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Missouri Limestone Quality What is ENM?

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Can you get a ton's worth of agricultural limestone out of a ton of agricultural limestone? Probably not. The effectiveness of agricultural limestone depends on two factors:

- Calcium carbonate equivalent and
- Particle size

The effectiveness of limestone refers to its ability to neutralize soil acidity. To measure the ability to reduce acidity, a rating system was developed. This rating system is called **effective neutralizing material (ENM).** It is rated per ton of agricultural lime. All limestone sold in Missouri must have an ENM rating.

Calcium carbonate equivalent (CCE). The CCE of a liming material is determined by chemically reacting agricultural lime with an acid. The amount of acid the liming material neutralizes tells how much CCE a liming material contains.

On an equivalent basis (pound for pound), the different liming materials found in nature are capable of neutralizing different amounts of acidity (See Table 1). In the pure form, a ton of burned lime has the ability to neutralize 79 percent more acidity than a ton of pure calcitic limestone.

CCE content also gives an indication of how pure the liming material is. In Missouri, a liming material must contain at least 65 percent CCE to be allowed for sale as agricultural lime.

Particle size. The fineness of a limestone material affects how rapidly the lime will react in the soil and how thoroughly it can be mixed in the soil. A great deal of research has been conducted to determine the effect particle size has on the reactivity of lime.

The smaller the particle size, the more effective the liming material. As particle size is reduced, the surface area of the particles per pound of lime greatly increases. This allows more of the liming material to react faster. On the other hand, particles generally give a more long-lasting effect.

A rating system was developed to show the effectiveness of different particle sizes to neutralize acidity. The rating is based on the amount of lime that would likely be expected to react in soils in a one-to-three-year time period. Sieves are used to determine particle size. Figure 1 shows the size ranges used for determining effectiveness of limestone particles. Table 2 rates each size range for efficiency.

Limestone particles, finer than a 60-mesh screen, are likely to react within a short time. Research has shown that there is little advantage to grinding agricultural lime finer than 60 mesh.

Liming material coarser than an 8-mesh sieve size has essentially no value. This size of particle reacts so slowly in soils that it does not appreciably reduce soil acidity. By Missouri law, no more than 10% of the particles in agricultural liming material can be coarser than 8 mesh.

effective neutralizing material (ENM). ENM per ton of liming material is calculated using the calcium carbonate

Table 1. Calcium carbonate equivalent (CCE) of the pure forms of commonly used liming materials.

Common Name	Compound	Calcium carbonate equivalent (%CCE)
Limestone	Calcium carbonate	100
Dolomite	Calcium magnesium carbonate	109
Slaked lime	Calcium hydroxide	136
Burned lime	Calcium oxide	179

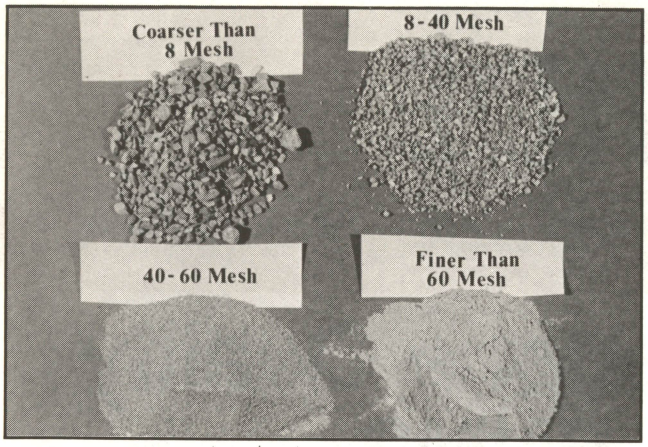

Figure 1. The size ranges for determining effectiveness of limestone particles.

equivalent (CCE) and particle size efficiency ratings. Sample calculations of two liming materials varying in calcium carbonate equivalent and particle size are given in Table 3.

In these calculations, two different liming materials, one with high purity (CCE) and the other with finer particles, have exactly the same ENM. Research has shown that those two liming materials will have the same effect on neutralizing soil acidity for every ton applied to the soil.

For any agricultural liming material, ENM is determined by this equation:

ENM = CCE X Fineness factor x 800

The 800 is a constant that refers to the pounds of effective calcium in one ton of pure lime.

How Do You Use ENM?

One pound of ENM will give you 1 pound of ENM, despite the liming material. The example in Table 3 showed two different liming samples with the same ENM. This means that for every ton of agricultural lime you buy, you get 490 pounds of ENM, despite the sources you choose.

What is the best source? Economically, the cheaper source is better, since both liming materials deliver the same amount of ENM per ton.

If two different liming materials have 300 ENM and 600 ENM per ton, which would be better?

Table 2. Efficiency ratings for particle size of agricultural liming materials.

Particle size range (sieve size)	Efficiency rating (%)
Coarser than 8 mesh	0
8 to 40 mesh	25
40 to 60 mesh	60
Finer than 60 mesh	100

In this case, 600 ENM will neutralize twice as much acidity as 300 ENM for each ton of lime applied to the soil. One ton of 600 ENM will neutralize as much acidity as 2 tons of 300 ENM. However, you could pay twice as much for the 600 ENM because it will neutralize twice as much acidity.

The best way to determine the cost of lime is to get the cost per pound of ENM.

Example

	Sample 1	Sample 2
Price per ton	$12.00	$10.00
ENM per ton	500	400
Price per ENM =	2.4¢ (12.00/ 500)	2.5¢ (10.00/ 400)

In this example, the $12.00-per-ton lime is actually cheaper per pound of ENM than the $10.00-per-ton lime.

Lime according to ENM requirement. Test soils for lime requirement. The University of Missouri Soil Testing Service will determine lime requirement on the basis of pounds of ENM required per acre. If this rate of ENM is applied, the proper soil pH_s will be achieved for top crop production.

When applying lime, don't apply tons of lime, apply pounds of ENM. If your soil test suggests that you need 1200 ENM per acre, price your lime for applying 1200 ENM per acre.

A pound of ENM **is** a pound of ENM, regardless of the source of liming material. Hunt out the cheapest source per pound of ENM that best fits your management system.

Table 3. Sample ENM calculations.

Sample 1

% CCE = 70

Particle size	% of samples in each mesh size range		Efficiency factor	
Coarser than 8 mesh	0	×	0	= 0.0
8-40 mesh	10	×	0.25	= 12.5
40-60 mesh	10	×	0.60	= 6.0
Finer than 60 mesh	80	×	1.00	= 80.0
			Fineness factor	= **88.5**

ENM = 0.70 × 0.885 × 800
ENM = 496 pounds per ton

Sample 2

% CCE = 95

Particle size	% of samples in each mesh size range		Efficiency factor	
Coarser than 8 mesh	4	×	0	= 0.0
8-40 mesh	26	×	0.25	= 6.5
40-60 mesh	28	×	0.60	= 16.8
Finer than 60 mesh	42	×	1.0	= 42.0
			Fineness Factor	= **65.3**

ENM = 0.95 × 0.653 × 800
ENM = 490 pounds per ton

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