AUTOMATED DETERMINATION OF ALKALINITY USING THE PC-TITRATE INSTRUMENTATION

1. SCOPE AND APPLICATION

The method is applicable to drinking, surface, ground and saline waters as well as industrial and domestic waste. The method detection limit (MDL) is 0.65 mg $CaCO_3$/L and the practical quantitation limit (PQL) is 2.5 mg $CaCO_3$/L. The test covered by this SOP is ALKALINITY.

2. SUMMARY OF THE METHOD

2.1. This method, based on Standard Methods 2320 B, is used for determining the alkalinity of water samples with an automatic titration instrument – PC-Titrate™.

2.2. A fully automatic titration procedure is employed to titrate aqueous samples electrometrically to an end point of 4.5 (or 4.5 and 4.2 for low alkalinity samples). The alkalinities are then calculated from the amount of the titrant (0.02 N H_2SO_4) used in the titration.

2.3. Interferences - Substances such as salts of weak organic and inorganic acids present in large amounts, may cause interference in the electrometric pH measurements. Oil and grease, by coating the pH electrode, may also interfere, causing sluggish response.

2.4. Samples for alkalinity determination are stored at ≤ 6 °C (not frozen) and must be analyzed within 14 days of collection to avoid qualification.

3. EQUIPMENT AND SUPPLIES

3.1. PC-Titrate™ System with a pH electrode

3.2. Graduated cylinder (class A; 50 mL)

3.3. Polypropylene (PP) centrifuge tubes (50 mL) for samples

4. REAGENTS AND STANDARDS (SEE DEP SOPS NU-041 and NU-042)

Note: Standard preparations must be documented in the Laboratory Information Management System (LIMS) 'Standard Preparation Tracker' module. Unique ID numbers for each standard are generated in the module and documented in the reagent and standard logsheet submitted with each analysis folder (NU-RGTSTD) located at

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\\FLDEP1\DEAR\LABS\Lab3\Chem_Data\Inorganic\Nutrients\Reagent_Prep\PCTitrate. Follow preparation and labelling instructions in DEP SOP NU-042. If available, a Certificate of Analysis for each purchased reagent is maintained in the REAGENT_PREP folder for PC-Titrate analyses on the Nutrients drive. Certificates of Analysis for purchased standards are kept in a binder in C307. All containers holding standards or reagents must be labeled with their unique ID and expiration date.

Note: The volumes prepared for the reagents and standards may be altered by the analyst as necessary. The final concentrations of the constituents of a standard or reagent must not be changed.

4.1. 0.020 N Sodium Carbonate Solution (only used for standardization of prepared acid (4.2.3.):

4.1.1. Add 1.0606 g (to the nearest +/- 0.05 mg) Na_2CO_3 (dried at 105 ºC overnight and cooled in a desiccator) to a 1 L volumetric flask and dilute to the mark with deionized (DI) water.

4.1.2. Invert flask at least 8 times to mix. Store refrigerated. Holding time, 30 days.

4.2. 0.02 N Certified Sulfuric Acid Standard - purchased from Fisher Scientific. If the certified standard is not available, use the following procedure:

4.2.1. To a 1L volumetric flask add approximately 500 mL DI water. Pipette 555.6 µL of Optima Grade conc. H_2SO_4 into the flask. Dilute to the mark.

4.2.2. Invert flask at least 8 times to mix.

4.2.3. Titrate against 0.020 N sodium carbonate solution (see 4.1.) to standardize.

4.3. 0.20 N (10,000 mg $CaCO_3$/L) Sodium Carbonate Spiking Solution

4.3.1. Add 1.0606 g (to the nearest +/- 0.05 mg) Na_2CO_3 (dried at 105 ºC overnight and cooled in a desiccator) to a 100 mL volumetric flask and dilute to the mark with DI water.

4.3.2. Invert flask at least 8 times to mix. Store refrigerated. Holding time, 30 days.

4.4. A certified quality control sample (AltQC) prepared following the supplier's instructions (e.g., purchased from Inorganic Ventures). Store in a refrigerator after opening. The concentration and expiration date is provided by the manufacturer.

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4.5. Laboratory Fortified Blank (LFB) - add 200 µL of 10,000 mg $CaCO_3$/L Na_2CO_3 solution (4.3.) to a 40 mL aliquot of DI water for a 50 mg $CaCO_3$/L spike. (Spike code _N2.)

4.6. Continuing Calibration Verification (CCV):

4.6.1. CHCK1 (100 mg $CaCO_3$/L check standard) - add 400 µL of 10,000 mg $CaCO_3$/L Na_2CO_3 solution (4.3.) to a 40 mL aliquot of DI water. Prepared daily.

