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Standard Terminology of Cellulose and Cellulose Derivatives[1]

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1. Scope

1.1 This terminology standard contains terms, definition of terms, descriptions of terms, nomenclature, and explanations of acronyms and symbols specifically associated with standards under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications; Subcommittee D01.36 on Cellulose and Cellulose Derivatives.

1.2 This terminology is divided into three classes as follows:

	Section
Cellulosic Materials and Constituents	3.1
Chemical Modifications and Derivatives of Cellulose	3.2
Properties of Cellulose and Associated Concepts that are applicable to both Sections 3.1 and 3.2	3.3

2. Referenced Documents

2.1 The numerous ASTM Standards to which this standard applies are found in the *Annual Book of ASTM Standards*, Vol 06.03.

2.2 *TAPPI Standards:*[2]

TAPPI Method T 203 om-93 Alpha-, Beta- and Gamma-Cellulose in Pulp

3. Terminology

3.1 Cellulosic Materials and Constituents

acetylation pulps—pulps used in the manufacture of cellulose acetate or other esters, and subject to various specifications by the manufacturers, including those of purity, moisture content, sheet properties, and viscosity.

alpha-cellulose—(*1*) Historically, a term used to indicate the pure, relative undegraded cellulose found in pulps. (*2*) Alpha-cellulose content is often measured by TAPPI Method T 203 om-93 where alpha-cellulose is that portion of the pulp which does not dissolve under the test conditions.

alpha pulps—see **chemical cellulose**.

araban—a pentosan yielding essentially only arabinose on hydrolysis.

arabinogalactan—a polysaccharide consisting of arabinose and galactose units, like the water-soluble polysaccharide of larch.

arabinose—a pentose that occurs as one of the sugar units in some hemicelluloses.

arabinomethylglucuronoxylan—a hemicellulose containing arabinose, 4-O-methylglucuronic acid, and xylose groups in its structure.

beta-cellulose—(*1*) Historically, a term used to indicate impurities of moderate chain lengths found in pulps, predominately degraded cellulose. (*2*) Beta-cellulose content, as measured by TAPPI Method T 203 om-93, is the pulp fraction soluble in caustic, which precipitates upon acidification.

carbohydrates not cellulose—the noncellulosic carbohydrates of a cellulosic material.

cellophane pulps—pulps used in the manufacture of cellophane, and subject to various specifications by the manufacturers, including those of purity, moisture content, sheet properties, and viscosity.

cellulose—(*1*) the main solid constituent of woody plants; it occurs widely elsewhere in the vegetable kingdom, and to a small extent in the animal kingdom. (*2*) chemically, cellulose is β-1-4 glucan of high degree of polymerization. It is desirable to apply "cellulose" to this material only and to designate the predominantly cellulosic residue obtained by subjecting woody tissues to various pulping processes as "cellulosic residues," "cellulosic pulps," or the like.

cellulose I—the crystalline modification of cellulose that normally occurs in nature.

cellulose II—the crystalline modification of cellulose that is found in mercerized cellulose, in regenerated cellulose, and in cellulose produced by the hydrolysis of various cellulose derivatives.

cellulose III—a crystalline modification of cellulose produced by treatment, under certain conditions, with ammonia or

[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 D01.36 on Cellulose and Cellulose Derivatives.

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[2] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.

sometimes by amines. The method of removing the reagent determines the modification produced.

cellulose IV—a crystalline modification of cellulose produced by heat treatment of cellulose II.

cellulose X—a crystalline modification of cellulose produced by treatment of cellulose with strong hydrochloric acid or phosphoric acid.

cellulose, purified cotton—see **cotton cellulose, purified**.

cellulose, purified wood—see **wood cellulose, purified**.

chemical cellulose—a chemically purified cellulosic material that is intended for chemical treatment to produce derivatives.

chemical cotton—chemical cellulose prepared from cotton; generally, but not necessarily, cotton linters.

chemical pulps—in the paper industry, pulps produced by chemical processes, as contrasted to those produced by mechanical processes. (see also **chemical wood pulp**)

chemical wood pulp—a term used in the paper industry for pulps obtained by digestion of wood with solutions of various chemicals.

