

SPF test specification no. 21

Outgassing of thermal insulation materials for solar thermal flat-plate collectors

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1 General

1.1 Introduction

The operational reliability and the durability of a solar thermal collector depend on the quality of all components used. One of these components is the thermal insulation. The evaluation of the thermal properties and of the safety is regulated in various international standards. However, for solar thermal collectors, the outgassing behaviour requires additional attention. Such outgassing is easily visible on the front cover of the collector (see Fig. 1), as this acts as a condensation trap. In general, these are mainly aesthetic problems, but they can be particularly annoying for the customer and for the system operator and should therefore be avoided if possible. In particular, when glass with an anti-reflective coating is used, there is also a risk that outgassing will reduce transmission of the glazing and cause a decrease in the collector efficiency over time.

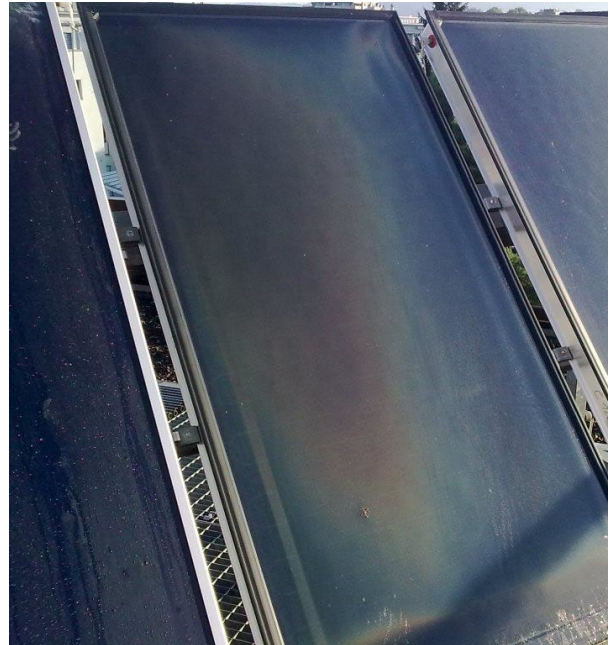
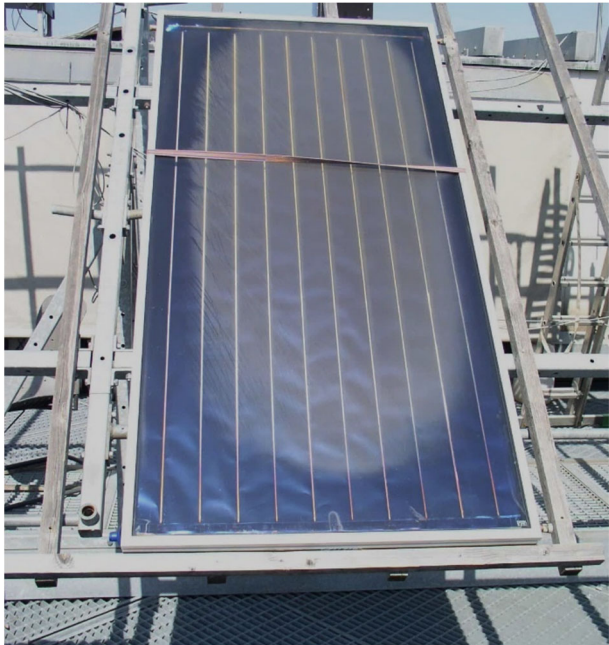


Fig. 1 Different forms of outgassing as they can be caused by thermal insulation.

As no corresponding procedure exists, the SPF Institute for Solar Technology has developed a suitable method for assessing and certifying the outgassing behaviour of thermal insulation.

The customer determines the maximum operating temperature for his product. Typical temperatures are between 220°C and 250°C. For modern thermal solar collectors with selective absorber coatings, temperatures below 220°C are no longer useful.

2 Test method

2.1 Test device

The test apparatus consists of a temperature-controlled heating plate, a metal cylinder and a glass cover, as shown in Fig. 2.

