

- I. TITLE: STANDARD OPERATING PROCEDURES FOR MEHLICH 3 EXTRACTION OF SOIL SAMPLES
- II. PURPOSE: This SOP defines the general procedures for extracting soil samples with the Mehlich 3 Extractant.
- III. ABSTRACT: This document outlines the general procedures to be followed for extraction of soil samples using the Mehlich 3 extractant. This procedure shall be used for the determination of P, K, Ca, Mg, Na and S in soil samples. The Mehlich 3 extract is composed of 0.2 N acetic acid-0.25 N NH_4NO_3 -0.015 N NH_4F -0.013 N HNO_3 -0.001 M EDTA.
- IV. REAGENT PREPARATION: The following reagents are used to make the Mehlich 3 Extractant.
- A. Calibrate a clean 20 L poly-carboy to 20 L (xxxx.x g) using diH_2O . Carboys are calibrated by adding diH_2O to a new, clean and dry carboy in 1000.0g increments.
- B. Place a 1.5-2.5 inch stir rod into the calibrated carboy and place carboy onto a magnetic stirrer.
- C. Add 8 L diH_2O to the carboy (16.5 Megaohm or higher).
- D. Using a digital scale (xxxx.xx g), weigh 400 g reagent grade NH_4NO_3 into a clean beaker. Add to the carboy and allow to dissolve. Dissolution will be relatively rapid, however thorough mixing will take approximately 20 minutes.
- E. Using a digital scale (xxxx.xx g), weigh 11.12 g reagent grade NH_4F into a new clean disposable plastic cup. Add to the solution in the carboy and allow to dissolve. Discard the cup after use. This step often takes 1 hour and some very small white precipitates might remain. These precipitates are CaF_2 or MgF_2 and are the result of impurities in the reagent grade NH_4NO_3 .
- F. Using a digital scale (xxxx.xx g), weigh 5.84 g reagent grade EDTA- H_4 into a new clean disposable plastic cup. Add to the solution in the carboy and allow to dissolve. Discard the cup after use. The reagent is slow to dissolve in neutral and acidic pH solutions. Mix for at least 3 hours or overnight. A white precipitate is likely to be observed. The manufacturing process results in very small traces of EDTA- Ca_2 and EDTA- Mg_2 to be present in the reagent grade EDTA- H_4 . This precipitate will remain in the bottom of the carboy and will be removed during normal washing of the carboy between Mehlich 3 solution batches.
- G. Acetic Acid.
1. Add 230 ml acetic acid to the solution using a poly graduated cylinder.
 - a. Do not use a glass cylinder as Na will be leached from the glass.
 - b. A dedicated poly cylinder is used for this measuring.
 2. Rinse the graduated cylinder with diH_2O into the carboy.
 3. Begin mixing.
- H. Nitric Acid

1. Add 16.4 ml nitric acid to the solution using a poly graduated cylinder.
 - a. Do not use a glass cylinder as Na will be leached from the glass.
 - b. A dedicated poly cylinder is used for this measuring.
 2. Rinse the graduated cylinder with diH₂O into the carboy.
 3. Begin mixing.
- I. Add diH₂O to the 20 L mark on the carboy.
 - a. Suspend mixing until carboy is filled to 20 L mark.
- J. Stir the solution until thoroughly mixed.
 - a. Mix for a minimum of 1 hour, date and record in solutions log.
- K. The pH of the solution should be 2.5 ± 0.1 pH units. Adjust as necessary using 1 M HCl to lower the pH or 1 M NH₄OH to raise the pH.
 - a. Always measure pH in solutions obtained from drawing off the bottom carboy tap. Never place pH electrode in carboy.
 - b. Allow 20-30 minutes for mixing prior to collecting new samples for pH measurement.
 - c. Always discard pH measurement samples.
- V. EVALUATION OF NEW EXTRACTING SOLUTION. Prior to using the new extracting solution for samples, the solution must be evaluated using the following procedures.
 - A. Collect two aliquots of the new extracting solution.
 - B. Analyze the two aliquots and the current extracting solution by ICP.

VI. SAMPLE EXTRACTION

- A. Samples shall be scooped (NCR standard 2 g scoop) for analysis and place in extraction cup.
- B. Dispense 20 ml of the Mehlich 3 extracting solution into each sample cup using the Oxford Dispenser or similar dispensing system which can dispense all samples in less than 2 minutes.
- C. Turn on the orbital shaker and set the timer. Shake the samples for 5 min using the 200 rpm shaker table (1 inch throw).

NOTE: Do not extract more than 60 samples at one time. This is the maximum numbers of samples that can be filtered yet minimize the soil/extract contact time after the 5 min shake time. All samples must be transferred to the filtration filter/cup combo within 3 minutes.

VII. SAMPLE FILTRATION

- A. Samples shall be filtered using medium porosity 15 cm filter paper (Whatman No. 2 equivalent).
- B. Transfer filtrate into disposable poly-propylene test tubes Do not use flint or borosilicate test tubes as the acid extractant will leach sodium and boron from the glass.

NOTE: As sodium is determined from the Mehlich 3 extract, do not use sodium borosilicate test tubes.

- C. Pour filtrate into the 15 mm x 100 mm disposable poly-propylene test tubes.
- D. Analyze all samples within 24 hrs via ICP analysis.

VIII. **Other notes:**

- A. The Mehlich 3 extract is not stable for long periods of time. Internal observations indicate that the extracting solution should not be used after 10 days (1.5 weeks).**
- B. Reagent grade chemicals are generally very uniform from a given manufacturer, although some differences are observed from lot to lot of the sample reagent.**
- C. Mehlich III sample analysis is relatively straight forward, however based on NAPT data, laboratories who do not routinely analyze this extract as their primarily method are generally outside the MAD statistical ranges. This method is best suited for laboratories analyzing 500+ samples per work week and 50+ per sample slug.**

IX. REFERENCES.

- A. Mehlich, A. 1984 Mehlich-3 soil test extractant: a modification of Mehlich-2 extractant. Commun. Soil Sci. Plant Anal. 15(12):1409-1416.
- B. Hanlon, E.A. and G.V. Johnson. 1984. Bray/Kurtz, Mehlich 3, AB/DTPA and ammonium acetate extraction of P, K, and Mg in four Oklahoma soils. Commun. Soil Sci. Plant Anal. 15(3):277-294.