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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
- 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 (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.

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

Common name	Compound	Calcium carbonate equivalent
Limestone	Calcium carbonate	100 percent
Dolomite	Calcium magnesium carbonate	109 percent
Slaked lime	Calcium hydroxide	136 percent
Burned lime	Calcium oxide	179 percent

CCE content also gives an indication of how pure the liming material is. Most limestone rock found in Missouri quarries contains some impurities such as clay, sandstone or other minerals that lower limestone purity measured as CCE. 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, larger articles generally have 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-year time period. Sieves are used to determine particle size. Table 2 rates each size range for efficiency.

Table 2
Efficiency ratings for particle size of agricultural liming materials

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

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 percent 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 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.

Table 3
Sample ENM calculations

Sample 1: percent CCE = 70					
Particle size	percent of samples in each mesh size range		Efficiency factor		
Coarser than 8 mesh	0	multiplied by	0	equals	0.0
8-40 mesh	10	multiplied by	0.25	equals	2.5
40-60 mesh	10	multiplied by	0.60	equals	6.0
Finer than 60 mesh	80	multiplied by	1.0	equals	80.0
				Fineness factor =	88.5
ENM = 0.70 x 0.885 x 800 = 496 pounds per ton					
Sample 2: percent CCE = 95					
Particle size	percent of samples in each mesh size range		Efficiency factor		
Coarser than 8 mesh	4	multiplied by	0	equals	0.0
8-40 mesh	26	multiplied by	0.25	equals	6.5
40-60 mesh	28	multiplied by	0.60	equals	16.8
Finer than 60 mesh	42	multiplied by	1.0	equals	42.0
				Fineness factor =	65.3
ENM = 0.95 x 0.653 x 800 = 496 pounds per ton					

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, regardless of 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 496 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'?

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	$10
ENM per ton	500	400
Price per ENM	2.4 cents (12.00 per 500)	2.5 cents (10.00 per 400)

In this example, the $12-per-ton lime is actually cheaper per pound of ENM than the $10-per-ton lime.

Lime according to ENM requirement
Test soils for lime requirement. MU Soil Testing and Plant Diagnostic Services will determine lime requirement on the basis of pounds of ENM required per acre. If this rate of ENM is applied, the proper soil salt pH 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 1,200 ENM per acre, price your lime for applying 1,200 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.

What if the limestone sources were essentially identical in cost per acre to meet the ENM rating per ton as with the above case? Which is a "better" buy? In the above case of 300 ENM vs. 600 ENM limestone, the 300 ENM limestone would be a better buy if priced the same per pound of ENM. Why? Because you would be receiving twice as much limestone material per acre to supply the needed ENM. The lower ENM material would probably contain more coarse lime that gets a reduced fineness efficiency factor. Reaction of the lower ENM limestone, if applied at the recommended rate of ENM, will be exactly the same as the higher ENM limestone within a year.

The advantage of using the lower ENM limestone comes years down the road as that coarser portion of limestone eventually breaks down and maintains a favorable soil pH for a longer time.

ENM and limestone mixtures

Two liming products commonly sold by fertilizer dealers as mixtures of limestone and fertilizer include fluid lime and pelleted lime. Confusion on expressing the ENM value of these materials is common.

The best method of determining the liming value of fluid lime is to find out what the ENM value is prior to mixing it with fertilizer. Pure limestone to be used for fluid lime will all be finely ground to be held in a fluid suspension. The purity can vary. As an example, the CCE of the limestone is 95 percent and fineness factor is 100 percent. The ENM of that lime is 0.95 x 1.0 x 800 = 760 ENM per dry ton. Then ask the dealer to indicate how many **dry** tons of that lime will be spread per acre in the fluid suspension. Commonly, 1/4 ton or less of this limestone per acre is applied or 190 pounds ENM per acre or less in a fluid blend.

Pelleted limestone also should have a guaranteed ENM per ton available from the dealer. Again, the required rate per acre can be determined by dividing the guarantee by the recommended amount from soil analyses.

Don't be misguided by the various methods of marketing and applying limestone or limestone mixtures. The dealer must provide a guarantee of the liming material. By law it states that the dealer must have the guaranteed ENM shown on the sales ticket, calculated on the basis of the quantity per ton in the load going to the field.

An example of the proper labeling of a truckload of pelleted limestone and fertilizer would include the guaranteed percent nitrogen, percent phosphate, percent potash and pounds ENM per ton. Suppose the pelleted limestone before mixing with the fertilizer was rated at 600 pounds ENM per ton. Five hundred pounds of pelleted limestone is added to 1,500 pounds of the fertilizer blend to make 1 ton. Therefore, the ENM of the fertilizer/lime mixture is now 150 pounds per ton (1/4 ton of 600 ENM pelleted lime in 1 ton of fertilizer/lime mixture). The dealer must guarantee 150 pounds ENM per ton of delivered fertilizer/limestone blend. Calculations are identical for fluid lime/fertilizer mixtures.

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