Designation: D7805 – 13 (Reapproved 2021)

Standard Terminology for Printing Ink Vehicles and Related Materials[1]

This standard is issued under the fixed designation D7805; 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 standard contains the definitions of terms as used in reference to printing ink vehicles and related materials.

1.2 *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. Referenced Documents

2.1 *ASTM Standards:*[2]

D2369 Test Method for Volatile Content of Coatings

D4713 Test Methods for Nonvolatile Content of Heatset and Liquid Printing Ink Systems

D6419 Test Method for Volatile Content of Sheet-Fed and Coldset Web Offset Printing Inks

3. Significance and Use

3.1 A common set of definitions is essential to improve communication and avoid misunderstanding among manufacturers of printing ink, printing ink vehicles, resins, solvents, oils and all other components of printing ink vehicles.

4. Terminology

acid number (value), *n*—an indication of the relative amount of –COOH functionality of a polymer or other molecule.

DISCUSSION—Acid number calculated by the number of milligrams of potassium hydroxide neutralized by the free acids present in 1 g of resin or other material. The determination is made by titrating the sample with KOH in alcohol using phenolphthalein as an indicator.

acrylates, *n*—chemical materials which contain the grouping $OCOCHCH_2$, usually in the form of monomers or oligomers.

acrylic resins, *n*—thermoplastic or thermosetting polymers or copolymers derived from ethenylically unsaturated monomers such as styrene, acrylic/methacrylic acid, and acrylic/methacrylic acid esters.

DISCUSSION—Acrylic resins are used most commonly in liquid (for example, flexo and gravure) inks. Most waterbased inks are formulated from acrylic resins or acrylic emulsions.

adhesion, *n*—state in which two surfaces are held together by interfacial forces that may consist of valence forces, interlocking action, or both.

alkyd, *n*—synthetic resins formed by the reaction of polybasic acids with polyhydric alcohols, typically modified with unsaturated vegetable oils.

DISCUSSION—Alkyds are typically used in oxidatively drying paste inks (for example, sheetfed).

amine number (value), *n*—the relative number of $–NH_3$ groups on a polymer or other molecule as determined by the milligrams of potassium hydroxide equivalent to the amine groups in one gram of the material.

antioxidant, *n*—organic compound added to a resin, vehicle, or other material to retard oxidation, deterioration, and rancidity.

apparent viscosity (*VD*), *n*—measured viscosity of a non-Newtonian fluid at a particular shear rate *D*.

DISCUSSION—A shear rate of 2500 s^{-1} has been found useful for printing inks.

biocide, *n*—a substance that kills microorganisms such as bacteria, molds, slimes, fungi, etc.

DISCUSSION—Typically used in aqueous printing ink systems.

cellulose acetate butyrate (CAB), *n*—synthetic polymers formed by the reaction of cellulose with acetic and butyric anhydrides.

DISCUSSION—CAB is typically used in solvent based liquid inks.

cellulose acetate proprionate (CAP), *n*—synthetic polymers formed by the reaction of cellulose with acetic and propionic anhydrides.

DISCUSSION—CAP is typically used in solvent based liquid inks.

cellulose ester, *n*—cellulose in which some or all of the free hydroxyl groups are replaced by acidic groups.

[1] This terminology is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.37 on Ink Vehicles.

Current edition approved June 1, 2021. Published June 2021. Originally approved in 2013. Last previous edition approved in 2013 as D7805 – 13. DOI: 10.1520/D7805-13R21.

