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Standard Terminology Relating to Solar Energy Conversion[1]

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1. Referenced Documents

1.1 *ASTM Standards:* [2]

C 859 Terminology Relating to Nuclear Materials[3]

D 93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

E 490 Standard Solar Constant and Zero Air Mass Solar Spectral Irradiance Tables

E 491 Practice for Solar Simulation for Thermal Balance Testing of Spacecraft

E 971 Practice for Calculation of Photometric Transmittance and Reflectance of Materials to Solar Radiation

G 173 Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37° Tilted Surface

2. Terminology

absorber—that part of a solar collector whose primary function is to absorb radiant energy and transform it into another form of energy.

NOTE 1—A thermal absorber usually possesses a solid surface through which energy is transmitted by thermal conduction to the transfer fluid; however, the transfer fluid itself can be the absorber in the case of an optically transparent container and a "black liquid". A photovoltaic absorber converts part of the incident solar flux into electrical energy, and part to thermal energy.

absorptance, α— the ratio of the absorbed radiant or luminous flux to the incident flux. (Practice E 491). See **radiometric properties and quantities**.

absorption—the process by which incident radiant energy is transformed into another form of energy by interaction with matter.

air handling unit—a device used for distributing conditioned air supply to a room, space, or area.

air mass, AM—the ratio of the mass of atmosphere in the actual observer-sun path to the mass that would exist if the observer was at sea level, at standard barometric pressure, and the sun was directly overhead.

NOTE 2—(Sometimes called air mass ratio.) Air mass varies with the zenith angle of the sun and the local barometric pressure, which changes with altitude. For sun zenith angle, *Z*, of 62° or less and local atmospheric pressure, *P,* where P_o is standard atmospheric pressure, AM ≃ sec Z (P/P_o).

albedo—the use of the term *albedo* is discouraged in favor of the preferred term, **reflectance**.

altazimuthal mount—a supporting device that facilitates tracking of the sun and allows rotation about horizontal and vertical axes. It can be used to aim equipment such as heliostats, concentrating collectors, exposure specimens, or radiometers.

angle of incidence—the angle between a ray and the normal to the plane on which it is incident. (The plane of incidence may be the aperture plane, the collector, or any other plane of interest.)

angle of reflection—the angle between the direction of propagation of a reflected ray and the normal to the surface at the point of reflection.

angle of refraction—the angle between the direction of propagation of a refracted ray and the normal to the interface at the point of refraction.

aperture area—see **area, aperture**.

apparent solar time, apt—the hours of the day as computed from the position of the sun using the equation of time. (See ASHRAE *Handbook of Applications,* 1982, Chapter 57.)

area, absorber—the total uninsulated heat transfer surface area of the absorber, including unirradiated as well as irradiated portions.

area, aperture— of a flat plate collector, (*1*) the maximum projected area of a solar collector through which the unconcentrated solar radiant energy may be admitted to the absorber. (*2*) *effective aperture area*—the area as defined above projected normal to the sun's rays and corrected for any shading. Units: square metres (m^2) [square feet (ft^2)].

[1] These definitions are under the jurisdiction of ASTM Committee E44 on Solar, Geothermal and Other Alternative Energy Sources and are the direct responsibility of Subcommittee E44.09 on Photovoltaic Electric Power Conversion.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Withdrawn.

area, collector panel—the total area of the panel assembly (with its containing box, if present), projected on the aperture plane.

area, gross aperture— *of a concentrating collector*, the maximum projected area through which the unconcentrated solar radiant energy is admitted, including any area of the reflector or refractor shaded by the receiver and its supports, and including gaps between reflector segments within a collector module.

area, gross collector—the maximum area of the complete collector module, including integral mounting means, projected on the aperture plane.

area, net aperture—*of a concentrating collector,* the maximum projected area through which the unconcentrated solar radiant energy is admitted, excluding any area of the reflector or refractor shaded by the receiver and its supports, and excluding gaps between reflector segments within a collector module.

auxiliary energy subsystem—in solar energy applications, equipment using nonsolar energy sources to supplement or backup the output provided by a solar energy system.

beam, radiant energy—a collection of rays confined to a specific path.

blackbody—a hypothetical "body" that completely absorbs all incident radiant energy, independent of wavelength and direction; that is, one which neither reflects nor transmits any of the incident radiant energy. It is the emitter of electromagnetic radiant energy which, at a given temperature, presents the maximum spectral density of radiant exitance or radiance at all wavelengths.

