Liming Terminology and Analysis

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What determines the quality of a liming material?

- Purity
  - Calcium carbonate equivalent
  - Determined in the laboratory
- Fineness
  - Particle size
  - Dry sieve analysis

Calcium Carbonate Equivalent (CCE) or Purity

- Neutralizing power per weight of material relative to pure $CaCO_3$

$$CaCO_3 + 2H^+ \rightleftharpoons Ca^{2+} + CO_2 + H_2O$$
$$Ca(OH)_2 + 2H^+ \rightleftharpoons Ca^{2+} + 2H_2O$$

$$\frac{100\ g/mol}{74\ g/mol} \times 100 = 135\ \%\ CCE$$

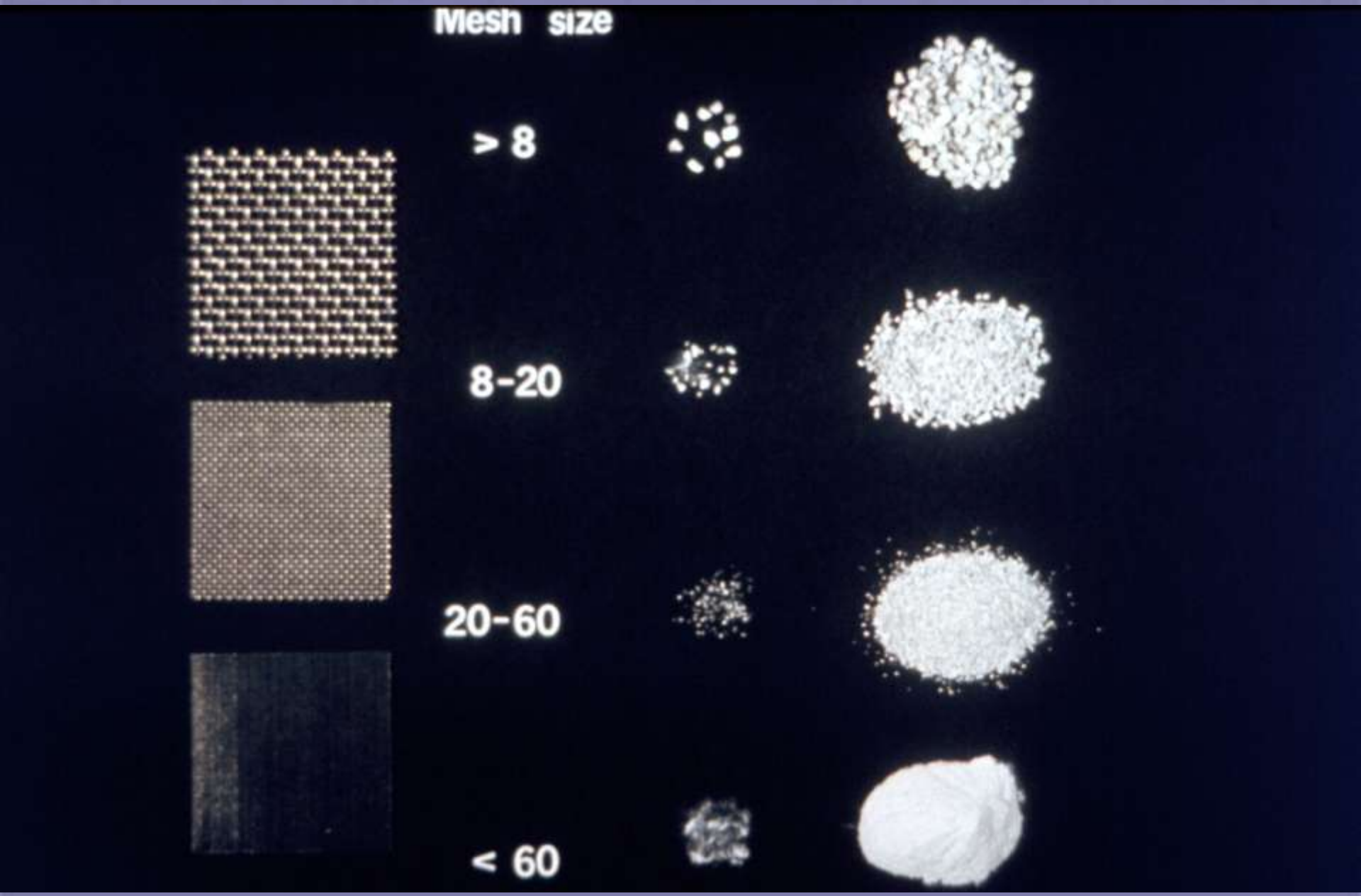
CCE Values (Purity Factor)