DISCUSSION—This term, which refers to pulp produced and purified by chemical processes, should not be confused with chemical cellulose which refers to pulp that is to be used in chemical processes.

cotton cellulose, purified—chemical cellulose from cotton fiber or linters. (see also **chemical cotton**)

cotton linters—see **linters**.

dissolving pulps—see **pulps, dissolving**.

extractives—compounds occurring in plant materials, but not forming part of the structural elements, that are removed with neutral solvents such as ether, alcohol, and water.

galactan—a polysaccharide composed essentially of galactose units. (see also **arabinogalactan**)

galactoglucomannan—one of the hemicelluloses of softwoods, containing three types of sugar units—galactose, glucose, and mannose.

galactomannan—a polysaccharide containing galactose and mannose units. Galactomannans usually have a long chain of mannose units with galactose side chains and are found in seed gums (guar, locust bean).

gamma-cellulose—(*1*) Historically, a term used to indicate impurities of short chain lengths found in pulps, predominately hemicelluloses. (*2*) Gama-cellulose content, as measured by TAPPI Method T 203 om-93, is the pulp fraction soluble in caustic, which remains in solution upon acidification.

glucan—a macromolecular substance that can be hydrolyzed to give almost exclusively glucose.

glucomannan—a hemicellulose consisting essentially of glucose and mannose.

glucuronoxylan—a common designation for the xylose-containing hardwood hemicelluloses. (see also **methylglucuronoxylan**)

hemicellulose—any of a number of cell-wall polysaccharides that are removable by extraction with aqueous alkali and that may be hydrolyzed by boiling with dilute acids to give constituent monosaccharide units; any of the noncellulosic cell-wall polysaccharides.

hexosan—frequently used in contradistinction to pentosan, for a polysaccharide consisting mainly of hexose units.

holocellulose—the total polysaccharide fraction of extractive-free wood. The method of isolation or of determination should always be given.

kraft pulp—pulp cooked by the alkaline liquor consisting essentially of a mixture of caustic soda and sodium sulfide. The make-up chemical is traditionally sodium sulfate, which is reduced to the sulfide in the chemical recovery process; hence the alternative designation, sulfate pulp.

lignin—that part of plant material which is not saccharified by the action of 72 % sulfuric acid or 42 % hydrochloric acid, after the resins, waxes, and tannins have been removed.

linters—the short fibrous material adhering to cotton seed after the ginning operation. After removal from the seed it is used to a limited extent as a fibrous raw material for special papers. The principal use, however, is for chemical cellulose, that is, as the raw material for the manufacture of cellulose derivatives.

mannan—strictly, a polysaccharide composed entirely of mannose units, but used conventionally to distinguish the hexosan wood hemicelluloses from the pentosans (xylan). (see also **galactoglucomannan** and **glucomannan**)

mannogalactan—see **galactomannan**.

methylglucuronoxylan—the main hemicellulose of hardwood pulps; a polysaccharide containing xylose and 4-O-methylglucuronic acid groups. In the wood it is partially acetylated.

nitrating pulps—pulps used for the manufacture of cellulose nitrate and subject to various specifications by the manufacturers, including those of alpha-cellulose content and viscosity.

oligosaccharides—polymeric carbohydrates containing relatively few (compared to the polysaccharides) sugar units connected by glycosidal linkages. Two to nine units has been suggested as a suitable range. For longer chains the polymers cannot be readily separated into individual molecular species.

pectic substrates—complex polysaccharides containing a large proportion of galacturonic acid units.

pectins—colorless, amorphous, water-soluble polysaccharides occurring in plant tissues that yield pectic acid and methanol on hydrolysis.

pentosans—one of the groups of amorphous carbohydrates included under the general term "hemicellulose." Pentosans yield principally pentoses on acid hydrolysis. The principal pentosan in wood is xylan.

polyuronides—polysaccharides containing uronic acid groups.

pulps, dissolving—chemical cellulose from wood pulp.

pulps for chemical conversion—chemical cellulose from wood pulp.

pulps for manufacture of cellulose derivatives—chemical cellulose from wood pulp.

purified cotton cellulose—see **cotton cellulose, purified**.

purified wood cellulose—see **wood cellulose, purified**.

R_{10}—the portion of a cellulose pulp that is insoluble in 10 % sodium hydroxide using Test Method D1696[3] or its equivalent.

DISCUSSION—R_{10} indicates the pure, relatively undegraded cellulose content of pulps, and as such may be compared to alpha-cellulose, although they are determined by different test procedures.

rayon pulps—pulps used in the manufacture of rayon, and subject to various specifications by the manufacturers, including those of purity, moisture content, sheet properties, and viscosity.