[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.

cellulose ethers (ethyl cellulose), *n*—synthetic polymers formed by the reaction of wood pulp with sodium hydroxide and ethyl chloride.

clarity, *n*—the characteristic of a transparent body whereby distinct high-contrast images or high-contrast objects (separated by some distance from the body) are observable through the body.

cloud point, *n*—point at which compatibility is lost causing a resin/solvent mixture to become turbid and lose clarity.

coagulum, *n*—clot, curd, or coagulated albuminoid substance.

cohesion, *n*—force by which the molecules of a substance are held together.

cold cut, *n*—dispersion of resin into solvent using high shear dispersion without external heating.

colloid, *n*—solid, liquid, or gaseous substance made up of very small, insoluble, nondiffusible particles that remain in suspension in a surrounding solid, liquid, or gaseous medium of different matter.

compatibility, *n*—ability of a mixture of two or more materials to form a clear, homogeneous, and stable solution at room temperature.

crosslinking, *v*—union of high-polymer molecules by a system involving primary chemical bonds that is done either by addition of a chemical substance (cross-linking agent), exposing the mixture to heat or by subjecting the polymer to high-energy radiation (UV or EB).

cure, *v*—the chemical conversion from a wet film to a solid dry film.

dissolution, *v*—point at which all resin completely dissolves in the solvent.

elastomer, *n*—any rubber-like substance or polymer.

exempt volatile compound, *n*—organic compounds that do not participate significantly in atmospheric photochemical reactions.

electron beam, *n*—conversion of an applied film from its application state to its final use state by means of a mechanism initiated by electron beam radiation generated by equipment designed for that purpose.

energy curing, *v*—a graphic arts process for the conversion of an ink or coating to a solid film whereby reactive materials are polymerized when exposed to a high energy source such as ultraviolet or an electron beam.

evaporation, *v*—change from the liquid state to a gaseous or vapor state as when solvent leaves a wet film.

film former, *n*—a material that when applied to a substrate provides a continuous layer.

fumaric resin, *n*—synthetic polymers formed by the addition reaction of fumaric acid to compounds containing conjugated double bonds such as rosin, tall oil or rosin acid, followed by esterification with polyhydric acids.

DISCUSSION—Fumaric resins can be used in both liquid and paste printing inks.

frequency sweep test, *n*—an evaluation of the dynamic mechanical properties, that is, the storage modulus and the loss of modulus, of attest material over a range of frequencies, for example, 100 to 0.1 radians/sec. One can specify the frequency in units of Hz (cycles/sec.) 1 Hz = 6.28 rad/sec.

DISCUSSION—The user provides a specified geometry, the oscillatory strain or stress, the temperature of the test, and the required frequency range. The storage and loss moduli will be determined as a function of frequency.

G', *n*—elastic (storage) modulus obtained from an oscillatory test represents the energy stored during each frequency cycle in which the stress is divided by the corresponding linear elastic strain.

G", *n*—viscous (loss) modulus obtained from an oscillatory test represents the amount of energy lost during each frequency cycle or the imaginary part of the complex modulus (for shear).

gel, *n*—any polymer solution or more complex blend of resins and alkyds that has been heat processed or reacted with a gelling or cross-linking agent (for example, organoaluminum compounds) to build molecular weight and that exhibits a pseudoplastic rheology (also called gelled vehicle).

gel length, *n*—the length of a string of gelled vehicle observed when pulling apart a small sample of vehicle with a spatula (that is, a long gel is very fluid and forms a "long" filament; a short gel has little flow and forms a "short" filament). Rated as long, medium or short.

gel seed, *n*—a non-homogeneous, gelatinous particle in a gel vehicle, often the result of poor mixing or localized over-reaction during gelation.

gelleant, *n*—*see* **gelling agent**.

gelation, *v*—time dependent process by which a liquid undergoes a transformation in rheology due to a three-dimensional cross-linked network within the material.

gelled vehicle, *n*—*see* **gel**.

gelling agent, *n*—a substance that modifies the rheological properties of an ink vehicle by a chemical reaction. Gelling agents or gellants are typically organoaluminum compounds that react with carboxylic acid and hydroxyl groups present on the backbone of resins and alkyds to form cross-linked networks (also called gellant).

glass transition temperature, *n*—temperature at which amorphous material (such as glass or a high molecular weight polymer) changes from a brittle, vitreous state to a plastic state.

grit, *n*—coarse foreign particles in a vehicle, often irregular in shape, that are hard, abrasive, and resistant to disintegration.

gums, *n*—natural occurring resinous materials such as guar and xanthan that improve printability and rheology for water base ink systems.

haze, *n*—a material that is not clear and somewhat cloudy.

