PELLETIZING LIMESTONE FINES
A Study of the Benefits of Pelletized Limestone Fines in the Commercial and Agricultural Market

Kurt B. Albert
Project Manager – Agglomeration
MMC/Mars Mineral
Mars, Pennsylvania

Don Langford
Limestone Specialist
MMC/Mars Mineral
Fincastle, Virginia

ABSTRACT

Pelletized limestone is becoming increasingly popular with homeowners. There also seems to be interest shown from farmers, turf farms, golf courses, lawn-service companies and other commercial and agricultural users. The pelletized limestone has material-handling characteristics that make it user friendly.

When applying the more common ground or pulverized agricultural limestone, some common problems become evident. The limestone is hard to apply with conventional rotary broadcasting spreaders or trough-type spreading devices. With these mechanical spreaders, the limestone tends to bridge and rathole in the spreader causing uneven amounts to be distributed. Once the limestone has been spread on a lawn, there is the possibility of windage loss and nuisance to neighbors from the airborne dust. Also, with the coarse grit of ground limestone, the availability to the soil is slow, sometimes taking several months to totally break down.

Pelletized limestone is easily and evenly applied in mechanical-type spreading devices. Once spread, the pellets stay put. Dusting during application is greatly reduced. The pellets, when exposed to rainfall or moisture, break down into finely pulverized limestone. This finely pulverized limestone, which is generally minus 100 mesh or finer, is immediately available to plant life.

INTRODUCTION

Pelletized limestone is relatively new on the market, becoming commercially available through retail and Lawn-and-Garden shops in the early 1980s. User response to the product was very positive. It has gained popularity with consumers and now it is preferred by the homeowner over the pulverized limestone. Farms have benefited from this form of limestone, but this market has not been developed on a large scale. The higher price may keep most farms from trying

pelletized limestone, although some farms in Ohio are currently using pelletized limestone on their row crops and seeing benefits from the increased availability of plant foods to their crops.

Limestone, applied to soil, decreases acidity by adding calcium and magnesium carbonates. The limestone reacts with the carbon dioxide and water in the soil to produce the bicarbonate form. The limestone also reacts with the acid colloidal complex such that calcium and magnesium replace hydrogen and aluminum. As these reactions take place, carbon dioxide is produced, thus increasing the soil pH to acceptable levels. Crop growing and leaching steadily deplete the soluble calcium and magnesium compounds, gradually decreasing soil pH. Eventually another application of limestone is required.

Soils that are alkaline, having a pH above 7.0, can also benefit from limestone. Nitrogen fertilizers, which produce an acidic reaction with the soil, are utilized more effectively when applied with limestone.

The most common binding agent used to pelletize limestone is lignosulfonate, which when thermally dried, produces a hard and durable pellet that is very water soluble. When introducing the pellet to water, it totally breaks down within two minutes, leaving the finely pulverized limestone to react with the soil.

When limestone is pulverized to less than 100 mesh, it is dissolved and reacts with soil quickly. The finer the limestone, the quicker the reaction.

EQUIPMENT

The equipment listed below is that which is most commonly found in a successful limestone pelletizing system. The system could be expanded upon or reduced to the user's specific needs and requirements. A flow diagram of this system is illustrated in figure 1.

RAW MATERIAL BIN -- Storage silo equipped with a live bottom bin activator, level probes, bin vent or connection to a dust collector.

RECYCLE BIN -- Storage silo equipped with a live bottom bin activator, level probes, bin vent or connection to a dust collector.

FEEDER -- Volumetric screw-type feeder or more costly weigh-belt feeder can be used to accurately control feed rates from the raw material bin and recycle bin.

FEED CONVEYOR -- A belt conveyor or screw conveyor is most commonly used.

PIN MIXER -- The pin mixer is used to precondition the limestone with the binding agent and produce "seed" pellets.

DISC PELLETIZER -- The disc pelletizer is used to define and agglomerate by coalescing the limestone pellets.

