

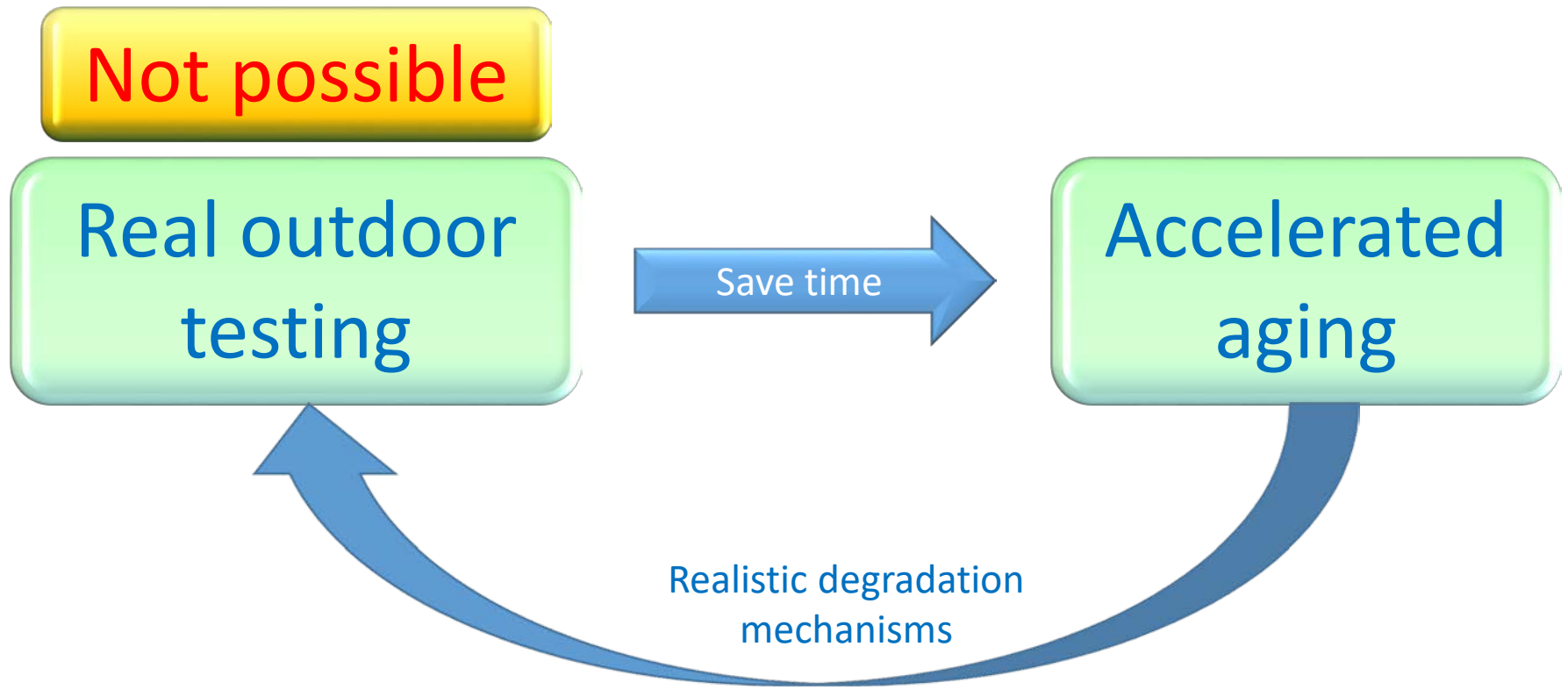
Testing of secondary reflectors

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Introduction

Durability testing of components for CSP technologies is a crucial aspect to guarantee the profitability of the plants and to ensure a proper efficiency during their lifetime



Introduction

Testing protocol at CIEMAT-PSA

- Standard tests
- Mechanical tests
- Tests to simulate operating conditions
- Test under real concentrated solar radiation



Standard tests

UNE 206016:2018. First standard for durability testing of solar reflectors for CSP technologies

