



Effective Means of Handling Sand-Laden Dairy Manure

by:

Curt Gooch¹, P.E. and Andrew Wedel², P.E.

Introduction

Are you a producer who would like to bed your cows with sand but have experienced or heard horror stories regarding handling of sand-laden dairy manure (SLDM)? Or are you currently bedding with sand but looking for ways to improve your manure system? Would you like to separate bedding sand from manure? If so, then read on to get the real scoop on dealing with SLDM efficiently and reliably.

Positive Aspects of Using Sand as Bedding

From the cows' perspective, the desirable aspects of a stall resting surface include comfortable to lie on, uniform support, cool in the summer, non abrasive, and offers comfortable footing during reclining and rising maneuvers. Producers look for a bedding material that will have a low opportunistic pathogen loading, will drain away moisture and leaked milk, is labor efficient to add and maintain in stalls, is available, and is of reasonable cost to procure. The use of a 6 to 8" deep bed of sand as a freestall or tie stall resting surface meets all of these criteria in most areas of the country.

Desired Characteristics of Bedding Sand

The specific gradation of sand used for bedding stalls should be based on maximizing its effectiveness in the stalls and achieve manure handling goals. The use of sand with less fines is a preferred material from a bedding material perspective.

Sand with less fines will more readily conform to a cows body, provides better drainage than sand with increased fines, requires less stall maintenance, and results in less sand being transported on cows' bodies to the milking center. Concrete and mason sands are both examples of sands with fewer fines and are available anywhere ready-mix concrete is sold. These sand gradations can also be separated effectively from SLDM with either confined (mechanical sand manure separation) or special (large basins) sedimentation systems are reused as bedding.

Sands with a higher percentage of finds are sometimes used on farms. These sands less readily conform to a cows body, are more likely to compact in a stall, have poorer drainage characteristics, and are harder to remove from SLDM. A

¹ Curt A. Gooch, P.E., Senior Extension Associate, Cornell University, PRO-DAIRY Program

² Andrew W. Wedel, P.E., Agricultural Engineer, McLanahan Corporation, Hollidaysburg, PA



sieve analysis is used to quantify sand samples and the results are plotted on a graph to determine their gradation. An example of a few sand sieve analysis is shown in Figure 1.

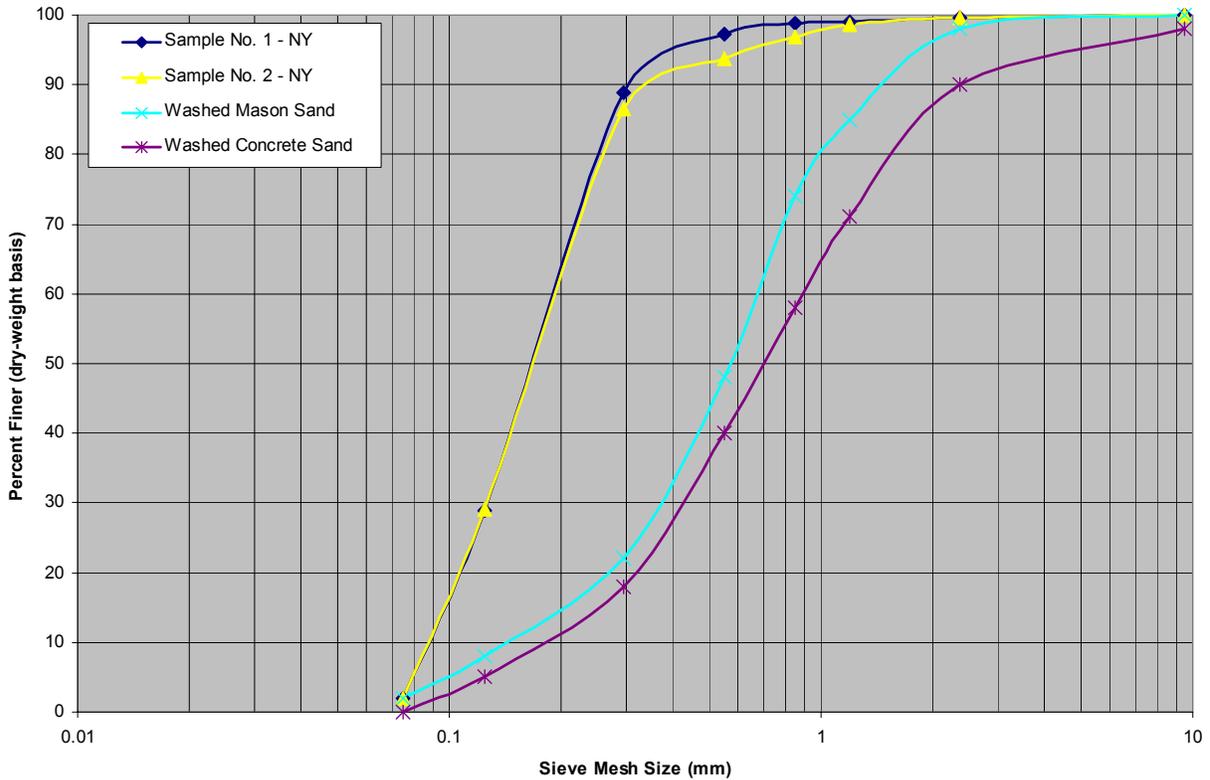


Figure 1 Sand sieve analysis for some sands used as bedding materials.

