STAGNATION TEST FOR COLLECTORS AND INTEGRAL COLLECTOR AND CONTAINER

(Normative)

A.1 SCOPE

This Appendix sets out two methods for assessing the ability of a collector or integral collector and container to withstand temperatures close to the maximum temperatures that it will encounter under some or all of the following conditions:

NOTE: Either of the two methods set out in this Appendix may be used, but it should be noted that Method 1 is not suitable for use with collectors with heat pipes.

(a) When empty during installation;

(b) When empty during its service life; and

(c) When full of water but not being used in peak summer conditions

Such temperatures occur during periods of no useful heat removal from the collector with high solar radiation and ambient temperatures.

NOTES:

1 In order to more realistically model extreme conditions, the test conditions have been changed from 1200 W/m^2 radiation and 40°C ambient temperature to 1100 W/m^2 and 50°C. Collectors compliant with the former conditions are deemed to comply with the new conditions. The conditions in ISO 9806-2 for high temperature resistance test 'Sunny C' are also deemed to comply.

The effective environmental temperature for New Zealand is 40°C for Method 1. For New Zealand the conditions in the ISO 9806-2 for high temperature resistance test 'Sunny B' are acceptable. However, the collector must be marked in accordance with Clause **Error! Reference source not found. Error! Reference source not found.** if this test method is used.

2 The Method 2 test has a lower radiation level and ambient temperature to account for the fact that the thermal radiation level received by the collector from the simulator lights is higher than from the natural sky.

A.2 APPARATUS

C2.1 Method 1

NOTE: This method is not appropriate for use with collectors with heat pipes.

The following apparatus is required (see also Figure C1).

(a) A pumped heat transfer loop using a suitable heat transfer liquid, with the collector forming part of the loop. A suitable heat transfer fluid is one that will remain in its liquid state at the stagnation temperature and the maximum operating pressure of the collector.

(b) A stand on which the collector will face normal to the direct beam solar radiation at solar noon. A suitable stand is described in AS/NZS 2535.1 or ISO 9806-1.

(c) Thermometers or temperature-measuring devices to measure the temperature of any critical materials or heat-sensitive components during the test.

C2.2 Method 2

The following apparatus is required:

(a) A solar simulator of suitable size.

(b) A temperature-controlled chamber in which the collector may be placed when exposed to the simulator.

(c) Thermometers or temperature-measuring devices to measure the temperature of any critical materials or heat-sensitive components during the test.

A.3 PROCEDURE

C3.1 Method 1

The procedure shall be as follows:

NOTE: In this procedure, two approaches are made to determine the stagnation temperature (T_s). The first approach is detailed in Steps (a) and (b), and the second approach (which is a cross-check and correction) in Steps (c) and (d).

(a) Test the collector for thermal performance in accordance with AS 2535.

(b) From the constants supplied from Step (a) calculate, in accordance with the equation below, the stagnation temperature (T_s) when —

(i) the efficiency is zero;

(ii) the total global radiation is 1100 W/m^2; and

(iii) the effective environmental temperature is 50°C.

The stagnation temperature (T_s) is calculated as follows:

$$T_S = T_{aS} + \frac{-\bar{a}_1 + \left(\bar{a}_1^{\,2} + 4 \times 1100 \eta_0 \bar{a}_2\right)^{1/2}}{2\bar{a}_2} \qquad \ldots C3(1)$$

The values for the terms used in the equation are obtained by testing in accordance with AS/NZS 2535.1.

(c) As a cross-check for the stagnation temperature, proceed as follows:

(i) Install the collector on the stand in accordance with the manufacturer's instructions and adjust its inclination to provide for maximum (clear sky) solar irradiation. Ensure all the air has been bled from the system.

(ii) Measure the total global solar radiation (G) on the plane of the collector and the ambient temperature (T_a). Adjust the temperature of the fluid (T_f) entering the collector to —

$$T_f = T_a + \frac{-\bar{a}_1 + \left(\bar{a}_1^{\,2} + 4G\eta_0 \bar{a}_2\right)^{1/2}}{2\bar{a}_2} \qquad \ldots C3(2)$$

(iii) Measure the temperature difference (ΔT_{fluid}) of the fluid flowing through the collector and determine that the collector has reached steady state by plotting the collector outlet temperature versus time. If there is a temperature rise, increase the fluid temperature entering the collector by 5°C, or, if there is a temperature drop, reduce the fluid temperature entering the collector by 5°C.

(iv) Measure G, T_a, and the temperature difference across the collector. If there is still a rise or drop, repeat Step (iii). If the rise has become a drop or vice versa, then the true stagnation temperature has been saddled.

(v) The correction to be applied to the predicted stagnation (T_s) is shown in Figure C2.

