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Recycling Lagoon Water

For Manure Flushing Systems

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Flushing systems for manure collection and transport from animal confinement buildings have the advantages of improved building environment and reduced labor. Flush water comes from either the domestic water supply or as recycled water from the lagoon receiving the wastes. The advantages of using recycled water are a decreased demand on the domestic water supply and less hydraulic or "fresh water" loading on the lagoon.

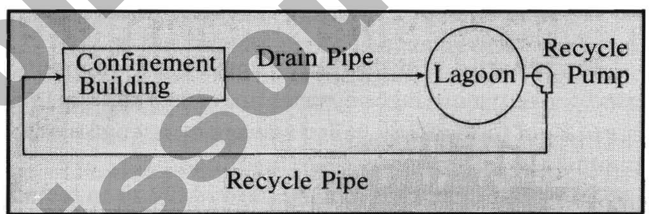

Figure 1. Basic components of a recycle system.

Recycle Pumps

A typical recycling system consists of a pump, recycle line or pipe to carry water from the lagoon to the confinement building, and the appropriate controls. These components are connected in a closed-loop configuration with the flushing gutter and the drain line from the confinement building. See figure 1.

Pump selection and location. These factors are important in developing a reliable recycling system. In most cases, locate the pump at or near the lagoon to minimize elevation and pipe friction losses on the suction side of the pump. Although self-priming pumps located in or near the confinement building are accessible and inexpensive to install, they may become difficult to maintain because of the high suction head, the resulting loss of prime, and dry running. For pumps located at the lagoon, you may supply the power by laying underground feeder electric cable in the same trench with the building drain or recycle line. A high voltage (220V) operation is preferred to minimize wire size.

A pump selected for recycling lagoon water should have an open or semi-open impeller to decrease the risk of plugging due to solids ingestion. See figure 2. Most

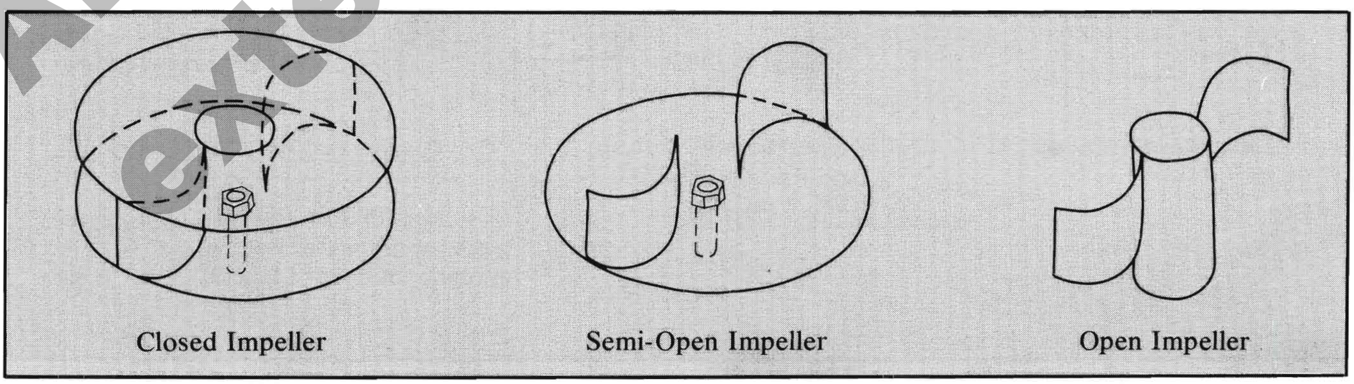

Figure 2. Three types of impellers commonly used in centrifugal pumps.

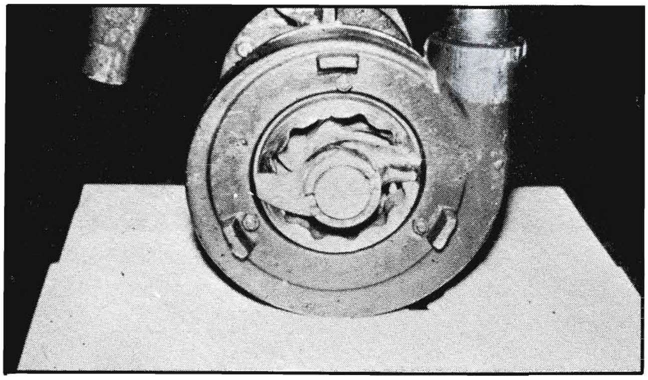

Figure 3. Chopper pump capable of pumping stringy, fibrous materials.

sewage or trash pumps have semi-open impellers, capable of handling the solids normally encountered in recycling systems.