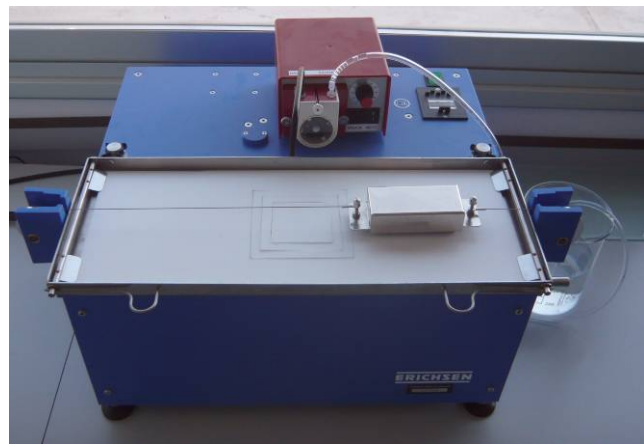
Test	Duration	Summary of testing conditions
Neutral Salt Spray (NSS) ISO 9227	480 h	T= 35±2°C, pH=[6.5,7.2] at 25°C Sprayed NaCl solution of 50 ± 5 g/l with condensation rate 1.5 ± 0.5 ml/h on 80 cm ²
Copper-accelerated acetic acid salt spray (CASS) ISO 9227	120 h	T=50±2°C, pH=[3.1,3.3] at 25°C Sprayed NaCl solution of 50 ± 5 g/l and 0.26 ± 0.02 g/l CuCl ₂ Condensation rate 1.5 ± 0.5 ml/h on 80 cm ²
Condensation ISO 6270-2	480 h	T=40±3°C; RH: 100%
Combined thermal cycling and humidity	10 cycles (240 h)	4 h at T=85°C, 4 h at T=-40°C, Method A: 16 h at T= 40°C and 97±3% RH Method B1: 16 h at T=85°C and RH=85±3% Method B2: 40 h at T=65°C and RH=85±3%
UV + humidity ISO 16474-3	2000 h	1 cycle: 4h at UV exposure at 60±3°C followed by 4h at 100% RH at 50±3°C



