Cation Exchange Capacity of soil (CEC)

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Soil colloids are negatively as well as positively charged (mainly negative charge). With the result, cations and anions are adsorbed by the soil colloids.

The capacity of the soil to adsorb cations in the exchangeable form is termed the Cation Exchange Capacity (meq /100 gm soil or Cmol⁺/kg soil)

While the capacity of the soil to adsorb anions is termed the anion exchange capacity (AEC).

The CEC is usually determined by saturation the exchange complex of the soil with a cation such as Na^+, NH^{4+}, Ca^{2+} or Ba^{2+} and then determining of the amount of adsorbed cation by appropriate method CEC determination comprise of three stages :-

1- *Saturation with a cation.*

2- *Washing.*

3- *Replacement or extraction of an indicator cation.*

Determination of CEC by saturation with Na^+ soil is treated with 1N sodium acetate (pH 8.2) to saturate exchange sites with Na^+. Soluble sodium then removed by washing with 99% isopropyl alcohol.

Therefore exchangeable Na is extracted with 1N ammonium acetate (pH 7) and determined by flame photometer.

Reagents*:-*

1- 1 N CH$_3$COONa (pH…8.2).
2- 1 N CH$_3$COONH$_4$ (pH….7).
3- 99% Isopropyl alcohol.
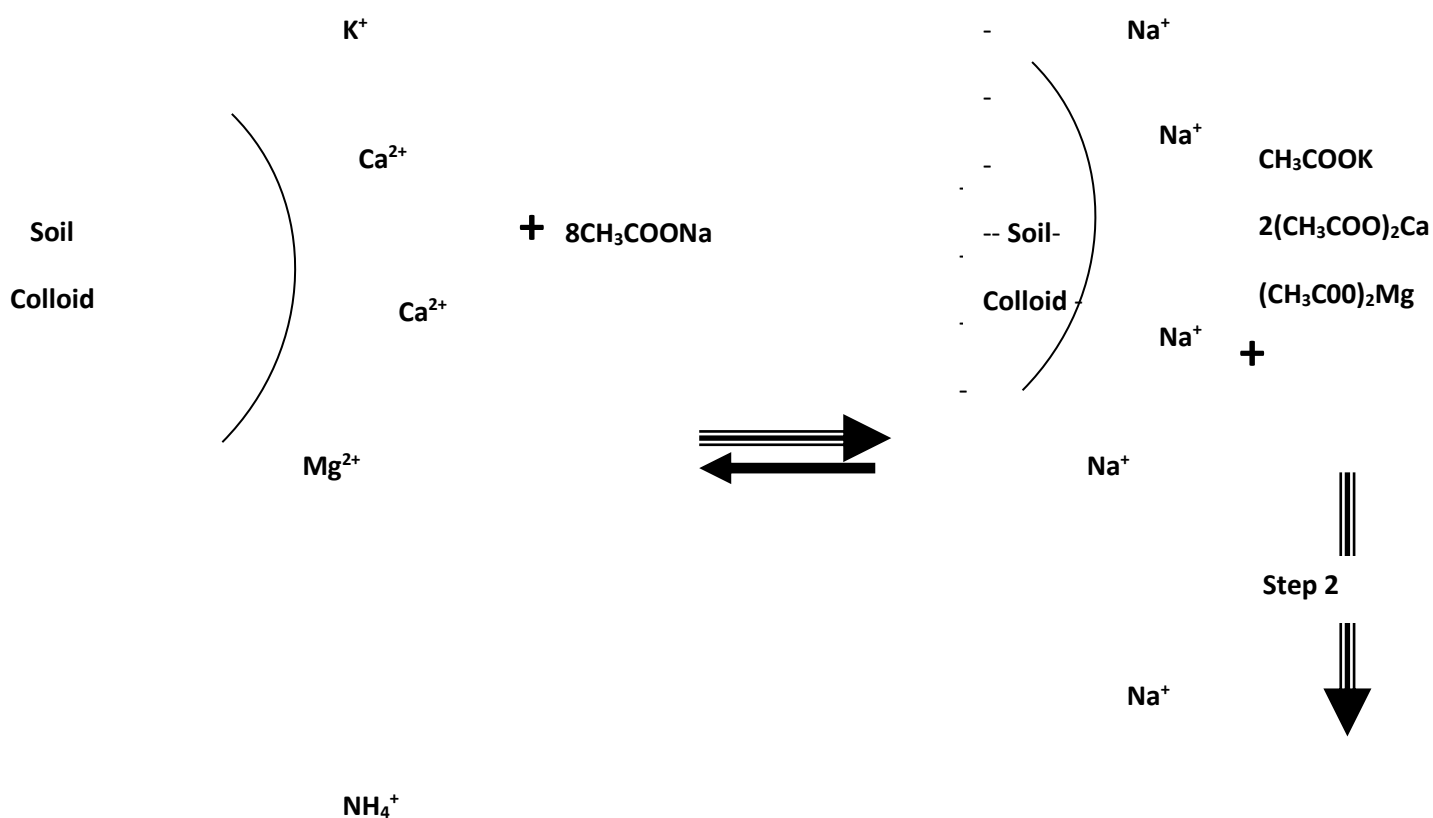4- 1000 ppm Na solution to preparer (0, 5, 10, 15 and 20 ppm) Na solution.