Table 6-5. Liming materials and their calcium carbonate ($CaCO_3$) equivalent

Liming material	Neutralizing agent	$CaCO_3$ equivalent of pure material (%)
Dolomitic limestone	$CaCO_3 \cdot MgCO_3$	110–118
Papermill lime sludge	Mainly $CaCO_3$	*
Marl	Mainly $CaCO_3$	variable
Calcitic limestone	$CaCO_3$	100
Water treatment lime waste	$CaCO_3$	variable
Wood ash	K_2CO_3, $CaCO_3$, $MgCO_3$	20–90
Fly ash	CaO, $Ca(OH)_2$, $CaCO_3$	variable
Hydrated lime	$Ca(OH)_2$	135
Air-slaked lime	$Ca(OH)_2 + CaCO_3$	100–135

* *According to the Wisconsin Lime Law, one cubic yard of papermill lime sludge is equivalent to one ton of aglime having a neutralizing index of 60–69.*

Fineness


Mesh size
> 8
8-20
20-60
< 60

Sieves Used By State

- Iowa – 4, 8, 60 mesh
- Illinois – 8, 30, 60 mesh
- Minnesota and Wisconsin – 8, 20, 60 mesh
- Michigan – 8, 60 mesh

Effect of Particle Size on Soil pH over 3 years

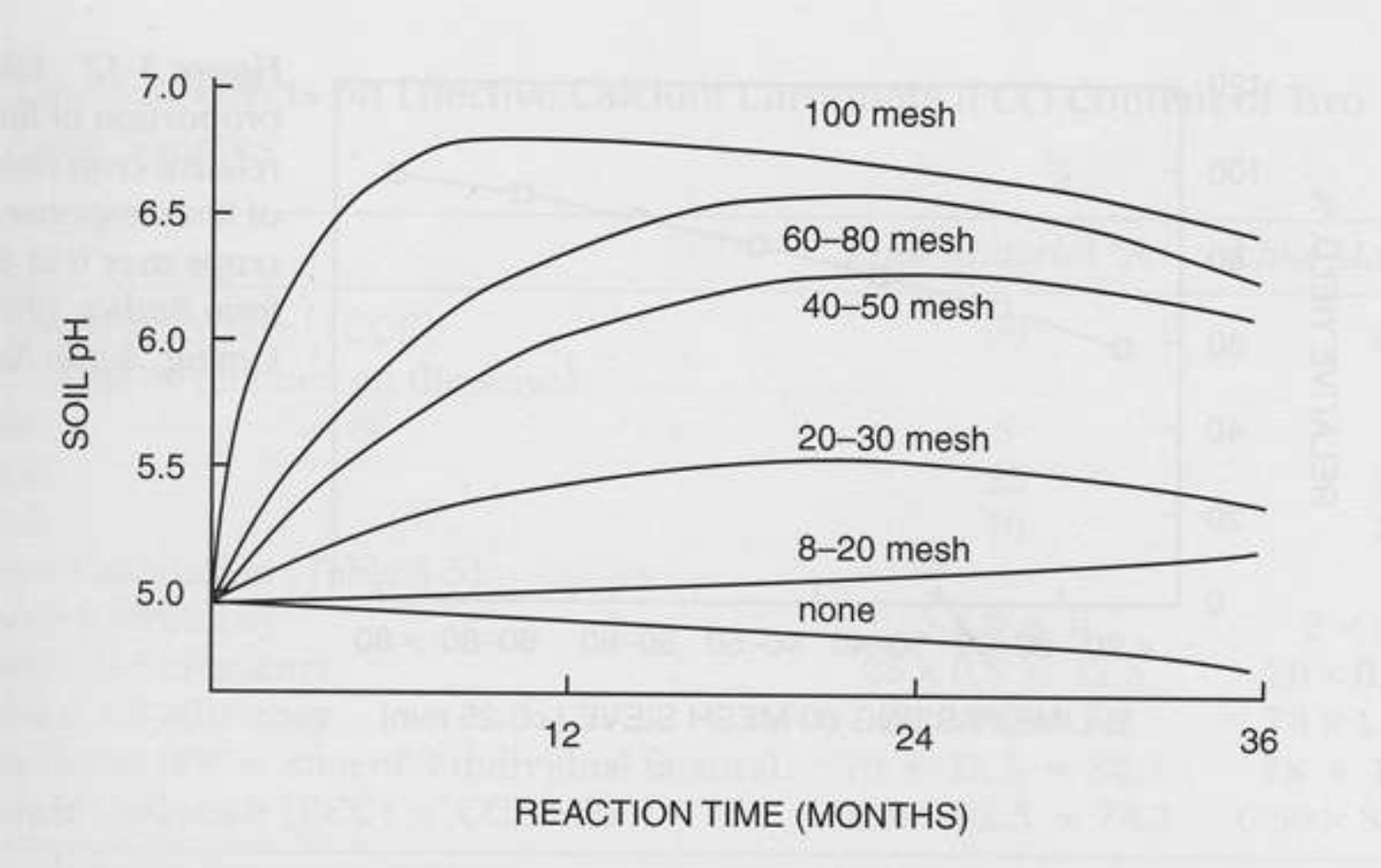
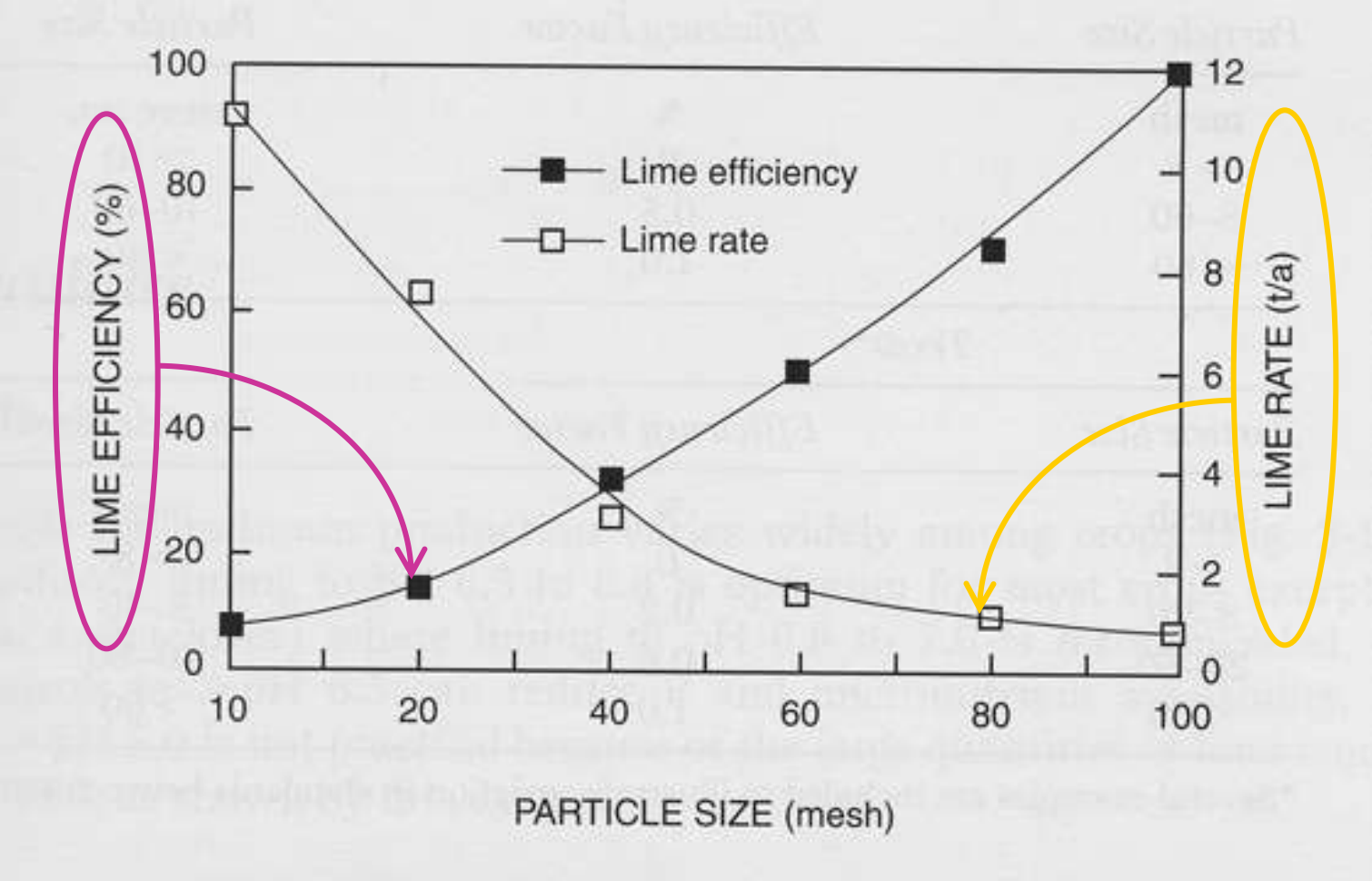


Figure 3-10 from Havlin et al., 2005

Relative lime efficiency and rate with particle size



To raise soil pH to 7.0

Figure 3-11 from Havlin et al., 2005

Wisconsin

Table 2. Effect of various rates of dolomitic lime sizes on the pH of Withee silt loam

