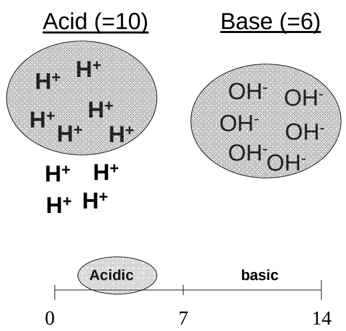
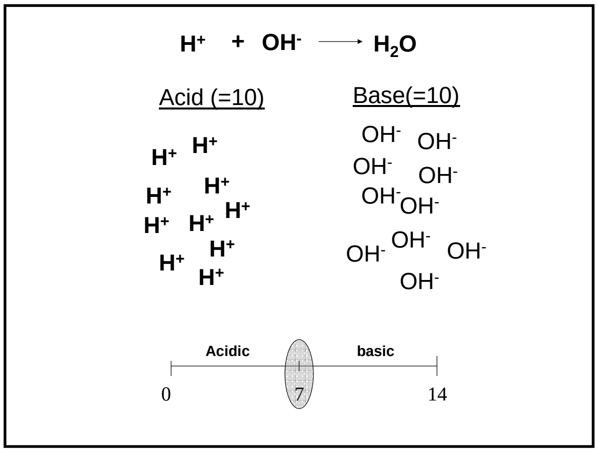
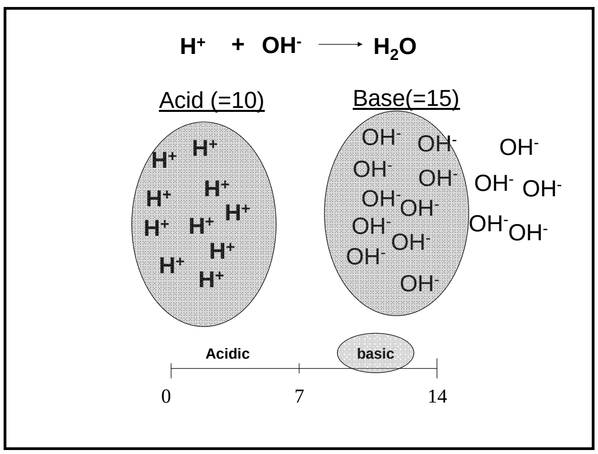
Soil Buffering and Management of Acid Soils

1. Acids increase the H+ ion concentration in solution
2. Bases are the opposite of acids
3. Bases neutralize acids.
4. When acids and bases are in equal amounts in a solution, the pH is 7. Neutral pH.
5. When the number of acids exceeds the number of bases the pH is lowered. (acid conditions)
6. When the number of bases exceeds the number of acids, the pH is raised. (basic/alkaline conditions)

$$H^+ + OH^- \longrightarrow H_2O$$





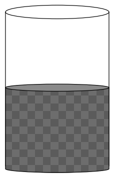


Two types of acidity in soils:

- Active Acidity
- Exchangeable Acidity

Active Acidity

Acidity associated with the soil solution



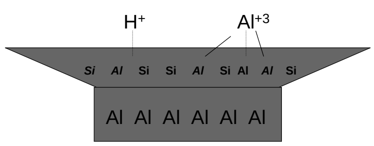
Typically a 1:1 or 2:1 extract

10 g soil and 10 mL water

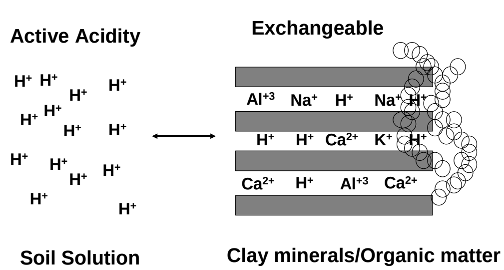
10 g soil and 20 mL water

Exchangeable Acidity

Acidity associated with cation exchange sites on mineral or organic colloids.



Types of Acidity



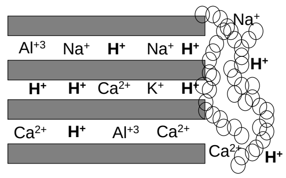
Percent Base Saturation

(charge basis)

$$\frac{\text{Exchangeable bases (cmol/kg)}}{\text{Cation exchange capacity (cmol/kg)}}$$

Base charge = 12
Exch. Cap. = 27

% B.S. = 44.4%



Clay minerals/Organic matter

Base Cations: Na, K, Mg, Ca

Soil Buffering

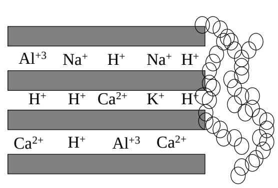
The ability of soils to resist changes in pH

Soil Buffering

Due to ultimate equilibrium between solution and colloids.

