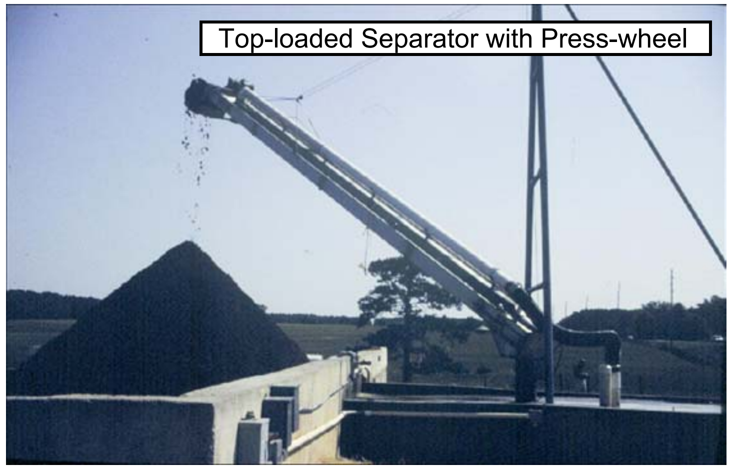
MANURE SOLIDS SEPARATORS

Dr. John W. Worley
Biological and Agricultural Engineering Department, College of Agricultural and Environmental Sciences, Cooperative Extension Service, University of Georgia



Top-loaded Separator with Press-wheel

One strategy for reducing the size of lagoon needed to effectively treat waste from a given number of animals is to remove much of the solid waste from the waste stream before placing it in the lagoon. A lagoon is sized based on the amount of "volatile solids" (solids which can be turned into gaseous form through bacterial digestion). These solids must be diluted with a large amount of water in order for the bacteria to efficiently break them down. If a large amount of these solids can be removed, the amount of dilution water can also be reduced, which reduces the required volume of the lagoon, or alternatively increases the capacity of an existing lagoon. Solids separation also gives managers more options for manure application since a portion of the waste stream is in solid form and can be hauled a longer distance than liquid waste and applied in areas where irrigation systems do not exist or cannot easily be used.

Solids separators have been around for a number of years and usually consist of either a mechanical solids separator, a settling basin, or a combination of these. Another type of solids separator that has recently been studied is "geotubes" which are porous plastic fabric bags, which retain most of the solids inside while the liquid seeps out through the fabric and is directed to a lagoon or liquid waste storage facility. Chemical amendments have also been used to enhance the performance of these technologies. Several studies have been done that examine the efficiencies of solids separation and the variations in nutrient separation into the two waste streams (solid and liquid).

Geotube (end view with drain area)

Settling Basin

Worley and Das (University of Georgia) did a study using a settling basin with and without alum amendment to separate solids from swine manure. Chastain (Clemson University) did a study on swine solids separation using a screw press and also separation of dairy manure by a screen (mechanical) separator, a settling basin, and the combination of the two with and without amendment with alum and PAM, a polymer used to flocculate solids. Studies on screen separators were done by Fulhage and Hoehne (University of Missouri), Zhang and Westerman (N.C. State), and (Graves and others (Penn State). The results of these studies are very interesting in that they show the tremendous variability of results from differences in manure handling systems, feeding systems, species, as well as solids separation technologies.

Table 1 shows separation efficiencies found by four research projects using mechanical screen separators to process dairy manure. The first two columns are for screens with paddle conveyors, while the last two are for gravity screen separators (manure is introduced at the top of the screen and separates without the use of paddles.) The difference between the first two studies is quite striking. Since both of these tests used similar mechanical separators, we would expect the results to be similar, but they are quite different. The difference can be explained when we look at the differences in the overall system. The first study was on a dairy that uses organic bedding material (shavings) and is arranged so that a significant amount of bedding and waste feed is included in the waste stream. It is flushed with clean water from a pond. The second test was done on a system where sand bedding was used and it is flushed with recycled lagoon water, a system more common on Georgia dairies. The incoming waste stream in the first study then contains many more large particles that are more easily separated by a screen separator. Water recirculated from the lagoon (second farm) has more suspended solids (small particle size) than fresh water, therefore a larger portion of the solids at the second farm are smaller and harder to separate from the liquid. The overall lesson from this table is that results can vary greatly for a given device, and we must be very careful in extrapolating data from any of these studies to individual farm situations.

