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Standard Terminology for Printing Ink Vehicles and Related Materials¹

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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 $-\text{COOH}$ 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.

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.

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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.

acrylic resins, n —thermoplastic or thermosetting polymers or copolymers derived from ethenically 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 $-\text{NH}_2$ 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 propionate (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.

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 conju-

gated 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 a test 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*—synthetic 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.