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Standard Terminology Relating to Activated Carbon¹

This standard is issued under the fixed designation D2652; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This terminology covers terms particularly related to activated carbon and encompasses finished products, applications, and testing procedures.

1.2 When any of the definitions in this terminology is quoted or published out of context, editorially insert the limiting phrase “in activated carbon” after the dash following the term to properly limit the field of application of the term and definition.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Significance and Use

2.1 This terminology ensures that terms peculiar to activated carbon are adequately defined so that other standards in which such terms are used can be understood and interpreted properly.

2.2 This terminology is useful to those who are not conversant with the terms related to activated carbon. However, it is also a ready reference for those directly associated with activated carbon to resolve differences and ensure commonality of usage, particularly in the preparation of ASTM standards.

2.3 Although this terminology is intended to promote uniformity in the usage of terms related to activated carbon, it can never be complete because new terms are constantly arising. The existence of this terminology does not preclude the use or misuse of any term in another context.

3. Terminology

abrasion resistance—the property of a particle to resist attrition or wearing away by friction.

¹ This terminology is under the jurisdiction of ASTM Committee D28 on Activated Carbon and is the direct responsibility of Subcommittee D28.03 on Nomenclature and Editorial.

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absorption—a process in which fluid molecules are taken up by a liquid or solid and distributed throughout the body of that liquid or solid.

accelerated adsorption tests—adsorption tests in which the end point is hastened by testing at conditions more severe than those anticipated in service.

acid-extractable material—substances dissolved by an acid under specified conditions.

activated carbon—a family of carbonaceous substances manufactured by processes that develop adsorptive properties.

activation—any process whereby a substance is treated to develop adsorptive properties.

activity—*for activated carbon*, the adsorptive capacity of an adsorbent, usually as measured by a standard test.

adsorbate—any substance that is adsorbed.

adsorbent—any solid having the ability to concentrate significant quantities of other substances on its surface.

adsorption—a process in which fluid molecules are concentrated on a surface by chemical or physical forces, or both.

adsorption zone—see *mass transfer zone*.

ash—residue after the combustion of a substance under specified conditions.

as-is basis—as received.

breakpoint—the appearance in the effluent of a specified concentration of an adsorbate.

breakthrough, *n*—the first appearance in the effluent of an adsorbate of interest under specified conditions.

channeling—the preferential flow of fluid through passages of lower resistance that can occur in fixed beds or columns of particles owing to nonuniform packing, irregular sizes and shapes of the particles, gas pockets, wall effects, and other causes.

chemical adsorption—see *chemisorption*.

chemisorption (chemical adsorption)—the binding of an adsorbate to the surface of a solid at strengths approximating those of a chemical bond.

coadsorption—the adsorption of two or more components on an adsorbent, each affecting the adsorbability of the other.

contact batch operation—an adsorption process in which an adsorbent is dispersed in a fluid to be treated and then separated when practical equilibrium is attained.

continuous moving bed—an adsorption process characterized by flow of a fluid through a continuously moving bed of granular adsorbent with continuous withdrawal of spent adsorbent and continuous addition of reprocessed or virgin adsorbent.

countercurrent adsorption—an adsorption process in which the flow of fluid is in a direction opposite to the movement of the adsorbent.

critical bed depth—the minimum depth of an adsorbent bed required to contain the mass transfer zone.

crushing strength—the property of a particle to resist physical breakdown when contained and subjected to a slowly increasing continuously applied force.

degassing—removal of gases.

density, absolute or true—the mass under specified conditions of a unit volume of a solid sorbent excluding its pore volume and inter-particle voids.

density, apparent (density, bulk, packing)—the mass under specified conditions of a unit volume of a solid sorbent including its pore volume and inter-particle voids.

density, block—see *density, particle*.

density, bulk—see *density, apparent*.

density, packing—see *density, apparent*.

density, particle (density, block)—the mass under specified conditions of a unit volume of a solid sorbent including its pore volume but excluding inter-particle voids.

density, tamped—the density of packed bed of powdered carbon.

desiccant—a substance such as silica gel or activated alumina or molecular sieve or similar material that has a high affinity for water and is used as a drying agent.

desorption—the separation of an adsorbate as such from a sorbent.

differential heat of adsorption—the heat evolved during the adsorption of an incremental quantity of adsorbate at a given level of adsorption.

dosage—the quantity of substance applied per unit weight or volume of the fluid being treated.

dry basis—exclusive of any moisture which may be present.

dust—an imprecise term referring to particulates capable of temporary suspension in air or other gases; also, particles smaller than an arbitrarily selected size.

dynamic adsorptive capacity—the quantity of a given component adsorbed per unit of adsorbent from a fluid, or fluid mixture moving through a fixed bed at the breakpoint for that component.

effective size—the particle size, in SI units, which corresponds to 10 percent finer on the cumulative particle size distribution curve.

end point—the occurrence in the effluent of the maximum permissible concentration of an adsorbate of interest.

equilibrium adsorptive capacity—the quantity of a given component adsorbed per unit of adsorbent from a fluid or fluid mixture at equilibrium temperature and concentration, or pressure.

expanded bed—a bed of granular particles through which a fluid flows upward at a rate sufficient to slightly elevate and separate the particles without changing their relative positions.

fine mesh activated carbon—activated carbon in particle sizes predominantly between 80 mesh and 325 mesh.

finer, *n*—particles smaller than the smallest nominal specified particle size.

fixed bed—a stationary bed of granular particles.

floaters—the material floating on the surface of water into which carbon has been added and has been thoroughly wetted.

fluidized bed—a bed of particles in which the fluid flows upward at a rate sufficient to suspend the particles completely and randomly in the fluid phase.

