Farm Structures
FACTSHEET

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CIRCULATORY AGITATION SYSTEMS FOR CONCRETE DAIRY MANURE STORAGE TANKS

The agitation of a concrete liquid manure storage tank is a serious problem when access around the perimeter is limited. Circulatory agitation storage facilities (sometimes called "racetrack storage tanks") have solved this problem. This factsheet describes various design and management considerations.

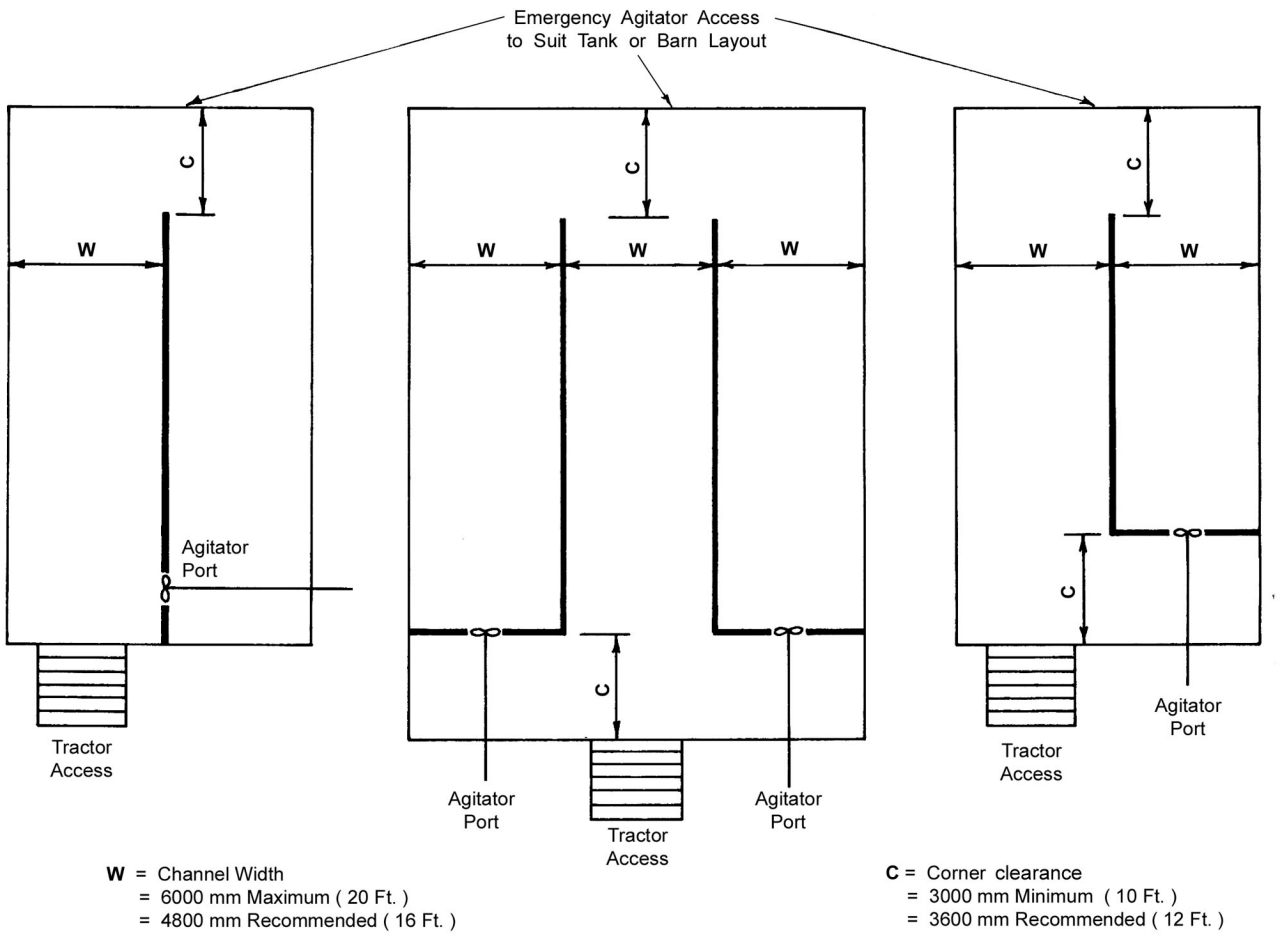

Figure 1

ADVANTAGES OF CIRCULATORY AGITATION

- Liquid manure is easily handled mechanically by agitators, vacuum tankers, augers and pumps.
- Circulatory agitation systems fit well into an integrated, farm manure management system.
- Circulatory agitation systems eliminate the need for tractor access at many points along the perimeter of the manure storage tank.
- Circulatory agitation systems allow for rapid mixing of manure, which in turn provides for timely field application. If the weather forecast is favourable, the operator can agitate and begin spreading the same day. As a service to help producers in carrying out good land application practices, forecasts and spreading advisories are available on the Farmwest website.

DISADVANTAGES OF CIRCULATORY AGITATION

- In slotted floor systems or covered pit designs with circulatory agitation features, gas buildup can reach hazardous levels. An increased awareness of these hazards is required for safe operation.
- Frequent agitation (once or more per month) is required to prevent crust buildup on the surface of the manure.

DESIGN OF CIRCULATORY AGITATION PITS