Procedure:-

1- Preparation of stand graph for sodium. Operate the flame photometer and calibrate the instrument using sodium standards (0 — 20 ppm) it is desirable that all the points fall on straight line.
2- Preparation of soil extract for CEC determination. Weigh 5 g of soil sample passed through 2 mm sieve into 50ml capacity centrifuge plastic tube.
3- Add 33ml of 1.0N sodium acetate (pH 8.2) solution into the centrifuge tube, and shake for 5 minutes. Run the centrifuge at 2000-2440 rpm gradually for 10 minutes or until the spirant liquid become clear. Decant the super ant, and treat the sample in the same manner two times more each time using 33ml portions of 1N sodium acetate and discard the super ant liquid each time. This would complete the process of saturation of the exchange complex with sodium.
4- Soil saturated with Na be washed in an identical manner with three 33 ml of 99% isopropyl alcohol using the procedure.
5- Extract adsorbed Na by the soil with 33ml of 1N ammonium acetate (pH 7) solution (repeat three times). decant each washing with ammonium acetate from one sample into a 100ml

Volumetric flask. Add few ml of ammonium acetate solution directly into the flask to make the volume up to 100 ml mark.
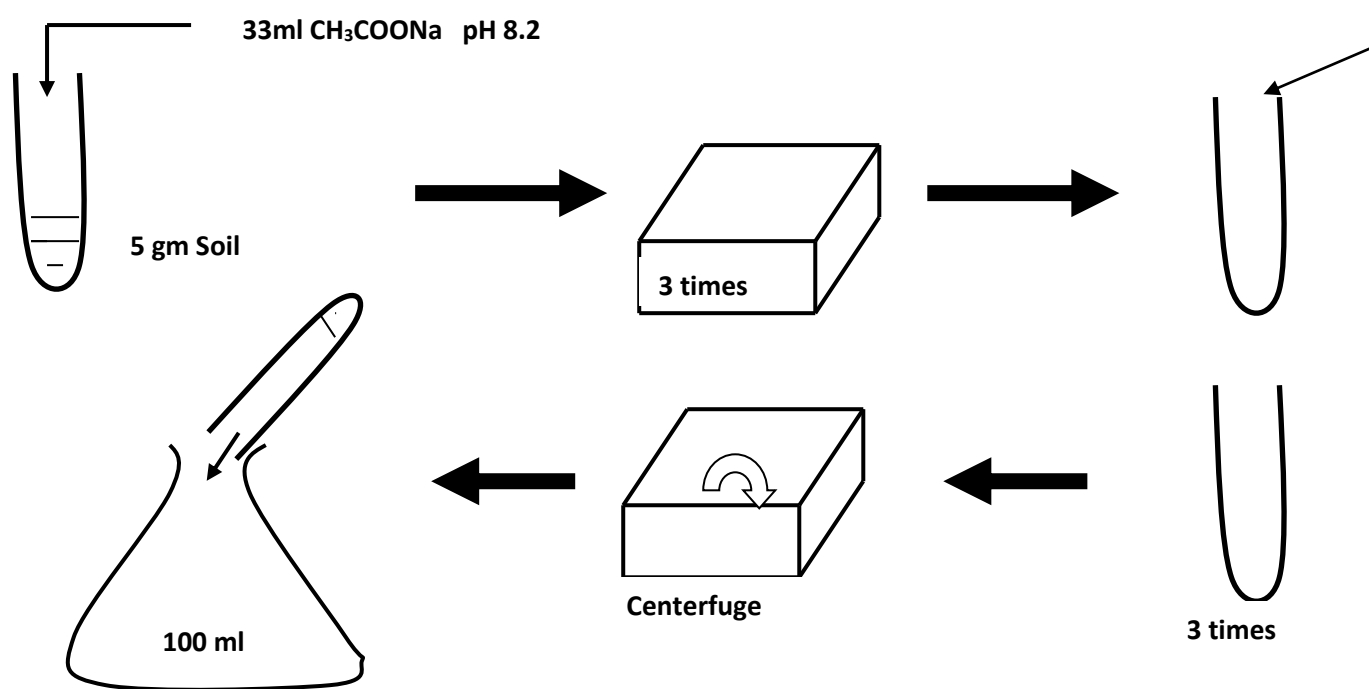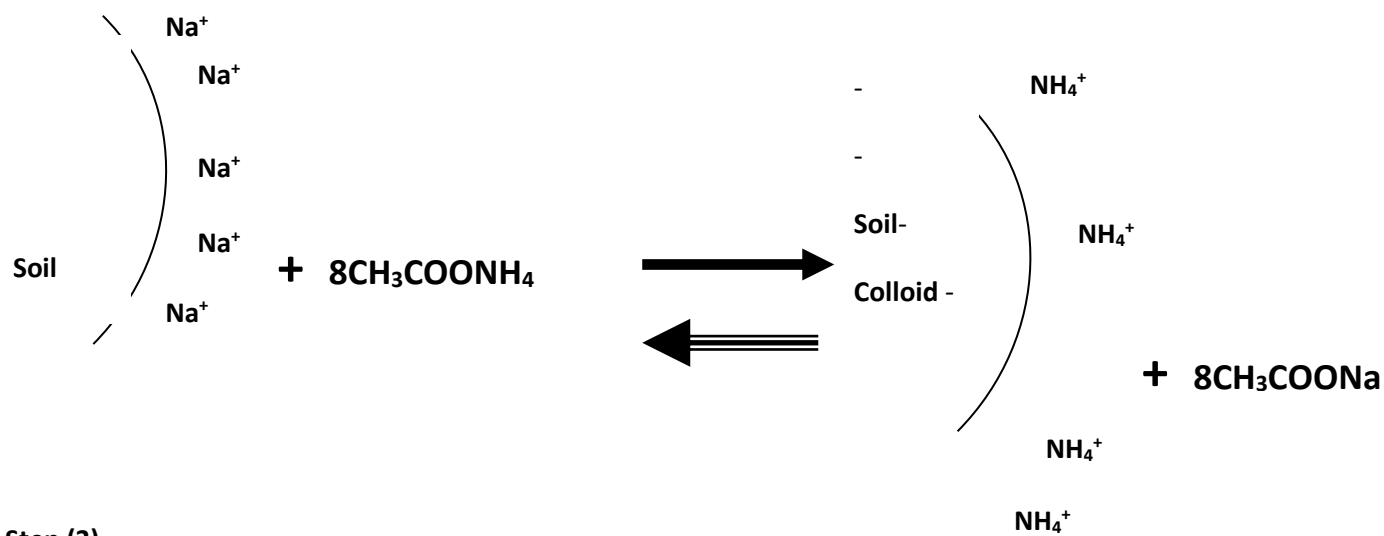
6- Determination of concentration of sodium in the CEC extract. Transfer 1.0ml of the CEC extract into 100ml volumetric flask. Add 1N ammonium acetate (pH 7) to dilute the contents to the 100ml mark.
7- Read the CEC extract by flame photometer. Find out the concentration of Na in the diluted CEC extract by reference to the standard graph for Na and multiply the concentration of Na by 100 to obtain the concentration of Na in undiluted CEC extract.