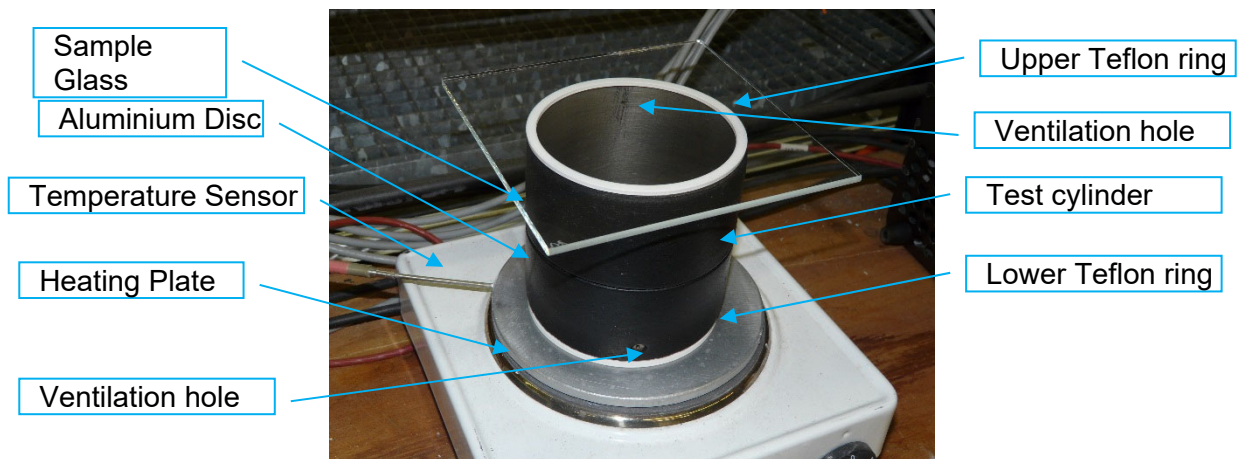


Fig. 2 Testing device for outgassing measurements

A hot plate is used to heat a 5 mm thick aluminium disc. A PT100 temperature sensor is inserted into this aluminium disc to measure the temperature at the centre of the disc. This temperature sensor is used to control the heating plate. The temperature is controlled to within better than ± 3 °K of the specified test temperature. This aluminium disc simulates the hot absorber in a thermal solar collector. The test sample is placed directly on this disc to simulate direct contact with an absorber.

The sample is placed in a metallic cylinder, which is placed on the aluminium disc. The metallic cylinder has an inner diameter of 100 mm and a height of 100 mm. The outside of the cylinder is insulated with 5 mm EPDM foam to prevent the device from excessive cooling. Two small ventilation holes (diameter 2 mm) are required to allow a certain air flow through the test cylinder: one ventilation hole at the lower end and one at the upper end on the opposite side of the cylinder. To assess outgassing, the cylinder is covered with a clear glass with an anti-reflective coating. Two PTFE rings with a thickness of about 2 mm are used to seal the test chamber at the top and bottom.

All materials used for the construction of the test device are resistant to the solvents/cleaning agents required for cleaning the entire device. The modular design of the test device makes it easy to clean. If necessary, individual parts of the device are replaced, for example if they are so heavily soiled that they can no longer be cleaned.

2.2 Test sample

The test sample must be approximately 75 mm x 75 mm and a maximum of 50 mm high. If the material submitted for testing is less than 50 mm thick, it will be tested as delivered. Materials with a greater thickness are cut to a maximum height of 50 mm. The test sample is then cut into an octagonal shape and placed directly on the aluminium disc (see Fig. 3 and Fig. 4). Care is taken to ensure that the test sample does not touch the test cylinder and that the ventilation holes are not closed by the test sample. If the material is covered with a fleece or with aluminium foil, this side must face the heating plate.

Two test samples are required for the test, preferably from different production batches. The material is cut to the correct size by the testing laboratory.



Fig. 3: typical test sample



Fig. 4: Test sample on the hot aluminium plate. The black fleece is in direct contact with the plate.

2.3 Test procedure

The test chamber is thoroughly cleaned and operated empty at the intended test temperature for at least one hour to ensure that possible outgassing on the test glass is not caused by any residues. The test device is then brought to laboratory temperature and the test sample is placed in the metal container. The metal container is covered with the cleaned sample glass. The heating plate is then heated to the test temperature and held at this temperature for ≥ 150 h, after which it is passively cooled to room temperature again. Within 3 h after complete cooling, the glass is visually inspected for deposits/outgassing and fogging.

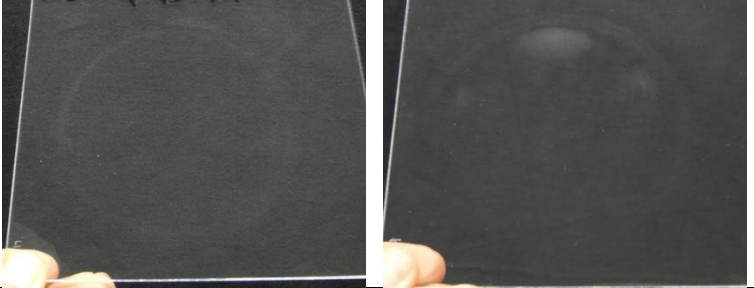
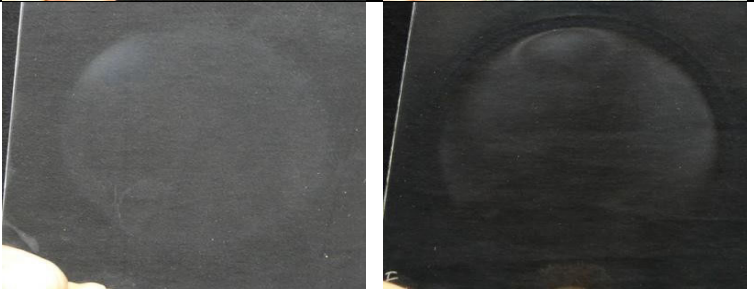
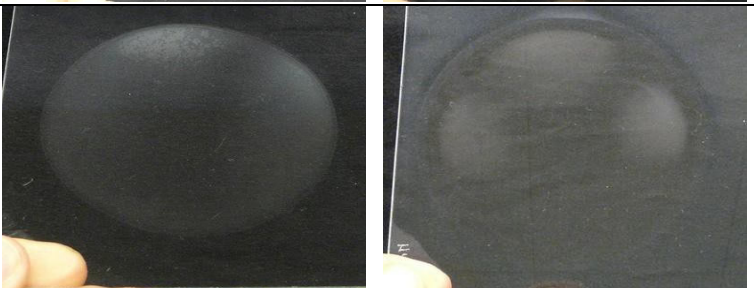
This visual inspection is carried out in an interior room by viewing the glass sample in front of a very dark, homogeneous and clean matt black surface (black felt). The fogging is evaluated according to the specifications listed in Table 1. The result of the evaluation is given in the test report together with the image. Photographs are taken to illustrate the extent of fogging. The test sample is also compared to a new and clean glass.