DRYER FEED CONVEYOR -- If horizontally conveying, a belt conveyor is adequate. If inclined conveying is necessary, a cleated belt conveyor with side walls is recommended.

DRYER -- A vibrating fluid bed dryer with a cooling section is recommended for the gentle handling of the pellets. A rotary kiln dryer can be substituted.

SCREEN FEED CONVEYOR -- If horizontally conveying, a belt conveyor is adequate. If inclined conveying is necessary, a cleated belt conveyor with side walls is recommended.

VIBRATING SCREEN -- A double-deck vibrating box screen is most commonly used, although a circular "Sweco type" screen could be substituted.

RECYCLE CIRCUIT -- This would include a belt conveyor or bucket elevator for fines return to the recycle bin. Also, the oversized pellets can be broken up and passed over the screen a second time or pulverized and conveyed to the recycle bin.

PRODUCT CONVEYOR -- A cleated belt conveyor is suggested to convey product to the product silo. A bucket elevator could be substituted, but pellet degradation is probable.

PRODUCT BIN -- This product storage silo can be used to bulk-load product and/or supply a bagging system.

BAGGING SYSTEM -- A forced-flow valve bag packer is recommended, although other types could be substituted.

BINDER STORAGE TANK -- A stainless steel tank with a minimum capacity of 6,000 gallons is recommended if binder is received in tanker trucks. If the binder is received in tank rail cars, the tank should be a minimum of 15,000 gallons.

BINDER SYSTEM -- The binder system should include a stainless steel binder mixing tank with an impeller-type agitator. As an option to the mixing tank, proportional pumps and a static in-line mixer could be substituted. The flow controls would include pumps, flow meters, pressure gauges, shut off valves, fine-adjustment valves, pressure regulators, solenoid valves and engineered spray nozzle tips.

DUST COLLECTOR -- A dedicated dust-collection system should be used on the dryer because of the moist, hot dust being collected. A high-efficiency cyclone or baghouse should be used for the remainder of the dust pickup points.

ELECTRICAL CONTROLS -- A well-laid-out and relayed control panel, centrally located, is recommended. The more sophisticated the controls, the higher the cost.

PROCESS

In a standard limestone pelletizing system there are two raw product silos. One silo holds the raw pulverized limestone feed, the second silo holds the recycled fines. The raw limestone feed

is accurately fed onto a belt conveyor along with recycled fines. The ratio of recycled fines to raw limestone fines should be kept under 10%. Because of the relative coarseness of the recycled fines, a percentage higher than 10% may disrupt the uniform pelletizing in the disc pelletizer.

The feed is conveyed at an even rate to the pin mixer. A binder solution is applied to the limestone in a finely atomized mist at a set ratio which must be kept constant. The mixing action of the pin mixer blends the binder solution with the limestone and also pre-agglomerates the limestone into very tiny "seed" pellets. Different limestones will require different moisture levels to pelletize due to fineness and differing amounts of constituents. Moisture levels usually range between 8% and 14%, 10% being most common. The greatest portion of binder solution is applied at the pin mixer, 90% or more of the total sum.

The conditioned and "seeded" limestone discharges the pin mixer onto, or is conveyed to the disc pelletizer where it is introduced to the rotating pan. The rotating pan of the disc pelletizer continues to agglomerate the limestone into larger pellets. The cascading bed of pellets, because of the angle of inclination, acts to classify the product spilling over the lip of the pan. The result is a very uniformly sized green pellet. A small amount of binder solution, usually less than 10% of the total, is applied in a fine spray at the disc pelletizer.

In most cases, on-size product can be increased to 90 - 95% with the use of a pin mixer. Without a pin mixer, on-size product percentages can run from 50 - 75%. The pin mixer is beneficial in ways other than product sizing - eliminating dust problems created when introducing the finely pulverized limestone directly onto the disc pelletizer and increasing product bulk density, which adds to the integrity of the pellet.

