

Sand-Manure Separation Systems

Information for Dane County Livestock Producers

Introduction

Sand bedding is a common choice for the livestock industry in Dane County. The removal of the sand prior to other manure management techniques not only reduces problems, but, in some cases, the sand can be reused.

Sands come in different gradations (we appear to have fine sand in Dane County), and the following article from the web page of *Dairy Business Communications* is useful in describing gradation issues:

Not all sand is the same

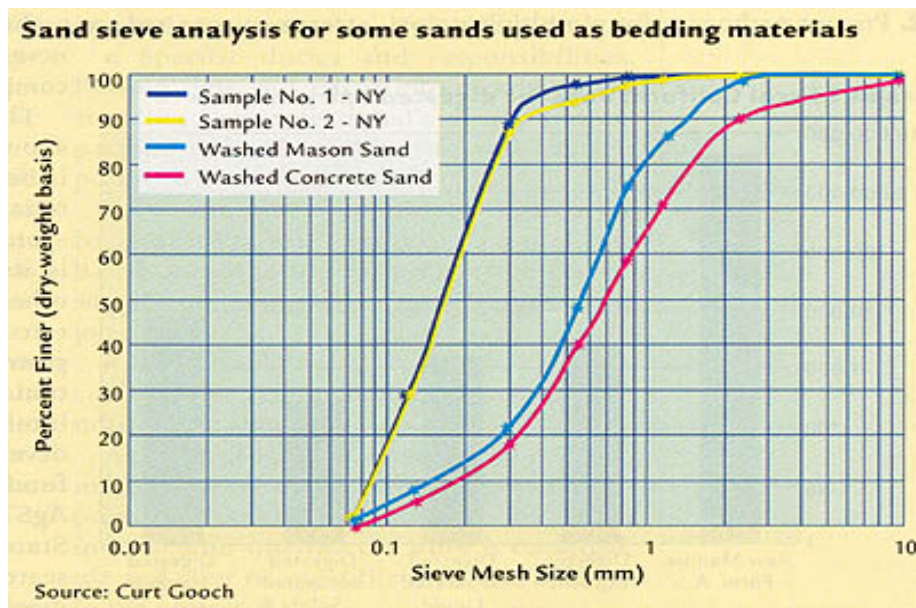
The gradation of sand differs. When deciding what type of sand to use, consider what works best in stalls and with your manure handling system.

For bedding material, sand with fewer fines, such as concrete and mason sand, is preferred. This type of sand more readily conforms to a cow's body, provides better drainage, requires less stall maintenance and doesn't adhere to cows' bodies like sand with more fines. Sand with fewer fines can also be separated from manure with either mechanical sand-manure separation or sedimentation systems.

A sieve analysis quantifies sand samples with the results plotted on a graph to determine gradation. (See graph.) Sands with high amounts of fines have a higher percentage of particles passing through the larger screen openings of the sieve. This results in graph plots with increased horizontal sections of the curve at the larger sieve sizes.

Sands with less fines 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.

Reputable sand supplies can supply sieve analysis. Or you can have an analysis run on a sample of your bedding material.

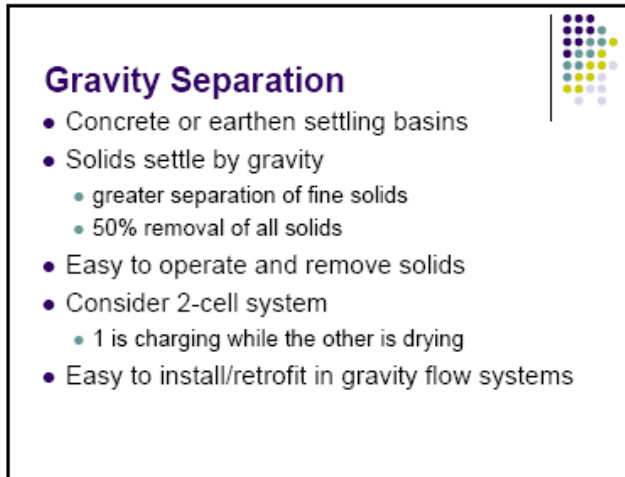


Percent Finer vs Sieve Mesh Size for Four Sand Samples from New York

Sand Separation Techniques

The two major methods of separating sand from manure are through passive gravity settlement and mechanical equipment. Passive settlement describes the separation of sand in storage lagoons and settling lanes.

