Solar Water Heaters & Heat pumps as alternate sources of hot water

Herman Strauss
INDEX

• Legal overview
• General testing
• Solar Water Heaters
• Heat Pumps
Government Gazette, 8 June 2001
R 509
Water Services Act, 1997

SANS 10252
“Water supply and drainage for buildings”

SANS 10252-1 makes direct reference to all the national standards for plumbing components.

SANS 10252-1: Clause 5.1.3: If it is desired or deemed necessary to use materials, components, fittings or fixtures not covered by this part of SANS 10252 or by an appropriate standard, proof of quality and performance of the material or workmanship shall be established by tests or by reference to other appropriate standards. A single test report may not sufficiently prove ongoing compliance.
Legal Overview

Consumer Protection Act

Clause 55
“Consumer’s rights to safe, good quality goods”

Section 2
.... Every consumer have the right to receive goods that –

d) “Comply with any applicable standards set under the standards act (act No. 29 of 1993), or any other public regulation
Why these regulations?
Legal Overview

Leaking system installed above DB Board
Legal Overview

Safety Valve blocked

15/02/2010

11/02/2010
Converting a non-pressure system to a pressurized system gives explosive results.
General Testing

**Typical tests**

- Torque test
- Durability / endurance test
- Pressure test
- Dezincification (DZR) test
- Flow rate test
- Impact test
- Dimensions
- Markings
- Instruction manual / booklets
General Testing

- Vacuum breaker – SANS 198
- Copper tube – SANS 460
- Pressure control valve – SANS 198
- T & P Safety valve – SANS 198
- Drain cock – SANS 1808-53
- Geyser drip tray – SANS 1848
General Testing

- Pressure control valve
  SANS 198

- Drain cock
  SANS 1808-53

- Tempering valve
  SANS 1299

- T & P Safety valves
  SANS 198
General Testing

- Gate valve – SANS 665
- Automatic shut-off valve – SANS 1240
- Float valves – SANS 752
- Copper alloy gate valves – SANS 776
- Ball valves – SANS 1056
General Testing

Electronically operated tap
SANS 1808-35

Demand type tap – SANS 1808-66

Single control mixer tap
SANS 1480

Metering tap – SANS 1808-9

Drinking fountain tap – SANS 1808-16

Plastic bodies water taps
SANS 1021
General Testing

SANS 815 - Shoulder-ended and groove-ended pipes, fittings and couplings
SANS 1067 - Copper-based fittings for copper tubes
SANS 16132 - Copper-based fittings for copper tubes
SANS 14236 – Plastics pipes and fittings
General Testing

STANDARDS:
SANS 21003 - Multilayer piping systems for hot and cold water installations inside buildings
Part 1: “General”
Part 2: “Pipes”
Part 3: “Fittings”
Part 5: “Fitness for purpose of the system”

This is a system.
Loose components cannot be certified

Consumer must be informed to prevent them inadvertently mixing components. (CPA 55-2-d)
Solar Water Heaters

SOLAR WATER HEATERS

SANS 1307
Solar Water Heaters

Mechanical tests

General Inspection & Markings
- All SANS 6210 tests
  - Thermal performance tests SANS 6211-1
  - 4.4 Hot water tank (SANS 151)
  - SANS 60335-2-21
  - 4.8.2 Fittings (SANS as req)
  - 4.6 Thermal insulation d) (UV test)

4.12 Materials
- aluminium
- Copper
- Stainless steel
- Polymeric materials
- Fibre cement
- Sealants
- Water absorption

4.2 Stagnation
4.3 Mechanical strength
4.4 Rain penetration
4.5 Resistance to hail
4.6 Freeze test
Destruct the Sample
4.7 DZR
4.8 Water Absorption
4.9 Corrosion
Solar Water Heaters

Thermal tests

- Thermal performance tests SANS 6211-1
- 4.4 Hot water tank (SANS 151)
- SANS 60335-2-21
- 4.8.2 Fittings (SANS as req)
- 4.6 Thermal insulation d) (UV test)

4.12 Materials
- aluminium
- Copper
- Stainless steel
- Polymeric materials
- Fibre cement
- Sealants
- Water absorption

4.2 Stagnation
- System installation
- Thermal Test
- Degree of mix
- Install in test room
- Heat loss test
- Destruct the Sample