However, in applications where fibrous, stringy material (such as hay or silage in a dairy lagoon) is present, use a cutter or chopper pump. These pumps have a cutting or chopping device (located just outside the pump inlet), which rotates with the impeller and shreds fibrous material as it enters the pump. See figure 3.

Pumps and installation. Pumps most commonly used for recycling lagoon water are either *submersible centrifugal* (commonly called sewage or sewage ejector pumps), or *self-priming centrifugal pumps*.

Submersible pumps may be more difficult to install, but have the advantages of continuous positive priming and no freezing because all components are located below the freezing level.

Self-priming pumps may be located on the lagoon berm, or in a wet well adjacent to the lagoon. With either location, you must provide freeze protection. You would also need to provide a means of automatically shutting off the pump if lost prime causes overheating. Figure 4 shows two methods of installing self-priming recycle pumps.

Install submersible sewage pumps by suspending them about 2 feet below the water surface, so they remain free of surface debris and bottom sludge. Figure 5 shows the preferred method of installing a submersible pump.

The catwalk should extend out far enough into the lagoon so that the pump will stay in 3 to 4 feet of water when the lagoon is pumped down. This installation has the advantages of freeze protection, positive prime, and the pump is easy to retrieve for service and repair. The greater time and expense required for this type of installation will be returned many times over through its convenience in maintenance, and through no freezing or loss of prime.

Figure 6 shows an alternative for installation when the lagoon is filled before the catwalk arrangement of Figure 5 can be built. A float suspends the pump 1-2 feet below the water surface. To prevent movement and stress on the recycle line, moor the floats to the lagoon berm with two or three stainless steel cables. This installation is easier than the one shown in figure 5, but it is more difficult to remove this pump from the lagoon for service or repair. Often, you will need a boat or chest waders to retrieve a pump installed in this manner.

Whichever method is used, always locate the pump on the side of the lagoon opposite the discharge pipe from the building. This location will assure maximum retention and treatment of the water before it is recycled back to the confinement unit.

Pump Controls

Recycle pump controls may be manual or automatic. In most installations, the pump runs continuously, and the flow rate is adjusted by valves or appropriate restrictions. These controls assure that the flush tank or tanks fill within the flush frequency time period.

Operators are sometimes reluctant to restrict or throttle the discharge from a pump for fear they will make the pump "work harder." However, most centrif-