The green pellets discharging from the disc pelletizer are conveyed to the inlet of the dryer. If a vibrating fluid bed dryer is used, it can be equipped with a cooling section that may help if bagging the product. The rotary-type dryer may tend to degrade the pellets somewhat, but is still an effective means of drying.

The dried product is conveyed to a vibrating multiple deck-screen, where the product is classified into three cuts: undersized fines, good product and oversized. Common pellet sizing is between 4 mesh and 30 mesh. Customer preference dictates the exact product sizing. Generally, the undersized is returned directly to the recycle bin, while the oversized can either be caught in a tote bin and discarded, broken up and rescreened, or subjected to size reduction and conveyed to the recycle fines bin. The good product is then conveyed to either a bulk storage tank or a bagging storage bin.

PELLET QUALITY

Certain pellet strengths are necessary for the rigors of material handling and spreading. The strengths must be such that the pellets can be transferred from conveyor to conveyor several times and bagged without breaking and keeping pellet degradation to a minimum. Three strength tests are commonly used to determine pellet strength.

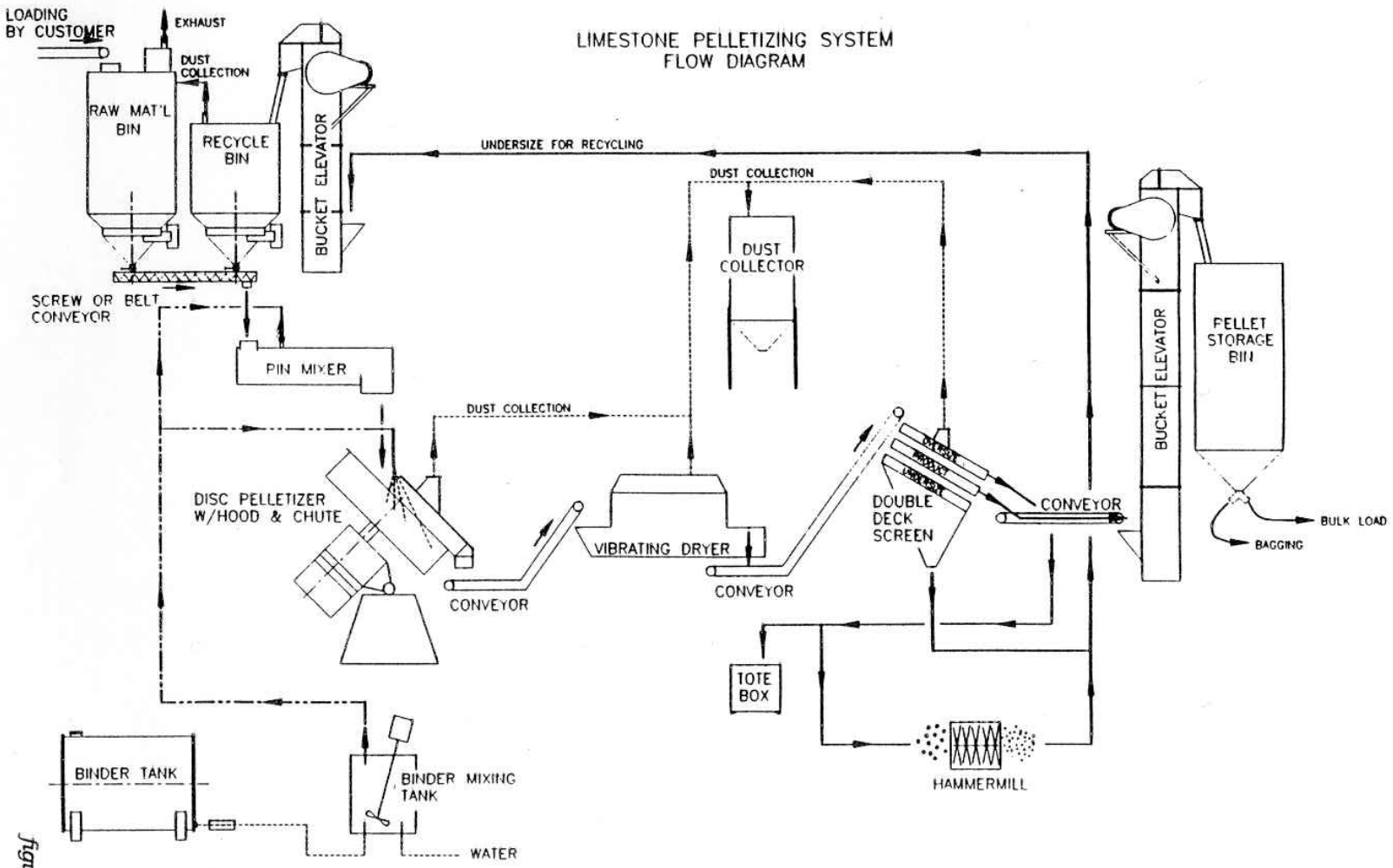
LIMESTONE PELLETIZING SYSTEM
FLOW DIAGRAM
LOADING BY CUSTOMER
EXHAUST
DUST COLLECTION
RAW MAT'L BIN
RECYCLE BIN
BUCKET ELEVATOR
UNDERSIZE FOR RECYCLING
DUST COLLECTION
DUST COLLECTOR
SCREW OR BELT CONVEYOR
PIN MIXER
DUST COLLECTION
DISC PELLETIZER W/HOOD & CHUTE
CONVEYOR
VIBRATING DRYER
CONVEYOR
DOUBLE DECK SCREEN
CONVEYOR
BUCKET ELEVATOR
PELLET STORAGE BIN
BULK LOAD
BAGGING
TOTE BOX
HAMMERMILL
BINDER TANK
BINDER MIXING TANK
WATER