S_{10}—the portion of a cellulose pulp that is soluble in 10 % sodium hydroxide using Test Method D1696, or its equivalent.

DISCUSSION—S_{10} is considered to contain both hemicellulose and degraded, short chain length cellulose (see R_{10}).

S_{18}—the portion of a cellulose pulp that is soluble in 18 % sodium hydroxide using Test Method D1696, or its equivalent.

DISCUSSION—S_{18} is considered to be mainly hemicelluloses, and may be compared to gamma-cellulose, although they are determined by different test procedures.

S_{10}–S_{18}—an estimate of the portion of degraded cellulose in a pulp obtained by subtracting S_{18} from S_{10}.

DISCUSSION—Some workers use S_{10} to S_{18} as an estimate of the hemicellulose content of pulps, and may be compared to gamma-cellulose, although they are determined by different test procedures.

sulfate pulp—see **kraft pulp.**

sulfite pulp—wood pulp produced by cooking with a sulfite liquor made by dissolving sulfur dioxide in an aqueous base.

wood cellulose, purified—chemical cellulose from wood.

xylan—a pentosan giving almost exclusively xylose on hydrolysis.

3.2 Chemical Modifications and Derivatives of Cellulose

carboxymethylcellulose, CMC—the common name for a cellulose ether of glycolic acid. It is usually marketed as a water-soluble sodium salt, more properly called sodium carboxymethylcellulose. In the early literature, it is sometimes called cellulose glycolate or cellulose glycolic acid.

cellulose acetate—in the broad sense, any of several esters of cellulose and acetic acid. (see also **cellulose triacetate**)

cellulose acetate butyrate—a mixed ester of cellulose containing both acetate and butyrate groups.

cellulose acetate phthalate—a mixed ester of cellulose containing both acetate and phthalate groups.

cellulose acetate propionate—a mixed ester of cellulose containing both acetate and propionate groups.

cellulose derivative—a substance derived from cellulose by substitution of one or more of the hydroxyl groups with some other radical. Most derivatives are ethers or esters.

cellulose esters—derivatives of cellulose in which one or more of the hydroxyl hydrogens have been replaced acyl groups.

cellulose ethers—derivatives of cellulose in which one or more of the hydroxyl hydrogens have been replaced by alkyl groups.

cellulose lacquer—a liquid coating composition containing as the basic film-forming ingredient a cellulose ester or ether and plasticizers with or without resins or pigments.

cellulose mixed ester—a cellulose ester containing more than one type of acyl group.

cellulose nitrate—any of various nitrate esters of cellulose.

DISCUSSION—Cellulose nitrate is often and erroneously called "nitrocellulose."

cellulose plastics—plastics based on cellulose compounds, such as esters (cellulose acetate) and ethers (ethylcellulose).

cellulose propionate—any ester of cellulose with propionic acid.

cellulose sodium glycolate—see **carboxymethyl cellulose.**

cellulose triacetate—that form of cellulose acetate in which the degree of substitution approaches 3 sufficiently that the product is not soluble in acetone.

cellulose xanthates—the salts of cellulose xanthic acid. Commonly, cellulose xanthate refers to sodium cellulose xanthate, the essential constituent of the viscose solution, from which viscose rayon is spun.

dope—a composition, usually a cellulose lacquer, for application on textiles and leathers. Also a very viscous crude reaction product, as acetylation dope.

ethylcellulose—any of several ethyl ethers of cellulose. The one most generally used in industry has sufficient substitution to be soluble in organic solvents.

hydrocelluloses—water-insoluble products of the hydrolysis of cellulose with acids. They are molecularly heterogeneous in the sense that they are composed of molecules varying in degree of polymerization. The average degree of polymerization (DP) and the DP distribution depend on the nature of the acid treatment and of the original cellulose. The term may also be applied to any insoluble polysaccharide so formed and separated as a more or less homogeneous

[3] *Annual Book of ASTM Standards*, Vol 06.03.

fraction from the mixture of products, but the singular form" hydrocellulose" should not be used without an article, to avoid the implication of a molecularly homogeneous species.

(2-hydroxyethyl)cellulose—any of several cellulose ethers in which some of the hydroxyl groups have been substituted with hydroxyethyl groups. Hydroxyethyl cellulose, except at very low degrees of substitution, is water-soluble.

(2-hydroxyethyl)ethylcellulose—a mixed ether of cellulose containing both hydroxyethyl and ethyl groups.

