

system at stated conditions, to the heat equivalent of the total energy input rate required to drive or operate the system.

Comfort Air Conditioning: The process of treating air so as to control simultaneously its temperature, humidity, cleanliness, and distribution to meet the comfort requirements of the occupants of the conditioned space. (See also general definition of *Air Conditioning* on page 1 of this chapter.)

Comfort Line: A line on the comfort chart showing relation between the effective temperature and the percentage of adults feeling comfortable.

Condensate: The liquid formed by condensation of a vapor. In steam heating, water condensed from steam; in air conditioning, water extracted from air, as by condensation on the cooling coil of a refrigeration machine.

Condensation: The process of changing a vapor into liquid by the extraction of heat. Condensation of steam or water vapor is effected in either steam condensers or in dehumidifying coils and the resulting water is called *condensate*.

Conductance, Surface (Unit): The time rate of heat exchange by radiation, conduction, and convection of a unit area of a surface with the surroundings and the surrounding air or other fluid. The common unit is: Btu per (hour) (square foot) (Fahrenheit degree). Symbol f . The temperature should be taken in a plane sufficiently far from the surface so it will not be affected by the temperature of the surface.

Conductance, Thermal: The time rate of heat flow through unit area of a body, of given size and shape, per unit temperature difference. Common unit is: Btu per (hour) (square foot) (Fahrenheit degree). Symbol C .

Conduction, Thermal: The process of heat transfer through a material medium in which kinetic energy is transmitted by the particles of the material from particle to particle without gross displacement of the particles.

Conductivity, Thermal: The time rate of heat flow through unit area of a homogeneous substance under the influence of a unit temperature gradient. Common units are: Btu per (hour) (square foot) (Fahrenheit degree per inch). Symbol k .

Conductor, Thermal: A material which readily transmits heat by means of conduction.

Convection: The motion resulting in a fluid from the differences in density and the action of gravity. In heat transmission this meaning has been extended to include both forced and natural motion or circulation.

Convective Heat Transfer: The transmission of heat by either natural or forced motion of a fluid (liquid or gas).

Convector: An agency of convection. In heat transfer, a surface designed to transfer its heat to a surrounding fluid largely or wholly by convection. The heated fluid may be removed mechanically or by gravity (Gravity Convectors). Such a surface may or may not be enclosed or concealed. When concealed and enclosed the resulting device is sometimes referred to as a concealed radiator. (See also definition of *Radiator*.) (See also Chapter 14.)

Decibel: A unit used to express the relation between two amounts of power. By definition the difference in decibels between two powers P_1 and P_2 , P_2 being the larger, is: db difference = $10 \log P_2/P_1$.

In acoustics the threshold of hearing at 1,000 cycles per sec has been standardized at 10^{-12} watts per sq cm. If P_s is the power in watts per square centimeter of a measured sound, then $10 \log P_s/10^{-12}$ is the db difference above the threshold and is known as the *intensity level*. This is a definite recognized way of describing the intensity of a sound.

Declination of Sun: The angle above or below equatorial plane. It is plus if north of the plane, and minus if below. Celestial objects are located by declination.

Degree Day: A unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal heating load of a building in winter. For any one day, when the mean temperature is less than 65 F, there exist as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65 F.

Dehumidify: To reduce by any process, the quantity of water vapor within a given space.

Dehydrate: To remove water in all forms from matter. Liquid water, hygroscopic water, and water of crystallization or water of hydration are included.

Density: The ratio of the mass of a specimen of a substance to the volume of the specimen. The mass of a unit volume of a substance. When weight can be used without confusion, as synonymous with mass, density is the weight per unit volume.

Dew Point: See *Temperature, Dew Point*.

Diffusivity, Thermal: Thermal conductivity divided by product of density and specific heat = $k/\rho c$. Expressed in units of square feet per hour.

Direct-Indirect Heating Unit: A heating unit located in the room or space to be heated and partially enclosed, the enclosed portion being used to heat air which enters from outside the room.

Direct-Return System (Hot Water): A hot water system in which the water, after it has passed through a heating unit is returned to the boiler along a direct path so that the total distance traveled by the water is the shortest feasible, and so that there are considerable differences in the lengths of the several circuits composing the system.

Down-Feed One-Pipe Riser (Steam): A pipe which carries steam downward to the heating units and into which the condensate from the heating units drains.

Down-Feed System (Steam): A steam heating system in which the supply mains are above the level of the heating units which they serve.

Draft: A current of air. Usually refers to the pressure difference which causes a current of air or gases to flow through a flue, chimney, heater, or space.