Dr. Ron Sheffield of the University of Idaho has a Power Point Presentation on the Internet, describing several types of sand separation systems, including the following slides, found on the Internet at (<http://www.oardc.ohio-state.edu/ocamm/MSR%202005%20Sheffield%20-%20Solid%20Sep.pdf>). This presentation shows both settling systems as well as mechanical separators:



Gravity Separation

- Concrete or earthen settling basins
- Solids settle by gravity
 - greater separation of fine solids
 - 50% removal of all solids
- Easy to operate and remove solids
- Consider 2-cell system
 - 1 is charging while the other is drying
- Easy to install/retrofit in gravity flow systems

Figure 1.

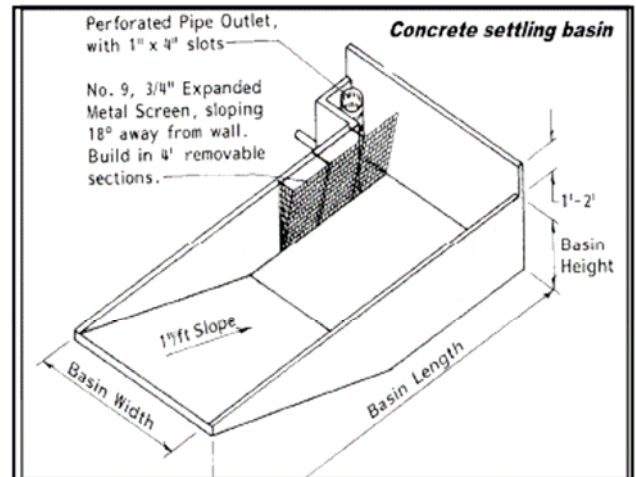


Figure 2.



Figure 3.

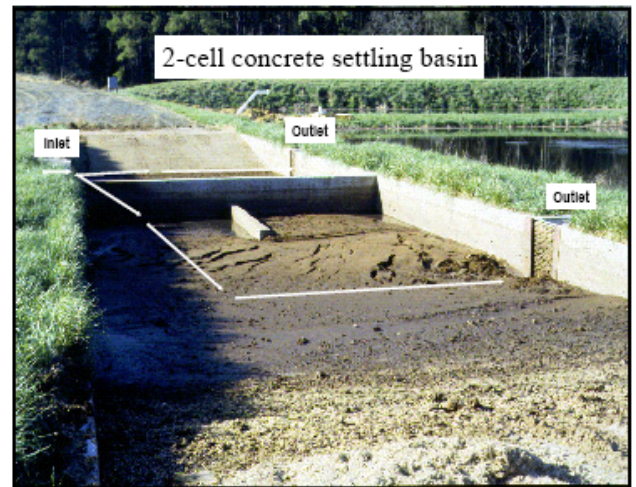


Figure 4.



Figure 5.

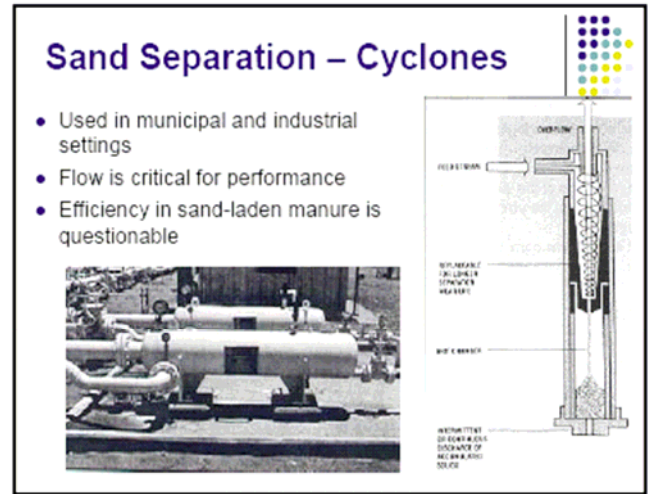


Figure 6.