There are two basic types of circulatory agitation systems: (1) storages located under cattle and equipment traffic areas, such as is typical in slotted floor dairy housing or suspended floor systems, and (2) tanks or pits located outside the barn. Figure 1 illustrates a variety of racetrack configurations. Wider barns will duplicate these arrangements or may incorporate variations of these on each side of the drive through feed alley.

In slotted floor barns, manure is continually added along the length of the channels due to cattle traffic or by automatic chain-driven, cable-driven or rope-driven scraper systems. This makes the slotted floor concept ideally suited to circulatory agitation. In the case of outside tanks, manure is usually added at a single location either by conveyors, pumps, augers, gravity-flow cross channels, flush flumes, or by tractor scraping to a drop slot above a cross channel.

When manure is added at a single location, a degree of solid/liquid separation occurs as the liquid flows away from this point of addition (see Figure 2). This means that the manure tends to be of thicker consistency and will tend to accumulate near the point of introduction. The result of this buildup is that, without frequent agitation, it can be difficult to get the manure to circulate properly.

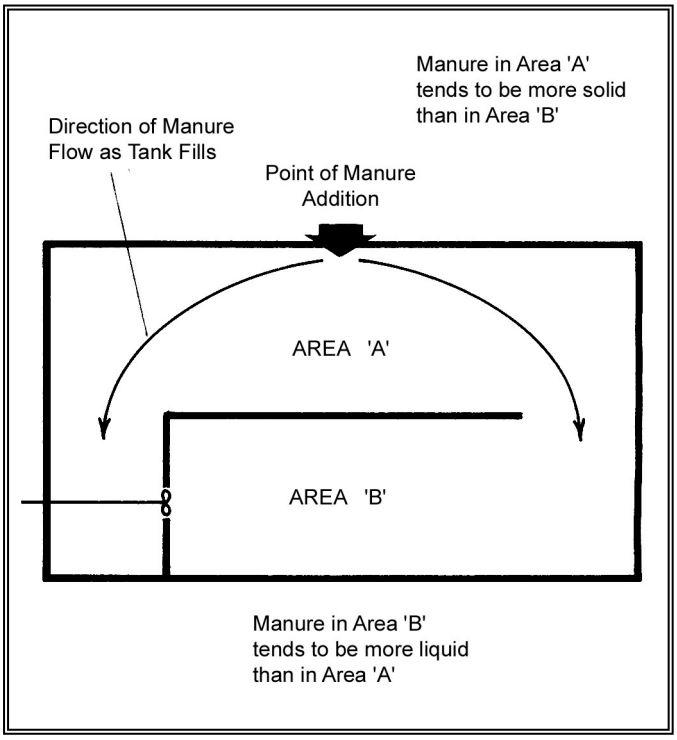

Figure 2

One of the design objectives of a circulatory agitation system is to add manure at as many points as is practical. This means the manure does not have to flow as far while the pit is filling, resulting in a reduced tendency for solid/liquid separation to occur. A good rule of thumb is to incorporate at least one point of addition for each channel. With outside pits, it is not often practical to deposit manure at more than one location. In cases where tractor access at many points is possible, it may be preferable not to incorporate channels if the operator does not wish to agitate as frequently as is required with circulatory systems.