NOTE 3—No real material is a blackbody. A completely enclosed cavity with opaque walls at a uniform temperature contains blackbody radiation. A blackbody radiator can be approximated in the laboratory to any desired degree of approximation by a furnace containing a cavity with opaque walls at a uniform temperature, that contains an aperture through which the blackbody radiation is observed. The degree of approximation to a true blackbody radiator is inversely related to the ratio of the area of the aperture to the area of the interior wall of the cavity.

*blackbody radiant energy***—** see **radiant energy, blackbody**.

building heat loss factor—a measure of the heat loss rate of a building expressed in joules per degree day (or Btu per degree day). This factor is multiplied by the number of degree days in a given period to estimate the energy required to heat the building during that period.

*charge capacity***—**see **thermal capacity**.

cloud cover—that portion of the sky which is covered by clouds, usually expressed in tenths of sky covered.

collector, concentrating—a solar collector that uses reflectors, lenses, or other optical elements to redirect and concentrate the solar irradiance on the collector aperture onto an absorber of which the surface area is smaller than the collector aperture area.

*collector efficiency***—** see **efficiency, collector**.

collector, evacuated tube—a solar collector made from transparent tubing (usually glass) with an evacuated space between the tube and the absorber. The absorber may consist of an inner tube or another shape, with means for removal of thermal energy and may be specially coated.

collector, flat plate—a nonconcentrating solar collector in which the absorbing surface is essentially planar.

collector, line-focus—a concentrating solar collector that concentrates the solar flux in one dimension only.

collector, point focus—a concentrating collector that focuses the solar flux to a point.

collector, solar thermal—a device designed to absorb solar irradiance and to transfer the thermal energy to a fluid passing through it.

collector subsystem—that portion of the solar system which includes the solar collectors and related piping or ducts.

collector, tracking—a solar collector that moves so as to follow the apparent motion of the sun during the day, rotating about one axis or two orthogonal axes.

collector, trickle—a flat plate solar collector in which unpressurized liquid flows or "trickles" over the absorber.

*collector cover (glazings)***—** see **cover plate, collector.**

combustible liquid—a liquid having a flash point at or above 37.8°C (100°F). The flash point of a liquid having a viscosity less than 45 SUS at 37.8°C (100°F) and a flash point below 93.4°C (200°F) shall be determined in accordance with Test Methods D 93.

*concentrating collector***—** see **collector, concentrating.**

concentration ratio, geometric—the ratio of the collector aperture area to the absorber area.

concentrator—an optical device (lenses or mirrors) that, as part of a solar collector, receives the unconcentrated solar irradiance and redirects (concentrates) it to a smaller area (the receiver).

conical, ω— over a solid angle larger than an infinitesimal element of solid angle and less than a hemisphere. The geometry of the solid angle must be described in the text. For incident beams it is assumed that the radiance is constant over the entire solid angle. (See **Radiometric properties and quantities)**

containment material—in a solar energy system, a material that encloses the heat-transfer fluid or is in contact with the heat transfer or heat storage material, or both.

convection—the transport of heat by fluid flow.

convection, forced—convection caused by mechanical forces such as fans and injectors.

convection, natural—convection within a fluid, due to density differences caused by temperature differences.

cover plate, collector—a sheet of transparent (or translucent) glazing placed above the absorber in a solar collector, to provide thermal and environmental protection.

*degree day***—**see **degree day, heating** and **degree day, cooling.**

degree-day, cooling, (DDC or DDF, Celsius or Fahrenheit respectively)—one cooling degree-day is counted for each degree that the daily mean temperature is higher than a base temperature; used to estimate energy requirements for air conditioning or refrigeration.

degree-day, heating, (DDC or DDF, Celsius or Fahrenheit respectively)—one heating degree-day is counted for each degree that the daily mean temperature is lower than a base temperature; used to estimate energy requirements for heating.

design life—the period of time during which a system or component is expected to perform its intended function, without significant degradation of performance and without requiring major maintenance or replacement.

diffuse, *adj*—referring to radiometric quantities, indicates that the flux propagates in many directions, as opposed to direct beam which refers to collimated flux. When referring to solar irradiance, it is the global irradiance less the direct beam irradiance. When referring to reflectance, it is the directional hemispherical reflectance less the specular reflectance.