figure 1.

1. **Compression or crush test** -- The compressive strength is determined by placing a pellet between two steel plates and evenly applying pressure until fracture occurs. The value is measured in pounds of pressure applied. Because of differing sizes of limestone pellets, a standard minimum value is difficult to assign. Smaller pellets of 16-mesh size may have a compressive strength of 1.0 pounds and still be strong enough for handling and spreading. Larger pellets of 4 mesh should have compressive strengths of at least 8 pounds and sometimes register as high as 50 pounds.

2. **Impact or drop test** -- The impact strength of a pellet represents its ability to survive multiple drops; i.e., conveyor-belt transfers. The impact strength of a pellet is determined by the repeated dropping of the pellet onto an iron surface from a height of 18 inches until the pellet fractures or chips. The strength is recorded in the average number of drops the pellet survived. A standard value for impact strength is 10 drops, although most limestone pellets survive in excess of 50 drops.

3. **Attrition test** -- The amount of pellet degradation during handling and bagging is critical, because one of the selling points of pelletized limestone is that it is relatively dust-free. The attrition test is determined by placing 10-mesh pellets on a 12-mesh sieve and vibrating with a common sieve shaker for five minutes. The amount of limestone passing the 12-mesh screen is measured as the attrition loss percentage. Dried limestone pellets should not exceed 5% attrition loss. An average of 2 - 3% loss is most common.

PELLET SIZING

The sizing of the pelletized limestone ranges from 4 mesh down to 30 mesh. The most common size distribution seems to be 4x20 mesh or 6x16 mesh. Common spreading devices used for pulverized limestone can also be used to apply these size ranges of pelletized limestone.

BINDER

The most common binding agent used in limestone pelletizing is lignosulfonate. Lignosulfonate is the soluble derivative of lignin, a major constituent of wood (20-30%). The lignosulfonate is derived from the sulfite pulping process. The base of lignosulfonate is known as spent sulfite liquor.