(2-hydroxyethyl)methylcellulose—a mixed ether of cellulose containing both hydroxyethyl and methyl groups.

(2-hydroxypropyl)methylcellulose—a mixed ether of cellulose containing both hydroxypropyl and methyl groups.

ionic cellulose ethers—those water-soluble cellulose ethers which contain ionizable groups, in more than trace amounts. Sodium carboxymethyl cellulose is an example.

lacquer—see **cellulose lacquer**.

methylcellulose—any of several methyl ethers of cellulose. Commercially, the water-soluble ether (degree of substitution approximately 1.5 to 2.0).

methylethylcellulose—a cellulose ether containing both methyl and ethyl groups.

microcrystalline cellulose—a commercial name for cellulose that has been hydrolyzed to the limiting DP and that consists essentially of microcrystals.

nitrocellulose—see **cellulose nitrate**.

nonionic cellulose ethers—that class of cellulose ethers which does not contain any ionizable groups.

oxycelluloses—water-insoluble substances formed by the action of oxidizing agents on cellulose. The chemical nature of oxycelluloses varies with the oxidant used, and the type is indicated by attaching the name of the oxidant adjectivally to "oxycelluloses" as in "hypochlorite oxycelluloses." Any such mixture is "an oxycellulose" and the word should not be used in the singular without either the definite or indefinite article. In many respects, the phrases "oxidized cellulose" or "partially oxidized cellulose" are preferable.

propylene glycol ether of methylcellulose—see **(2-hydroxypropyl)methylcellulose**.

regenerated cellulose—cellulose regenerated from a solution of cellulose or from a cellulose derivative.

sodium carboxymethylcellulose—see **carboxymethylcellulose.**

viscose—a solution of sodium cellulose xanthate prepared by dissolving the reaction product formed by the interaction of carbon disulfide and alkali cellulose in an aqueous solution of sodium hydroxide. Viscose is used mainly in the manufacture of rayon or cellophane, where it is extruded through fine openings of the proper shape into a coagulating bath.

3.3 **Properties of Cellulose and Associated Concepts**

accessibility—the fraction of total cellulose present that is accessible to certain reagents under certain specified conditions. The conditions of determination should always be indicated.

acetylation—substitution of an acetyl radical for an active hydrogen. Specifically, formation of cellulose acetate from cellulose.

acetyl groups—the characteristic groups of acetic acid; CH_3CO—.

acyl groups—radicals derived from carboxylic acids by removal of the hydroxyl group.

acid groups—functional groups having the properties of acids. In cellulose and its derivatives, these are usually carboxyl groups.

aging—in general, the change of properties with the passage of time. Specifically, the changes occurring in shredded alkali cellulose when allowed to stand exposed to air.

air-dry—a condition applied to paper or pulp whereby its moisture content is in equilibrium with the atmospheric conditions to which it is exposed. According to trade custom, pulps are generally understood to be air dry when they contain 10 % of moisture, for example, a pound of air-dry pulp contains 0.9 lb of oven-dry pulp and 0.1 lb of moisture (see *STP 60-B*).

alcohol-benzene solubility—solubility of a cellulosic pulp in a mixture of ethanol and benzene. The term is without precise meaning unless complete specification of an analytical procedure is attached explicitly or implicitly.

aldehyde groups—carbonyl groups to which a hydrogen atom is attached; the first oxidation stage of an alcohol;— CHO.

alkali resistance—for a cellulosic pulp, the fraction insoluble in alkali, usually sodium hydroxide, of a fixed concentration under specified conditions. The term is without precise meaning unless complete specification of an analytical procedure is attached explicitly or implicitly. (see also **alkali solubility**)

alkali solubility—for a cellulosic pulp, the fraction in alkali of a fixed concentration under specified conditions. This term is without precise meaning unless complete specification of an analytical procedure is attached explicitly or implicitly. Some related terms imply at least a partial specification, for example, "ten percent potassium hydroxide solubility" or "nondilution alkali solubility."

alkali stability—for a cellulosic pulp, resistance to strength loss due to exposure to alkaline environments.

alkali staining—discoloration caused by the presence of an alkali.

alkyl groups—monovalent aliphatic radicals derived from aliphatic hydrocarbons by removal of a hydrogen.

amorphous regions—those regions within a cellulosic material which, on the basis of X-ray diffraction or other suitable technique, do not show any evidence of crystalline structure. The technique should be specified.

