

## Calculating Cation Exchange Capacity and the Percent Base Saturation

The cation Exchange Capacity (CEC) is a term used to describe the holding capacity of a particular soil for positively-charged elements (cations). It may also be described as the capacity for a soil to exchange cations for another. In simple terms the higher the clay content, the higher the CEC since clay particles have the greatest surface area per unit volume of soil and, therefore, can hold the most cations.

The CEC is a part of the soil test which is calculated from the levels of potassium, magnesium, calcium, sodium and hydrogen which were extracted in the soil analysis. These cations are the ones of greatest concentration in most soils. The calculations will be explained below:

Each of these elements has its individual atomic weight as found on a Periodic Table.

Calcium	= 40	Sodium	= 23
Magnesium	= 24	Hydrogen	= 1
Potassium	= 39		

From the atomic weight the equivalent weight can be calculated. Calcium and magnesium have two valences or positive charges. Sodium, potassium, and hydrogen each have one positive charge. By dividing the atomic weight by the number of valences we determine the equivalent weight. Therefore,

Calcium	= 20	Sodium	= 23
Magnesium	= 12	Hydrogen	= 1
Potassium	= 39		

By getting the equivalent weights we now have each element in equal terms or in other words 20 ppm of calcium can displace 12 ppm of magnesium on the soil complex.

However, the CEC is reported in meq/100 gm. The equivalent weights are reported as equivalents per gram. Therefore, the equivalent weights must be multiplied by ten to be converted to meq/100 gm.

Now that we have these values we can calculate the CEC from the ppm of each of these elements on the soil test. The following will be used for an example:

A soil test shows we have 379 ppm of potassium, 133 ppm of magnesium, 1600 ppm of calcium, 22 ppm of sodium and a pH of 8.0. (Since the pH is above 7.0, we have no hydrogen reported, but if the pH was 6.0, you would use the meq/100 gm of hydrogen given on Midwest Lab's soil analysis in the calculation.)

Potassium	379/390 =	.972
Magnesium	133/120 =	1.11
Calcium	1600/200 =	8.0
Sodium	22/230 =	.1
Hydrogen	0	

$$\text{CEC} = .97 + 1.11 + 8.0 + .1 = 10.2 \text{ meq/100 gm}$$

As you can see, the largest factor in the calculation is that of calcium. Soil exchange sites contain mostly calcium; however, in higher pH soils large amounts of free calcium may also be present in soil solution which may also be extracted in the test reflecting a higher holding capacity than what the texture analysis would actually indicate. Midwest Laboratories, Inc. procedures try to reduce the effects of this excess calcium, but the CEC may still reflect a somewhat inflated number as compared to what would be indicated by the texture.

The Percent Base Saturation is then calculated from these values by dividing the milliequivalents of each by the CEC as shown below:

Potassium	.97/10.2 =	9.6%
Magnesium	1.11/10.2 =	10.9%
Calcium	8.0/10.2 =	78.6%
Sodium	.1/10.2 =	.9%

The Percent Base Saturation could be defined as the relative availability of each of these cations.