Calculation:-

meq Na/100gm soil = ppm Na (con. after plotting) /equivalent wt. of Na (23) *100/1 dilution ratio * 100/mass of soil gm)

Leaching with alcohol

Na⁺

Na⁺

Na⁺

$- \qquad NH_4^+$

Na⁺

$-$

Soil $\qquad Na^+ \qquad$ **+ 8CH₃COONH₄** $\longrightarrow$ **Soil-** $\qquad NH_4^+$

Colloid -

$\Longleftarrow$

NH_4^+

+ 8CH₃COONa

NH_4^+

NH_4^+

Step (3)

33ml CH₃COONa   pH 8.2

5 gm Soil $\qquad \longrightarrow$ **3 times** $\longrightarrow$

Centerfuge $\longleftarrow$

100 ml $\qquad$ **3 times**

meq Na/100gm soil = ppm Na (con. after plotting) /equivalent wt. of Na (23) *100/1 dilution ratio * 100/mass of soil gm)

ppm Na *100 (dilution ratio)= ppm Na undiluted

amount of Na in the 100ml extract = (ppm Na /10) mg…….. (ppm=mg/1000g)

meq Na=mg Na /23

this amount of Na is CECof 10g soil, so * 100/wt =10 to find CEC by unit meq/100g soil

so

meq Na/100g soil=ppm Na *100/10/23*100/wt

eg

5gm soil sample

Na reading is 15 ppm

Concentration of Na in extract= ppm *100 (dilution effect)=1500ppm

Amount of Na in the extract =1500mg/kg = ?/100ml= 150mg Na

Meq Na= 150/23= 6meq

For 100g soil amount of Na is 6meq/5*100=120meq/100g soil