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Standard Practice for Dissolving Polymer Materials[1]

This standard is issued under the fixed designation D5226; 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.

ε[1] NOTE—Reapproved with editorial changes throughout in January 2010.

1. Scope

1.1 This practice outlines the parameters applicable to the preparation of a polymeric solution, such as solvent, concentration, temperature, pressure, time, agitation, and heating mode.

1.2 The proper use of this practice requires knowledge of solvents and their effect on polymeric materials.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D883 Terminology Relating to Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

2.2 *Other Document:*

Polymer Handbook[3]

3. Terminology

3.1 Definitions are in accordance with Terminology D883.

3.2 Abbreviations are in accordance with Terminology D1600.

4. Summary of Practice

4.1 A polymer solution can be described or prepared using the cell classifications listing the parameters relative to solvate the polymer. The cell classifications are listed in the following order: polymer, solvent, concentration, temperature, time, container, heating mode, and agitation.

4.1.1 A polymer and a list of suggested solvents for making a solution are listed in Annex A1.

4.1.2 Table 1 designates the parameters for container, heating mode, and type of agitation.

NOTE 2—To illustrate the use of the cell classifications with Table 1, a 2 % solution of poly(vinyl chloride) using cyclohexanone would be written as:

PVC − cyclohexanone − 20 − 66 − 40 − BEC

where:

PVC	=	abbreviation of the polymer from Annex A1,
cyclohexanone	=	the solvent from Annex A1,
20	=	weight of polymer in tenths of a percent,
66	=	temperature in degrees Celsius,
40	=	time in tenths of an hour,
B	=	glass container from Table 1,
E	=	bath heater from Table 1, and
C	=	random agitation from Table 1.

5. Significance and Use

5.1 This practice embodies the specifications to describe the preparation of a polymeric solution.

6. Procedure

6.1 *Polymer*—Select the applicable polymer from Annex A1 and write its abbreviation.

6.2 *Solvent*—Select the solvent applicable to the polymer from Annex A1.

6.3 *Concentration*—Write the polymer gram weight in tenths of a percent per milliliter of solvent.

6.4 *Temperature*—Write the solution temperature in degrees Celsius.

6.5 *Time*—Write the time for solution in tenths of an hour.

6.6 *Container*—Select the type of container from Table 1.

6.7 *Heating Mode*—Select the heating mode from Table 1.

6.8 *Agitation*—Select the agitation mode from Table 1.

[1] This practice is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.70 on Analytical Methods.

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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.

[3] Available from John Wiley and Sons, New York, NY.

*A Summary of Changes section appears at the end of this standard

TABLE 1 Parameters

Designation	Container	Heater Mode	Agitation Mode
A	unspecified	unspecified	unspecified
B	glass	none	none
C	sealed glass vial	oven	random
D	metal	hot plate	magnetic stirrer
E	fluoropolymer	bath	propeller blade
F		block heater	wrist action
G		electric mantle	ultrasonic
H		microwave	

7. Precision and Bias

7.1 No statement is made about the precision or bias of this practice since the procedure is descriptive with no measurements being made.

8. Keywords

8.1 polymer solutions; solution preparation; solutions; solvents

ANNEX

(Mandatory Information)

A1. SUGGESTED SOLVENTS FOR POLYMERIC SOLUTIONS

A1.1 Note the following:

A1.1.1 The solvents in Table A1.1 are listed in random order.

A1.1.2 An increase in polymer molecular weight reduces solubility.

A1.1.3 Branching increases the solubility compared to a linear polymer of the same molecular weight.

A1.1.4 Solubility normally increases with rising temperature.

A1.1.5 The temperature is for room temperature unless noted.

A1.1.6 The following abbreviations are used in Table A1.1:
D.S. = degree of substitution,
S.C. = substituent content,
conc. = concentrated.

