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Mechanical Solid/Liquid Separation for Dairy Waste

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Manure slurry is separated into high-solid and high-liquid fractions for a number of reasons. These include production of value-added products, such as bedding or feed and improving the handling, processing and storage properties of the products.

Removing the larger solids reduces the risk of plugging liquid handling equipment, such as pumps, piping and sprinkler nozzles. Reduction of the solids fraction reduces the biological loading on the lagoon. Often, removing solids allows a dairy to increase the herd size served by an existing lagoon.

Removal of manure solids from a large storage lagoon is a big problem and may not be feasible. Dairymen with large herds avoid the problem by separating the solids from the manure-water stream. The solids may be further processed by composting them and using them for bedding, with the surplus applied to cropland or sold to plant nurseries and other markets.

Composting, with temperatures up to 140 degrees F, reduces the level of organisms. Without this treatment, use of the solids as bedding will increase the incidence of mastitis in milking cows. Composting will produce a drier product than most newly separated solids. The optimum moisture content for composting is 50 percent to 60 percent. Higher moisture requires aeration by forced air or turning.

Solids may be separated in settling tanks/basins or by mechanical devices. A wide variety of commercial separators are used. Some of the more commonly used types are static inclined screen, vibrating screen, rotary screen, belt press, perforated roll press, screw press and centrifuge. Each of these separator types has one or more disadvantages, such as high initial cost, high operating cost, high maintenance cost or inadequate degree of separation.

In general, these devices produce a solid with about 70 percent to 80 percent moisture. Solids with less than 15 percent dry matter weep moisture that must be collected and handled. Frequently, solids recycled as feed are stored in a silo for a short time. Usually, the bulk of the separated solids consists of non-digestible fiber that has little feed value,

unless wasted feed includes a portion of the solids.

A holding tank equipped with a pump and agitator may be a necessary component in a flushing system to allow feeding a reasonably sized mechanical separator at a slower rate than the flushing operation.

Screens

There are several screening methods. Usually, the screen is formed with wedge-shaped bars spaced from 0.02 inches to 0.06 inches apart. The most commonly used method has a stationary screen mounted on an incline with the slurry applied to the top edge of the screen (see Figure 1). The liquid passes through the screen and is drained away. The solids move down the face of the screen and drop into the storage area or a conveyor. It may be necessary to install a wash-down system to follow use to prevent solids from drying and plugging the screen.

Figure 1. A stationary inclined screen for liquid and solid waste separation.

The stationary inclined screen is the simplest type of mechanical separator (see Figure 2).

Figure 2. The stationary inclined screen.

A second method has a rapidly vibrating screen. The vibration aids movement of the solids across the screen and reduces clogging. There are many vibrating screen configurations. Slurries containing more than 8 percent solids may clog a vibrating screen separator. Screened solids typically contain 12 percent to 18 percent dry matter.

Another screening method uses a drag conveyor to move the slurry over an inclined screen, discharging the solids at the top of the conveyor (see Figures 3, 4 and 5).

Figure 3. This elevated mechanical separator has a race-track conveyor for moving solids over a screen.

Figure 4. Solids are discharged into press rolls for de-watering at the upper end of the separator.

Figure 5. This inclined separator with conveyor paddles has a horizontal auger to form a pile of solids under a shed roof.

A fourth screening method applies the slurry to the outer surface of a rotating cylindrical screen. The liquid falls through the screen and the solids are scraped off the surface (see Figure 6).

Figure 6. Three different types of separators that use rollers to assist in reducing moisture content.

Presses

There are three types of presses (see Figure 6). One type of press has a rotating screen. The slurry passes between cylindrical screens and press rollers in one or more steps. The liquid passes through to the center of the screen and out the other side of the discharge. The solids are conveyed to the next screen section and then to storage.

A second method moves the slurry across two concave perforated screens with a series of brushes and spring-loaded rollers.

In a third press, slurry is applied on top of a porous belt that passes through rollers. The liquids are pressed through the rollers and the solids are carried along on the belt.

In a test of the three methods, the dry matter content of the solids ranged from 11 percent to 28 percent The flat belt unit produced the driest solids.

Screw press

One manufacturer produces a screw press, which it claims will produce solids with 33 percent dry matter from dairy slurry.

Piston press

A piston-type press, currently being developed by the USDA/ARS Dairy Forage Research center and the University of Wisconsin, shows promise for possible future commercialization. Tests have produced fiber with up to 30 percent dry matter.

Centrifuge

Centrifuges have consistently produced the driest solids, but at a high cost. One manufacturer produces a tapered screw press/centrifuge that discharges solids at the small end of the screw and liquid at the large end. The screw is enclosed in a conical bowl that rotates at 2800 rpm. The screw conveyor differential speed is 17 rpm.

The manufacturer claims an average solids dry matter of 28 percent to 30 percent, with a 25 percent to 35 percent range.

Currently, batch operation of some centrifuges seem to be the most feasible mode of operation.

Effect of waste characteristics

Waste characteristics can influence the performance of mechanical solid-liquid separators. Most mechanical separators work best at separating fibrous and organic material, such as undigested feed and straw or other types of bedding of a forage origin.

Abrasive and high-density materials, such as sand or ground limestone used as freestall bedding, may have severe effects on the mechanical separator. If sand or a similar material is used for bedding, consider using a sand trap or a similar sedimentation step ahead of the separator. In any event, consult the manufacturer for information on the effects of sand on the mechanical separating device.

References

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