Fraction (mesh size)	Soil pH*			
	1 mo	1 yr	2 yr	3 yr
0 ton/a lime				
—	4.96	5.18	5.23	5.30
2 ton/a lime				
20-40	5.04	5.39	5.70	5.91
40-60	5.12	5.52	5.82	6.05
60-100	5.18	5.64	5.94	6.03
< 100	5.44	5.58	5.97	6.03
6 ton/a lime				
8-20	4.98	5.28	5.78	6.10
20-40	5.17	5.66	6.15	6.40
40-60	5.29	5.81	6.40	6.50
60-100	5.33	5.95	6.48	6.60
< 100	5.73	6.19	6.59	6.61
16 ton/a lime				
8-20	5.41	5.66	6.24	6.47
20-40	5.35	5.99	6.50	6.71
40-60	5.56	6.10	6.63	6.81
60-100	5.70	6.21	6.73	6.82
< 100	6.17	6.45	6.97	6.98

** Each value represents the average of three replicates. Adapted from Love et al. (1960)*

Total Fineness Efficiency in IA

Sieve	% of Particles Passing Each Screen	Fineness Factor	% Available Based on Fineness
4-mesh	100	0.1	10
8-mesh	90	0.3	27
60-mesh	55	0.6	33
	Total Fineness Efficiency	=	70

Example limestone material

From J. Sawyer, ISU

Effective Calcium Carbonate Equivalent (ECCE) in IA

- ECCE =

$$\frac{\text{Total Fineness Efficiency}}{100} \times \frac{\%\ \text{CCE}}{100} \times \frac{(100 - \%\ \text{moisture})}{100} \times 2000$$

- Example:
  - Total fineness efficiency = 70
  - CCE = 92 %; Moisture = 2 %

$$\frac{70}{100} \times \frac{92}{100} \times \frac{(100 - 2)}{100} \times 2000 = 1{,}260\ \text{ECCE}$$

$$\frac{1{,}260}{2{,}000} = 63\ \%\ \text{ECCE}$$

From J. Sawyer, ISU

Lime Recommendation in IA

	6 inch incorporation depth	
Buffer pH	Target pH 6.5	Target pH 6.9
	----- $CaCO_3$ to apply (lb/acre) -----	
7.0	0	1,100
6.8	600	2,700
6.6	2,100	4,400
6.4	3,500	6,000
6.2	5,000	7,700
6.0	6,400	9,300
5.8	7,900	10,600

From PM-1688, ISU 2002

Adjusting Iowa's Lime Recommendation for Lime Quality

Example:

Crop Rotation:	corn-soybean
Soil test pH:	5.7
Buffer pH:	6.6
Target pH:	6.5
Limestone ECCE:	63 %

Lime recommendation from previous chart = 2,100 lb/acre

Adjustment for lime quality = $\frac{2,100}{0.63}$ = 3,300 lb/acre

Lime recommendation adjusted for lime quality

From J. Sawyer, ISU

Calculating the Fineness Factor of a Liming Material in WI

Example 2: Lime B (90% calcium carbonate equivalent)

Screen size	Screen analysis		Effectiveness factor		
	%				
greater than 8 mesh	5.0	x	0.0	=	0.0
8 to 20 mesh	25.0	x	0.2	=	5.0
20 to 60 mesh	20.0	x	0.6	=	12.0
less than 60 mesh	50.0	x	1.0	=	50.0
			Total	=	67.0

IA: Fineness factor

WI: Fineness factor
IA: Total Fineness Efficiency

Neutralizing Index (NI) in WI

- In Wisconsin, lime quality is listed by neutralizing index
  - NI = Fineness factor x Purity factor
  - Lime with CCE of 90% and fineness of 67
    - NI = 67 x 90% = 60.3
- Lime requirement (LR) in Wisconsin is given for NI of 60-69 and 80-89
  - If liming material has a NI different than above then,

$$\text{LR (T/a) of material} = \text{T/a of 60-69 LR} \times \frac{65}{\text{NI of material}}$$

Illinois Terminology

- Effective neutralizing value (ENV)
  - ENV = total fineness factor x (% CCE/100)
- Correction factor
  - $= \frac{\text{ENV of typical limestone (46.35)}}{\text{ENV of sampled lime material}}$
- Correction factor x LR = T/a of lime material needed

Lime requirement of typical limestone

Minnesota Terminology

- Effective neutralizing power (ENP)
- Lime recommendations made in terms of:
  - lb of ENP per acre
- Total Neutralizing Power (TNP) = CCE
- Fineness Index (FI) = total fineness efficiency
- % ENP of a lime material =
  - % TNP x FI x % Dry Matter = % ENP

From: FS-05957
See also: FS-05956 and BU-06240-S

Remember

- Lime recommendations (LR) are based on specified plow depths
  - If actual plow depth differs from what is used in the calculations, then LR must be adjusted
- Terminology of LR in different states in different but the concept is similar

Questions?