TABLE A1.1 Solvents

Abbreviation	Polymer	Solvents
ABA	Acrylonitrile-butadiene-acrylate	aromatic hydrocarbons, chlorinated hydrocarbons, tetrahydrofuran, esters, ketones, *N,N*-dimethylformamide, *N,N*-dimethyl-acetamide (if high acrylonitrile)
ABS	Acrylonitrile-butadiene-styrene	*N,N*-dimethylformamide, *N,N*-dimethylacetamide (if high acrylonitrile), cyclohexanone (above 35°C), cyclohexanone/acetone, methylcyclohexane/acetone, decahydronaphthalene/dimethyl oxalate, benzene, toluene, ethylbenzene, styrene, lower chlorinated hydrocarbons, phenol/acetone, tetrahydrofuran, dimethyltetrahydrofuran, dioxane, methyl ethyl ketone, diisopropyl ketone, glycol formal, ethyl acetate, butyl acetate, methyl-, ethyl-, *n*-butyl phthalate, 1-nitropropane, carbon disulfide, tributyl phosphate, phosphorus trichloride
	Alkydes	Tetrahydrofuran
AMMA	Acrylonitrile/metha methacrylate	benzene, toluene, xylene, methylene chloride, chloroform, ethylene chloride, chlorobenzene, isobutanol (hot), cyclohexanol (hot), *B*-ethoxyethanol, dioxane, methyl ethyl ketone, diisopropyl ketone, cyclohexanone, acetic acid, isobutyric acid, methyl formate, ethyl acetate, cyclohexyl acetate, isobutyl propionate, butyl lactate
ADC	Allyl diglycol carbonate	benzene, chloroform, acetone
CMC	Carboxylmethyl celluose	S.C. = 5 to 10 % —alkali S.C. = 15 to 30 % —water (sodium salt) S.C. = high—benzene/alcohol, benzene/acetone, chloroform, pyridine, acetone, esters, tetrahydrofuran
CA	Cellulose acetate	D.S. = 0.6 to 0.8—water D.S. = 1.3 to 1.7—2-methoxyethanol D.S. = 2.0 to 2.3—methylene chloride/methanol at 80:20, chloroform/methanol, benzyl alcohol, phenols, ethylene glycol ethers, dioxane, diethanolamine, pyridine, analine, acetone, cyclohexanone, formic acid, acetic acid glacial), methyl acetate, ethyl acetate/nitrobenzene, glycol monoethyl ether acetate, nitromethane, tetrahydrofuran
CAB	Cellulose acetate-butyrate	D.S. (acetate) = 0.8 and D.S. (butyrate) = 2.35—benzene, toluene (hot), chloroform, carbon tetrachloride, tetrachloroethane, methanol (hot), acetone, cyclo-hexanone, dioxane, aliphatic esters, nitroethane
CAB	Cellulose acetate-butyrate	D.S. (acetate) = 2.1 and D.S. (butyrate) = 0.7—chloroform, dichloroethane, tetrachloroethane, dioxane, acetone, cyclohexanone, methyl acetate, ethyl acetate, nitroethane
CAP	Cellulose acetate propionate	benzene, dichloromethane, chlorobenzene, acetone, ethyl acetate