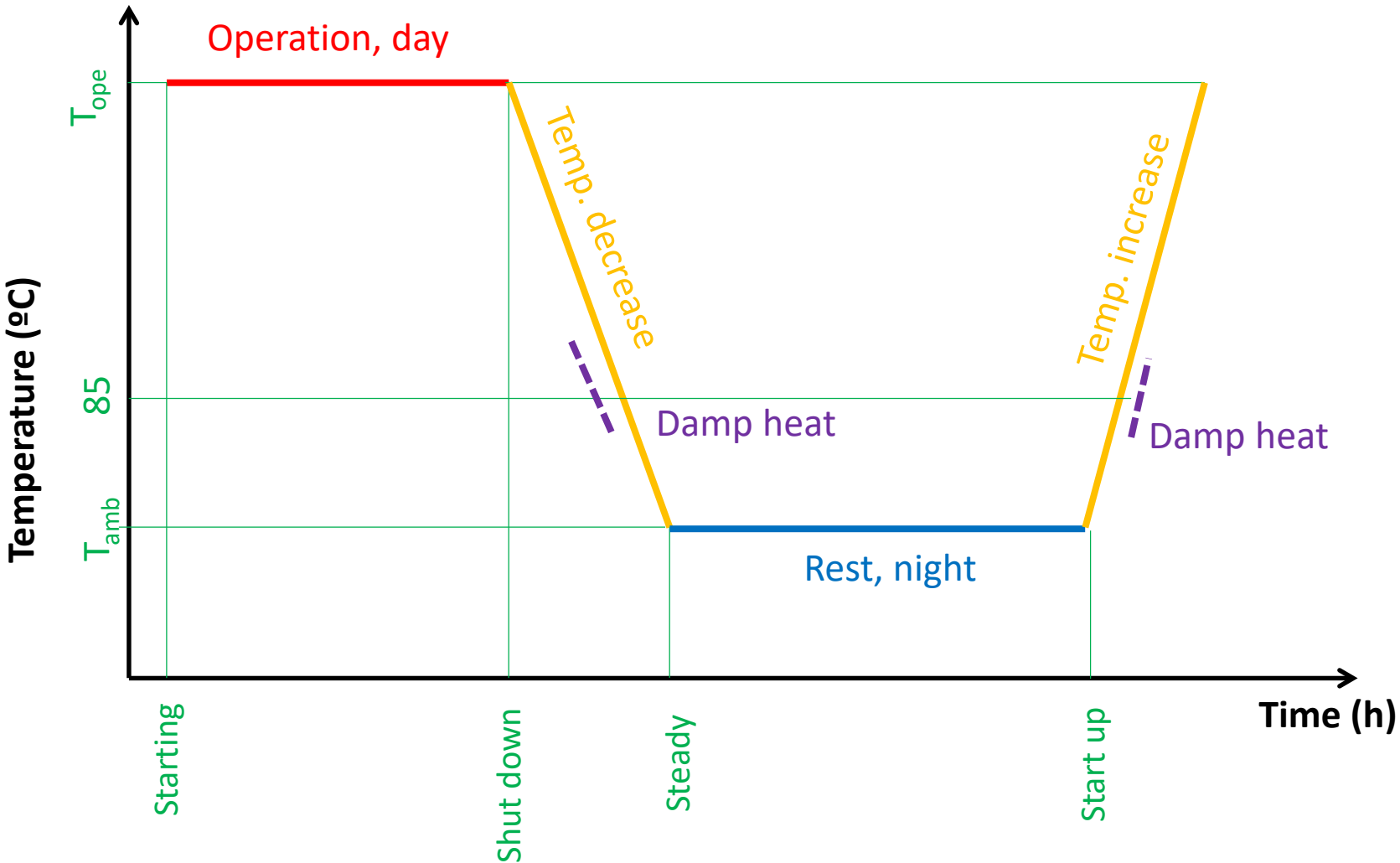
Mechanical tests

To simulate sand storms and cleaning with brush

Test	Duration	Summary of testing conditions
Sandstorm	1 cycle = 5min 3 cycles	70 g of dust to 20m/s
Taber	100 cycle	UNE 206016. Alternative linear movement of an abrasive head (CS10 ¾") at room temperature
Washability	200 cycle	ISO 11998, Linear movement of a brush head back and forth at room conditions under ambient running water



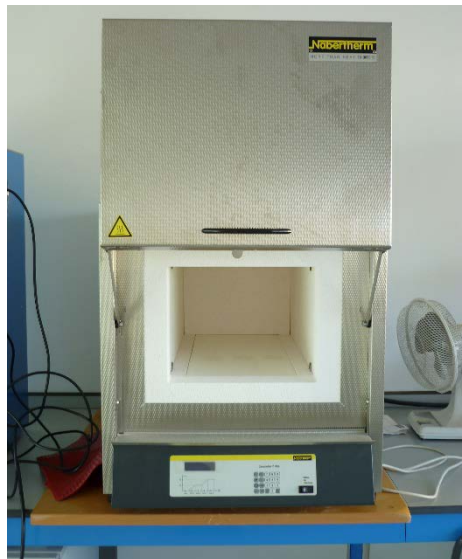
Tests to simulate operating conditions



Tests to simulate operating conditions

Constant temperature test

- Simulate conditions under operation
- The operating temperature, T_{ope} , depends on the cooling system (CFD simulations)
- Chamber: Muffle furnace



For cooled systems:

- T_{ope} is around 85-120 °C
- The key issue is the adhesive



Interaction of adhesives with reflector

Tests to simulate operating conditions

Temperature cycling test

- Simulate start up and shut down
- The upper temp, T_{ope} , depends on the cooling system
- The lower temp, T_{amb} , depends on the location
- Chamber: device specially developed at the PSA, based on a muffle furnace



Tests to simulate operating conditions

Damp heat test

- Simulate humid + warm conditions during sunrise and sunset
- The typical testing conditions are 85°C, 85%
- Chamber: conventional weathering chamber



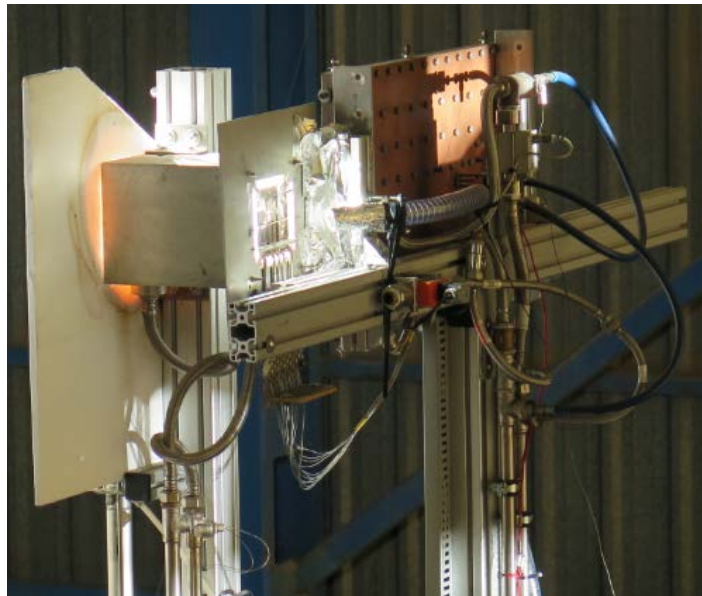
Test under real concentrated solar radiation

