

Department of Biosystems Engineering and Soil Science

INTRODUCTION TO MANURE SOLIDS SEPARATORS

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Animal manure management systems may require some degree of solids separation in order to facilitate handling, reduce storage volume requirements or for material reclamation. Manure solids can be separated by gravitational or mechanical means. Settling chambers use gravitational settling to remove solids from manure slurries. Mechanical separators are commonly used to reduce the volume of solids entering waste lagoons and manure storage ponds. Reduction of the solids loading into an animal waste lagoon can increase the life and effectiveness of the lagoon. Separated dairy manure solids with high fiber content may be reclaimed for use as bedding material. Manure with low fiber content (i.e., swine) may require chemical treatment in order to achieve effective separation. This publication provides a basic introduction to manure solids separators.

Types of manure separators

Several types of solids separators are currently marketed for use with animal manures. Separators generally employ screening, pressing, or centrifugal techniques, or a combination of these methods, to separate manure solid and liquid fractions. Types of separators commonly marketed for use with manure management systems include hydro-cyclone, several variations of static screen separators, and screw-press separators.

Hydro-cyclone Separators

The operating principle of a hydro-cyclone type separating device is shown in Figure 1. The influent manure slurry enters the cyclone at the top of the cone at an angle. The manure slurry enters at a pressure of approximately 50 pounds per square inch and travels around the circumference of the cyclone in a circular

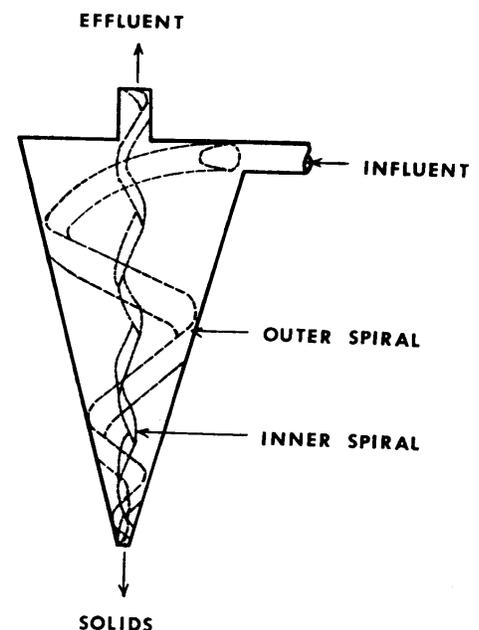


Figure 1. Schematic of a hydro-cyclone (Shutt et al.1975)

path. Centrifugal force causes the more dense manure solids to travel down the cone, while the liquid fraction exits out the top of the device. Centrifugal separators may be of the cyclone type or use a combination of centrifugal separation through screening bowls or cones. Hydro-cyclone separators use centrifugal force to separate materials of different density. Since manure solids and fibers have a similar density to water, hydro-cyclones are not effective for manure fiber recovery. Hydro-cyclones are effective at separating high density materials, such as sand and stones, that have been mixed with manures from manure slurries. Since the specific gravity of sand is twice that of manure, hydro-cyclones are often utilized to recover sand from sand laden dairy manure. When manure fiber, sawdust or other organic materials with a density similar to manure are needed to be recovered from a manure slurry, screen or screw-press separators should be considered.

Screen Separators

Screen separators that utilize stationary inclined screens and are sometimes called “side-hill” or “static screen” separators. A stationary screen separator is shown in Figure 2.

Stationary screen separators work best with dilute manure slurries with a total solids content of 4 percent or less.

Stationary screen separators are simple in design and are commonly utilized with flush manure collection systems. As shown in Figure 3, these units flow manure across a fixed screen allowing free liquid to gravity flow through the screen openings. Dairies that use a flush manure collection system and bed with organic materials such as sawdust or wood chips, often use static screen separators. System maintenance is minimal and typically only includes washing the screen surface when needed. These systems have a lower capital investment compared to other mechanical separation systems. The smallest static screen units represent the most affordable line of mechanical separators available.