TABLE A1.1 *Continued*

Abbreviation	Polymer	Solvents
CN	Cellulose nitrate	N = 6.8 % —water N = 10.5 to 12 % —alcohol (lower), alcohol/diethyl ether, acetone, amyl acetate, ethylene glycol ethers, acetic acid (glacial) N = 12.7 % —halogenated hydrocarbons, ethanol/diethyl ether, acetone, methyl amyl acetone, cyclo-hexanone, methyl acetate, ethyl acetate, ethyl butyrate, ethyl lactate, ethylene glycol ether acetates, ethylene carbonate, furan derivatives, nitrobenzene
CP	Cellulose propionate	benzene, dichloro-ethane, chlorobenzene, acetone, ethyl acetate
CTA	Cellulose triacetate	methylene chloride, methylene chloride/ethanol at 80:20, chloroform, chloroform/alcohol, trichloroethane, tetrahydrofuran, dioxane, acetone, acetone/water at 80:20, methyl acetate, ethylene glycol ether acetates, ethylene carbonate
EPDM	Diene-modified elthylene-propylene	1,2,4-trichlorobenzene, toluene at 75°C, 1,2,4-trichloro-benzene at 135°C
EP	Epoxy, epoxide	Tetrahydrofuran
EC	Ethyl cellulose	D.S. = 0.5 to 0.7—aqueous alkali D.S. = 1.0 to 1.5—pyridene, formic acid, water (cold), cuoxam D.S. = 2—methylene chloride, chloroform, dichloroethylene, chlorohydrins, ethanol, tetrahydrofuran D.S. = 2.3—benzene, toluene, alkyl halogenids, alcohols, furan derivatives, ketones, acetic esters, carbon disulfide, nitromethane D.S. = 3.0—benzene, toluene, methylene chloride, alcohols, esters
EEA	Ethylene/ethyl acrylate	aromatic hydrocarbons, chlorinated hydrocarbons, tetrahydrofuran, esters, ketones
EMA	Ethylene/methacrylic acid	water, aqueous hydrogen chloride (0.002M above 30°C), dilute aqueous sodium hydroxide
ETFE	Ethylene-tetrafluoroethylene	copolymer perfluorokerosene (350°C)
EVA	Ethylene/vinyl acetate	benzene, toluene, chloroform, carbon tetrachloride/ethanol, dichloroethylene/ethanol at 20:80, chlorobenzene, methanol, ethanol/water, n-butanol/water, allyl alcohol, 2,4-dimethyl-3-pentanol, benzyl alcohol, tetrahydrofurfuryl alcohol, tetrahydrofuran, dimethyltetrahydrofuran, dioxane, glycol ethers, glycol ether esters, acetone, methyl ethyl ketone, acetic acid, lower aliphatic acids, vinyl acetate, acetals, acetonitrile, nitromethane, *N,N*-dimethylformamide, dimethyl sulfoxide, 1,2,4-trichlorobenzene at 135°C (if high ethylene content)
LCP	Liquid crystal polymer	50:50 1,2,4-trichlorobenzene/phenol at 175°C, pentafluorophenol
MF	Melamine formaldehyde	Very low molecular weight—alcohol, water Intermediates—pyridine, formalin, formic acids, dilute and concentrated acids High molecular weight—*m*-cresol at 100°C, *N,N*-dimethylformamide, *N,N*-dimethylacetamide, *N*-methyl pyrrolidone at 85 to 100°C
PF	Phenol-formaldehyde	Novalks and low molecular weight—hydrocarbons, diethyl ether, acetone, esters, 4-tert-butylphenol and 4-phenylphenol polymers, drying oils, tetrahydrofuran, methanol Final resins—molten phenols (with some decomposition)
PAA	Poly(acrylic acid)	Atactic—methanol, ethanol, ethylene glycol, methyoxyethanol, dioxane, formamide, *N,N*-dimethyl-formamide, water, dilute alkali solution Isotactic—dioxane/water at 80:20
PAN	Polyacrylonitrile	Polyacrylonitrile (PAN)—*o*-, *m*-, *p*-phenylene diamine, *N*-formylhexamethyleneimine, *N*-nitrosopiperidine, maleic anhydride, chloromaleic anhydride, succinic anhydride, acetic anhydride, citraconic anhydride, *g*-butyrolactone, dioxanone, *p*-dioxanedione, ethylene oxalate, ethylene carbonate, propylene carbonate, 2-oxazolidone, 1-methyl-2-pyridone, 1,5-dimethyl-2-pyrrolidone, E-caprolactam, *N,N*-dimethyl-formamide, dimethylthioformamide, *N*-methyl-*B*-cyanoethylformamide, cyanoaceticacid, a-cyano-acetamide, *N*-methylacetamide, *N,N*-diethylacetamide, *N,N*-dimethylacetamide, dimethylmethoxyacetamide, *N,N*-dimethyl-a,a,a-trifluoroacetamide, *N,N*-dimethylpropionate, *N,N,N′,N′*-tetramethyloxamide, hydroxyacetonitrile, chloro-acetonitrile/water, *B*-hydroxypropionitrile, malonitrile, fumaronitrile, succinonitrile, adiponitrile, bis(2-cyanoethyl)ether, bis(2-cyanoethyl)sulfide, bis(4-cyanobutyl)sulfone, 1,3,3,5-tetracyanopentane, nitromethane/water (94:6), 1,1,1-trichloro-3-nitro-2-propane, tri(2-cyanoethyl)nitromethane, 3-,4-nitrophenol, methylene dithiocyanate, trimethylene dithiocyanate, dimethyl sulfoxide, tetramethylene sulfoxide, dimethyl sulfone, ethyl methyl sulfone, 2-hydroxyethyl methyl sulfone, ethylene-1,2-bis-(ethyl sulfone), dimethyl phosphite, diethyl phosphite, sulfuric acid, nitric acid, *p*-phenol sulfonic acid, conc. aqueous lithium chloride, conc. aqueous zinc chloride, conc. aqueous aluminum perchlorate, conc. aqueous sodium thiocyanate, conc. aqueous calcium thiocyanate, molten quaternary ammonium salts and their aqueous solutions