NOTE 4—Diffuse has been used in the past to refer to hemispherical collection (including the specular component) or irradiation, with equal radiance for all directions over a hemisphere. This use is deprecated in favor of the more precise term hemispherical.

directional—over an infinitesimal element of solid angle in a given direction. For properties, a solid angle small enough that the property does not vary within the solid angle may be considered an element of solid angle. Indicated by the symbols θ, Φ, where θ is the angle between the given direction and the normal to the sample surface, and;uf is the azimuth angle of the direction measured counter-clockwise from a reference mark on the sample. See **radiometric properties** and **quantities.**

discharge capacity, thermal—the amount of heat that can be removed from a storage device during a period of time and for a specific set of values for the initial and final temperatures of the storage device, the temperature of the entering fluid, and the mass flow rate of fluid through the storage system.

discharge test time—the duration of a single transient test in which energy is removed from the storage device.

distribution subsystem—that portion of the solar system from the storage device to the point of ultimate use.

drainback solar energy system—see **solar energy system, drainback.**

draindown solar energy system—see **solar energy system, draindown.**

efficiency, collector—*of a solar thermal collector*, the ratio of the amount of energy removed by the heat transfer fluid to the solar energy incident on the collector.

NOTE 5—For flat-plate collectors, the value of the incident solar energy used is usually based on gross collector area; for concentrating collectors the value is usually based on the aperture area.

efficiency, instantaneous collector—ratio of the amount of energy removed by the heat transfer fluid of a solar collector over a specified time period (usually 5 or 15 min) to the solar energy incident on the collector area in the same period, under steady-state or quasi-steady state.

NOTE 6—For flat plate collectors, the area used is usually the gross collector area; for concentrating collectors the area used is usually the gross aperture area.

efficiency, period system—ratio of the useful energy supplied by the solar energy system over a period of time to the solar energy incident on the collector area of the system in the same period.

NOTE 7—The period considered has to be of a suitable length for the type of system. For example, it would not be useful to define the efficiency of a solar space heating system over a month in the summer.

NOTE 8—For flat-plate collector systems, the value of incident solar energy used is usually based on the gross collector area; for concentrating collector systems, the value is usually based on the aperture area.

emissive power—the use of the term emissive power is discouraged in favor of the preferred term **radiant exitance**.

emittance, ϵ— for a sample at a given temperature, ratio of the radiant flux emitted by a sample to that emitted by a blackbody radiator at the same temperature, under the same spectral and geometric conditions of measurement. See **radiometric properties and quantities**.

equatorial mount—a sun-tracking mount, usually clock-driven, whose axis of rotation is parallel to that of the earth.

evacuated tube collector— see **collector, evacuated tube.**

exitance, radiant— see **radiant exitance.**

exposure racks, at-latitude—in solar energy applications, racks that hold specimens at an inclination angle equal to the latitude of the rack location, facing south.

flammable liquid—a liquid having a flash point below 37.8°C (100°F) and having a vapor pressure not exceeding 40 psi (absolute) at 37.8°C and shall be known as a Class I liquid.

flash point—of a liquid, the minimum temperature at which it gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid within the vessel as specified by appropriate test procedure and apparatus.

flux, radiant—see **radiant flux**.

forced convection— see **convection, forced.**

free convection—see **convection, natural.**

Fresnel lens, circular—a sheet of transparent material into which concentric grooves have been formed in such a pattern that light will be focused as with a lens. (Focusing mirrors of similar design are also available.)

Fresnel lens, linear—a sheet of transparent material into which parallel grooves have been formed in such a pattern that light will be focused as by a cylindrical lens. (Focusing mirrors of similar design are also available.)

Fresnel-reflector system—flat mirrors arranged in an array such that they reflect onto a target, the illuminated area of which simulates the shape and size of the flat mirror. (Such an array simulates the ray-tracing of a parabolic trough of the same aperture angle.)

full radiator—see **blackbody.**

gross collector area— see **area, gross collector.**

heat-actuated cooling—the use of thermal energy to initiate a thermodynamic cycle which results in a local decrease in temperature.

heat capacity—see **thermal capacity.**

heat loss rate—the rate at which heat is lost from a system or component of a system, per degree temperature difference between its average temperature and the average ambient air temperature.

heat transfer fluid—(*1*) *in solar energy systems*, a liquid or gas that passes through the solar collector and carries the absorbed thermal energy away from the collector. (*2*) any fluid that is used to transfer thermal energy between subsystems in solar energy systems.