DISCUSSION—When applied to transparent materials, it is based on the percentage of transmitted light that is scattered relative to that which is transmitted.

homopolymer, *n*—a polymer derived from a single monomer.

hydrocarbon oil, *n*—petroleum based oil that can be saturated, unsaturated, cyclic or aromatic in nature.

hydrocarbon resin, *n*—petroleum based resins that consist exclusively of carbon and hydrogen. May be aliphatic or cyclic in nature.

DISCUSSION—Hydrocarbon resins are typically used in lithographic inks.

hydrolysis, *v*—chemical reaction in which water reacts with another substance to form one or more new substances.

DISCUSSION—This involves splitting of the water molecule into ions.

hydroxyl number, *n*—an indication of the relative number of –OH groups on a polymer or other molecule. Hydroxyl number is determined by acetylation with acetic acid anhydride and titration of the excess anhydride with potassium hydroxide.

DISCUSSION—In the case of a pure compound, the hydroxyl number is inversely proportional to the hydroxyl equivalent weight.

incompatibility, *n*—inability of two or more materials to exist in close and permanent association for an indefinite period. In printing ink vehicles, it is a resin and solvent mixture that does not form a clear, homogeneous, and stable solution. In printing ink vehicles it is typified by a resin and solvent mixture that is not uniform; consisting of an opaque or two-phase mixture.

kauri butanol value (KB), *n*—a measure of the solvent power of hydrocarbon solvents and oils.

DISCUSSION—Titration with kauri gum butanol reagent. Values range from 20, which represents low solvency, to 105, which is high solvency.

latex, *n*—a white, free flowing liquid obtained from some species of shrubs and trees in which microscopically small particles or globules of nature rubber are suspended in a watery serum. Synthetic latex can be made through a chemical process; examples include polystyrene, styrene-butadiene rubber (SBR), and neoprene.

maleic resin, *n*—synthetics polymer formed by the addition reaction of maleic anhydride to compounds containing conjugated double bonds such as rosin, tall oil or rosin acid, followed by esterification with polyhydric acids.

DISCUSSION—Maleic resins can be used in both liquid and paste inks.

methanol number, *n*—a measurement of the solubility of an offset resin or alkyd, based on the tolerance of a methanol titration.

monomer, *n*—low molecular weight material in the range of 125 to 2100 that is capable of combining with itself or other similar molecules at its reactive sites to form polymers.

DISCUSSION—Monomers can be used to reduce viscosity in energy curable systems.

morphology, *n*—the shape, structure, or form of such substances as high molecular weight polymers, crystals, reinforcing agents, and the like.

near-Newtonian liquid, *n*—liquid in which the variation of viscosity with shear rate is small and the effect on viscosity of mechanical disturbances such as stirring is negligible.

Newtonian liquid, *n*—a liquid where the viscosity is independent of the shear stress or shear rate.

DISCUSSION—If the ratio of shear stress to shear rate is not constant, the liquid is non-Newtonian.

nitrocellulose resin, *n*—naturally derived polymer produced by treating cellulose with mixtures of nitric and sulfonic acids.

DISCUSSION—Nitrocellulose is typically used in solvent based liquid inks.

non-Newtonian liquid, *n*—a liquid whose viscosity varies with shear rate.

DISCUSSION—Such liquids may be either shear thinning (pseudoplastic) or shear thickening (dilatant). Most printing inks are shear thinning.

nonvolatile material, *n*—solid material remaining after volatiles have been removed from a coating under specified test conditions.

novolac, *n*—phenolic resins where the molar ratio of formaldehyde to phenol is less than one.

odor, *n*—important property of many substances manifested by a physiological sensation caused by contact of molecules with the olfactory nervous system.

