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Modelling of heated water systems in accordance with AS/NZS 4234:2021, using TRNSYS



SA/SNZ MP 104:2021

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Preface

This Miscellaneous Publication (MP) was prepared by the Joint Standards Australia/Standards New Zealand Committee CS-028, Solar Heating and Cooling.

The objective of this document is to provide software tools to support the application of AS/NZS 4234:2021, *Heated water systems — Calculation of energy consumption*, for evaluating the annual energy performance of water heaters, to determine the standardized annual purchased energy use.

This document is accompanied by additional files for use with third party software. The additional files may be obtained on purchase of the document in the following manner:

- (a) USB Flash drive containing a Zip file, for hard copy purchasers.
- (b) Zip file for online purchasers, to be downloaded from the website of purchase.

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Section 1 Scope and general

1.1 Scope

This Miscellaneous Publication (MP) details application of the TRNSYS modelling software to support assessment of the annual energy performance and CO₂ equivalent emission of water heaters to AS/NZS 4234:2021 requirements.

The performance evaluations use a combination of test results for component performance and a mathematical model of the complete product to determine the standardized annual purchased energy use. The procedure is applicable to electric, gas and solar water heaters with integral boosting or preheating into a conventional storage or instantaneous water heater and to heat pump water heaters. For solar and heat pump water heaters, displaced purchased energy relative to reference water heaters is also calculated.

For products not covered in the application of AS/NZS 4234:2021 and this document, or if it is not possible to model the product using the TRNSYS software, such products may be tested under AS 2984 to obtain an annual performance assessment.

Performance is determined for a range of climatic conditions using models implemented for use in the TRNSYS version 15 simulation package.

The modelling given in this document may be applied to the following water heaters:

- (a) Electric and gas storage water heaters.
- (b) Electric and gas instantaneous heaters.
- (c) Solar water heaters with —
 - (i) flat plate, concentrating or evacuated tubular solar thermal collectors;
 - (ii) solar photovoltaic collectors;
 - (iii) thermosiphon or pumped fluid circulation through the solar collectors;
 - (iv) collector loop heat exchangers in a thermosiphon loop;
 - (v) horizontal or vertical water storage tanks;
 - (vi) storage tanks with single or dual electric element(s);
 - (vii) storage tanks with internal gas boosting; and
 - (viii) storage tanks with delivery side heat exchangers.
- (d) Solar preheaters in series with electric or gas storage or instantaneous boosters.
- (e) Solar-boosted heat pump water heaters with —
 - (i) solar collectors acting as the refrigerant evaporator;
 - (ii) water-cooled condenser; and

- (iii) in-tank electric booster.
- (f) Air-source heat pump water heaters with —
 - (i) internal tank condensers;
 - (ii) external wraparound, or in-wall embedded tank condensers; and
 - (iii) external condensers, circulating water into one or more tanks.

Example TRNSYS deck files for the following systems are provided with this document:

- (A) Horizontal tank thermosiphon solar water heater with in-tank electric booster.
- (B) Horizontal tank thermosiphon solar water heater with series instantaneous gas booster.
- (C) Pumped circulation solar water heater with in-tank electric booster.
- (D) Pumped circulation solar water heater with series instantaneous gas booster.
- (E) Pumped circulation solar water heater with series instantaneous electric booster.
- (F) Conventional electrical storage water heater.
- (G) Conventional gas storage water heater.
- (H) Conventional gas instantaneous water heater.
- (I) Standalone air source heat pump.
- (J) Integral air source heat pump with wraparound tank condenser.
- (K) Pumped circulation solar water heater with standalone air source heat pump as primary booster and in-tank electric element as secondary booster.
- (L) Electric water heater with indirect coupled photovoltaic (PV) electricity supply.
- (M) Standalone air source heat pump with indirect coupled PV electricity supply.

Other water heater configurations incorporating the above components may also be modelled.

NOTE 1 Sample decks are suitable for modelling both flat plate and evacuated tube thermal collectors.

NOTE 2 In some instances, test data produced through physical test procedures that measure the performance of a system when it delivers hot water (e.g. AS/NZS 5125.1:2014 Appendix G; AS 2984) may assist in TRNSYS model development and to assess the accuracy of some TRNSYS inputs and some simulation outputs.