4.6.2. CHCK3 (50 mg $CaCO_3$/L check standard) - add 200 µL of 10,000 mg $CaCO_3$/L Na_2CO_3 solution (4.3.) to a 40 mL aliquot of DI water. Prepared daily.

4.7. Buffer solutions at pH 4.0, 7.0 and 10.0 (purchased from Fisher). The expiration date is provided by the manufacturer.

5. SAMPLE ANALYSIS/QUANTITATION (SEE DEP SOP NU-033)

This SOP should be used in conjunction with DEP SOP NU-060 - Automated PC Titrate Instrument Operating Procedure, which gives a more detailed description of the instrumentation.

IMPORTANT - All sample tubes must have their caps removed prior to operation of the instrument or the probe will be damaged.

Note: Allow the samples to come to room temperature prior to measuring the alkalinity.

5.1. Calibration:

5.1.1. Pour approximately 45 mL of buffers 4.0, 7.0 and 10.0 (4.7.) into three separate PP centrifuge tubes appropriately labeled.

5.1.2. A multi-level calibration with pH 4.0, 7.0, 10.0 buffers may be carried out either independently on a daily basis or together with samples in each run.

5.1.3. If the calibration does not comply with the manufacturers specifications the instrument will not continue to perform sample pH analysis.

5.2. Analysis of samples:

5.2.1. Start-up of the PC-Titrate Software - Log in to the PC-Titrate software; choose the appropriate method (alkalinity alone or in combination with other tests). Set up the run sequence corresponding to the timetable of PC-Titrate software (see DEP SOP NU-060 for details).

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5.2.2. Loading samples - Pour 45-50 mL of sample or standard into a 50 mL PP centrifuge tube. Load the sample tubes onto the autosampler in a sequence determined in section 5.2.1. It is recommended to run a couple of DI water cups at the very beginning as a rinse to clean up the system and condition the probe.

Example Run Sequence:

Rinse – tap water
Rinse – DI water
pH CAL (5.1.)
Rinse – DI water
MDL (blank)
ALTQC (4.4.)
CHCK1 (4.6.1.)
Blank
MBLK (Method blank: DI water)
LFB_N2 (4.5.)
Batched samples: one samples run in duplicate (sample ID_D) for each batch of max. 20 samples.
CHCK 3 (4.6.2.)
Blank

Click on the START button to start the run.

5.3. Calculations:

5.3.1. Standardization/acid normality is given by (used if certified H_2SO_4 solution is unavailable) -

$$\frac{(\text{grams of } Na_2CO_3\text{/L solution}) \times (\text{mL of } Na_2CO_3 \text{ titrated})}{53.00 \times (\text{mL of acid used in standardization})}$$

5.3.2. Alkalinity of samples (performed by instrument software) -

$$\frac{(\text{Normality of acid}) \times (\text{mL of acid}) \times 50{,}000}{\text{Volume of sample (mL)}}$$

5.3.3. Alkalinity of low samples (performed by instrument software) -

$$\frac{[(2A - B) \times \text{Normality of acid} \times 50{,}000]}{\text{Volume of sample (mL)}}$$

A = mL of acid to pH 4.5
B = mL of acid to pH 4.2

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5.4. For general calculations including RPDs, LFB recoveries, and QC statistics (UCL and LCL for LFB's and RPD's) see Sections 5.9 of the FDEP Quality Manual.

6. TROUBLESHOOTING/MAINTENANCE

6.1. Problems with calibration may be due to instrument failure. Consult trouble shooting section of instrument manual.

6.2. Always keep the probe in water or buffer when not in use. For further details on maintenance of the instrument and the probe, refer to DEP SOP NU-060 and related hardware manual.

7. DATA ARCHIVAL

7.1. All analytical results are automatically saved in the database of the instrument software. Raw data is retrievable with the 'HISTORICAL DATA' function of PC-Titrate software.

7.2. A tab delimited text file for each run must be exported to the network drive: \\FLDEP1\DEAR\LABS\Lab3\Chem_Data\Inorganic\Nutrients\PC-Titrate or \\FLDEP1\DEAR\LABS\Lab3\Chem_Data\Inorganic\Nutrients\PC-Titrate\PC-Titrate 2, depending on which instrument is used. The file name should use the format YYMMDDN-A# where YY is the year, MM is the month, DD is the day, N is the first letter of the test/s conducted, A is autotitrator, and # is 1 or 2 which indicates what instrument was used (e.g., alkalinity, fluoride and conductivity run = 120206AFC-A1). This file is used by QC manager for data processing and uploading into LIMS.