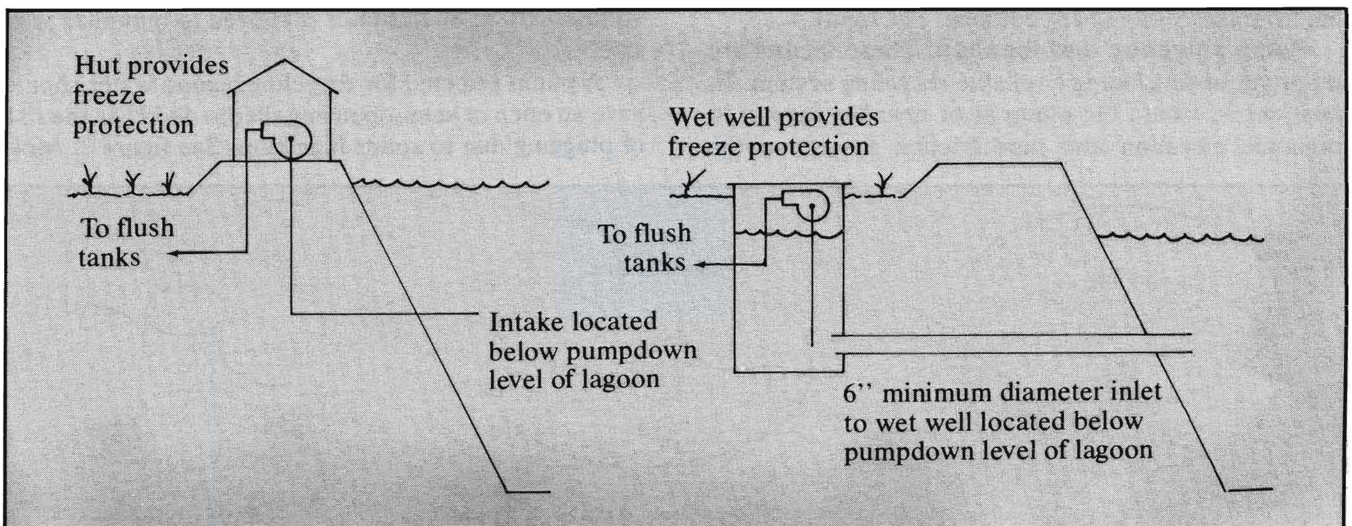

Figure 4. Two methods of installing self-priming recycle pumps.

System Design

Recycle system design and equipment selection require a knowledge of hydraulic head, pipe friction losses and other factors. The following steps are only a guide for estimating component sizes. Consult your local extension center or other qualified individuals for detailed design assistance.

1. Determine the required *system flow rate*. This rate depends on building size, animal numbers and flushing frequency.
2. Select a *pipe size* using Table 1 for a guide. Minimum pipe size should be 1½ inches. Larger sizes are used for higher flow rates.

Table 1. Selecting pipe size for recycle systems.

Flow Rate (gallons/minute)	Pipe Size
0 - 15	1½″
15 - 25	2″
25 - 50	2½″
50 - 80	3″
80 - 150	4″

3. Determine the *lift head* the pump will be working against. Lift head is the elevation difference in feet between the lagoon water level and the point of discharge into the flush tanks.
4. Determine the *friction loss* in the pipe from the lagoon to the confinement building.

   Multiply the friction loss value in Table 2 (using your pipe size and flow rate) by the length of the recycle pipe and divide by 100. The result is the pipe friction loss (in feet) for your system.

   For example, a 30-gallon-per-minute system 350 feet long with 2″ pipe would have a friction loss of $2.36 \times 350/100 = 8.26$ feet of head.
5. Add the lift head (step 3) to the friction head (step 4 to obtain the *Total head* the pump will be working against. Select a pump which will deliver the required flow rate against this total head.

   Table 3 shows typical power requirements of submersible sewage pumps for various pressures (total head) and flow rates. Most sewage pumps in the ½ -1 horsepower range have head limitations of 25-40 feet. When pumping heads are greater than 25-40 feet, you may need a special high head sewage pump.

   In some cases, the head-flow rate requirements of the system may indicate that pumps smaller than ½ horsepower would be adequate. However, pumps smaller than ½ horsepower have limited solids handling capacity, and do not have the "heavy duty" characteristics necessary for operating in the lagoon environment.

Crystallization

Crystalline deposits in pumps, pipes and plumbing may develop in some recycle systems. Although crystallization may not occur, such deposits can stall the pump, ruin pump seals, or close off recycle pipes, severely restricting the flow. It is difficult to predict the formation of these crystals. However, crystals appear to form most often in lagoons which are highly concentrated or overloaded with manure.

The causes of crystallization. The crystals result from concentrations of magnesium, ammonium and phosphate ions in anaerobic lagoon water. These ions form the magnesium ammonium phosphate crystalline complex.

Crystals form most quickly on metal components.