A more complex version of a static screen separator is a drag-flight separation system. Drag-flight systems incorporate a moving set of flights that are driven by a chain and used to drag manure over a static-screen. While they



Figure 2. Static-screen separator. Source: Author Photo

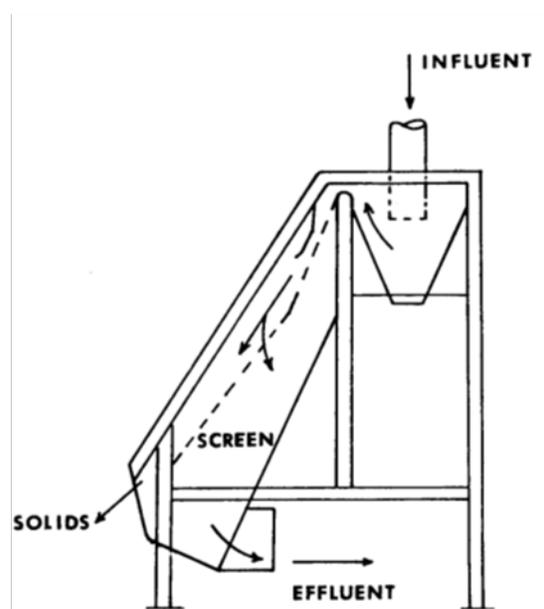


Figure 3. Stationary screen separator. USDA, 1992.

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can be more effective on higher solids manure slurries than a standard side-hill separator, they are more prone to mechanical issues. The solids recovered using static screen and drag flight units usually have moisture contents around 85 percent. They are typically too wet to use as bedding material for free-stall dairy barns without significant drying.



Figure 4. Screw-press separator. Source: Author Photo

Screw-press Separators

Screw-press separator systems use augers in combination with screened surfaces. A screw press separator is shown in Figure 4. In this system the manure slurry is fed in at one end of the auger or screw. The screw then compresses the manure slurry forcing water out through a screen surrounding the screw. The screw has an inclined flight and rotates inside a circular screen. Backpressure maintained at the outlet of the unit forces both free and bound water out of the manure solids and fiber. The water drains through the circular screen. Screw-press separators work best with manures that have a total solids content of 6 percent or greater. Recovered solids from a screw-press separator typically range from 60 percent to 75 percent moisture content. Screens and screws are both prone to wear and must be either re-surfaced (screws) or replaced (screens) on a regular interval.

Summary

It is important to note that different separator types work most effectively with manure slurries of a specific total solids content. Before purchasing and installing any manure solids separator the manufacturer of the equipment should be consulted to ensure that the separator will operate effectively in conjunction with the current or proposed waste handling system. Press and hydro-cyclone systems can generally operate with higher total solids content manure slurries than stationary screen systems can. Screen systems require periodic cleaning to prevent plugging of the screen openings with manure solids or biomass accumulation, and screw-press systems require resurfacing a replacement of screws and screens.

The total solids content of manure slurries will vary by species and by farm. This variation can be caused by several factors. Factors such as diet; type of manure collection system; amount of water entering the waste system, such as rainfall or runoff; the evaporation rate from the waste storage; and bedding type will influence the total solids content in the manure slurry. Because of the variability of these factors the total solids content of manure on a single farm can vary seasonally or after rainfalls. The manure throughput capacity of the separator should also be considered when selecting a manure solids separator. The throughput of different separator types can vary greatly and should be matched to the required manure slurry volume at the facility in question. Systems with low slurry processing capacities will require longer operation times and may be unable to process the required amounts on larger production units. It is important to note that solids separation systems work well with manures that contain significant amounts of fiber,

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such as dairy manure. It is challenging to separate manure solids from manures that have low fiber content, such as swine manure. Chemical addition (metal salts and long-chain polymers) are typically required to successfully recover manure solids from low fiber manures using mechanical separation systems. Metal salts are used to destabilize, or remove the negative charge from manure solids particles, and long-chain polymers are used to floc the neutrally charged particles together. If metal salts and polymer addition is required, it is important to recognize that their use can represent a significant added operational cost to a manure separation system.

Current purchase costs for mechanical separators range from less than \$30,000 to more than \$250,000 depending on type, size and brand of equipment. The installation cost will be additional to the purchase cost and will vary with type of separator. The installation cost will also vary from farm to farm depending on the amount of material and construction required at each farm to provide properly located and sized slurry delivery and solids storage facilities.

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