(d) Adjust the fluid temperature to T_s plus the correction obtained in Step (c).

(e) Adjust the flow rate through the collector so that the average inlet temperatures and the average outlet temperature over the test period are both greater than the stagnation temperature (measured at least every 5 min).

(f) Run the system at this flow rate and temperature for 12 h and then turn the pump off for 12 h. Continue this cycle of operation for 10 days. Ensure that the heat transfer fluid is at the calculated stagnation temperature prior to commencement of each cycle of operation.

(g) Visually inspect the collector daily and note any changes in its appearance.

(h) Terminate the test after 10 days or when there is evidence of structural or material deterioration that would impair the operation of the collector, whichever is sooner.

(i) Carry out a test of the thermal performance of the collector in accordance with AS/NZS 2535.1, at a single test point using a fluid inlet temperature of at least 50°C or a value of $(T_f - T_e)/G_T$, which is half of the stagnation value at G_T = 1000 W/m^2 and T_a = 25°C; whichever is the lower. Compare the results of this test with those obtained in Paragraph C3.1(a).

C3.2 Method 2

The procedure shall be as follows:

(a) Test the collector for thermal performance in accordance with AS 2535.

(b) Install the collector on the stand in a temperature-controlled chamber and adjust its inclination so that it receives normal incident radiation from the solar simulator. Ensure that all the air has been bled from the system.

(c) Ensure that the collector is full of heat transfer fluid. It is not necessary to have any flow through the collector for this test method.

(d) Ensure that the air temperature adjacent to the collector is greater than 38°C, or, for the New Zealand only test, greater than 30°C, when the lamps are operating.

(e) Adjust the solar simulator output so that the average radiation measured at 6 uniformly distributed points on the collector is 1050 W/m^2 or greater, with less than 20% variation across the aperture. Solar spectral lamps as specified in AS/NZS 4445.1 shall be used.

NOTE: Alternative arc lamps may be used; however, these lamps have a higher long wave radiation output and will result in a more severe test for some covers and glazing seals.

(f) Run the system under these conditions with the simulator being operated 12 h on and 12 h off for 10 days.

(g) Visually inspect the collector daily and note any changes in its appearance.

(h) Terminate the test after 10 days or when there is evidence of structural or material deterioration that would impair the operation of the collector, whichever is sooner.

(i) Carry out a test of the thermal performance of the collector in accordance with AS/NZS 2535.1, at a single test point using a fluid inlet temperature of at least 50°C or a value of $(T_f - T_e)/G_T$, which is half of the stagnation value at G_T = 1000 W/m^2 and T_a = 25°C; whichever is the lower. Compare the results of this test with those obtained in Paragraph C3.2(a).

A.4 REPORTING OF RESULTS

The following results shall be reported:

(a) The make and model identification of the system of which the collector forms a part.

(b) Full details of the temperature measurements and the dates and duration of the test.

(c) Details of the condition of the collector following the test with particular regard to —

  (i) any structural failure;

  (ii) any burning, scorching or heat shrinkage;

  (iii) any effect likely to impair the serviceability of the collector; and

  (iv) any degradation in performance as a result of the test.

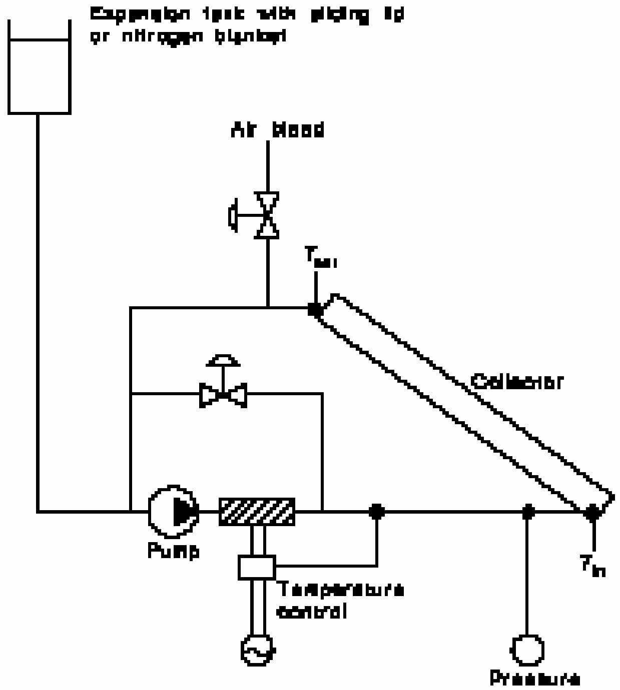

FIGURE C1 SCHEMATIC OF APPARATUS TO MEASURE EFFECTS OF PROLONGED STAGNATION TEMPERATURE (T_s)