Additional design considerations are noted below:

1. The storage tank must be designed to withstand soil, manure and vehicle loads. In addition, uplift forces must be considered if a high water table exists. To prevent unwanted stresses within the concrete and upward movement of the floor slab,

the floor of the tank should generally not be located more than 600 millimetres (24 inches) below the highest expected groundwater table. Limitations in allowable depth of construction below the ground surface will of course affect storage capacity.

2. If water table effects are not applicable for a given desired location, a 2400-mm (8 ft) depth is a practical compromise. Tanks that are very shallow have a high unit cost of storage construction (dollars per cubic metre), while tanks that are very deep are difficult to agitate. A compounding additional problem is that most vacuum tankers cannot pump out manure from depths greater than 3000 mm (10 ft). As a rule of thumb, tanks should not be shallower than 1800 mm (6 ft) or deeper than 3000 mm (10 ft).
3. Sediment buildup is a potential problem for circulatory agitation systems. If possible, a tractor entrance to the tank should be incorporated to allow for complete cleanout of heavy sediments and solid manure that may accumulate over a period of several years. At no time should a covered pit be entered unless the person so doing is equipped with a self-contained breathing apparatus or equivalent personal protective equipment. A second person should always be on watch when others are entering potentially hazardous areas.
4. Locate the agitation and manure access so that it does not interfere with potential future barn or farm expansions, or with minimum required distance to the milk room. It is a good idea to check these requirements with your dairy inspector to prevent conflict in the future.
5. Install a sturdy fence around all open tank areas if the storage walls are less than 1050 millimetres (about 42 inches) above the surface of the ground. Use of chain link fencing is highly recommended for the safety and protection of small children.
6. Outside tanks which incorporate ramps or suspended slabs over the tank for tractor scraping of manure require a heavy duty protective fence in such areas. It should be impossible for the tractor to fall into the tank or ride off the edge of the ramp. This fence should be constructed of 100-mm (4 inch) welded steel pipe set in concrete. For most tractors, a fence height of 900 millimetres (36 inches) is adequate. Do not use chain instead of pipe because tractors are capable of climbing over safety rails made of chains.
7. To ensure vigorous manure flow and to prevent plugging and crust blockage problems, a 5000-mm (about 16 ft) maximum channel width is ideal, although widths of up to 6000 mm (about 20 ft) are considered acceptable.
8. A minimum clearance opening of 3000 mm (about 10 ft) is required for corners or turns in the channel. Openings smaller than this will result in crust blockage problems.
9. Channel length is not a critical factor in a good design. As a general rule, however, lengths greater than 60 metres or about 200 feet should be avoided.
10. Channels should be as free from obstructions as possible. In order to maximize storage volume, under-floor storage systems are frequently designed to utilize the space beneath both free stalls and slatted floor alleys. In such cases, posts with beams are required to support the suspended floor slabs and the columns will need to be located within the channel. Posts disturb flow patterns and make it more difficult to break up crust. A circulatory agitation system layout should avoid stand-alone posts in the channel, if at all possible. If unavoidable, round concrete columns are preferred over rectangular or square ones.
11. Most slotted floor barns are designed with a circulatory agitation tank on both sides of the central drive-through alley. An overflow pipe is installed between the two tanks to allow manure levels to equalize. This overflow pipe should be a large 600-mm to 900-mm (24 inch to 36 inch) diameter concrete or polyvinyl chloride (PVC) pipe and be located at the top of the tank wall.
12. Manure drop slots are best located over the centre of the channel. Adequate steel reinforcing of concrete floor slabs near the drop slots is essential. The drop slot and surrounding area should be approved by a structural engineer for the weights of equipment they are intended to support.
13. It is important to provide agitator access at both ends of the channel. The second agitator port is essential for breaking up crust that may build up at the end of the channel opposite the main agitator port.
14. Select a reversible agitator. Being able to reverse the direction of flow can be very helpful in breaking up crust and unplugging the channel.

15. Placement and operation of agitation equipment are key components of good system design. In all cases, the main agitator fits through a bulkhead wall. The agitator opening should be sized to meet the manufacturer's specifications and should be located at the base of the bulkhead. See Figure 3 for a typical cross section of the agitator access port. A good design will incorporate an agitator section which is 300 mm (12 inches) lower than the rest of the tank. This provides a sump area for the vacuum tanker to drain the tank completely and also encourages more turbulent flow in the immediate vicinity.