4.3 Mechanical strength
- 4.4 Rain penetration
- 4.5 Resistance to hail
- 4.6 Freeze test

4.7 DZR
- 4.8 Water Absorption
- 4.9 Corrosion
Solar Water Heaters

Safety & General tests

- General Inspection & Markings
  - All SANS 6210 tests
    - Thermal performance tests SANS 6211-1
    - 4.4 Hot water tank (SANS 151)
    - SANS 60335-2-21
    - 4.8.2 Fittings (SANS as req)
    - 4.6 Thermal insulation d) (UV test)

- 4.12 Materials
  - Aluminium
  - Copper
  - Stainless steel
  - Polymeric materials
  - Fibre cement
  - Sealants
  - Water absorption

- 4.2 Stagnation
  - System installation
  - Thermal Test
  - Degree of mix
  - Install in test room
  - Heat loss test
  - Destruct the sample

- 4.3 Mechanical strength
- 4.4 Rain penetration
- 4.5 Resistance to hail
- 4.6 Freeze test
- 4.7 DZR
- 4.8 Water Absorption
- 4.9 Corrosion
Solar Water Heaters

So what is the Q Factor all about?

The terminology Q-Factor is technically not correct.

The national standard SANS 6211-1 describes a test method that allows you to determine a formula that characterizes the system performance under different conditions,

ESKOM selected conditions that would represent a standard day applicable to their rebate scheme. A VALUE for Q is determined when these values are entered into the formula that describes the system performance. This VALUE is commonly referred to as the Q Factor.

\[
Q = \alpha_1 H + \alpha_2 (T_a - T_c) + \alpha_3
\]
Solar Water Heaters

Single day’s test

\[ Q_t = C_s \sum_{i=1}^{n} M_m (T_m - T_c) \times 10^{-3} \]
Solar Water Heaters

Results from 6 days combined

\[ Q = \alpha_1 H + \alpha_2 (T_a - T_c) + \alpha_3 \]
Solar Water Heaters

Degree of Mix test

The thermal performance test verifies the total energy absorbed by the system.

This test verifies how much usable hot water is available to the end user.
Solar Water Heaters

Degree of Mix test

<table>
<thead>
<tr>
<th></th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
</tr>
</thead>
<tbody>
<tr>
<td>65°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20°C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pass / fail
Solar Water Heaters

Over night heat loss test

A badly designed system might absorb a high percentage of heat during the day, but it could also loose this heat at night again.

Current test is performed outdoors with limited controls.

2012 edition the test will be performed indoors with tight controls.
Solar Water Heaters

Thermal Performance

Hail resistance
Solar Water Heaters

Freeze Resistance

Pressure Cycling
Air source Hot Water Heat Pumps

New application in South Africa

SA adopted international standard for Electrical safety of heat pumps.

National standard for performance of hot water heat pumps in progress
Why test Heat pumps?
To verify the energy efficiency.
Measured as Coefficient Of Performance (C.O.P.)

\[
C.O.P. = \frac{\text{Energy (Heat) to Water}}{\text{Energy (Electricity) used}}
\]

Typical C.O.P. values expected: 2.2 - 4.0
Testing of Heat Pumps

C.O.P. is not a SINGLE value, it varies with changes in operating conditions.

- Water Temperature
- Ambient Temperature
- Ambient Humidity
Testing of Heat Pumps

Instantaneous C.O.P.

This provide the relationship between the C.O.P. and the water temperature during the heating cycle.

![Graph showing the relationship between C.O.P. and inlet water temperature for different temperature settings.](image-url)
System C.O.P.

This indicates the overall C.O.P.

Total energy used vs the total amount of heat gain.

![Graph showing C.O.P. vs Ambient Temp]
COP values on heat pump data plates relate to a single specific condition only. The COP of a system as installed in the home owners house could vary drastically.
Testing of Heat Pumps

Fully Automated Test Facility
Testing of Heat Pumps

Test in progress
Testing of Heat Pumps

Test in progress
Testing of Heat Pumps

Test in progress
Thank you