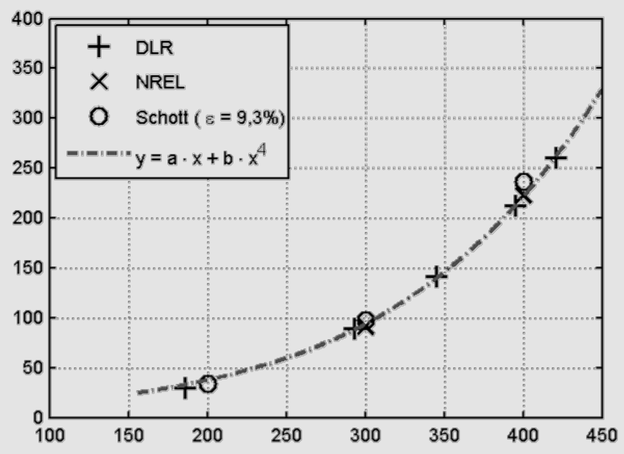

Figure 3: Heat loss of typical parabolic trough receiver [1]

Aging of Receivers

For the **overheating test** the absorber is heated above operating temperature in order to induce accelerated aging of the absorber coating. Standardized aging parameters of 478 °C for 1000 h for oil receivers are currently used. Heating is performed with resistance heaters inserted in the absorber. The test bench (Figure 4) is also used for **thermal cycling** of parabolic trough receivers, where the receiver is heated for 100 cycles from 200 °C to 478 °C.

Figure 4: Test bench for overheating and thermal cycling of parabolic trough receivers

After a second measurement of receiver performance, the receivers are subjected to the **bellow fatigue test**. A scheme of this test is shown in Figure 5. The absorber is heated to 200 °C to induce an absorber elongation half of that at 400 °C. The absorber is fixed to the test bench and the glass envelope is pushed back and forth for 20 000 cycles at 1 hz. Receiver heat loss is monitored for detection of leackage from cracks in the bellow or the glass to metal seal. The test is finished 24 hours after stopping the cycling.

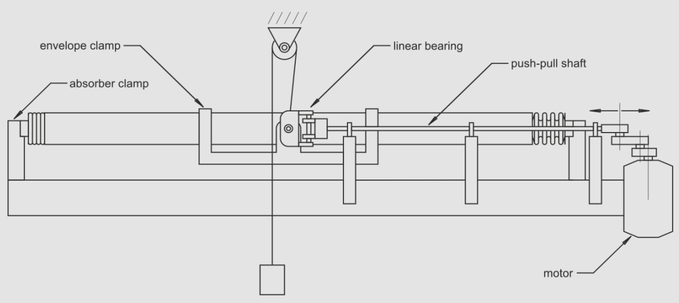

Figure 5: Scheme of bellow fatigue test bench

Performance Measurement of the AR-coating on Small Glass Samples

Tests of the AR-coating of the parabolic trough receiver are performed on small glass samples. The transmittance is measured with a spectrophotometer at the entrance port of an integrating sphere with 15 cm diameter before and after testing.

Aging of the AR-coating on Small Glass Samples

AR-coatings are tested for abrasion resistance and weather durability. Abrasion resistance is tested with the Taber Linear Abrasor and rubber MIL 12397 ¼'', compare Figure 6. Research regarding a realistic sand erosion test simulating the effect of sand and dust storms is ongoing.

Figure 6: Taber Linear Abrasion Test for AR-coating testing

Several weathering chambers are available at the OPAC laboratory jointly operated by Ciemat and DLR. The principal test performed is

- Condensation Test ISO 6270-2.

Also available are

- UV-light stability/ Humidity Test ISO 11507
- Humidity freeze test IEC 62108 Test 10.8.

Parabolic trough receiver testing capability is available for industry and introduced in international standardization activites.

[1] Pernpeitner et al.: Durability testing of parabolic trough receivers – Overheating, thermal cycling, bellow fatigue and antireflex-coating abrasion, Proceedings of SolarPACES Conferences, 2014, Beijing, China
[2] Eichel et al.: Heat loss measurements on parabolic trough receivers, Proceedings of SolarPACES Conferences, 2010, Perpignan, France

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