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DRAFT TANZANIA STANDARD

(Draft for comments only)

Solar heating-Domestic water heating systems-Part 1: Performance rating procedure using indoor test methods.

TANZANIA BUREAU OF STANDARDS

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0 National Foreword

This draft Tanzania Standard has been prepared by the Renewable Energy Technical Committee, under the supervision of the Electrotechnical Divisional Standards Committee (EDC)

This draft Tanzania Standard is an adoption of the International Standard **ISO 9459-1** ***Solar heating-Domestic water heating systems-Part 1: Performance rating procedure using indoor test methods*** which has been prepared by the International Organization for Standardization (ISO).

1 Terminology and conventions

Some terminologies and certain conventions are not identical with those used in Tanzania standards; attention is drawn especially to the following: -

1) The comma has been used as a decimal marker for metric dimensions. In Tanzania Standards, it is current practice to use "full point" on the baseline as the decimal marker.

2) Where the words "International Standard(s)" appear, referring to this standard they should read "Tanzania Standard(s)".

INTERNATIONAL STANDARD

ISO 9459-1

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Solar heating — Domestic water heating systems —

Part 1:
Performance rating procedure using indoor test methods

Chauffage solaire — Systèmes de chauffage de l'eau sanitaire —

Partie 1: Méthodes d'essai à l'intérieur pour l'évaluation des performances

Reference number
ISO 9459-1:1993(E)

3.23 heat exchanger: Device specifically designed to transfer heat between two physically separated fluids. Heat exchangers may have either single or double walls.

3.24 heat transfer fluid: Fluid that is used to transfer thermal energy between components in a system.

3.25 irradiance: Power density of radiation incident on a surface, i.e. the radiant flux incident on a surface divided by the area of that surface, or the rate at which radiant energy is incident on a surface per unit area of that surface.

NOTE 3 Solar irradiance is often termed "incident solar radiation intensity", "instantaneous insolation", or "incident radiant flux density"; the use of these terms is deprecated.

3.26 load: Daily system hot water load defined as the product of the mass, specific heat and temperature increase of the water as it passes through the solar hot water system.

3.27 potable: Suitable for human consumption; drinkable.

3.28 precision: Measure of the closeness of agreement among repeated measurements of the same physical quantity.

3.29 preheating: See solar preheat system [5.1 b)].

3.30 pyranometer: Radiometer for measuring the irradiance on a plane receiver surface which results from the radiant fluxes incident from the hemisphere above within the wavelength range 0,3 µm to 3 µm.

NOTE 4 The spectral range given represents roughly the spectral range of solar radiation (also called solar or short-wave range) at the ground and is only nominal. Depending on the material used for the domes which protect the receiver surface of a pyranometer, the spectral limits of its responsivity approximate to the limits mentioned above.

3.31 pyrgeometer: Instrument for determining the irradiance on a plane receiving surface which results from the radiant fluxes incident from the hemisphere above within the approximate wavelength range 4 µm to 50 µm.

NOTE 5 The given spectral range is nearly identical with that of so-called terrestrial radiation or long-wave radiation, and is only nominal. Depending on the material used for the domes which protect the receiving surface of a pyrgeometer, the spectral limits of its responsivity approximate to the limits mentioned above.

3.32 pyrheliometer: Radiometer for measuring direct (solar) irradiance which results from the radiant fluxes incident from a well-defined solid angle whose axis is perpendicular to the plane receiver surface.

NOTE 6 According to this definition pyrheliometers are applied to the measurement of direct solar irradiance at normal incidence. The field-of-view angle of pyrheliometers ranges typically from 5° to 10°.

3.33 solar energy: Energy emitted by the sun in the form of electromagnetic radiation (primarily in the wavelength range 0,3 µm to 3 µm), or any energy made available by the reception and conversion of solar radiation.

3.34 solar contribution: Ratio of the energy supplied by the solar part of a system to the total load of the system.

3.35 solar noon: Local time of day, for any given location, when the sun is at its highest altitude for that day, i.e. the time when the sun crosses the observer's meridian.

3.36 solar radiation: Radiation emitted by the sun, practically all of which is incident at the earth's surface at wavelengths less than 3 µm; often termed "short-wave radiation".

3.37 solar irradiance simulator: Artificial source of radiant energy simulating solar radiation (usually an electric lamp or an array of such lamps).

3.38 solar storage capacity: Quantity of sensible heat that can be stored per unit volume of store for every degree of temperature change.

3.39 solar hot water system: Complete assembly of subsystems and components necessary to convert solar energy into thermal energy for the heating of water; may include an auxiliary heat source.

3.40 standard air: Air weighing 1,204 kg/m^3 which approximates dry air at a temperature of 20 °C and a barometric pressure of 101,325 kPa.

3.41 standard barometric pressure: Barometric pressure of 101,325 kPa at 0 °C.

3.42 storage device (thermal): Container(s) plus all contents of the container(s) used for storing thermal energy.

NOTE 7 The transfer fluid and accessories such as heat exchangers, flow switching devices, valves and baffles which are firmly fixed to the thermal storage container(s) are considered a part of the storage device.

3.43 storage tank volumetric capacity: Measured volume of the fluid in the tank when full.

3.44 temperature, ambient air: Temperature of the air surrounding the thermal energy storage device or solar collectors being tested.

3.45 time constant: Time required for a first-order system to change output by 63,2 % of its final change in output following a step change in input.

3.46 thermopile: Set of thermocouples wired consistently in series or parallel to measure small or average temperature differences.

