Designation: D 1141 – 98 (Reapproved 2003)

An American National Standard

Standard Practice for the Preparation of Substitute Ocean Water[1]

This standard is issued under the fixed designation D 1141; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice covers the preparation of solutions containing inorganic salts in proportions and concentrations representative of ocean water.[2]

NOTE 1—Since the concentrations of ocean water varies with sampling location, the gross concentration employed herein is an average of many reliable individual analyses. Trace elements, occurring naturally in concentrations below 0.005 mg/L, are not included.

1.2 This practice provides three stock solutions, each relatively concentrated but stable in storage. For preparation of substitute ocean water, aliquots of the first two stock solutions with added salt are combined in larger volume. An added refinement in adjustment of heavy metal concentration is provided by the addition of a small aliquot of the third stock solution to the previous solution.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1129 Terminology Relating to Water[3]

D 1193 Specification for Reagent Water[3]

E 200 Practice for Preparation, Standardization, and Storage of Standard and Reagent Solutions for Chemical Analysis[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology D 1129.

3.2 *Definition Of Term Specific to This Standard:*

3.2.1 *chlorinity, , n*—the weight of silver ion (g) required to completely precipitate the halides in 0.3285 kg of water (g/kg).

4. Significance and Use

4.1 This substitute ocean water may be used for laboratory testing where a reproducible solution simulating sea water is required. Examples are for tests on oil contamination, detergency evaluation, and corrosion testing.

NOTE 2—The lack of organic matter, suspended matter, and marine life in this solution does not permit unqualified acceptance of test results as representing performance in actual ocean water. Where corrosion is involved, the results obtained from laboratory tests may not approximate those secured under natural testing conditions that differ greatly from those of the laboratory, and especially where effects of velocity, salt atmospheres, or organic constituents are involved. Also the rapid depletion of reacting elements present in low concentrations suggests caution in direct application of results.

5. Reagents and Materials

5.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society.[5] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

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[1] This practice is under the jurisdiction of ASTM Committee D19 on Water and is the responsibility of Subcommittee D19.02 on General Specifications, Technical Resources, and Statistical Methods.

Current edition approved Aug. 10, 2003. Published September 2003. Originally approved in 1950. Last previous edition approved in 1998 as D 1141–98$^{\epsilon 1}$.

[2] This practice is based upon the following studies:

May and Black, "Synthetic Ocean Water," *Naval Research Laboratory Report P-2909*, August 1946.

May, T. P. and Alexander, A. L., "Spray Testing with Natural and Synthetic Sea Water, Part I–Corrosion Characteristics in the Testing of Metals," *Proceedings*, ASTM, Vol 50, 1950.

Alexander, A. L. and May, T. P., "Spray Testing with Natural and Synthetic Sea Water, Part II–A Study of Organic Coatings," *Proceedings*, ASTM, Vol 50, 1950.

[3] *Annual Book of ASTM Standards*, Vol 11.01.

[4] *Annual Book of ASTM Standards*, Vol 15.05.

[5] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

5.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water conforming to Specification D 1193, Type II.

5.3 *Sodium Hydroxide, Solution, Standard* (0.10 *N*)— Prepare and standardize as directed in Practice E 200.

5.4 *Stock Solution No. 1*—Dissolve the indicated amounts of the following salts in water and dilute to a total volume of 7.0 L. Store in well stoppered glass containers.

$MgCl_2 \cdot 6H_2O$	3889.0 g (= 555.6 g/L)
$CaCl_2$(anhydrous)	405.6 g (= 57.9 g/L)
$SrCl_2 \cdot 6H_2O$	14.8 g (= 2.1 g/L)

5.5 *Stock Solution No. 2*—Dissolve the indicated amounts of the following salts in water and dilute to a total volume of 7.0 L or a convenient volume. Store in well stoppered amber glass containers.

KCl	486.2 g (= 69.5 g/L)
$NaHCO_3$	140.7 g (= 20.1 g/L)
KBr	70.4 g (= 10.0 g/L)
H_3BO_3	19.0 g (= 2.7 g/L)
NaF	2.1 g (= 0.3 g/L)

5.6 *Stock Solution No. 3*—Dissolve the indicated amounts of the following salts in water and dilute to a total volume of 10.0 L or a convenient volume. Store in well stoppered amber glass containers.

$Ba(NO_3)_2$	0.994 g
$Mn(NO_3)_2 \cdot 6H_2O$	0.546 g
$Cu(NO_3)_2 \cdot 3H_2O$	0.396 g
$Zn(NO_3)_2 \cdot 6H_2O$	0.151 g
$Pb(NO_3)_2$	0.066 g
$AgNO_3$	0.0049 g

NOTE 3—To make the addition of $AgNO_3$ in the above solution, dissolve 0.049 g of $AgNO_3$ in water and dilute to 1 L. Add 100 mL of this solution to Stock Solution No. 3 before diluting to 10.0 L.

6. Preparation of Substitute Ocean Water

6.1 To prepare 10.0 L of substitute ocean water, dissolve 245.34 g of sodium chloride and 40.94 g of anhydrous sodium sulfate in 8 to 9 L of water. Add 200 mL of Stock Solution No. 1 slowly with vigorous stirring and then 100 mL of Stock Solution No. 2. Dilute to 10.0 L. Adjust the pH to 8.2 with 0.1 *N* sodium hydroxide solution. Only a few millilitres of NaOH solution should be required.

NOTE 4—Prepare the solution and adjust the pH immediately prior to use.

7. Preparation of Substitute Ocean Water with Heavy Metals

7.1 Add 10 mL of Stock Solution No. 3 slowly and with vigorous stirring to 10.0 L of the substitute ocean water prepared as described in Section 6.

8. Keywords

8.1 substitute brine; substitute ocean water; substitute salt water; substitute seawater

APPENDIX

(Nonmandatory Information)

X1. COMPOSITION OF SUBSTITUTE OCEAN WATER

X1.1 The substitute ocean water prepared in accordance with Section 6 will have the composition shown above the line in Table X1.1(upper half of the table). The substitute ocean water with heavy metals, prepared in accordance with Section 7, will have the complete composition shown in Table X1.1.

TABLE X1.1 Chemical Composition of Substitute Ocean Water [A,B]

Compound	Concentration, g/L
NaCl	24.53
$MgCl_2$	5.20
Na_2SO_4	4.09
$CaCl_2$	1.16
KCl	0.695
$NaHCO_3$	0.201
KBr	0.101
H_3BO_3	0.027
$SrCl_2$	0.025
NaF	0.003
$Ba(NO_3)_2$	0.0000994
$Mn(NO_2)_2$	0.0000340
$Cu(NO_3)_2$	0.0000308
$Zn(NO_3)_2$	0.0000096
$Pb(NO_3)_2$	0.0000066
$AgNO_3$	0.00000049

[A]Chlorinity of this substitute ocean water is 19.38.
[B]The pH (after adjustment with 0.1 *N* NaOH solution) is 8.2.