Reclamation of Acid soils

In the regions of high rainfall, soils are acidic in their reaction because of the facts that soluble basic salts such as those of Ca, Mg, K, Na, are leached away by drainage water and insoluble acidic residues composed chiefly of oxides and silicates of iron, silicon, aluminium are left which accumulate in pretty high amount. These salts are acidic in reaction; hence the soils are acidic. Besides that, reason, there may be other causes also which produce acidity in the soil.

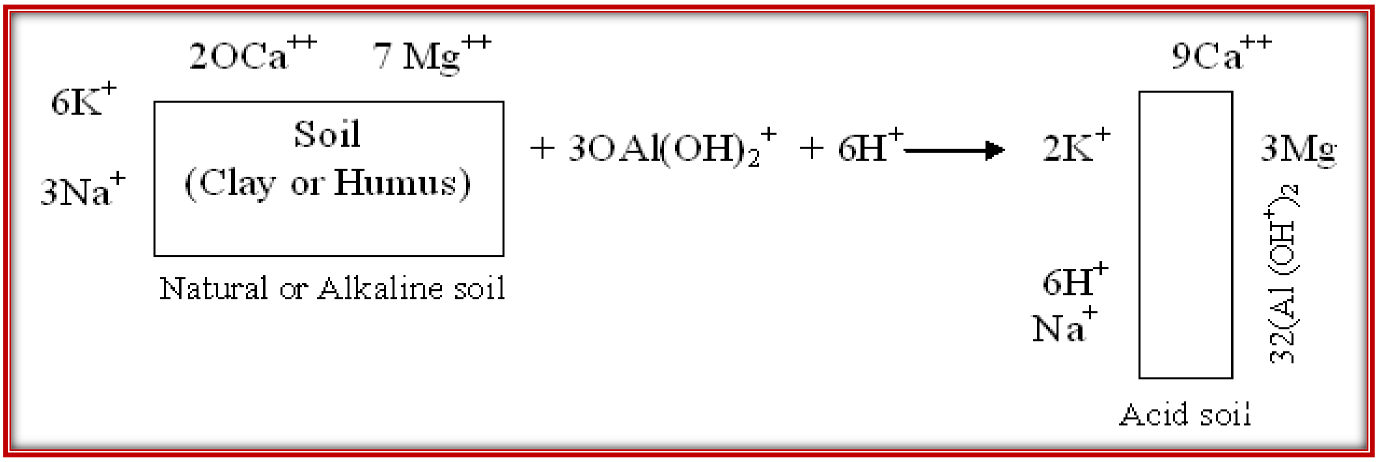
different forms of (hydrated aluminum) and some lesser amounts of (H^+) ion for example

$(Al(H_2O)_6^{+3}) \longrightarrow (Al(H2O)^5\ OH^{++}) + H^+$ …..(1) Hexaquine ion

$Al(H_2O)_5\ OH \longrightarrow [Al(H_2O)_4(OH)_2^+] + H^+$ at about PH = 5-6.5

$[Al(H_2O)_4(OH)_2^+] \longrightarrow [Al(H_2O)_3(OH)_3]^0 + H^+$ at PH about 6.5 - 8.5

The following figure or scheme explain neutral or alkaline soil and acid soils



Sources of Acidity

1. CO_2 form decomposing organic matters and root respiration then dissolving in water

$$CO_2 + H_2O \longrightarrow H_2CO_3 \longrightarrow H^+ + HCO_3$$

2. Oxidation of Ammonium by bacteria (by nitrifying bacteria).

$$NH_4^+ + 2O_2 \longrightarrow NO_3 + H_2O + 2H^+$$

3. Oxidation of sulfur by Thiobacillus bacteria:

$$2S + 3O_2 + 2\,H_2O \longrightarrow 2SO_4^= + 4H^+$$

4. Releasing some hydrogen ions (H^+) by plant roots. Studies have shown pH values as much as (1.2) units lower in soil near roots (Rhizospher) in comparing with general mass of soil.

5. Acid rain.

6. Crop removal helps to make soil more acidic by depleting. Ca^{++} / Mg^{++} / Na^+ / K^+ from the soil.

These effects are briefly mentioned below:
1. Direct influences. These are as follows:
(a) Toxic effects of low H^+ ion concentrations on root tissues.
(b) Influence of soil acidity on the permeability of the plasma membrane for cations.

(c) Disturbance in the balance between basic and acid constituents through roots.

(d) Affects enzymatic processes since enzymes are particularly sensitive to pH changes Different crop plants have their specific optimum pH requirement. Rice, oat and linseed can endure a fairly acidic reaction (pH = 5.0) while barley, sugar-beet, lucerne etc. can tolerate a fairly alkaline reaction (pH = 8.0)

2. Indirect effects.
These are listed below:
(a) Availability of various nutrients, e.g., phosphorous, copper, and zinc.

(b) High solubility and availability of elements like aluminium, manganese and iron in toxic amount due to high acidity in the soil.

(c) Deficiency of some nutrients such as calcium and potassium due to soil acidity.

(d) Prevalence of plant diseases.

(e) Beneficial activities of soil microbes are adversely affected.

The common liming materials used for reclamation of acid soils are as follows:

(1) Calcic limestone ($CaCO_3$) which is ground limestone. (2) Dolomite ($CaCO_3$. $MgCO_3$).
(3) Quick lime (CaO) which is burnt limestone.

(4) Hydrated (slaked) lime [$Ca(OH)_2$].
(5) Coral shell lime.

(6) Marl or chalk ($CaCO_3$).
(7) Slags Obtained as by-products from iron and steel plants, slags are used in agriculture for reclaiming acid soils.