anhydroglucose units—the repeating unit of many polysaccharides, including cellulose; since the glucose molecules have combined with elimination of water, the unit is called "anhydroglucose" rather than "glucose."

ash—the inorganic residue obtained by igniting a specimen of pulp, paper, or other cellulosic material in such a way that all combustible and volatile compounds are removed. Conditions of ashing should be specified.

bleachability—the capacity of a pulp to bleach to a given whiteness. This is approximately and indirectly related to lignin content.

bone-dry—see **oven-dry**.

brightness—as commonly used in the paper industry, the reflectivity of a sheet of pulp or paper for blue light measured under standardized conditions on a particular instrument designed and calibrated specifically for the purpose.

carbonyl group—the bivalent radical,— CO—, especially as it occurs in aldehydes or ketones.

carboxyl group—the radical —COOH characteristic of most organic acids.

CED (*cupriethylenediamine*) *viscosity*—see **viscosity, cupriethylenediamine**.

chain length distribution—in a linear polymer like cellulose, the frequency distribution of molecular size, usually expressed in units of degree of polymerization.

chlorine number—the number of grams of chlorine gas or of bleaching powder (expressed as its equivalent in chlorine) that is consumed by 100 g of ovendry pulp in a definite time under certain specified conditions. The chlorine number is an indication of the bleach requirement of the pulp and an indirect estimate of the lignin content.

coarseness—for cellulosic fibers, linear density given in units of mg/100 m.

color reversion—a process common to almost all bleached cellulose pulps in which the color darkens to a greater or lesser extent on standing.

commercial moisture regain—see **moisture regain, commercial**.

copper number—the number of grams of copper in the cuprous oxide reduced from a cupric compound by 100 g of pulp or paper (after deduction of moisture, ash, and sizing materials) treated under specified conditions with an excess of cupric solution. The copper number is an indication of the relative number of reducing groups in the pulp or paper.

cross linking—the reaction of a difunctional molecule with each of two molecules of a polymer. This change of the polymer from linearity produces profound changes in the physical properties.

crystalline regions—see **crystallinity**.

crystallinity—a regular arrangement of the atoms of a solid in space. In most polymers, including cellulose, this state is usually imperfectly achieved. The crystalline regions (ordered regions) are submicroscopic volumes in which there is more or less regularity of arrangement of the component molecules. In these regions there is sufficient geometric order to enable definite X-ray diffraction patterns to be obtained. (see also **degree of crystallinity; degree of order**)

crystallinity index—a number used to represent the state of crystallinity of cellulose as a whole. Unfortunately, it has been differently defined by different investigators and should not be used unless it is clearly stated which crystallinity index is meant. (see also **crystallinity**)

crystallite—a single crystalline region. (see also **crystallinity**)

cuam viscosity—see **viscosity, cuprammonium**.

cuene viscosity—see **viscosity, cupriethylenediamine**.

cuprammonium process—a process for making rayon by dissolving cellulose in an ammoniacal copper solution and spinning the resulting solution into an acid bath, thereby regenerating the cellulose as fibers.

cuprammonium viscosity—see **viscosity, cuprammonium**.

cupriethylenediamine viscosity (*cuene or CED*)—see **viscosity, cupriethylenediamine**.

degradation—in general chemical use, the conversion of a complex compound to a simpler. Specifically for cellulose, the breakdown of the polymer chain, usually by hydrolysis or oxidation. Degradation is usually applied to changes in chemical structure. (see also **deterioration**)

degree of crystallinity—the fraction by mass of a cellulose sample occurring in crystalline regions. The method of determining crystallinity must be stated. (see also **crystallinity**)

degree of lateral order—the relative degree of molecular alignment. As for degree of crystallinity, quantitative values must be defined in terms of the experimental measurements. (see also **crystallinity**)

degree of polymerization, DP—in general, the average number of base units, or of monomeric units per molecule in linear polymers. Specifically, the average number of anhydroglucose units (or derivative units) per molecule of cellulose (or cellulose derivative). The type of average obtained depends upon the method used for the determination. Hence, the method must always be specified.

degree of substitution, DS—in a cellulose derivative, the average number of hydroxyl groups substituted per anhydroglucose unit. DS varies from zero to about 3.

density—the mass per unit volume at a specified temperature.

density, apparent—the mass per unit volume of a sheet of pulp or paper. It is commonly calculated by dividing the basis weight by the caliper, although it must be recognized that the numerical value thus obtained is dependent upon the definition of the ream.