In addition to the visual inspection, the transmission T_{sol} is measured over an AM1.5 spectrum before and after exposure. The decrease in transmission is then assessed based on the specifications in Table 2.

3 Rating

3.1 Visual inspection

The condensation traps are visually inspected and photographed. On this basis, they are categorised into one of the four categories v1 to v4 according to Table 1.

Class	Description	Examples of references
v1	No visually recognisable condensation is expected on the cover.	
v2	Only slightly visible condensation is to be expected on the cover.	
v3	Visibly condensation is to be expected on the cover.	

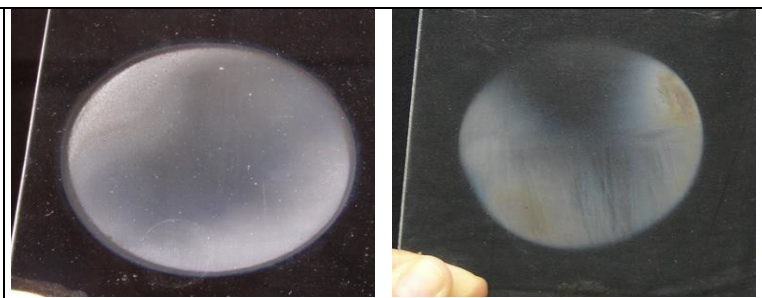
<p>v4</p>	<p>Visibly disturbing condensation is to be expected on the cover.</p>	
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Table 1: Visual classification of outgassing

3.2 Measurement-based assessment

In addition to the visual inspection, the transmission T_{sol} is measured before and after exposure with an AM1.5 spectrum. This means that we not only take into account the visible part of the spectrum, but the entire range that is important for thermal collectors. In the spectrum shown in Fig. 5, a change in the transmission curves can be seen. The transmission (integral over AM1.5) before the test is 0.937, and after the test it is 0.927. This is a difference of 0.01, which would then also result in an approximately 1% power reduction for the collector.

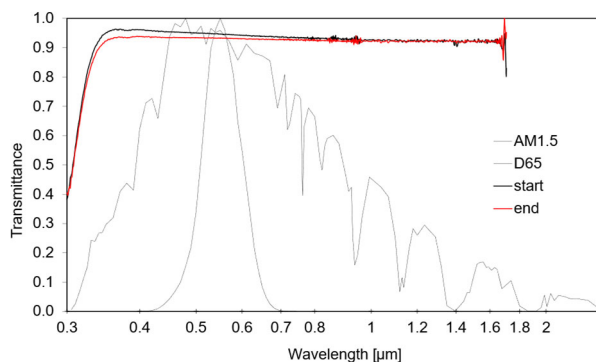


Fig. 5: Example of transmission measurements before and after the outgassing test.

The resulting changes in the transmission values ΔT_{sol} define the classification into one of the four categories t1 to t4 according to Table 2.

Class	ΔT_{sol}	Rating
t1	≤ 0.003	Good
t2	≤ 0.010	Acceptable
t3	≤ 0.015	Acceptable
t4	> 0.015	not acceptable

Table 2: Measurement-based classification of outgassing

The insulation materials are then categorised according to these ratings. If any of the ratings are in class 4 (i.e. either v4 or t4), no certificate is issued because the product is deemed unsuitable for the intended use.

4 Test report, certificate

A test report is issued for each test, containing the most important results. If the test is passed (no classification 4) and an official data sheet is available for the tested sample, a certificate can be issued upon request by the client. This certificate is then also published under www.spftesting.info. This certificate is considered valid for three years and is issued as such. It remains only valid if the materials used and the manufacturing process are not changed. There may be production fluctuations in the production of insulation materials. The certificate is therefore to be understood as a confirmation that the client or manufacturer is able to produce thermal insulation that is free of outgassing according to the assessment in chapter 3.