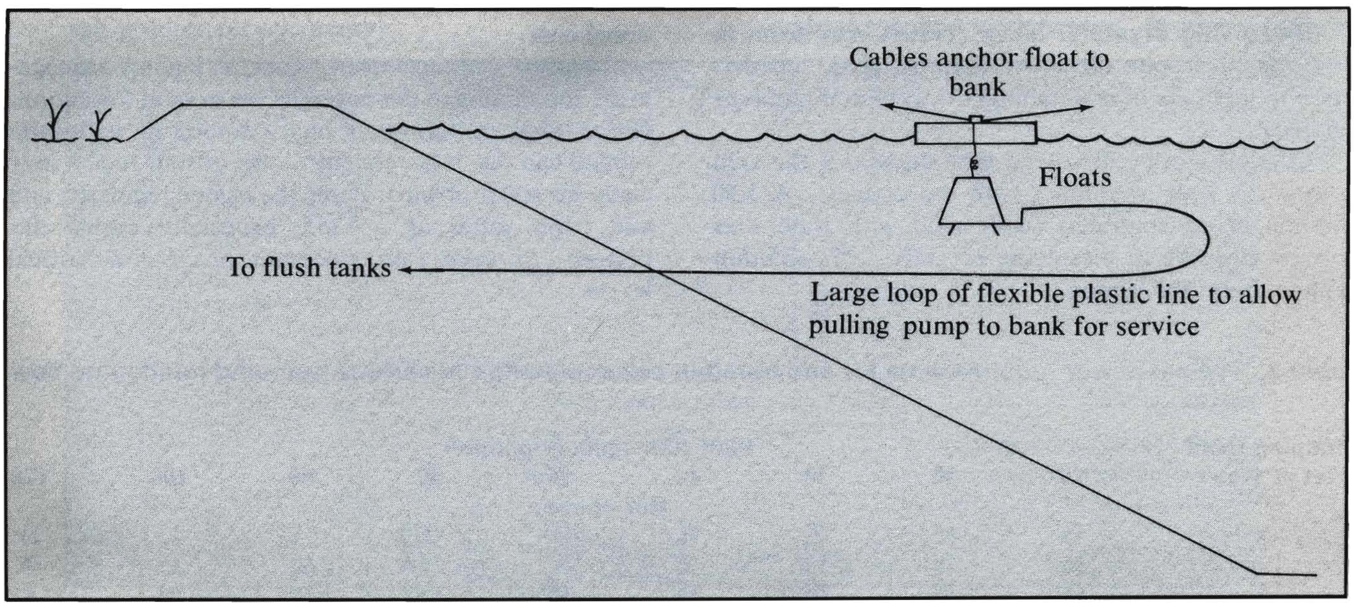

Figure 6. Submersible recycle pump installation using a float for pump support.

Table 2. Pipe friction loss (in feet) of water per 100 feet of plastic pipe.

Flow Rate (gallons/minute)	Pipe Size 1½″	2″	2½″	3″	4″
5	0.35				
10	1.26				
15	2.65	0.65			
25	6.83	1.68	0.57		
30		2.36	0.80		
40		4.02	1.36		
50		6.07	2.05	0.84	
60			2.87	1.18	
80			4.89	2.01	0.50
100			7.40	3.04	0.75
125				4.60	1.13
150				6.45	1.59

Steel, cast iron, bronze and brass appear to be equally susceptible. Although deposition in plastic pipes has been observed in several cases, plastic components are not as susceptible.

The crystals usually begin to form on some grit or other solid material lodged in the pipe. After the initial formation, the crystals build upon themselves quite readily. The deposit accumulates both along the length of the pipe and across the diameter of the pipe.

Precautions. Crystal buildup seems to start most readily at joints, elbows and fittings. Grit and solid material tend to lodge at these locations and provide a base from which the deposit can grow.

For this reason, recycle pipes should be a minimum of 1½ inches in diameter. If possible, flexible plastic pipe should be used for direction changes rather than short- or even long-sweep plastic elbows.

Systems in which the only metal parts are the pump housing and the impeller are the least susceptible to crystalline deposits.

Dissolving crystals. Since crystals may form in any system despite these precautions, give consideration to methods of maintaining the system if buildups do occur.

Crystals can be dissolved with an acid if the acid solution is kept in contact with the crystals. A 1:50 dilution of concentrated acetic acid with water has proven effective in dissolving crystals. This solution will not harm the lagoon.

A recirculation pipe installed along with the recycle pipe provides the capability for circulating an acid solution through the system. See figure 7.

An acid mixing tank, sized to hold enough acid solution to fill the system, is located at the discharge end of the recycle pipe. The recirculation pipe carries the acid solution from the mixing tank to the inlet of the pump. On submersible pumps, weld a collar or coupling to the pump inlet for connecting the recirculation pipe. The size of the recirculation pipe is not critical because high recirculation flow rates are not required, but the pipe should not be less than 1¼ inches in diameter.