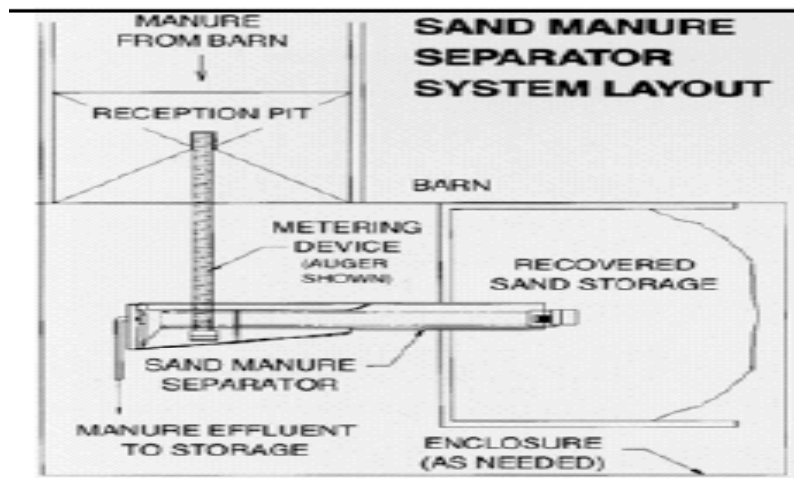


Figure 7.

For those farmers that use sand and have lagoon storage, it is clear the lagoon provides for sand settlement. However, this is often a problem for removal and spreading of the manure. Settling lanes are a more active method for separation and provide both more control as well as a more feasible method to recovering the sand for reuse. A typical sand settling lane is about 12 feet in width, several hundred feet long, with a slope of up to ¼%, or 3 inches per 100 feet in length, and an energy dissipater/flow dispersion system at the inlet end. The length of the lane depends on the size of the sand grains; the smaller the size, the longer the length of lane needed. Often made of concrete, sand settling lanes are only a few feet in height and a typical system will have two lanes to allow one to provide for drainage and clean out, while allowing the other lane to be in use. Clean out can be with a front end loader. Sand settling lane systems are used at six or more farms in Wisconsin. As shown in the photo below, the quality of the sand is such that it can be reused in the barn after a drainage and aeration period.



Figure 8.

A more active and energy intensive approach to sand separation is with a mechanical separator (figures 5, 7, 8, 10). Several firms make equipment to separate sand from manure, as described below.

Manufacturers of Sand Separation Equipment

Through a search of both the Internet as well as ads in several trade publications on manure management, four firms in North America were identified that make sand separation equipment.

Accent Manufacturing

It appears they use a system with a number of pieces of equipment, separating the sand from the manure, but details are not provided on the web page. However, an ad in *Manure Manager*, Sept/Oct 2006, shows a schematic of the sand recovery system, using a cyclone-shaped separator that looks similar to the Parkson equipment.

The systems to said to be able to extract 90-95% of the sand with the separator. The system has a roller press with a 3 hp motor, the separator uses a $\frac{3}{4}$ hp motor, and there is another $\frac{3}{4}$ hp motor in the system. The sand trap costs about \$21,000.

Braun Electric is their representative in Wisconsin, which has done a number of tests on sand in Wisconsin. The contact is R. C. Ludke at (920)773-2143.

As of early April, there was only one Accent sand separation system installed, located in Canada. In addition, the March/April 2007 issue of *Manure Manager* describes a system for separating both solids and sand from a lagoon on a farm near Litchfield, Minnesota that used a combination of the Accent IFRS (internally fed rotary screen) separator, a McLanahan sand separator and a Hydro Cyclone sand separator.