density, bulk—the mass of a cellulosic material that will fill a unit volume of a container under specified conditions.

deterioration—a permanent impairment of the physical properties. (see also **degradation**)

dry weight—a term is usually applied to the mass of the ovendry material, but it is ambiguous unless the method of drying is specified.

end groups—the functional groups at either end of the cellulose molecule. It is frequently used for the terminal glucose units that contain these groups. It is usually clear from the context which is meant, and the differentiation is seldom important. One end group is reducing (probably a hemiacetal) and one nonreducing (a free hydroxyl in the 4-position).

equilibrium moisture content—the percentage mass of moisture in a material when it has attained equilibrium with water vapor at a specified pressure or partial pressure. It is determined by successive weighings of the sample, either on the adsorption or desorption curve, and plotting moisture content against the logarithm of time. It should be designated as adsorption equilibrium or desorption equilibrium.

exchange capacity—see **ion-exchange capacity**.

fiber—the unit cell of vegetable growth, which is many times longer than its diameter and which consists largely of cellulose. It is the basic unit of pulps and papers.

fiber length—when applied to a pulp, this applies to the mean fiber length and both the experimental details and the calculations must be specified.

fiber length distribution—the frequency distribution of the individual fiber lengths in a material about the mean fiber length.

fiber saturation point—the moisture content in the absorption of water by cellulose when the cell walls are saturated, but virtually no free water is present in the grosser capillary structure. The concept is based on the hypothesis that a discontinuity occurs in the sorption curve at this point. Some careful studies of the region have failed to show a discontinuity, but it is still possible to define "fiber saturation point" as an extrapolation of the adsorption curve. In any case, it should only be used with reference to the method of determination.

fiber structure—the morphological structure of a fiber at the visual or microscopic level. (see also **fine structure**)

fibril—a fiberlike bundle of molecules, oriented in one direction either with the fiber axis or spirally around it. It makes up the fibrous structural unit of the single fiber. The cellulose fibrils are crystalline as shown by X-ray diffraction.

film—sheeting, including that composed of cellulose or its derivatives, having nominal thickness not greater than 10 mils. (see also **films**)

films—transparent sheeting. If this is used as a generic term, regardless of sheet thickness, the plural should be used and the singular restricted to a specified size. (see also **film**)

fine structure—a generic term denoting the submicroscopic structure that depends on molecular arrangement.

fluidity—the reciprocal of viscosity.

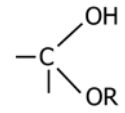
gamma number—degree of substitution (DS) × 100. This term is of widespread use in the cellulose xanthate field.

gloss—the geometrically selective reflectance of a surface responsible for its shiny or lustrous appearance. Surface reflectance is commonly at a maximum in or near the geometric directions in which a mirror would reflect light.

hardness—a term referring to the degree of cooking of a pulp. A hard pulp is one in which the residual lignin content is relatively high.

haze—the turbidity produced by the material in some cellulose derivatives that is not completely soluble in the medium. This turbidity may refer to solutions or to the solid plastic.

hemiacetal groups—functional groups derived from carbonyl groups by addition of one molecule of an alcohol, of the general structure:



hornification—the behavior of certain forms of cellulose and related materials on drying, which results in a lowered reactivity. This is apparently caused by the formation of new hydrogen bonds with a corresponding decrease in accessibility.

hydrodynamic specific surface—the specific surface of a fibrous material as measured by the filtration resistance of a compacted pad formed from a fiber suspension under specified conditions.

hydrophilic—having an affinity for water.

hydrophobic—having an antagonism to water.

hydroxyl groups—the monovalent group —OH, characteristic of hydroxides and alcohols.

inherent viscosity—see **viscosity, inherent**.

intrinsic viscosity—see **viscosity, intrinsic.**

ion exchange—a reversible process by which ions are interchanged between a solid and a liquid with no substantial structural changes in the solid.

ion-exchange capacity—for cellulosic ion-exchange materials, the number of milliequivalents of ions that can be exchanged by 1 g of the ion-exchange material.

ion-exchange materials—insoluble solid materials with the ability to exchange reversibly certain ions, in the structure or attached to the surface as functional groups, with ions in a surrounding medium.

iron-sodium tartrate, EWNN or FeTNa—a complex tartaric acid salt of sodium and ferric iron. Solutions in aqueous sodium hydroxide will dissolve cellulose. Both the German abbreviation, EWNN, and the English, FeTNa, are to be found in English articles. The details of preparation of the solution should always be given.