Action of lime on acidic soils:

$CaCO_3 = 40 + 12 + 16(3) = 100$

100g $CaCO_3$ contains 40g Ca^{++} or contains 56g CaO

Effective $CaCO_3$ (Neutralizing index):

An effective technique for assessing a liming material is to consider both chemical and physical factors together.

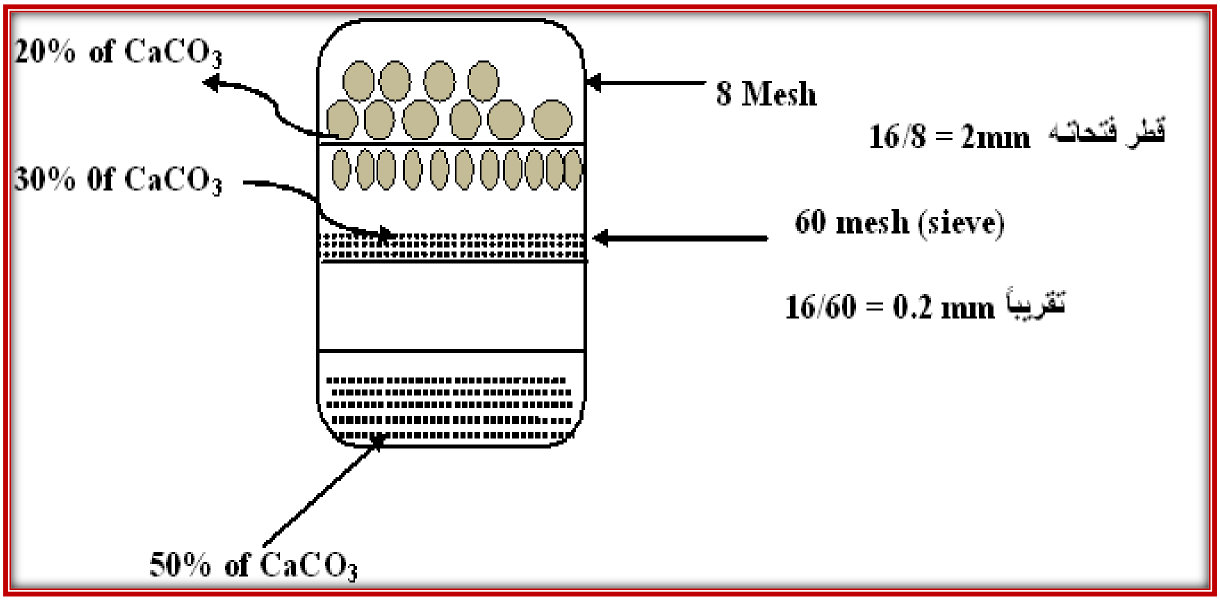
1. Determining the $CaCO_3$ equivalent.

2. Sieve analysis which expresses (fineness) to calculate the effective $CaCO_3$ also called neutralizing index.

Example:

Calculate neutralizing index for acid soil having pH value = 5 if the purity of $CaCO_3$ = 90%, and sieve analysis indicated to the following results:
$CaCO_3$ retained on 8 mesh sieve = 30%
$CaCO_3$ retained on 60 mesh sieve = 10%
$CaCO_3$ passed on 60 mesh sieve = 60%

Solution: -



- $CaCO_3$ particles greater than 8 mesh sieve size is not active or it has zero effectiveness for this reason 30% of applied $CaCO_3$ is not active or its activity = zero

- $CaCO_3$ that passes between 8 – 60 mesh sieves has 50% effective which regards as a fine $CaCO_3$: 10 * 50/100 = 5
- CaCO3 passed 60 mesh sieves has 100% effective:

60 * 100/100 = 60
- Total fineness factor = 0 + 5 + 60= 65

Neutralizing index = % CaCO3 equivalent * fineness factor

90/100 * 65 = 58.5

Example2:

Calculate the neutralizing index if $CaCO_3$% = 90%

Sieve analysis: Retained on 8 mesh sieve = 20%

Retained on 60 mesh sieve =20% passed 60 mesh sieve =60% of Total

Solution:

1. Greater than 8 mesh sieve size lime is a coarse lime which requires (3) years to neutralize acid soil for this reason it has zero effectiveness. There for 20% of sample > 8 mesh x o effectiveness = zero
2. Lime that passes between 8-60 mesh sieve has 50% effective as finder lime :

20* 50/100 = 10

3. presuming < 60 mesh lime is 100% effective: 60* 100/100 = 60

4. Total fineness factor = 10 + 60 =70
Effective CaCO3 or (Neutralizing index) equal to = % CaCO3 equivalent x fineness factor = 0.90*70 = 63

The main amendments are:

Ca Cao
CaCO3 Ca $(OH)_2$
Mg Mg O
Mg (OH)2 Mg Co3
Pure Dolomite (CaCO3- Mg CO3)

Note: Mesh = Number of pores / inch2 = mm = 16/number of opening per inch square

Acidity of soil is due to predominance of H^+ ions over OH^- ions, the bulk of H^+ ions being held in close association with clay-organic colloid complex. Strong acid soils are not much productive. The soils which are less productive owing to high degree of acidity can be made more productive by liming (application lime).
When lime is added to moist soil, the soil solution becomes charged with cations and the exchangeable hydrogen and aluminium ions on clay-organic colloid complex as well as the H^+ ions soil solution are displaced by calcium ions. Hydrogen combines with OH^- to form neutral water or with CO_3 or HCO_3^- to form unstable H_2CO_3, which readily dissociates to form CO_2 and water.