A demonstration of the Accent system was conducted in Dane County in mid July, 2007 at Ripp's Dairy Valley Farm. Braun Electric brought a mobile system with a 1/8" rotary separator to remove the solids, followed by a sand separator. Unfortunately, the pumping location from the manure pit was at a spot that did not receive much of the sand from the barns and so only a small amount of fine sand was removed. Test runs were done both with polymer and without polymer. In comparing the input to the liquids after the sand trap, the system removed the following:

Test Removal Results
Ripp Dairy Farm, Dane County, WI
July 2007

Test	Solids	N	P	K	S
Without polymer	50-52%	41%	45%	47%	54%
With polymer	62-63%	48%	61%	56%	64%

It should be note that these were limited tests and these results may not apply to other situations.



Figure 9 – Accent Rotary Separator for Solids Removal
at Ripp Dairy Valley Farm Demonstration



Figure 10 – Accent Sand Separator at Ripp Dairy Valley Farm Demonstration

Accent's phone number is (877)855-4890

<http://www.accentmanufacturing.com/manure-separators-pic-gallery.htm>

Energy Unlimited Inc.

An ad from this company in *Manure Manager*, Sept/Oct 2006, says they can reclaim sand bedding, but their web page has no information on any manure-related equipment. The firm is located near Dodgeville, Wisconsin. The firm was called in early February to get additional information, but has not yet responded.

Phone is (608)935-9119

<http://www.energyunlimited.com>

McLanahan

Their web page lists two systems. The smaller system can handle 60-90 cows-days per hour, while the larger system is said to be able to handle 150-200 cow-days per hour. The sand discharged from the sand manure separator (SMS) contains approximately 10-12% moisture and is damp to the touch. Recovered sand contains minimal amounts of organic matter – typically less than 2% on a dry basis. Since a majority of the organic matter is removed, excess water is able to drain freely. When bedding with mason sand (ASTM C-144) or concrete sand (ASTM C-33), the SMS recovers approximately 80 or 90% of the sand from the manure, respectively.

Motor requirements are 5¾ hp for the smaller system and 10¾ HP for the larger system. Prices are not listed, nor is there a picture on their web page that shows how the device looks or operates.

On their web page at http://www.mclanahan.com/agricultural/agr_smsdemo.asp, McLanahan gives the following process description (see figure 7), along with photos:

All sand-laden manure is conveyed to a centralized reception area before processing. Manure conveyance systems can be scrape, flush, or scraped into a flush flume.

An Inclined Manure Auger(s) conveys the sand-laden manure into the Sand-Manure Separator at a controlled rate.

Approximately 15 gallons per minute of recycled water (less than 1% solids) is used to dilute the sand-laden manure to allow the sand to settle out.

Settled sand is conveyed up the Sand-Manure Separator by a mining duty auger. The Sand-Manure Separator auger consists of a steel pipe shaft with continuous spiral steel screw flights equipped with wear-resistant wear shoes.

The sand is rinsed with 1-2 gallons per minute of fresh water before leaving the machine.

The manure effluent from the Sand-Manure Separator flows over a rear weir, and down the side channel out the rear discharge pipe of the machine.

Manure effluent from the Sand-Manure Separator can flow by gravity to a settling basin for fine sand recovery, or be pumped to a mechanical solid separator.

Separated clean sand stacks into a pile under the discharge end of the Sand-Manure Separator at 10-12% moisture.

Clean sand should be stock piled and have time to drain before reuse. It is recommend sand drain for 2 to 3 days before putting it back into the free stall.

The web page of the company lists three sand separation facilities in the US; the closest is Emerald Dairy, Transition Management Facility, Baldwin, WI, in St. Croix County. In a phone conversation with McLanahan in April 2007, they said that another facility is located at the Thistle Dairy in Van Dyke, WI in Winnebago County and that a facility is under construction at the Larson Farm in Evansville, WI in Rock County.