iron-sodium tartrate viscosity—the viscosity of a solution or dispersion of cellulose or pulp under standardized condition when dissolved in the iron-sodium tartrate solvent. (see also **iron -sodium tartrate**)

kappa number—the number of millilitres of 0.1 *N* potassium permanganate solution consumed by 1 g of ovendry pulp under specified conditions. It is an indication of the hardness or bleachability of a pulp. An indirect estimate of lignin content.

lateral order—the degree of regularity of arrangement of atoms and atomic groups in the direction normal to the molecular chain axes in linear polymers. Quantitative evaluation is impossible without further specification and without description of the particular experimental technique.

leveling-off degree of polymerization, LODP—the nearly constant degree of polymerization of cellulose reached after very prolonged mild hydrolysis or short drastic hydrolysis.

limiting viscosity number—see **viscosity, intrinsic**.

luster—in the pulp and paper industry, synonymous with "gloss" or "sheen." (see also **gloss**)

mercerization—the process of subjecting a vegetable fiber to the action of a fairly concentrated aqueous solution of a strong base so as to produce great swelling with resultant changes in fine structure, dimensions, morphology, and mechanical properties.

mesomorphous cellulose—those portions of cellulose in which the segments of the individual molecules have some regularity of arrangement, but not enough to permit strict lattice order to give a distinct X-ray diffraction pattern.

methoxyl group—the monovalent group —OCH_3, characteristic of methyl alcohol and its esters or ethers.

moisture content—the moisture present in a cellulosic material, as determined by prescribed methods, conventionally expressed as a percentage of the total mass of the "wet" material.

moisture equilibrium—the condition reached by a sample when it no longer takes up moisture from, or gives up moisture to the surrounding air.

moisture equilibrium for preconditioning—the moisture equilibrium condition reached by a sample after free exposure to air controlled at the standard condition for preconditioning.

moisture equilibrium for testing—the equilibrium moisture condition reached by a sample after free exposure to moving air controlled at standard conditions.

moisture regain—the moisture present in a cellulosic material, as determined by prescribed methods, expressed as a percentage of the ovendry mass.

moisture regain, commercial—an arbitrary figure formally adopted as the regain to be used in calculating the commercial or legal mass of shipments or deliveries of any specific material.

moisture regain, standard—the moisture regain of sample brought from a lower moisture regain into equilibrium with the standard atmosphere.

moles of substituent combined, MS—in a cellulose derivative, the average number of substituent molecules per glucose unit. For most derivatives, MS = DS, but for a few, such as hydroxyethylcellulose, the substituted group may also be reactive and MS may be greater than DS.

nonreducing end groups—those terminal glucose units of cellulose or its derivatives which contain a free hydroxyl in the 4-position and do not reduce Fehling's solution or similar reagents.

oleoresins—nonaqueous secretions of resin acids dissolved in terpenic hydrocarbons that are produced or exuded from the intercellular resin ducts of living trees, especially the conifers, and accumulated, together with oxidation products, in the wood of weathered limbs or stumps.

order distribution—see **lateral order**.

orientation—the angle made by the crystallites of the cellulose with the fiber axis. This is approximately the same angle as that made by the molecules or the fibrils.

overdry—the state of a cellulosic material that has been dried to constant mass at a temperature of 100 to 105°C.

percent hydrolysis-resistant cellulose—the residue after treatment of cellulose with acid under specified conditions, expressed as a percentage of the original.

permanganate number—the number of millilitres of 0.1 *N* potassium permanganate solution that is consumed by 1 g of ovendry pulp under certain specified and carefully controlled conditions. It is an indication of the hardness or bleachability of a pulp. It also is an indirect estimate of lignin content.

plastic—(*1*) capable of being deformed continuously and permanently in any direction without rupture, under a stress exceeding the yield value. (*2*) made of, consisting of or pertaining to plastics. (*3*) a material containing as an essential ingredient an organic substance of large molecular mass, which is solid in its finished state and, at some stage

in its manufacture or in its processing into finished articles, can be shaped by flow.

porosity—the existence in a material of connected air voids. It is frequently expressed as the ratio of void volume to total volume.

reactivity—the ability to react. For proper use of the term, the reaction in question and the conditions should be stated and the parameter used in measuring reactivity indicated, such as rate, uniformity, or the like.

reduced viscosity—see **viscosity, reduced**.