Na^+ H^+ H^+ Ca^{+2}
K^+ H^+ H^+ H^+
Na^+ Na^+ H^+
Ca^{+2} H^+ H^+ K^+

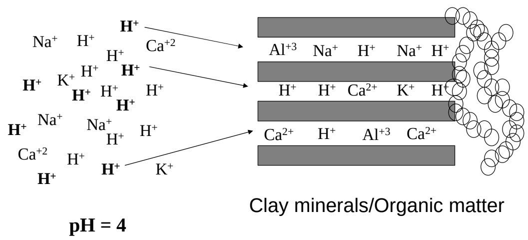
pH = 6



Clay minerals/Organic matter

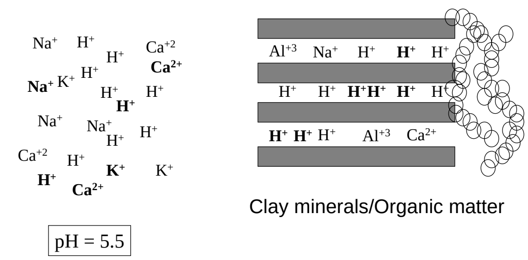
Soil Buffering

Add acid: HCl => H^+ + Cl^-



Soil Buffering

Final equilibrium



Base

A substance which decreases the Hydrogen ion concentration in solution

OH^-
CO_3^{2-}
SO_4^{2-}

A substance which decreases the Hydrogen ion concentration in solution

$$OH^- + H^+ \longrightarrow H_2O$$

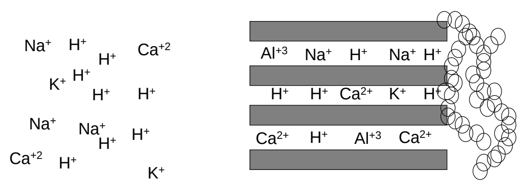
$$CO_3^{2-} + H^+ \longrightarrow HCO_3^-$$

(Neutralization)

NaOH
$CaCO_3$

Soil Buffering

Equilibrium between solution and colloids.

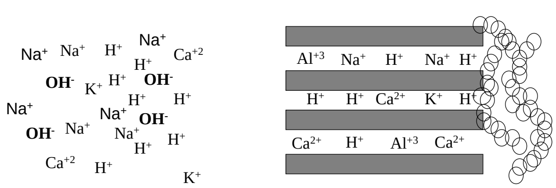


pH = 6

Clay minerals/Organic matter

Soil Buffering

Add Base: $NaOH + H^+ = Na^+ + H_2O$

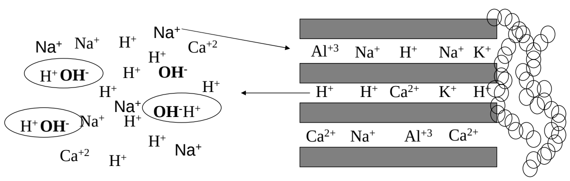


pH = 7

Clay minerals/Organic matter

Soil Buffering

NaOH



Clay minerals/Organic matter

pH = 6.3

Active Acidity

Plant	pH Range
Alfalfa Sweet Clover	6.0 – 8.0
Beets Cauliflower	5.5 - 8.0
Spinach Peas Carrots	5.3 - 7.5
Cotton Wheat Tomatoes	5.0 – 7.2
Potatoes Blueberries Azaleas	4.5 – 5.5 < 5

Sometimes soil pH must be adjusted to accommodate plants

Liming: raising soil pH

$MgCO_3$ $CaCO_3$

$$CaCO_3 \longrightarrow Ca^{2+} + CO_3^{2-}$$

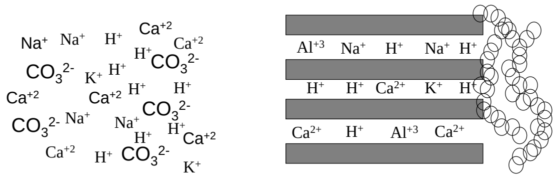
Ca^{2+}: Displaces cations From exchange sites

CO_3^{2-}: Combines with Hydrogen ions (neutralization)

$$CO_3^{2-} + H^+ = HCO_3^-$$

Soil Buffering

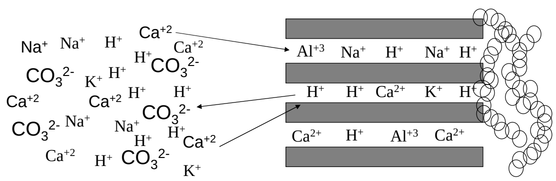
Add Base: $CaCO_3 \rightarrow Ca^{2+} + CO_3^{2-}$



Clay minerals/Organic matter

Soil Buffering

Add Base: $CaCO_3 \rightarrow Ca^{2+} + CO_3^{2-}$



Clay minerals/Organic matter

$$CO_3^{2-} + H^+ = HCO_3^-$$

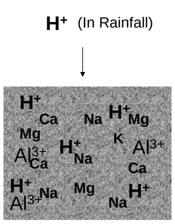
Buffering Capacity

1. CEC → Kaolinite; → Smectite; → Organic Matter

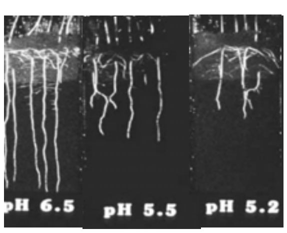
2. % base saturation

pH and Nutrient Availability

Florida Soils Tend to be Acidic



Aluminum Toxicity



Aluminum most available at low pH

Macro-Nutrients

Generalizations: Nitrogen: NH_4^+ users below pH 5.5

$NH_4^+ \longrightarrow NO_3^-$

Ammonium may accumulate
Organism dependent.

Phosphorus: $H_2PO_4^-$ and HPO_4^{2-}

Greatest availability at pH 6-7

Potassium: K+

Liming tends to increase availability
(Increased CEC)

Micro-Nutrients

Boron, manganese, iron, cobalt copper, zinc

Oxides of these metals tend to be
broken down at low pH

Availability generally increases
With increasing soil acidity
(low pH)

Acidity can be local: roots - acids