Sands that have a high percentage of fines have more particles passing through the larger screen openings. This results in a plot with increased horizontal sections of the curve for the larger sieve sizes. Sands with less fines will have more material retained on the larger sieve openings resulting in a gradation plot with less of a horizontal curve at the larger sieve openings.

Sieve analysis can be obtained from reputable sand suppliers or you can have an analysis run on a sample taken from your bedding material.

Basic Characteristics of SLDM

SLDM is a complex mixture of two vastly different materials. “Raw” manure is essentially a combination of water and undigested feed. When manure—a material that is pumpable—is mixed with sand—a material that is stackable, the result is a mixture that can neither be readily pumped nor stacked. Take for instance 115 lb of manure at 15% solids content and a bulk density of 62 lb/ft³ mixed with 55 lb of sand at 95% solids content and a bulk density of 110 lb/ft³.



When added in these proportions the result is 170 lb of SLDM at approximately 40% solids content and a bulk density of about 72 lb/ft³.

Relative flowability of manure has traditionally been used to predict potential manure handling methods. For instance, traditional flowability standards suggest manure at 35% solids content (bedded pack manure) is stackable and can be handled as a solid. However, at 35%, SLDM is not stackable nor is it readily pumpable. The difference in flowability between manure mixed with sand and manure mixed with organic bedding stems from the fact sand does not absorb liquid. Organic bedding does. SLDM flowability is function of manure sand content, moisture content of the excreted manure, ambient environment, etc. Manure with minimal amounts of sand can be handled using regular manure handling systems. However, from the standpoint of cow comfort and well being, minimization of sand usage is not recommended.

Traditional Challenges of Bedding with Sand

Like all things in life, there are positives and negatives associated with each management decision made on the farm. Traditionally, using sand bedding has been known to offer challenges to manure handling systems. These challenges were mostly a result of improper system design or management. In other cases, equipment has not, until the recent past, been readily available to dairy industry to handle the abrasive nature of sand. The major disadvantages included:

- increased load and wear on equipment used to clean shelter alleys
- accelerated wear on equipment used to mechanically transport manure to storage or separation area
- clogged pipes and channels
- not able to be successfully separated from manure
- increased compaction of fields

Today's Solutions to Yesterday's Challenges

Collection Within the Shelter

Sand is readily drug from and kicked out of freestalls by cows as they enter, use, and exit the stall. This is a good thing to happen from a cow comfort/udder health standpoint as sand bedding can become soiled with manure, urine, and/or leaked milk while in the stall.

The best mechanical method to clean shelter alleys is with a rubber scraper blade mounted to a skid-steer loader or small farm tractor. The rubber scraper is durable and can withstand the abrasive nature of sand. It also creates less wear on the flooring surface than steel scraper blades. SLDM can be scraped to a conveyance device or directly outside to a push off ramp with storage located below.



Alley scrapers are popular with many dairy producers because they can be adjusted to frequently clean floors and require minimal daily labor. Look for scrapers that are designed to handle SLDM both from an increased load and wear standpoint. Long barns with minimal drops to across-the-barn reception gutters result in large accumulation of SLDM being pulled by the drive equipment. From a wear perspective, select heavy-duty scrapers that have less moving parts. Scrapers that pivot or collapse during the non-scraping pass down the alley are reported to wear better than those that fold up. Modify the steel scraper blade by retrofitting it with reinforced hard rubber to interface with the alley surface. Producers have reported that rubber flooring has reduced the wear on alley scrapers that convey SLDM.

Flush cleaning the barn with a wave of water is also an option to consider for new facilities or those that are extensively renovating their manure system. Flush water volumes need to be adequate to ensure proper removal of manure from the alley. Required water volumes are determined by three variables: length, width and slope of the alley as well as the size of the sand grains that must be cleaned from the alleys. Complete removal of the manure component of SLDM is essential to clean the shelter but some residual sand left in the alley is acceptable as it enhances traction. Be sure to work with a qualified agricultural engineer when designing flush systems.

Conveying To Storage/Separation Area

Pumps and horizontal augers can be used to convey SLDM. Key design principles that result in resistance of equipment to the abrasive nature of SLDM include using highly abrasive resistance steel components, minimum contact of steel to steel moving parts, and lower linear or radial rates of speed.