Table 1. Separation efficiencies for dairy manure by mechanical screen separators

Study	Chastain et al.	Fulhage & Hoehne	Zhang & Westerman	Graves et al.
% Total Solids Removal	61	46	49	55-74
% TKN Removal	49	17	NR	NR
% NH_4 N Removal	45	8	NR	18-33
% P Removal	53	11	NR	NR
% K Removal	51	10	NR	NR

Table 2 shows separation efficiencies for two studies on swine manure. The first two columns show data from a screw press at two different initial solids contents. The data show that the efficiency of this separator is highly dependant on the initial solids content with much higher efficiencies achieved at higher initial solids content. The third column is from a settling basin. The results demonstrate that a settling basin is much better at removing a larger portion of solids and nutrients than a mechanical separator, especially small particles. This difference is significant because many of the nutrients, especially phosphorus, tend to adhere to these small particles, so that a settling basin will more effectively remove phosphorus and some nitrogen into the solid waste stream than a mechanical separator. The disadvantage of a settling basin is that the solid fraction from a settling basin is much wetter than from a mechanical separator and thus more difficult to transport and/or spread. The addition of alum to the settling basin system improved solids separation significantly, but had an even more drastic effect on phosphorus removal, almost doubling the separation efficiency. The result is a more balanced fertilizer going into the lagoon since much more phosphorus than nitrogen is removed by this system. Most animal waste has too much phosphorus compared to the amount of nitrogen that plants can use, so a decrease in phosphorus, and an increase in nitrogen yields a more balanced fertilizer. The excess phosphorus, then can be hauled a further distance and distributed on other land which can use it more effectively because it is handled as a solid.

Table 2. Separation Efficiencies for Swine Waste

Study	**Screw Press 3% solids**	**Screw Press 6% solids**	**Settling Basin (1-2% solids) No Amendment**	**Settling Basin (1-2% solids) 0.4% Alum**
% Total Solids Removal	**7**	**20**	**58**	**72**
% TKN Removal	**5**	**16**	**18**	**25**
% NH_4 N Removal	**NR**	**NR**	**7**	**10**
% P Removal	**7**	**20**	**38**	**75**
% K Removal	**NR**	**NR**	**6**	**9**

Screw Press Separator with Gravity Screen Separator in background.

Table 3 shows a comparison between different separation technologies on dairy manure. The first four columns are the results of tests on one farm while the fifth column resulted from a test on a different farm. The first farm was equipped with a mechanical screen separator followed by a two-cell settling basin. The first column shows the efficiency of this system as used on the farm. The second column gives the results when the mechanical separator was not used, but a polymer (PAM) was added. The third and fourth columns compare the complete system with the addition of polymer and alum as amendments. Both amendments yielded similar results with the exception that alum was better at removing phosphorus. Alum (aluminum sulfate) combines with phosphorus to form aluminum phosphate, a nonsoluble form of phosphorus, which tends to stay with the solid fraction of the waste stream. Since the separation equipment used on the farm is already so efficient, it is questionable whether the additional efficiency would pay for the cost of adding amendments. This would have to be determined on a case by case basis. If for instance, these changes would allow a dairy to increase the number of cows without increasing the size of the lagoon, additional costs may very well prove economical. If the mechanical separator were not already present, that investment could be saved by using PAM and a settling basin to achieve similar results (column 2.) The only major difference between the first and second columns was the low removal of potassium in the 2nd column, which at this point is not a problem for most farms.

The "geotube" achieved a very high separation efficiency for all quantities except potassium. The tube however, is an extremely slow separation device. It would require a number of tubes operating in parallel to handle all of the flow from a livestock building flush system. Additional research is needed to determine the economic viability of this system.

Table 3. Separation efficiencies for different technologies on dairy manure

Study	Screen & Basin	Basin with PAM (0.03%)	Screen & Basin with PAM (0.03%)	Screen & Basin with Alum(0.3%)	"Geotube"
% Total Solids Removal	70	76	92	89	95
% TKN Removal	51	45	71	74	78
% P Removal	60	62	86	99	65
% K Removal	48	3	51	46	23

The University of Georgia
Cooperative Extension Service
College of Agriculture and Environmental Sciences