Freundlich adsorption isotherm—a logarithmic plot of quantity of component adsorbed per unit of adsorbent *versus* concentration of that component at equilibrium and at constant temperature, which approximates the straight line postulated by the Freundlich adsorption equation

$$X/M = kC^n$$

where:

X = quantity adsorbed,
M = quantity of adsorbent,
C = concentration, and
k and *n* = constants.

granular activated carbon—activated carbon in particle sizes predominantly greater than 80 mesh.

hardness—a generic term referring to the resistance of a particle to breakdown as measured by specific tests.

heat of adsorption—the heat evolved during adsorption.

hysteresis loop—the divergence between the paths of the adsorption and desorption isotherms.

ignition temperature (kindling point)—the lowest temperature at which combustion will occur spontaneously under specified conditions.

impact strength—the property of a particle to resist physical breakdown when subjected to a rapidly increasing applied force.

integral heat of adsorption—the sum of the differential heats of adsorption from zero to a given level of adsorption.

intermittent moving bed (pulse, slug)—an adsorption process characterized by upward flow of a fluid through a fixed bed of granular adsorbent with periodic withdrawal of spent adsorbent from the bottom of the bed and additions of reprocessed or virgin adsorbent to the top of the bed.

irreversible adsorption—adsorption in which the desorption isotherm is displaced toward higher equilibrium adsorption capacities from the adsorption isotherm.

isobar—a plot of quantity adsorbed per unit of adsorbent against equilibrium temperature when concentration or pressure is held constant.

isotere—a plot of equilibrium concentration or pressure against temperature when the quantity adsorbed per unit of adsorbent is held constant.

isotherm—a plot of quantity adsorbed per unit of adsorbent against equilibrium concentration, or pressure, when temperature is held constant.

Langmuir adsorption theory—the theory that assumes that the surface of an adsorbent has only uniform energy sites and that adsorption is limited to a monomolecular layer.

Langmuir isotherm—a plot of isothermal adsorption data which to a reasonable degree fits the Langmuir adsorption equation.

macropore—a pore with widths exceeding 50 nanometres (500 angstrom units).

mass transfer zone (adsorption zone)—the region in which the concentration of the adsorbate of interest in the fluid decreases from influent concentration to the lowest detectable concentration.

mean particle diameter—the weighted average particle size, in SI units, of a granular adsorbent computed by a standard procedure.

mesopore—a pore of width between 2 and 50 nanometres (20 and 500 angstrom units).

micropore—a pore with width not exceeding 2 nanometres (20 angstrom units).

moisture content—the water content of a substance as measured under specified conditions.

monomolecular layer—an adsorbed film, one molecule thick.

multimolecular layer—an adsorbed film more than one molecule thick.

oven drying loss—the reduction in weight resulting when a substance is heated in an oven under specified conditions.

pelleted activated carbon—a form of granular activated carbon consisting of cylindrical particles.

physical adsorption (van der Waals adsorption)—the binding of an adsorbate to the surface of a solid at energies approximating those of condensation.

pore diameter—the diameter of a pore in a model in which the pores in a sorbent are assumed to be cylindrical in shape and which is calculated from data obtained by a specified procedure.

pores—the complex network of channels in the interior of a particle of a sorbent.

pore volume—volume of the pores in a unit weight of a sorbent.

pore volume distribution—the distribution of pore volumes among pores of different sizes or diameters.

powdered activated carbon—activated carbon with a mean particle diameter less than 45 μm .

preferential adsorption—adsorption in which one or more components are adsorbed to a much greater extent than others.

reactivation (revivification)—oxidation processes for restoring the adsorptive properties of a spent sorbent.

regeneration—distillation or elution-type processes for restoring the adsorptive properties of a spent sorbent.

relative efficiency—the rating of the adsorptive capacity of an adsorbent based on a comparison of its performance with that of a reference adsorbent in a defined test.

retentivity—the ability of an adsorbent to resist desorption of an adsorbate.

reversible adsorption—adsorption in which the desorption isotherm approximates the adsorption isotherm.

revivification—see *reactivation*.

service life (service time)—the elapsed time until the end point is reached in an adsorption process.

service time—see *service life*.

sorption—a process in which molecules of a fluid are taken up by absorption or adsorption, or both.

split feed—a liquid-phase adsorption process in which a powdered adsorbent is added to the solution to be treated in two or more steps, with or without intermediate separation of the adsorbent.

surface area (B.E.T.)—the total surface area of a solid calculated by the B.E.T. (Brunauer, Emmett, Teller) equation, from nitrogen adsorption or desorption data obtained under specified conditions.

surface area distribution—the distribution of surface area according to some parameter such as pores of different size or diameter.

tamped density—see *density, tamped*.

threshold concentration—the minimum concentration at which a substance can be detected or recognized by its taste or odor.

uniformity coefficient—the ratio of the particle diameter corresponding to 60 % finer on the cumulative particle size