Draft Head (Side Outlet Enclosure): The height of a gravity convector between the bottom of the heating unit and the bottom of the air outlet opening. (*Top Outlet Enclosure*): The height of a gravity convector between the bottom of the heating unit and the top of the enclosure.

Drift: A pipe, or a steam trap and a pipe considered as a unit, which conducts condensation from the steam side of a piping system to the water or return side of the system.

Dry: To separate or remove a liquid or vapor from another substance. The liquid may be water, but the term is also used for the removal of liquid or vapor forms of other substances.

Dust: An air suspension (aerosol) of solid particles of any material. (See also Chapter 7.)

Enthalpy: A term used in lieu of *total heat* or *heat content*. Expressible in Btu per pound. Mathematically defined as $h = u + pv/f$. When a change occurs at constant pressure, as when water is boiled, the change in enthalpy is equal to the heat added, in this case latent heat.

Enthalpy, Free: A thermodynamic property which serves as a measure of the available energy of a system with respect to surroundings at the same temperature and same pressure as that of the system. No process involving an increase in available energy can occur spontaneously.

Enthalpy, Specific: A term sometimes applied to enthalpy per unit weight, the English unit being Btu per pound.

Entropy: The ratio of the heat added to a substance to the absolute temperature at which it is added. Mathematically, for a reversible process, $ds = dq/T$ or $S = \int dq/T$.

These formulas are applicable when temperature is not constant. During a reversible adiabatic change, entropy is constant. During a reversible isothermal change, the heat absorbed by the substance is equal to the product of the absolute temperature of the substance and its change of entropy.

Entropy, Specific: A term sometimes applied to entropy per unit weight, the English unit being Btu per (Fahrenheit degree, absolute) (pound).

Equivalent Evaporation: The amount of water a boiler would evaporate, in pounds per hour, if it received feed water at 212 F and vaporized it at the same temperature and corresponding atmospheric pressure.

Fan Furnace System: See *Warm Air Heating System*.

Fog: Suspended liquid droplets generated by condensation from the gaseous to the liquid state, or by breaking up a liquid into a dispersed state, such as by splashing, foaming, and atomizing. (See also Chapter 7.)

Terminology

Force: The action on a body which tends to change its relative condition as to rest or motion.

Fumes: Smoke; aromatic smoke; odor emitted, as of flowers; a smoky or vaporous exhalation, usually odorless, as that from concentrated nitric acid. The word *fumes* is so broad and inclusive that its usefulness as a technical term is very limited. Its principal definitive characteristic is that it implies an odor. The terms vapor, smoke, fog, etc., which can be more strictly defined, should be used whenever possible.

Also defined as solid particles generated by condensation from the gaseous state, generally, after volatilization from molten metals, etc., and often accompanied by a chemical reaction such as oxidation. Fumes flocculate and sometimes coalesce. (See also Chapter 7.)

Furnace: That part of a boiler or warm air heating plant in which combustion takes place. Also a complete heating unit for transferring heat from fuel being burned to the air supplied to a heating system.

Furnace Volume (Total): The total furnace volume for horizontal-return tubular boilers and water-tube boilers is the cubical contents of the furnace between the grate and the first plane of entry into or between tubes. It therefore includes the volume behind the bridge wall as in ordinary horizontal-return tubular boiler settings, unless manifestly ineffective (i.e., no gas flow taking place through it), as in the case of waste-heat boilers with auxiliary coal furnaces, where one part of the furnace is out of action when the other is being used. For Scotch or other internally-fired boilers, it is the cubical contents of the furnace, flues, and combustion chamber, up to the plane of first entry into the tubes. (*ASME Power Test Codes, Series 1929*.)

Grate Area: The area of the grate surface, measured in square feet, to be used in estimating the rate of burning fuel. This area is construed to mean the area measured in the plane of the top surface of the grate, except that with special furnaces, such as those having magazine feed, or special shapes, the grate area shall be the mean area of the active part of the fuel bed taken perpendicular to the path of the gases through it. For furnaces having a secondary grate, such as those in double-grate down-draft boilers, the effective area shall be taken as the area of the upper grate plus one-eighth of the area of the lower grate, both areas being estimated as previously defined.

Gravity, Specific: The ratio of the mass of a unit volume of a substance to the mass of the same volume of a standard substance at a standard temperature. Water at 39.2 F is the standard substance usually referred to. For gases, dry air at the same temperature and pressure as the gas, is often taken as the standard substance.