- High concentrated radiation solar fluxes
- Solar furnace at CIEMAT-PSA



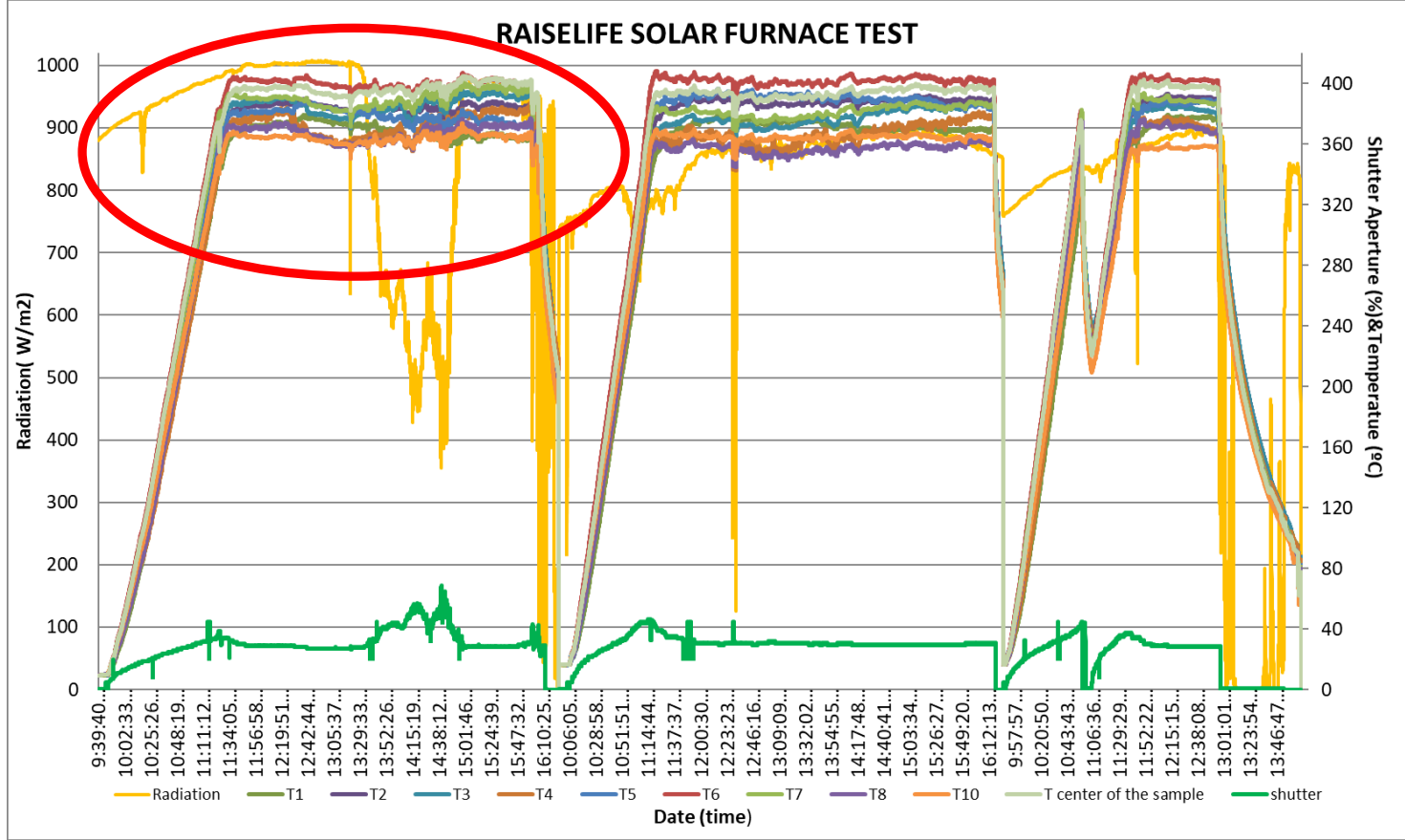
Test under real concentrated solar radiation

- A shutter to control the concentrated solar radiation flux
- A homogeneizer in the focus to ensure uniform distribution
- An active cooling system to control the flux distribution temperature
- A CCD camera to characterize the solar



Test under real concentrated solar radiation

Independently of the solar radiation fluctuations, the temperature and solar flux targets are successfully achieved and kept



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Thank you for your attention!

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