4 Symbols and units

A_a collector module aperture area, in square metres;

$\frac{A_a F_R (\tau\alpha)_{e,n}}{A_g}$ intercept of the collector efficiency curve determined in accordance with collector tests, dimensionless;

$\frac{A_a F_R U_L}{A_g}$ slope of the collector efficiency curve determined in accordance with collector tests, in kilojoules per hour square metre degree Celsius $[kJ/(h \cdot m^2 \cdot °C)]$;

A_g gross collector area, in square metres;

$c_{p,c}$ specific heat of the transfer fluid used in the collector during the collector tests, in kilojoules per kilogram degree Celsius $[kJ/(kg \cdot °C)]$;

$c_{p,s}$ specific heat of the transfer fluid used in the collector during the solar hot water system test, in kilojoules per kilogram degree Celsius $[kJ/(kg \cdot °C)]$;

$c_{p,w}$ specific heat of water, in kilojoules per kilogram degree Celsius $[kJ/(kg \cdot °C)]$;

D nozzle throat diameter, in metres;

F collector absorber plate efficiency factor, dimensionless;

F_R collector heat removal factor, dimensionless;

G_{bp} beam irradiance from solar irradiance measured in a plane parallel to the collector aperture, in kilojoules per square metre hour $[kJ/(m^2 \cdot h)]$;

G_d diffuse irradiance from solar irradiance measured in a plane parallel to the collector aperture, in kilojoules per square metre hour $[kJ/(m^2 \cdot h)]$;

G_t total (global) irradiance incident upon the aperture plane of the collector, in kilojoules per square metre hour $[kJ/(m^2 \cdot h)]$;

$K_{\alpha\tau}$ incident angle modifier, dimensionless;

M number of rows of collector modules in parallel in the collector array, dimensionless;

$\dot{m}_c$ mass flowrate of the transfer fluid through the collector during the collector tests, in kilograms per second;

m_j mass of the jth withdrawal of water, in kilograms;

$\dot{m}_s$ mass flowrate of the transfer fluid through the collector array during the solar hot water system test, in kilograms per second;

N number of collector modules in series in each parallel row in the collector array, dimensionless;

Q_{AUX} daily energy consumed for auxiliary heating in the solar hot water system, in kilojoules;

$Q_{L,NS}$ daily system hot water load defined as the product of the mass, specific heat, and temperature increase of the water as it passes through the solar hot water system for the case of no solar energy input, in kilojoules;

Q_{LOS} thermal losses from solar system during the test day, in kilojoules;

$Q_{L,S}$ daily system hot water load defined as the product of the mass, specific heat, and temperature increase of the water as it passes through the solar hot water system for the case of solar energy input, in kilojoules;

$\dot{Q}_{lh}$ rate of energy output from the collector loop heater in series with the non-irradiated solar collector array (if used), in kilojoules per hour;

Q_{PAR} daily energy consumed for parasitic power by pumps, controls, solenoid valves, etc. in the solar hot water system, in kilojoules;

Q_{OUTPUT} energy output from the collector loop heater (if used) during the test, in kilojoules;

Q_S daily net energy supplied by solar energy for the system during the test day, in kilojoules;

$\dot{Q}_u$ rate of useful heat output from the collector, in kilojoules per hour;

R rating number which is the ratio of the auxiliary plus parasitic energies to the daily system load during the solar day $[(Q_{AUX} + Q_{PAR})/Q_L]$, dimensionless;

sf fraction of hot water load supplied by solar energy, dimensionless;

t_a ambient air temperature, in degrees Celsius;

$t_{a,l}$ ambient air temperature in the laboratory during the system test, in degrees Celsius;

$t_{a,t}$ ambient air temperature specified for the test solar day, in degrees Celsius;

$t_{f,i}$ temperature of the transfer fluid entering the collector, in degrees Celsius;

$t_{f,e}$ temperature of the transfer fluid leaving the collector, in degrees Celsius;

t_i mixed temperature of the water withdrawn from the solar hot water system, in degrees Celsius;

$t_{p,m}$ mean plate temperature of the collector absorber, in degrees Celsius;

$t_{p,m,non}$ mean plate temperature of the collector absorber under non-irradiated conditions, in degrees Celsius;

t_{set} ultimate desired hot water delivery temperature after the addition of supplemental energy, in degrees Celsius;

$t_{w,j}$ mixed temperature of the jth withdrawal of water to the load, in degrees Celsius;

$t_{s,j}$ mixed temperature of the jth withdrawal of water from the solar tank, in degrees Celsius;

t_{main} temperature of the incoming cold water supply to the solar hot water system, in degrees Celsius;

U_L collector heat transfer loss coefficient, in kilojoules per hour square metre degree Celsius $[kJ/(h \cdot m^2 \cdot °C)]$;

V total volume draw as determined from no-solar-input test, in litres;

Subscripts

NS no solar energy input;

S solar energy input;

Greek symbols

α_n absorptance of the collector absorber coating to the solar spectrum at normal incidence, dimensionless;

θ angle of incidence between the direct solar beam and the normal to the collector aperture, in degrees;

θ_m angle of incidence between the beam irradiance from the solar irradiance simulator and the normal to the collector aperture, in degrees;

ρ_d specular reflectance of the cover plate assembly at an incident angle of 60°, dimensionless;

τ_n transmittance of the cover plate assembly to the solar spectrum at normal incidence, dimensionless;

$(\tau\alpha)_{e,n}$ effective transmittance–absorptance product for the collector at normal incidence, dimensionless;

$\sum_{j=1}^{n}$ summation over all water withdrawal periods during a test day.

5 System classifications

Solar domestic hot water systems are classified by seven attributes, each divided into two or three categories. The categories of each attributed are defined as shown in table 1.