Examine the recycle system regularly to determine the pattern and rate of crystal buildup. Then use the recirculation system as needed to prevent excessive buildup and subsequent failure of the system.

Installation of recirculation capability will increase the cost of the recycle system. However, the probability that total failure of the system could occur if crystal buildup becomes excessive appears to justify the additional cost.

Lagoon management. Careful lagoon management can minimize the potential for crystal formation. Overloading or periods of high evaporation with little rainfall can result in concentrations of salts which may cause crystal problems. Pump the lagoon regularly, and add fresh water as needed, especially during dry periods, to keep salt concentrations below critical levels.

Table 3. Typical power requirements for submersible sewage pumps at various pumping heads and flow rates.

Pumping Head Feet of Water	Flow Rate (gallons/minute) 10	20	30	40	50	60	80	100	120
	Horsepower								
5	½	½	½	½	½	½	½	½	½
10	½	½	½	½	½	½	½	½	¾
15	½	½	½	½	½	½	½	¾	1
20	½	½	½	½	½	¾	¾	1	—
30	¾	¾	¾	1	1	1	—	—	—

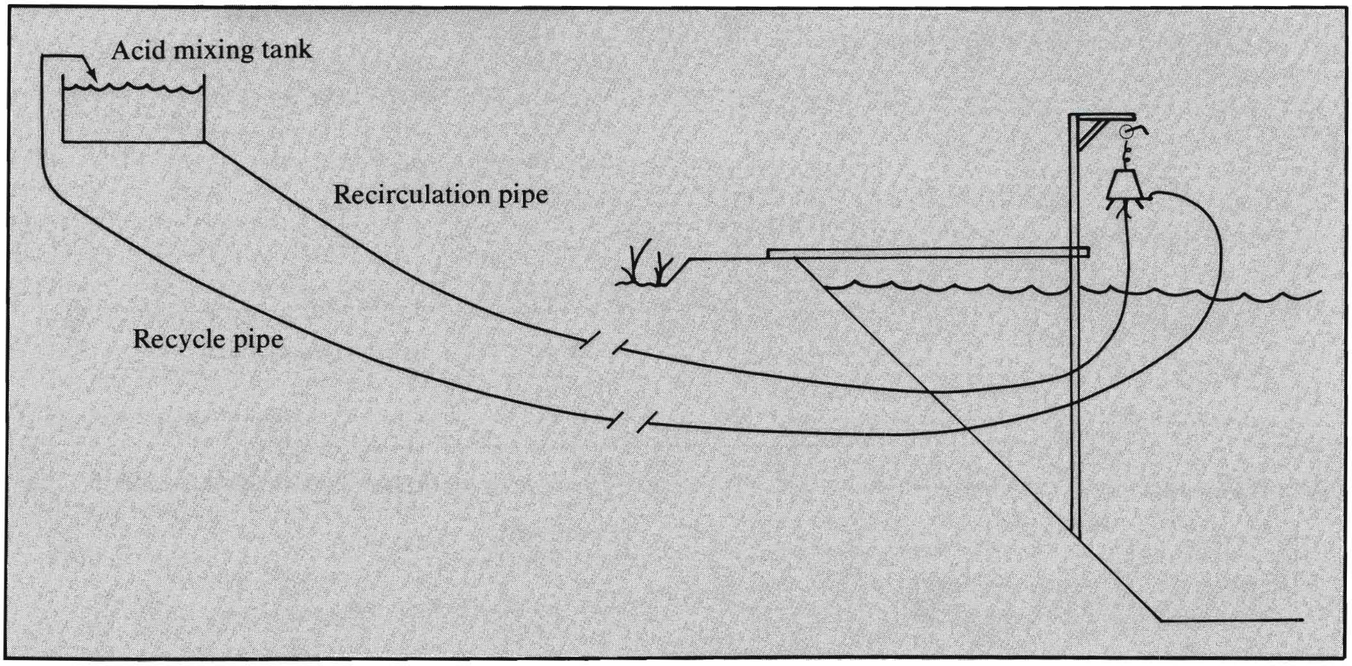

Figure 7. Recirculation system for dissolving crystals in recycle line.

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