7.3. The raw data is archived in paper format. A report folder is created for each analytical run. Occasionally more than one run may be in one folder. The folder is labeled with the test (e.g., ALK, W-COND, and/or W-F), filename/s (YYMMDDN-A#), and initials of the analyst.

7.4. Each report folder should contain the following items - general results report, calibration report/s, running list report (bench sheet), reagent and standard logsheet/s, and a copy of the data and QC assessments uploaded from QC Manager to LIMS at the time of test authorization.

7.5. The report folders are on file with the nutrients and general chemistry supervisory personnel. Periodically, the files are moved to the State Records Center for long time storage according to DEP SOP LB-006.

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8. QUALITY CONTROL/DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QUALITY CONTROL MEASURES (SEE DEP SOP NU-038 AND NU-043)

8.1. A blank, CCV standard (CHCK1, 4.6.1. or CHCK3, 4.6.2.) and a QC standard (ALTQC, 4.4.) must be analyzed prior to running samples. Recoveries must be < 0.65 and > -0.65 mg $CaCO_3$/L for the blanks and 90 to 110 % for the CCV standards. Recovery for the ALTQC standard must be within the manufacturer's certified limit but not exceed 85 to 115 %.

8.2. Analyze a blank and a CCV (CHCK1 or CHCK3) standard every 20 cups tested and at the end of the analyses.

8.3. Each sample batch begins with an MBLK. Also analyze one LFB (4.5.) and one randomly selected samples in duplicate for every batch of 20 samples.

8.4. Acceptable limits for the recovery of the LFBs (4.5.) are established from the upper and lower control limits (UCL and LCL) calculated in the QC Statistics module in LIMS. The limits are evaluated regularly, and updated at least annually. The QC Statistics Calculation Reports are archived with the PCTitrate instrument validation data on the Chemistry drive: \\FLDEP1\DEAR\Labs\Lab5\Chemistry\Inorganic\Nutrient\General Chemistry_Validations.

8.5. Unless below the PQL sample duplicate analyses should have an RPD of less than the upper control limit calculated in the QC statistics module. See Section 8.4. for evaluation and archival information.

8.4. For general method performance and acceptance criteria for QC measures and corrective action for out-of-control data and contingencies for handling out-of-control or unacceptable data, refer to DEP SOPs NU-038 and SOP NU-043.

9. SAFETY/HAZARDOUS WASTE MANAGEMENT

9.1. Review the laboratory Health and Safety Plan (accessible on the intranet at https://www.fldepnet.org/content/dear/bureau-laboratories-health-and-safety-plan).

9.2. Safety glasses, gloves and lab coats should be worn at all times whilst handling samples and reagents.

9.3. Read the MSDS information for safe reagent and sample handling.

9.4. Buffers and leftover samples with a pH value of > 2 or < 12.5 units may be flushed down the sink with water.

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10. REFERENCES/DEFINITIONS/VALIDATION DATA

For definitions see section 3 of the FDEP Quality Manual. All abbreviations used throughout the document are defined at least once in the document usually at the first time of use. Method validation data is on file with the supervisor.

10.1. Standard Methods Online, 2320 B-97.

10.2. Automatic PC-Titrate Instrument Operations Manual.

10.3. DEP SOP NU-033, Summary of Sample Analysis Procedures for the General Chemistry and Nutrients Workgroups.

10.4. DEP SOP NU-038, Nutrients and General Chemistry: Quality Assurance and Quality Control.

10.5. DEP SOP NU-041, Reagent Preparation Procedure.

10.6. DEP SOP NU-042, Standard Preparation Procedure.

10.7. DEP SOP NU-043, Nutrients and General Chemistry Quality Assurance and Data Authorization Guidelines.

10.8. DEP SOP NU-060, Automated PC-Titrate Instrument Operating Procedure.

10.9. Quality Manual, Bureau of Laboratories, FDEP.

10.10. Laboratory Health and Safety Plan.

10.11. DEP SOP LB-006, Standard Operating Procedure for Records Maintenance and Storage.

Appendix of Significant Changes

04/28/2008 Reference method changed from EPA 310.1 to SM 2320 B.

04/14/2015 Data archival information was clarified in Section 7. Section 8 was modified and acceptance limits for CCV's, ALTQC, and RPD updated. Frequency of sample duplicate analysis was changed to one per batch.

02/04/2016 The test name was updated to ALKALINITY in Sections 1 and 7.3. File paths and web addresses were updated.

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