Gravity Warm Air Heating System: See *Warm Air Heating System*.

Head, Dynamic: Same as *Total Pressure* expressed in height of liquid.

Heat: That form of energy which transfers from one system to another, by virtue of the temperature difference which exists between the two systems, when they are placed in communication.

Heat, Humid: Ratio of increase of enthalpy per pound of dry air to rise of temperature under conditions of constant pressure and constant humidity ratio.

Heat, Latent: A term used to express the energy involved in a change of state.

Heat, Sensible: A term used in heating and cooling to indicate any portion of heat which changes only the temperature of the substances involved.

Heat of the Liquid: The increase in enthalpy per unit weight of a saturated liquid as its temperature increases from a chosen base temperature. For water, the base temperature is usually taken as 32 F.

Heat Pump: In year-round air conditioning, refrigeration equipment used in such manner that heat is taken from a *heat source* and given up to the conditioned space when heating service is wanted, and is removed from the space and discharged to a *heat sink* when cooling and dehumidification are desired.

Heat, Specific: The heat absorbed (or given up) by a unit mass of a substance when its temperature is increased (or decreased) by 1 deg. Common Units: Btu per (pound) (Fahrenheit degree), calories per (gram) (Centigrade degree). For gases, both specific heat at constant pressure (c_p) and specific heat at constant volume (c_v) are frequently used. In air conditioning, c_p is usually used.

Heat Stress Index: A numerical index of the relative degree of heat stress imposed by various combinations of metabolic heat production with environmental radiant heat, air temperature, air velocity, and moisture content of the air. A young man in good physical condition and acclimatized to heat can withstand a total heat load having an HSI = 100 for eight hours a day of simple physical work without suffering undue physiological strain. Older men and others with physiological impairments and men engaged in more exacting work require lower HSI values.

Heat, Total: See *Enthalpy*.

Heat Transmission, Coefficient: Any one of a number of coefficients used in the calculation of heat transmission by conduction, convection, and radiation, through various materials and structures. (See *thermal conductance, thermal conductivity, thermal resistance, thermal resistivity, thermal transmittance*, etc.)

Heating Element, Electric: A unit assembly consisting of a resistor, insulated supports, and terminals for connecting the resistor to electric power.

Heating Unit, Electric: A structure containing one or more heating elements, electrical terminals or leads, electric insulation, and a frame or casing, all assembled together in one unit.

Hot Water Heating System: A heating system in which water is used as the medium by which heat is carried from the boiler to the heating units.

Humidity: To increase, by any process, the density of water vapor within a given space.

Humidistat: A regulatory device, actuated by changes in humidity, used for the automatic control of relative humidity.

Humidity: Water vapor within a given space.

Humidity, Absolute: The weight of water vapor per unit volume, pounds per cubic foot, or grams per cubic centimeter.

Humidity, Relative: The ratio of the mol fraction of water vapor in a mixture to the mol fraction of water vapor in saturated air at the same dry-bulb temperature and barometric pressure. (See discussion in Chapter 3.) Also defined in various texts as the ratio of the actual partial pressure of the water vapor in a space to the saturation pressure of pure water at the same temperature.

Humidity Ratio: In a mixture of water vapor and air, the weight of water vapor per pound of dry air. Symbol W . Also called *Specific Humidity*.

Humidity, Specific: See *Humidity Ratio*.

Hydronics: The science of heating and cooling with liquids.

Hygrostat: Same as *Humidistat*.

Inch of Water: A unit of pressure equal to the pressure exerted by a column of liquid water 1 in. high at a standard temperature. The standard temperature is sometimes taken as 60 C and sometimes as 62 F. One inch of water at 62 F = 5.197 lb per sq ft.

Insulation (Thermal): A material having a relatively high resistance to heat flow, and used principally to retard the flow of heat.

Isobaric: An adjective used to indicate a change taking place at constant pressure.

Isothermal: An adjective used to indicate a change taking place at constant temperature.

Load, Estimated Design: In a heating or cooling system, the sum of the useful heat transfer, plus heat transfer from or to the connected piping, plus heat transfer occurring in any auxiliary apparatus connected to the system. The units are Btu per hour or, in heating, equivalent direct radiation (EDR).

Load, Estimated Maximum: In a heating or cooling system, the calculated maximum heat transfer that the system will be called upon to provide.

Manometer: An instrument for measuring pressures; essentially a U-tube partially filled with a liquid, usually water, mercury, or a light oil, so constructed that the amount of displacement of the liquid indicates the pressure being exerted on the instrument.