NOTE 3 AS 4552—2005 has been replaced by AS/NZS 5263.1.2:2016; however, energy performance tests to AS 4552—2005 are acceptable for use with this document, i.e. SA/SNZ MP 104.

1.2 Application

This document outlines procedures for determining the annual energy performance of water heaters. These annual performance models are developed for use with the TRNSYS modelling package.

NOTE The TRNSYS software is not supplied with the software examples included with this document.

1.3 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document:

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 2984, Solar water heaters—Method of test for thermal performance—Outdoor test method

AS 4552, Gas fired fuel water heaters for hot water supply and/or central heating

AS/NZS 2535.1, Test methods for solar collectors, Part 1: Thermal performance of glazed liquid heating collectors including pressure drop (ISO 9806-1:1994, MOD)

AS/NZS 2712, Solar and heat pump water heaters—Design and construction

AS/NZS 4234, Heated water systems — Calculation of energy consumption

AS/NZS 5125.1:2014, Heat pump water heaters—Performance assessment, Part 1: Air source heat pump water heaters

AS/NZS 5263.1.2, Gas appliances, Part 1.2: Gas fired water heaters for hot water supply and/or central heating

ISO 9806, Solar energy — Solar thermal collectors — Test methods

EN 12975-2, Thermal solar systems and components — Solar collectors, Part 2: Test methods

1.4 Terms and definitions

For the purpose of this document, the terms and definitions given in AS/NZS 4234:2021 apply.

Section 2 Performance evaluation

2.1 General

The task performance simulation for AS/NZS 4234:2021 uses the TRNSYS simulation program (version 15) and extensions developed for new product features. TRNSYS is a transient system simulation program developed by the Solar Energy Laboratory at The University of Wisconsin. TRNSYS has gained worldwide acceptance as a result of its modular configuration and the availability of the FORTRAN source code in the public domain. The modular nature of the code means that it can be readily extended to include new energy devices and systems. The software required for the implementation of AS/NZS 4234:2021 is available from The University of Wisconsin.[\[1\]](#)

Extensions to TRNSYS for thermosiphon solar water heaters, specialized heat exchangers and controllers have been developed by the Solar Thermal Energy Laboratory at The University of New South Wales[\[2\]](#) and others. The University of New South Wales extensions to TRNSYS are referred to in this document as the TRNAUS software. TRNAUS version 19 or later is required to run some of the simulations defined in this document.

The standardized annual energy use of water heaters shall be determined using the TRNSYS simulation program with a computational time step of 0.02 h or less to determine the annual purchased energy use for the specified load and environmental conditions.

2.2 TRNSYS deck examples

Example TRNSYS input files (deck files) for the following water heaters are supplied with this document. These decks were used to produce the performance data in Table 3.1 of AS/NZS 4234:2021.

- (a) Thermosiphon_elec.dck — Horizontal tank thermosiphon solar water heater with in-tank electric booster.
- (b) Thermosiphon_gas.dck — Horizontal tank thermosiphon solar water heater with series instantaneous gas booster.
- (c) Pump_elec.dck — Pumped circulation solar water heater with in-tank electric booster.
- (d) Pump_inst_gas.dck — Pumped circulation solar water heater with series instantaneous gas booster.
- (e) Pump_inst_elec.dck — Pumped circulation solar water heater with series instantaneous electric booster.
- (f) Separate_HP.dck — Standalone air source heat pump.
- (g) Integral_external_HP.dck — Integral air source heat pump with wraparound tank condenser.
- (h) Pump_HP_boost.dck — Pumped circulation solar water heater with standalone air source heat pump as primary booster and in-tank electric element as secondary booster.
- (i) PV_elec.dck — Electric water heater with indirect coupled PV electricity supply.
- (j) Separate_HP_PV_Powered.dck — Standalone air source heat pump with indirect coupled PV electricity supply.
- (k) Electrical_storage.dck — Conventional electrical storage water heater.
- (l) Gas_storage.dck — Conventional gas storage water heater.
- (m) Gas_instantaneous.dck — Conventional gas instantaneous water heater.