reducing end groups—those terminal glucose units in cellulose or its derivatives in which the 1-position is not substituted or involved in a glycosidic linkage. These end groups will reduce Fehling's solution or similar reagents.

regain—see **moisture regain**.

relative viscosity—see **viscosity, relative**.

reversion—in general, the tendency of pulp or paper properties to return to those of the material at some other stage. It is frequently specifically applied to the loss of brightness with time, after bleaching has produced a high brightness.

ripening—in the manufacture of viscose rayon, that stage where the cellulose xanthate solution is stored several days under controlled conditions to reach a state from which coagulation is easier.

sliver—a continuous strand of loosely assembled fibers that is approximately uniform in cross-sectional area and without twist.

specific gravity—the ratio of the mass of a specimen to the mass of an equal volume of water, both at the same specified temperature. Generally, density is more useful. (see also **density**)

specific surface—the surface per unit mass (or less frequently per unit volume) of a moisture-free sample. The specific external surface is used as a measure of the degree of fineness of fibrillation.

specific viscosity—see **viscosity, specific**.

standard moisture regain—see **moisture regain, standard**.

surface area—the total area of the surface. As usually used for reactive pulps, this applies not to external surface, but to the internal surface as well, the total surface available to gases or penetrating liquids. It is useful to express this as specific surface, area per gram.

swelling—increase in volume and dimensions caused by penetration of a liquid.

total internal surface—the surface of a cellulosic material available for absorption of a given substance. A useful substance for this purpose is water; the value obtained with water is close to the potential maximum surface that can be developed without disruption of the crystalline structure.

unit cell—a parallelepiped element of crystal structure, containing a certain number of atoms, the repetition of which through space will build up the complete crystal.

uronic acids—oxidation products of the sugars in which a primary alcohol group has been oxidized to a carboxyl without changing the reducing functional group.

viscosity—in general, the resistance of a fluid to flow or motion within itself. As applied to cellulose or its derivatives, the viscosity of a solution of the substance.

viscosity, cuprammonium—the viscosity of a solution or dispersion of cellulose or pulp in cuprammonium hydroxide under standardized conditions.

viscosity, cupriethylenediamine—the viscosity of a solution or dispersion of cellulose or pulp under standard conditions when dissolved in a solution of copper hydroxide in ethylenediamine.

viscosity in absolute units, CGS poises—the force in dynes required to move, at a velocity of 1 cm/s, one surface having an area of 1 cm^2 past another parallel-like surface 1 cm away, overcoming the resistance to shear of the material filling the space between.

viscosity index—the ratio of the viscosity of a highly concentrated solution to that of a dilute solution. It is a measure of solvent power and, in derivatives, of uniformity of substitution.

viscosity, inherent—the quotient of the natural logarithm of relative viscosity by the concentration, that is, $\ln \eta_{rel}/c$. The concentration should be specified.

viscosity, intrinsic—the limiting value of reduced viscosity, η_{sp}/c, as c (concentration) approaches zero. In the cellulosic field the concentration is generally expressed as grams per decilitre. The IUPAC Committee of Nomenclature has recommended the expression "Limiting viscosity number" for this and the concentration is generally expressed as grams per millilitre.

viscosity number—see **viscosity, reduced**.

viscosity ratio—see **viscosity, relative**.

viscosity, reduced—the specific viscosity divided by the concentration. In the cellulosic field the concentration is generally expressed as grams per decilitre. The IUPAC Committee on Nomenclature has recommended the expression "viscosity number" for this, in which case the preferred expression of concentration is grams per millilitre.

viscosity, relative—the ratio of the viscosity of a solution to that of the pure solvent. The IUPAC Committee on Nomenclature has recommended the expression "Viscosity ratio" for this.

viscosity, specific—the difference between the viscosity of a solution and that of a solvent, divided by the latter.

viscosity, xanthate—for a cellulosic pulp, the viscosity of the viscose that will be obtained as a result of a specified series of processes.

viscous flow—flow, usually at low velocity, in which fluid elements flow in a straight line parallel to the direction of flow of the liquid in the absence of turbulence.

water vapor permeability—the rate of water vapor transmission per unit of thickness and per unit of vapor pressure differential. Test conditions must be specified.

whiteness—the degree of approach of the color of a substance to that of the ideal white, commonly represented by a standardized preparation of magnesium oxide.

xanthate viscosity—see **viscosity, xanthate**.

4. Keywords

4.1 cellulose; cellulose derivatives; definitions; glossary; terminology