Quality Assurance in solar thermal heating and cooling technology

Keeping track with recent and upcoming developments

Summary report
Absorber surface durability

SP – Technical Research Institute of Sweden
Peter Kovacs

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1 Background

Presently there are no requirements for the long term durability of absorber coatings specified in the EN 12975 [4] and [5] or in any other standard. Considering the rapid and continuously on-going development of new materials, coatings etcetera and the increasing specialization among manufacturers, it is assumed that manufacturers of absorbers could benefit from methods that can ”predict” a long service life. Standardised methods and requirements would also benefit their clients, the collector manufacturers, who would then be able to strengthen quality requirements on their suppliers. In the case of absorber coatings, such a method does exist since several years but so far did not make it all the way to a European or International standard. Despite this fact, demand from the solar industry led to that it has been applied by at least three laboratories in Europe since several years. It has then been referred to as “the Task 10 method”.

The method was developed within the IEA SH&C Task 10 and presented as an ISO draft in 1997 [1]. However, due to the fact that the work on collector material standards in ISO did not proceed as planned, this work item was later cancelled. The method was later reviewed and updated within the framework of IEA SH&C Annex 27 “Performance of solar façade components”. The document: “Recommended qualification test procedure for absorber surface durability” [3] describes tests applicable to organic and inorganic coatings. The tests are designed so as to predict a 25 year life of the coating.

2 Absorber surface characterization and durability testing

The proposed method takes into account high temperature degradation, degradation due to condensation and degradation caused by air borne pollutants in the form of humidity and sulphur dioxide. It is based on a series of short term durability tests where the degradation mechanisms mentioned are being applied to the test sample. The humidity plus sulphur dioxide is considered as an optional test.

During a test the optical performance of the absorber surface tested is determined by measuring its solar absorptance and thermal emittance according to well-defined procedures which are part of the method. Additionally the adhesion and the surface homogeneity are both part of the qualification procedure. From the loss in optical performance of the absorber surface, its failure time in the test performed is assessed and compared with the shortest acceptable failure time set by the design service life of the absorber.

The general performance requirement applied in the method to classify the durability of the absorber surface is defined by the following equation:

$$PC = -\Delta\alpha_S + 0{,}50\,\Delta\varepsilon \leq 0{,}05 \quad (1)$$

where

$\Delta\alpha_S$ is the change in the solar absorptance defined as

$$\Delta\alpha_S = \alpha_{S,t} - \alpha_{S,I} \quad (2)$$

with $\alpha_{S,t}$ equal to the value of the solar absorptance at the actual time of the test or at service, and

with $\alpha_{S,i}$ equal to the initial value of solar absorptance

$\Delta\varepsilon$ is the change in the thermal emittance

$$\Delta\varepsilon = \varepsilon_t - \varepsilon_i \quad (3)$$

with ε_t equal to the value of the thermal emittance at the actual time of the test or at service and

with ε_i equal to the initial value of thermal emittance.

Depending on the value of PC plus the adhesivity determined after initial test sequences, the surface can either be directly qualified, disqualified or additional sequences may be required before a final judgement can be made.

3 Inputs to standardization

As mentioned in the introduction, a widely accepted standard for absorber surface durability can serve several purposes:

- To help producers of surfaces and absorbers to optimize their products and to ascertain the general quality of their products as well as the products' expected lifetime
- To give collector manufacturers tools for defining more accurate requirement specifications to their absorber suppliers and thereby optimizing the collector
- Since 2010 the Solar Keymark has applied a procedure for determining the equivalence of different absorber coatings in order to facilitate the process when a collector manufacturer wants to change the absorber coating in his collector, see document SKN_N0137_R2. Tests of absorber surfaces according to an EN- or ISO standard would be a good alternative option to determine the equivalence of different absorber coatings

Also taking into account that there has been a demand for these tests from the industry ever since they were introduced, there is thus a strong rationale for having the "Task 10 method" approved as a standard. This topic was therefore prioritized in the Qaist WP2 and furthermore introduced for discussions in the Solar Keymark Network and in CEN/ TC 312/ WG1 which proposed it as a new work item in TC 312. Following some editorial work, the draft standard was sent on a public inquiry in 2011 [6]. Next step in the process is the

formal vote which is expected to take place early 2013 with publication following months after, provided the outcome of the vote is positive. The method will be published as EN 12975-3-1 "Thermal solar systems and components - Solar collectors - Part 3-1; Qualification of solar absorber surface durability."

Later in 2011, due to positive developments in the work of ISO and to the activities of Qaist partners, the method was also adopted by ISO/TC 180 and proposed as part of a multipart standard on solar thermal collector components and materials. This work is to be performed according to the Vienna agreement and the part related to absorber surface durability will be led by CEN. It will be published as ISO 22975-3 "Solar Energy-Collector components and materials-Part 3; Absorber surface durability.

4 Further work

Coatings of receivers for high temperature applications are not in the scope of the proposed method and no other standardized methods exist. It would therefore be desirable to support the CSP industry with further method development in this field. As CSP products are presently dealt with in a newly established project under IEC/ TC 117 this is probably where this work will be initiated and concluded.

5 References

[1] ISO/ CD 12592.2: Solar energy- Materials for flat plate collectors- Qualification test procedures for solar absorber surface durability, January 9th 1997

[2] B Carlsson, U Frei, M Köhl and K Möller: Accelerated life testing of solar energy materials-Case study of some selective solar absorber coating materials for DHW systems. A report of IEA SH&C Task X.

[3] Carlsson B (2004) Recommended qualification test procedure for absorber surface durability. IEA Solar Heating and Cooling Program Annex 27 Performance of Solar Façade Components. Project: Service life prediction tools for Solar Collectors

[4] CEN, European committee for standardization, 2006 "EN 12975-1:2006, Thermal solar systems and components - Collectors - Part 1: Requirements"

[5] CEN, European committee for standardization, 2006 "EN 12975-2:2006, Thermal solar systems and components - Collectors - Part 2: Test methods"

[6] prEN 12975-3-1Thermal solar systems and components - Solar collectors - Part 3-1; Qualification of solar absorber surface durability. November 2011