SCOPE

This method measures the acidity that is exchangeable by the barium chloride ($BaCl_2$)-TEA extractant that is buffered at pH 8.2. The exchangeable acidity (also called potential acidity or reserve acidity) is the extractable acidity or exchangeable H^+ comprised of exchangeable aluminum (Al) and any hydrogen (H) absorbed on soil colloids that will dissociate when the soil is brought to a pH 8.2. It is also a measure of the variable charge developed between the soil pH and pH 8.2. The pH 8.2 corresponds to the H^+ activity maintained in solution by calcium carbonate in equilibrium with the partial pressure of carbon dioxide in the atmosphere. Data of exchangeable acidity by $BaCl_2$-TEA is used in the determination of Base Saturation Percentage in a soil.

PRINCIPLE

In addition to bases (e.g., Ca, Mg, K, Na) there is also an amount of acidity that can be displaced from the exchange complex of a soil. The amount of this acidity is largely a function of soil pH and the exchange capacity. In most soils the exchangeable acidity will be composed of (i) exchangeable H^+, (ii) exchangeable Al as either Al^{3+} or partially neutralized Al-OH compounds such as $AlOH^{2+}$ or $Al(OH)_2^+$, and (iii) weak organic acids.

When a soil is limed, the exchangeable acidity is neutralized as the pH rises. Hence, exchangeable acidity is one measure of the amount of lime that will be needed to correct soil pH.

When the exchangeable acidity of the soil is high with a resultant low pH, it affects the soil condition and many processes in the soil. In an acidic condition, aluminum fixes phosphorus causing its deficiency in plants, the bioavailability of iron, aluminum, or manganese can be very high and may reach toxic levels at lower pH.

Sometimes an estimate of the nutrient capacity of a soil, the CEC at a particular pH is made by adding the meq% values of all the nutrient cations, plus sodium, to the exchangeable acidity meq% figure. The relative proportion of exchangeable acidity compared to the other cations is important. If more than 25% of the estimated CEC is made up of exchangeable acidity it is likely that your soil is acidic, leached, has low fertility or has all of these properties.

In this method, the soil is leached with barium chloride solution buffered with triethanolamine at pH 8.2. The leachate is titrated with a standard acid using bromocresol green-methyl red indicator. A blank titration is also performed on the same volume of the leachate. The exchangeable acidity in the soil is neutralized by the triethanolamine which is a weak base.

TEST PRECAUTIONS

With some soils, the end point will fade (pH increases) upon standing owing to slow dissolution of $Al(OH)_3$, but this color fading should be ignored. The small amount of aluminate dissolved in the soil extract will be converted to $Al(OH)_3$ when titration is completed but will not introduce any error in the determination of exchange acidity.

Upon standing however, the precipitated $Al(OH)_3$ will continue to react with the free acid, and any further addition of acid to restore the end point would thus lead to a small negative error.

EQUIPMENT

a) Balance, precision of at least 0.001 g
b) pH meter
c) Magnetic stirrer
d) Digital Titrator/burette

LABORATORY WARE

a) Leaching tubes
b) Volumetric flasks, 50 ml
c) Erlenmeyer flasks, 125 ml

CHEMICALS AND REAGENTS *(Peech, 1965)*

a) Buffered barium chloride solution. Dissolve 183 grams of $BaCl_2 \cdot 2H_2O$ in 330 ml distilled water. Dissolve 25 ml triethanolamine in 100 ml distilled water and dilute 4 ml conc. HCl in 100 ml distilled water. Add with stirring, the HCl solution to the barium chloride solution first, followed by the TEA solution. Mix and make up to three liters with distilled water.
b) Mixed Indicator. Dissolve 1.25 g methyl red and 0.825 g methylene blue in 1L of 90% ethanol
c) Bromocresol green (BCG), 0.1% in aqueous solution
d) Standard HCl, 0.2 M. Dilute 34.48 ml conc. HCl to two liters with distilled water.
e) Ethanol, 90%.
f) NIST traceable THAM

HEALTH AND SAFETY

Wear proper protective equipment. Use laboratory coat, close shoes, gas mask or dust mask and chemical gloves when performing analysis to mitigate the harmful effect of exposure on chemicals.

Observe careful and proper handling of chemicals when using strong acids, strong bases, barium chloride ($BaCl_2$), triethanolamine and indicators to avoid potential direct skin contact or any of the body parts to directly contact with these chemicals due to spills. Repeated and prolonged exposure to these substances can produce target organs damage and may cause skin necrosis and /or ulceration of the skin. It may affect the liver, kidney, upper respiratory tract and nervous system.

PROCEDURE *(Peech, 1965)*

Standardization of 0.2 M HCl with THAM

1. Weigh 1 g of THAM into 125 ml Erlenmeyer flask.
2. Dissolve in about 20 ml of deionized water and add 3 drops of mixed indicator. Titrate with the HCl until the solution is coloured purple.

Molarity (M) of HCl = weight of THAM, g × 1000
[illegible]

where: 1000 = conversion factor of g to mg
121.14 = [illegible]

Leaching and Titration

1. Prepare leaching materials.
2. Place 2.5 g soil sample in the leaching tube and leach with 10 ml aliquots of ($BaCl_2$)-TEA solution, so that the leaching process will take no less than two hours (add five portions of ten ml ($BaCl_2$)-TEA solution at 30 minutes interval).
3. Collect the leachate in a 50 ml volumetric flask. Always include two blanks and three QCM.
4. Transfer the leachate in a 125 ml Erlenmeyer flask.
5. Wash the volumetric flask, adding the washings to the leachate in the Erlenmeyer flask.
6. Add two drops of BCG and 10 drops of mixed indicator and titrate with the standard acid to the exact end point.

   Note: (1) Titrate from green until first full purple color.
   (2) Titrate blanks first to establish the point of color change.

CALCULATION

$$\text{Exchangeable Acidity} = \frac{(V_S - V_B) \times M \times 100 \times MCF}{W}$$

where:
- V_S = volume of acid used for sample, ml
- V_B = volume of acid used for blank, ml
- M = molarity of acid
- W = weight of sample, g
- MCF = moisture correction factor
- 100 = unit conversion factor derived as :

$$100 = \frac{1L}{1000ml} \times \frac{100cmol}{1\ mole} \times \frac{1000g}{1kg}$$