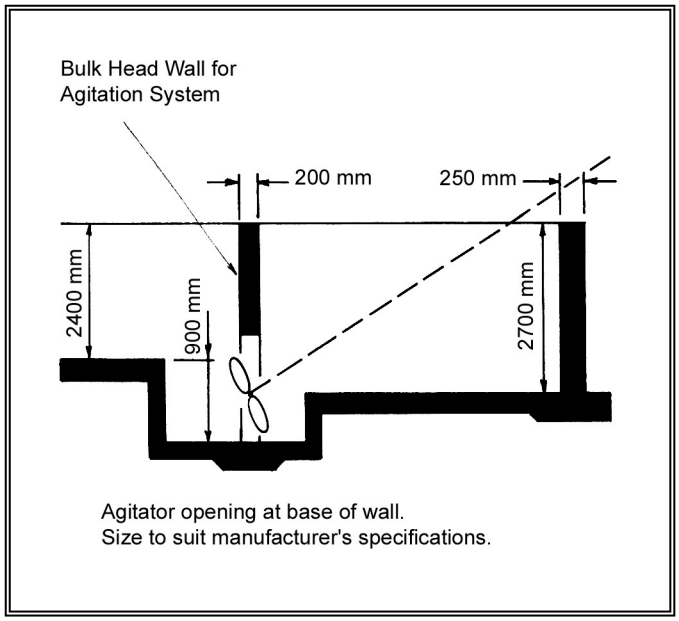

Figure 3

16. In addition to the bottom agitator which provides the pumping energy for manure flow, a surface agitator will usually be required. The surface agitator is needed for breaking up crust buildup resulting from infrequent agitation. There are several ways to provide surface agitation. If a PTO-driven three-point hitch unit is used, the agitator can be lifted to run near the manure surface. Other systems include a permanently mounted electrically-driven agitator. It is best to design this part of the system with the help of an equipment dealer.

MANAGEMENT POINTS

1. The most important point to remember about manure tanks of any kind is safety. Gases are released by all stored manure, especially if in liquid form and especially during agitation when bubbles contained within the liquid are released. These gases can be deadly and the producer must practice proper precautions.
2. Warning signs should be installed at all agitator port locations.
3. A manure tank should never be entered unless the operator is equipped with a self-contained breathing apparatus or equivalent personal protective equipment. A safety rope should be attached to the person entering the pit and held by an observer located in a safe position, ready to pull the person out if any problems occur.
4. During agitation of slotted floor structures, the maximum possible barn ventilation should be provided by opening all doors, side vents and ridge ventilators. No person should be allowed in the building during agitation. If possible, all animals should also be removed from the barn. For barns incorporating mechanical ventilation, fans should be set to run at the highest speed possible.
5. Sand bedding should not be used in the free stalls of barns equipped with slotted floors. The sand will accumulate in the bottom of the tank and will eventually plug the channels.
6. The manure storage should be agitated at least once a month. This will save time in the long run. Frequent, one-hour agitation periods keep the crust down and the manure well-mixed. Not agitating for weeks at a time will result in a thick, heavy crust which is much harder to break up. If agitation is neglected for as long as three or four months, it becomes a particularly challenging chore, defeating the very reason a circulatory channel system was constructed in the first place.
7. Manure should not be pumped out of the tank before it has been well agitated. So doing will remove the liquid layer at the bottom of the tank and will eventually lead to plugging problems.
8. If a heavy crust buildup does occur, the bottom agitator alone will not be effective at breaking up a surface crust. The best solution is to have a separate surface agitator running at the same time as the bottom agitator.

If a surface agitator is not an option, it may be possible to raise the bottom agitator to the manure surface to break up the crust which has been drawn toward the agitator port.

9. To break up crust which is hanging up, it may be helpful to reverse the direction of channel flow. If this does not work, the additional agitator port or ports will need to be used.

10. If no amount of agitation is successful in moving the manure, there is likely insufficient water in the manure. Extra water can be added by vacuum tanker at both port locations or can be sprayed over the surface to help soften the crust.

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