The grade of lignosulfonate generally used in limestone pelletizing contains 50 - 58% solids. It is available by 55-gallon drums, tank trucks and rail car tankers. The price will vary greatly depending on how far the lignosulfonate must be shipped. For example, in truck-load quantities, a liquid ton of lignosulfonate would cost about $80 F.O.B. Pittsburgh, Pennsylvania.

Other binding agents such as industrial cane molasses, brewex and molex may be used in place of lignosulfonate. Their prices are relatively lower, but as a limestone binding agent they are slightly less effective.

When figuring binding agent cost, a guide line is $2.50 to $3.50 per ton of dried limestone pellets.

The binding agent is most commonly diluted with water at a ratio of one part binder to three parts water.

EQUIPMENT COSTS

Given a production rate 10 tons per hour, the required equipment involved can vary with the customer's needs and amount of capital with which he has to work.

For a system that is put together with used or refurbished equipment, where possible, and streamlined to include only essential equipment, anticipated costs of operation might be around $400,000.

For a well-engineered system, with top-of-the-line equipment, anticipated operational costs might run in the $1.5-to $3-million range.

Most systems fall somewhere in the middle of the two extremes. Other factors that will affect total system cost are electrical, structural and equipment installation, permits, erection of building or retrofitting into an existing structure, engineering, etc.

OPERATIONAL COSTS

The costs involved with operating a limestone pelletizing system will include binder cost, drying cost (fuel), power consumption, labor and maintenance.

The binder cost is estimated between $2.50 and $3.50 per ton of dried pellets.

The drying cost, using a natural gas rate of $3.25 per million Btus, translates to a cost of about $2.00 to $3.00 per ton of product.

An average 10-ton-per-hour system will include a total connected horsepower of 200. With 480-volt service, the amp load will be approximately 250 amps, which is 120 kilowatts. At a rate of $0.041 per kilowatt hour, the cost will be $0.85 per ton of product.

The labor cost is very difficult to determine, depending upon the regional technical pay rate, benefits package, number of technicians required, amount of operation time, and supervision required. This cost varies too much for an accurate estimate.

The maintenance could range from $10,000 - $50,000 per year, depending upon condition of equipment.

PRICE AND AVAILABILITY

Pelletized limestone is most commonly available at Lawn-and-Garden retail outlets. Larger retail chains, such as WalMart and K-Mart, also carry pelletized limestone. Lawn-maintenance companies, such as ChemLawn, often use pelletized limestone when adjusting soil pH on their customers' lawns. Some limestone companies pelletize and market the product under their own label or package it for the retail chains.

Prices for pelletized limestone in the western Pennsylvania region range between $4 to $5 for a 50-pound bag. In comparison, a 50-pound bag of ground limestone ranges from $1 to $2. Bulk quantities of pelletized limestone in the North Central Ohio region, which are supplied to the farming market, bring around $28 to $34 per ton.

Some limestone companies are able to bring $90 to $100 per ton of pelletized product in bulk, which is usually repackaged by retail outlets. In comparison, pulverized limestone in bulk runs between $18 and $24 per ton.

ADVANTAGES

Pelletized limestone is a value-added product that replaces low-profit dusty pulverized agricultural limestone.

It can be used to replace current inert fertilizer fillers in premium products and will enhance the performance of the fertilizer.

Pelletized limestone is immediately available to plant life.

Dust problems associated with pulverized limestone can be eliminated with pelletized limestone.

Material-handling problems are alleviated, enabling more thorough and even soil coverage.

It is easily blended with bulk fertilizer.

It stays put, will not blow away.

It converts nuisance limestone fines into a profitable product.

CONCLUSION

In addition to the Lawn-and-Garden and agricultural markets, pelletized limestone may already be or soon be marketed for flue gas desulfurization and as a fluxing material in the manufacturing of iron and steel.

For now, the major market for pelletized limestone is for the homeowner and lawn-maintenance services for reducing lawn acidity. In the near future, the market could swing to farm

use for high-priced row crops. This could induce all the limestone companies, small or large, to look into pelletizing more seriously.

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