Centrifugal pumps may also be used to convey SLDM, however, since centrifugal pumps generally operate at high speeds and smaller clearances, they are very susceptible to wear and clogging. Piston pumps operate essentially like a very large syringe drawing and discharging material. Large intake and discharge lines and few moving make piston pumps relatively well-suited for handling SLDM. The drawback of piston pumps stems from the fact, piston pumps do not provide a continuous high velocity flow and therefore clogged pipes may result from their use. Where pump discharge pipes are buried it is recommended clean-outs be spaced liberally (every 60') throughout the system.

Horizontal augers may also be used to convey SLDM from shelter to storage or separation area. Augers are typically placed in a trough in the floor of the freestall cross alley. Augers potentially eliminate the need to “turn” or “chase” manure out of the barn. Manufacturers experienced with SLDM can design augers to be highly wear resistant. Horsepower requirements range from five to 15 horsepower depending on auger length which is usually limited to 120 feet. However, multiple horizontal augers can be positioned end-to-end or in “piggy back” fashion to achieve lengths in excess of 120 feet.



Clogging of Pipes and Channels

Not under any circumstances is **gravity flow of undiluted (raw) SLDM recommended**. The eventual settling of sand particles causes clogging of pipes and channels. Many dairy producers have given up using sand as a bedding material because of the failure of a gravity flow SLDM system. SLDM that has been diluted by flush cleaning or flush flume conveyance can be successfully transported by gravity in pipes and channels if the scour velocity (speed at which the sand particle stays suspended or keeps it rolling along) of the largest sand particle size is maintained by the transport water.

Sand Manure Separation

Separation of sand from manure has many benefits. The sand fraction of separated SLDM can sometimes be reused as a bedding material while the manure fraction can readily be pumped to remote storage. Field applied effluent can be irrigated or spread with liquid tanks—either method reduces field compaction as compared to spreading of raw SLDM. The manure fraction of SLDM that has gone through an effective sand-manure separation process can be stored long-term in structures typically designed to handle liquid dairy manure.

Sand separation systems can be classified as mechanical or non-mechanical. Non-mechanical separators rely on sedimentation - the process of utilizing water as a media to separate various materials based on their specific weight and size. A sand trap is a non-mechanical separation means that is used exclusively with flush systems. Sand traps function by slowing a flush wave to a velocity of less than 1 foot per second for a retention time of approximately 1-minute thereby allowing sand grains to settle. At this velocity, most sand grains and some manure solids settle. The effectiveness of a sand trap is limited by how it is managed since as sand accumulates in the trap, separation efficiency is reduced. Sand traps can also be somewhat limited by climate. In order for a sand trap to function as it was designed it must be emptied on regular intervals. The amount of sand captured depends on the type of sand used. Sand with large quantities of fines is not recommended since fine particles tend to remain in suspension with manure that passes through the trap. The sand recovered from a sand trap contains some organic material and is generally not suitable for reuse. Sand trap design can be performed by a qualified consulting engineer based on flush volumes and sand types.

Mechanical sand-manure separators (SMS) separate sand from scraped or flushed manure. Mechanical SMS should not be confused with mechanical manure separators. The distinction being, sand-manure separators separate sand that is recyclable from manure and water whereas manure separators separate manure solids and some sand which is not recyclable from water. SLDM is usually delivered to a sand-manure separator by an inclined auger. Once in the separator, SLDM is mixed with air and recycled water which suspend the manure solids. Sand is allowed to settle in the separator and is recovered by a mining-duty auger. Sand is discharged at 10 to 12% moisture with less than



2% organic matter and can be reused for bedding. As with non-mechanical separators, sand with minimal fines is preferred. Recovery efficiency of 90% or greater is attainable when an SMS is used in conjunction with the proper sand gradation which is also optimal for the cow. The manure discharged from mechanical separators is relatively sand free and can be pumped or allowed to gravity flow to storage.

Equipment Overview

There is a noticeable distinction between manure and sand handling equipment. Manure equipment is usually constructed from mild steel whereas sand equipment is comprised of abrasion resistant alloys. Manure equipment relies on close tolerances and high speeds whereas sand equipment uses large tolerances that prevent sand grains from grinding between metal surfaces. When purchasing equipment for handling SLDM consider equipment designed specifically for sand. Manufacturers experienced with handling sand are knowledgeable of manufacturing techniques and raw materials which when used together result in machinery that stands up to the abrasiveness and weight of sand.

Getting Help

Producers interested in using sand bedding material should seek out assistance from equipment manufactures and design engineers who readily know and understand collecting, conveying, and processing SLDM. These professionals will use a systems approach to help find solutions that are right for you. The targeted result is a manure handling system that is effective, affordable, requires only preventative maintenance, and is a joy to share with your peers.