The firm's web page for sand separation is http://www.mclanahan.com/agricultural/agr_sandmanure.asp

Parkson Corporation

Their web page lists their equipment under the name of Tru-Grit® Manure Sand Saver. Two models are shown on their web page, with recovery rates given at 80-90% for the sand, with less than 1% organics. There are only limited data for one model (1¾ hp motor requirements), and no data for the second. The device is shaped like a cyclone, in which manure is introduced at the top and wash water is introduced at the bottom in a counter flow method, as shown in Figures 11 and 12 below.

Additional information was faxed by a Parkson distributor and the firm later sent further data. These notes that the Tru-Grit® systems have been in use in the municipal wastewater industry for over 20 years, and for dairy for over 3 years. Within the cleaning chamber, a lifting device moves slowly through the sand to loosen and dislodge organic matter that is trapped with the sand. The rising flow of water moves the organics upward and out through the overflow. The cleaned sand is removed from the bottom of the tank by a shaftless screw, which rotates slowly and intermittently, facilitating drainage of water before the sand is discharged.

The distributor closest to Dane County is Badgerland Agri-Systems, Inc. in Edgerton, WI, telephone 608-884-9422, fax 608-752-4062.

The company can be contacted at telephone (800)965-3922 as well as the web page <http://www.parkson.com/parksonAssets/Brochures/Manure%20Sand%20Saver.pdf>

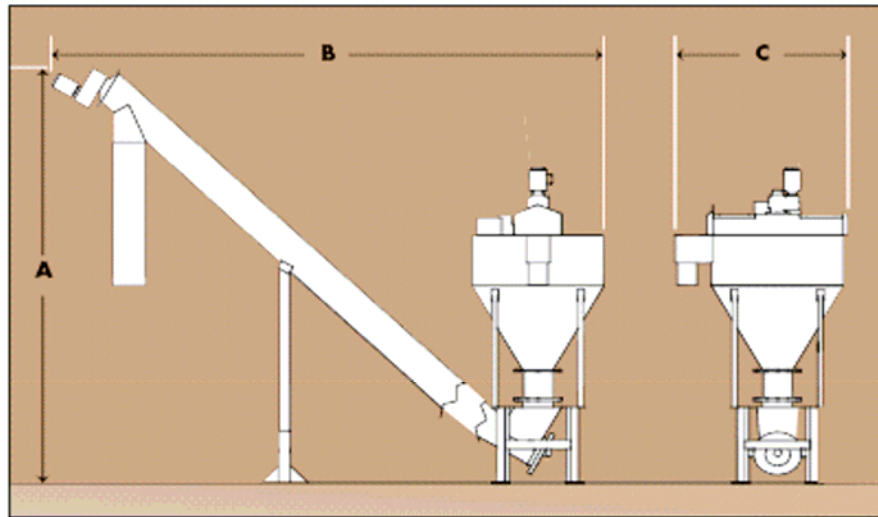


Figure 11. Parkson Sand Separator, side views



Figure 12. Parkson Sand Separator at Williams Brothers Bedrock Bovines Farm, Wisconsin

Sheahan Industries

From a patent search for sand-manure separators, an application for a patent from Sheahan Industries in Reedsville, Wisconsin was found. The patent application includes the following summary:

“A first separator or container having means for agitating the water and air will efficiently break up manure entering into the device. The device allows sand to drop to the bottom of the container quickly, which allows the manure solids to float to the surface of the container and to be removed. A second separator containing a spinning device or container will then use centrifugal force to separate the water and the manure solids removed from the first separator. The separation of the water from the separated manure provides for a more useable manure and, also, an easier to haul product. Furthermore, this is beneficial in not only reducing the weight of the manure, but, also, in removing more bacteria and similar unwanted organisms from the manure than in previous separator designs. “

In a telephone conversation with the inventor in April 2007, the inventor said that he is not pursuing this system any longer, and believes that a simpler system can be developed using existing storage silos.

TriFlo International

At the 2007 World Dairy Expo, Waste Management demonstration the TriFlo International system.

