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Standard Terminology of Cellulose and Cellulose Derivatives[1]

This standard is issued under the fixed designation D1695; 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 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

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. 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.

[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.

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 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

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