DISCUSSION—Odor and flavor are closely related and both are profoundly affected by submicrogram amounts of volatile compounds.

oleoresinous, *n*—a generic term for a combination of oil and resin.

DISCUSSION—Examples are oil based oxidizable, heatset, and letterpress inks and vehicles.

oligomer, *n*—polymers with an intermediate molecular weight, typically in the range of 440 to 7700.

organosol, *n*—a suspension of polymer particles in organic solvents, typically made with vinyl resins, solvents and plasticizers.

phenolic resin, *n*—synthetic polymers formed by the reaction of phenols with formaldehyde.

phenolic rosin ester, *n*—a specific class of rosin esters modified with phenolic resins.

photoinitiator, *n*—a substance that decomposes into free radicals when exposed to light.

polyamide resin, *n*—synthetic polymers formed by the reaction of polyamines with polycarboxylic acids.

DISCUSSION—Polyamides based on dimer acids are widely used in solvent based liquid inks for foils and films.

polyester resins, *n*—synthetic polymers formed by the reaction of dicarboxylic acids with polyhydric alcohols.

polyethylene, *n*—synthetic homopolymers formed by the polymerization of gaseous ethylene.

polymer, *n*—a large molecule or macromolecule composed of many monomer units.

polystryrene resin, *n*—synthetic polymers formed by the polymerization of styrene.

polyurethanes, *n*—synthetic polymers formed by the reaction of polyisocyanates and polyhydric alcohols.

DISCUSSION—Polyurethanes are used extensively in solvent based and water based liquid inks, especially for film and foil.

polyvinyl butyral (PVB), *n*—synthetic polymers formed by the reaction of polyvinyl alcohol with butyraldehyde.

DISCUSSION—Polyvinyl butyral is typically used in solvent based liquid inks.

polyvinyl chloride, *n*—synthetic polymer formed by the polymerization of vinyl chloride.

DISCUSSION—Most PVC resins are copolymers of vinyl chloride with small amount of vinyl acetate.

polyvinylidene chloride, *n*—(PVdC) synthetic polymer formed by the polymerization of vinylidene chloride.

DISCUSSION—Saran is the well-known commercial name for PVdC. PVdC resins are used to provide barrier properties to oxygen and moisture.

polymer, *n*—a macromolecule formed by the reaction product of five or more monomer units.

precipitation, *n*—resin separates from the resin/solvent mixture, typically as a solid mass.

precipitation temperature, *n*—temperature at which resin separates from the resin/solvent solution.

pregel—resin solution or vehicle components comprising the vehicle before the addition of gelling agent and viscosity adjusting solvent (also called pregel vehicle).

primary amine value, *n*—an indication of the relative number of –NH groups.

DISCUSSION—Amine value is determined by the number of milligrams of potassium hydroxide (KOH) equivalent to the primary amine basicity in 1 g of sample

proteins, *n*—naturally occurring complex high polymer containing carbon, oxygen, nitrogen and usually sulfur, comprised of chains of amino acids connected by peptide linkages.

resin solution dilutability, *n*—maximum amount of diluents tolerated to reach a defined degree of turbidity.

DISCUSSION—Beyond this point, resin precipitation will occur.

resol, *n*—phenolic resins where the molar ratio of formaldehyde to phenol ratio is greater than one.

resolubility, *v*—ability to a dried ink or ink vehicle to redissolve in added ink or ink vehicle.

DISCUSSION—Poor resolubility leads to printability problems.

rosin esters, *n*—synthetics polymer formed by the addition reaction of maleic anhydride and/or fumaric acid to compounds containing conjugated double bonds such as rosin, tall oil or rosin acid, followed by esterification with polyhydric acids.

NOTE 1—Specific examples of rosin esters include maleic resins and fumaric resins.

shear rate (*D*), *n*—velocity gradient through the stressed liquid; the unit is 1/s or 1 s^{-1}.