From the firm's web page at <http://www.triflo.com/separators.shtml>, it lists four different models of their system, with capacities from 260 to 1,040 gallons per minute. The site provides the following description:

Triflo manufactures a hydrocyclone unit that efficiently removes sand and silt sized particles down to a 15 micron cut. The hydrocyclone units are complete with mud trough, manifold, 4" polyurethane hydrocyclones, pressure gauge, and all necessary connections. Triflo's durable skid mounted sand/silt separators are matched with a 40 horsepower electric or Lister diesel pumping motor.

Besides these North American manufacturers, a search was also done for German language web sites using the words of:

sand	Sand
manure	Dung, Mist, Gülle
separation	scheiden/Scheidung, trennen/Trennung

However, no manufacturers were found.

Wisconsin Farms with Sand Separation Systems

Brian Holmes, Extension Agricultural Engineer of the University of Wisconsin has compiled a list of farms in Wisconsin and neighboring states that have sand separation systems. His latest list has nine farms included, as follows:

Cottonwood Dairy, LLC
South Wayne, Lafayette County
Two sand lanes

Heijman's Dairy
Lone Rock, Richland County
Flush Flume to basin (two basin system)– set up for sand settling lanes when future expansion of barns occurs.

Lake Breeze Dairy
Malone, Fond du Lac County
Single sand lane to be expanded to two, two Accent drum separators, separated solids to plug flow digester, liquids back to barn flush system.

Merry Waters Farms, Inc.
Lake Geneva, Walworth County
Two sand lanes

Shilo Dairy
Brillion, Calumet County
Two sand lanes

Siemers Holsteins
Newton, Manitowoc County
Two sand lanes

Soaring Eagle Dairy
Newton, Manitowoc County
Single lane (to be expanded to two)

Sugar Creek Dairy
New London, Waupaca County
Parkson system

Williams Brothers Bedrock Bovines
Brodhead, Green County
Parkson separator

However, there are probably other farms in the state that use sand separation systems and additional information will be added when it becomes available.

University Research

The only research on sand separation that was found on the Internet is from Cornell Cooperative Extension, which reports the following:

Manure treatment research conducted by the state-funded PRO-DAIRY Team in 2005 included two projects, one to monitor and evaluate manure digester performance on 5 dairy farms, and another to evaluate the financial viability of digestion, and also a sand separation project examining the effectiveness of mechanical manure-sand separation to recover sand for use as bedding. Furthermore, new farm technologies or practices relating to energy use and consumption on farms and by manure treatment systems, air ammonia emissions, long-term manure storage and separation of manure solids and liquids were conducted.

Results of their work are available on the Internet at <http://www.manuremanagement.cornell.edu/HTMLs/Papers.htm>, in the following papers:

- [Handling Sand-Laden Dairy Manure from Barn to Storage](#)
Presented at the 5th Annual NYSERDA Innovations in Agriculture Conference
- [Sand for Bedding Dairy Cow Stalls](#)
Presented at the 5th Annual NYSERDA Innovations in Agriculture Conference
- [Effective Means of Handling Sand-Laden Dairy Manure](#)
Presented at the 5th Annual NYSERDA Innovations in Agriculture Conference
- [Economic Analysis of Mechanical Sand-Manure Separation of Flushed Sand-Laden Dairy Manure](#)
Presented at the 5th Annual NYSERDA Innovations in Agriculture Conference
- [Economic Analysis for A Dairy Waste Treatment System that Employs Mechanical Separation of Bedding Sand from Scraped Sand-Laden Dairy Manure](#)
Presented at the 5th Annual NYSERDA Innovations in Agriculture Conference

In addition, Brian Holmes of UW-Madison recently (March 2007) gave a presentation on sand settling lanes at a manure conference in Madison. A copy can be obtained by contacting Mr. Holmes at bjholmes@wisc.edu.

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I want to deeply thank Brian Holmes and Nolan Andersen of the University of Wisconsin Extension for their reviews and comments of this document. However, any errors are my responsibility alone and any corrections or new information should be sent to me at reindl@co.dane.wi.us .