“Particle Size Reduction for Aglime Production”

By Jim Suetholz & Eric Marcotte
About the Presenters

• Jim: Electrical Engineering Degree ~ 20 years of industrial sales experience including 4 Years as Midwest Territory Manager with Stedman; involved in several aglime projects in multiple states

• Eric: Mining Engineering Degree, ~ 3 Years of Mining Experience combined in Aggregate and Coal Operations. 5 Years of Sales Experience with Stedman Machine Company

What is Agricultural Lime?

• Aglime, or agricultural lime, is a soil conditioner most commonly produced from crushed limestone or dolomitic limestone. It provides a source of calcium and magnesium for plants.

• Aglime dissolves in soil, calcium (Ca) moves to the surface of soil particles, replacing the acidity. The acidic H+ ions react with the carbonate (CO$_3$) to form carbon dioxide (CO$_2$) and water (H$_2$O). The result is a soil that is less acidic (has a higher pH).
Benefits of Reducing Soil Acidity

• Reduces toxic conditions caused by iron, aluminum, and manganese

• Increases the availability of critical plant nutrients (nitrogen, phosphorus, and potassium) by providing an environment that allows micro-organisms to break down organic matter

• Increases the effectiveness of herbicides

How does Aglim Pay?

“Aglime can return $5 to $10 for each dollar invested in lime. Raising soil pH from 5.7 to 6.5 in mineral soils may improve corn or soybean yields by 20 percent or more, and alfalfa yield by 35 percent or more”.

Source: Michigan State University Extension Bulletin E-1566
Aglime can be a by-product

- Many aggregate plants produce aglime as a by-product, the only additional plant equipment required is a screen
- Typical aglime screens are 1/8” slotted style cloth/wire

Why does size matter for Aglime?

- The smaller the particle size, the higher the percentage is absorbed in the soil within the first year of application
- Particles smaller than 50 mesh are completely absorbed within the first year of application - 100% effective
- Particles between the 10 mesh X 50 mesh size are 50% effective over a three year period
- Materials larger than 10 mesh are considered too large to dissolve within a three to four year time period
### Sizes for Aglime

*Sieve Sizes by State used in the Evaluation of Aglime*

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**Finest Sieve for 100% efficiency by State**

- 100 Mesh: 22 states, 56%
- 60 Mesh: 11 states, 28%
- 50 Mesh: 5 states, 13%
- 40 Mesh: 1 state, 3%
Sizes for Aglime

States with Alkaline Soil
Colorado
Nevada

States without listed Sieve Sizes
Arizona North Dakota
Hawaii Rhode Island
New Mexico South Dakota
Texas Utah
North Dakota Wyoming

Types of Crushing

Impact

Shear Tearing

Compression

Attrition
The Aggregate Handbook

“Additional crushing equipment can be utilized to supplement production of this material when the market dictates. Aglime crushers are typically high-speed mills having high horsepower requirements.”

Primary Method used in Aglime?

IMPACT
Crushers for Aglime Production

• Hammer Mills
• Cage Mills
• Vertical Shaft Impactor (VSI)

Hammer Mills

How do they work?

Hinged or fixed hammers rotate around a horizontal shaft and impact the material as it is fed into the mill. Depending on the design, material is then impacted against an adjustable grinding plate and/or housing breaker plates. Final product size is typically controlled by grate bars or perforated screens.
The Gruendler or “Fluff Mill” was commonly used in aglime production.
Hammer Mills (continued)

- Lowest Initial cost
- Highest HP/ton ratio ~ 10:1
- High maintenance, many hammers and grate bars or screens to replace
- Does not handle moisture well due to blinding of the screen / grates
- High RPM / Cannot handle uncrushable Items

Cage Mills

How do they work?

Two cage assemblies are nested inside one another and rotate in opposite directions.

Material is fed in to the middle of the inner most cage where it is impacted by the sleeves or pins and propelled outwards to additional rows of sleeves.

Additional collisions with pins, material and housing breaker plates continue until the product exits the mill.
Cage Mills (continued)

- HP/ton ratio ~ 7:1
- Lower maintenance than a Hammer Mill
- Produces a PSD that passes most state specs without additional screening
- Handles moisture well
- No screens or grate bars
- Cages are reversible
- Higher initial cost
Vertical Shaft Impactors (VSI)

How do they work?

Material is fed by gravity through a feed tube into the center of the rotor table.

Material is impacted and propelled, typically by shoes, away from the table to an outer ring of anvils or rock shelf.

The material then travels along the discharge path to exit the mill.

VSI (continued)
VSI (continued)

- HP/ton ratio ~ 3:1
- High throughput
- Requires screening to pass most aglime specs
- Moisture can cause buildup problems

How do these Crushers Compare?

- Finished product quality
- Wear metal/maintenance cost
- Energy consumption
- Capacity
Finished Product Quality

Fineness Factor in a single pass *(highest to lowest)*

- Cage Mills
- Hammer Mills
- Vertical Shaft Impactors
- Screening *(as a by product)*

Wear Materials - Maintenance

Cost of wear items and maintenance per ton of throughput *(highest to lowest)*

- Vertical Shaft Impactor *(shoes, anvils, liners)*
- Cage Mills *(sleeves, bolts, bands, liners)*
- Hammer Mills *(hammers, liners, screens or grate bars)*
Energy Consumption

Horsepower requirements per ton of throughput
(highest to lowest)

Hammer Mills
Cage Mills
Vertical Shaft Impactors

Capacity

Maximum throughput, largest model of each type
(highest to lowest)

Vertical Shaft Impactors (requires a screening circuit)
Hammer Mills
Cage Mills
Capital Cost

Initial capital cost of each crusher  *(highest to lowest)*

Cage Mills
Vertical Shaft Impactors
Hammer Mills

Less common Crushers for Aglime

- Ball Mills
- Roller Mills
- Rod Mills

- Able to crush much finer than the previous equipment.
- Typically reserved for manufacturing fine, high value products.
- Higher initial capital and operating costs.
Where should I start?

Testing your feed material is the first step and should determine the following

- Feed size (PSD)
- Energy consumption 
  \( \text{(horsepower per ton per hour or kW per ton at the target PSD)} \)
- Wear metal estimate per ton of throughput
- Finished product particle size distribution

In Conclusion

The production of aglime can be achieved in many ways and each operation will have its own set of specific requirements that influence final production.

When deciding what crusher type is best for your specific operation it is important to consider the following:

- Local market conditions and state specifications
- Existing equipment and facilities
- Maintenance requirements
- Total power consumption and existing capacity
- Auxiliary capital equipment
Thank You