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Siphon Tanks for Dairy Flushing

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Several types of flush tanks are commonly used for flushing dairies in Missouri. This publication will discuss siphon tanks and their application to flushing in a dairy operation.

Siphon characteristics

Siphon tanks offer unique design and operational characteristics. Here are several advantages to using the tanks.

A siphon tank can be designed and built to contain any volume of flush water. They are applicable to any width and/or length gutter or flush alley, see Figure 1.

Figure 1. A siphon is used to flush this 20-foot wide dairy holding pen.

Flush water rates can be tailored to each operation, provided it is properly designed to deliver that rate of water.

A tank can be placed adjacent to the gutter to be flushed, so it does not block the upper end of the gutter. When the siphon tank is not actually flushing, there is no protrusion above the alley floor to interfere with traffic, see Figure 2.

Figure 2. Siphon tanks can be placed adjacent to the gutter being flushed, so there are no traffic obstructions.

Siphon tanks can be constructed of materials that will not deteriorate in the harsh environment. In dairy operations, tank construction materials may include concrete, PVC, stainless steel, see Figure 3, or fiberglass. These materials can be expected to last as long as the facility is used.

Figure 3. Water pressure from the siphon tank raises a steel lid to allow water to flow down the flush alley.

Siphon tanks are highly reliable. If properly designed and installed, the tanks operate with little or no maintenance. Because there are no moving parts to wear out, siphon tanks can provide trouble-free operation over a long period of time.

Siphon tanks also have some disadvantages, relative to other types of flushing devices commonly used in dairy operations.

Design and construction are critical for proper operation. Siphons must be precisely designed and accurately installed.

Although siphons are relatively simple hydraulic devices, it may not be immediately apparent to the builder or operator how they work.

Siphons may be difficult to install in existing facilities. Tanks in dairy operations generally involve some excavation and pouring of concrete and are best installed in the construction phase of the facility.

Installation of siphons may be more expensive and time-consuming than with other flush devices, such as rollover tanks.

Practical construction limits the water-pressure head available in siphons, compared to water tower/pipeline-valve systems. This may impose a limit on the discharge rate and the maximum width gutter that can be flushed with a siphon.

Siphons are limited to flushing a single gutter. In some cases it may be possible to flush two gutters at the same time, but design requirements usually limit such applications. In contrast, with a tower/pipeline-valve system, several gutters can be flushed with one or two water towers.

How does a siphon work?

In order to understand how a siphon works, it is necessary to identify the basic components in a siphon tank (see Figure 4).

Figure 4. Components in a siphon tank.

Tank. The tank is sized to discharge the required volume of water for the gutter being flushed. In dairy applications, the tank is usually concrete.

Discharge pipe. The discharge pipe is sized to provide an adequate flow rate of water from the flush tank. The size of the pipe depends primarily on the width of the gutter being flushed and the depth of water, or pressure head, in a full tank. Discharge pipes are usually PVC, stainless steel or fiberglass.

Bell. The bell, similar to an inverted barrel, covers the discharge pipe so that air is trapped in the system. Usually, the bell is made of stainless steel, fiberglass or plastic.

Vent hole. The vent hole in the bell allows the inside and outside air pressure to equalize after each flush. This is necessary to ensure reliable operation of the siphon.

Air release. Air is released from under the bell to activate the siphon and complete a flush.

Air-release devices include manually operated valves, flexible hoses or automatic trigger tubes.

Trap. The trap is a reservoir under the tank that holds air in the system. The trap also provides a flow avenue for the flush water from the discharge pipe to the gutter. In dairy operations, traps are usually made of cast-in-place concrete.

At the beginning of fill, after a flush, water lowers (see Figure 5). As the tank fills, water covers the vent hole in the bell and a specific volume of air is trapped under the bell and in the discharge pipe. After the vent hole is covered, the water level under the bell rises at a slower rate than the water level in the tank. The water level in the discharge pipe is pushed downward by air pressure as water rises inside the bell. See Figure 6 for the water level at the end of the fill cycle.

Figure 5. Water levels in a siphon tank at the beginning of a fill cycle following a flush.

Figure 6. Water levels in a siphon at the end of the fill cycle.

After the tank fills, a flush is started by the operator releasing the pressurized air under the bell through the air-release device. The air-release device remains open until air is purged from the system. As water replaces air in the system, flow begins (see Figure 7).

Figure 7. Siphon conditions after the air release device is opened. Air under the bell is displaced with water and the flush flow begins.

After flow is established, the water level in the tank continues to drop until air enters the system underneath the bottom edge of the bell and the siphon breaks. Since the vent hole is exposed at this point, air is admitted into the bell until pressure exists inside the bell and conditions are correct for the next fill cycle (see Figure 5).

Siphon design

There are several precise dimensions and installation techniques necessary to ensure proper siphon operation (see Figure 8):

- Tank depth
- Bell area and bell height
- Discharge pipe diameter
- Vent hole diameter and position
- Height of discharge pipe in tank
- Distance pipe extends into trap under tank
- Depth of trap under tank

Siphons must be designed to flush the required volume of water at the proper rate.

Additionally, dimensions must be correct to obtain the proper water levels and air volume in the system when the tank is full (see Figure 6). Although siphons can be designed by hand calculations, the large number of input variables is best handled by a computerized design program. Siphons should be designed by individuals familiar with the operation and requirements.

Siphon construction

Siphons used in dairy operations generally use reinforced concrete for the tank and trap underneath. Tanks are usually 4 to 8 feet deep. Discharge pipes may be stainless steel, PVC or fiberglass. Figure 8 is a tank designed to flush an 8.5-foot wide alley in a dairy freestall barn and should not be used for other siphon designs.

Figure 8. The cross-section of a siphon constructed on-site with a concrete tank.

Although most siphons are constructed on-site, there are a few commercially available siphons for flushing dairies (see Figure 9).

Figure 9. A commercially available siphon tank. (Courtesy of the Farm Co., Uniontown, Kansas)

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