DISCUSSION—In the falling-rod viscometer, shear rate is inversely proportional to fall time *F* per unit distance *L* over which a unit thickness *x* of the liquid is stress: $D = L/xF$.

shear strain, *n*—relative deformation in shear.

DISCUSSION—Term often abbreviated to shear.

shear stress (*S*), *n*—shearing force per unit area; the unit is 1 $g/cm \cdot s^2$ (1 $dyne/cm^2$).

DISCUSSION—In the falling-rod viscometer, shear stress is proportional to total weight *W* per unit of shearing area *A* times the gravitational constant *g*, in accordance with the equation: $S = Wg/A$.

shellac, *n*—a naturally derived resin from the secretions of the insect laccifer lacca.

shortness ratio, *n*—ratio of yield value to apparent viscosity.

solubility, *n*—ability or tendency of one substance to blend uniformly with another, for example, solid in liquid, liquid in liquid, gas in liquid, or gas in gas.

DISCUSSION—In printing ink vehicles, solubility is the degree of resin compatibility at all levels of resin and solvent.

stability, *n*—property of a chemical compound that allows it to remain in a compatible phase over a period of time and/or environmental conditions.

strain, *n*—measurement of material deformation relative to a reference configuration.

tack, *n*—function of the force required to split a thin fluid film of a printing ink or vehicle between two rapidly separating surfaces.

DISCUSSION—Tack of a printing ink or vehicle is it is rheological parameter indicative of internal cohesion of the fluid. Tack is not a fixed number but varies with operating conditions, primarily separation velocity, splitting area, and film thickness. Tack also varies with changes in the rheological properties of the ink or vehicle as a result of time, temperature, and interactions with the separating surfaces. In practice, one or more of these surfaces usually consist of rubber-like rollers that differ in composition and geometry and whose properties tend to change with age, nature of previously run fluids, type of wash-up solvent, and mechanical flaws. On laboratory instruments, tack readings are also sensitive to the calibration and zero accuracy of the tack meter used.

tan delta (*d*), *n*—ration of *G″* (viscous modulus) to *G′* (elastic modulus), a rheological property measured during oscillatory testing in the dynamic mode.

ultraviolet curing, *n*—(*1*) conversion of a film from its application state to its final use state by means of a mechanism initiated by ultraviolet radiation generated by equipment designed for that purpose; (*2*) conversion of wet film to a crosslinked solid dry film when exposed to light in the wavelength range from 100 to 3900 A.

varnish, *n*—a fluid composition consisting of one or more resins, oils, solvents, driers and/or waxes.

vehicle, *n*—(*1*) the liquid portion of an ink that holds and carries the pigment, provides requirements for application, drying properties, and binds the pigment to the substrate after the ink has dried; (*2*) the portion of a printing ink that excludes the pigment.

viscoelasticity, *n*—phenomena exhibited by a liquid when energy is applied, and once the force is released, the liquid recovers towards its original state by means of stored energy.

viscometer, *n*—a device for measuring the rheological properties of a liquid.

viscosity, *v*—ratio of shear stress to shear rate.

DISCUSSION—The viscosity of a liquid is a measure of the internal friction of the liquid in motion. The cgs unit of viscosity is 1 g/cm·s (1 dyne·s/cm^2) and is called a poise. The SI unit is 1 N·s/cm^2 and is equal to 10 P.

volatile organic compound (VOC), *n*—the evaporative portion of an ink vehicle that participates in atmospheric photochemical reactions.

DISCUSSION—See Test Methods D2369, D4713, and D6419 for the determination of the VOCs of printing inks and vehicles.

yield stress (S_0), *n*—minimum shear stress required to initiate motion in a non-Newtonian liquid.

yield value, *n*—Lehman's yield value that is defined as the stress at 2.5 s^{-1}.

DISCUSSION—This value can be either extrapolated or measured.

5. Keywords

5.1 printing ink vehicle; printing ink vehicle raw materials; printing ink vehicle testing; resin; varnish