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Salt Buildup in Flush Recycle Systems

Joseph L. Taraba
University of Kentucky

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A major operating problem that has occurred in recycle flush lagoon systems is the buildup of a crystalline solid in the recycle pipelines, pump, flush devices, and concrete gutters. The major crystalline solid has been identified as magnesium ammonium phosphate -- \( \text{Mg(NH}_4\text{PO}_4 \) \}. There have been a couple of reports of other types of phosphate salts of calcium and magnesium. All the cases of salt buildup in the recycle lines of swine flushing systems that have been investigated in Kentucky were found to be magnesium ammonium phosphate.

Occurances in Kentucky

Three swine production facilities with salting problems are summarized below.

1. Swine finishing facility with 2-stage anaerobic lagoon. The 2-stage lagoon volumes were based on Soil Conservation Service recommendations. At the time of the salt buildup occurrence, the lagoon was 4 years old and had never been pumped down. The production capacity of the finishing floor was at least 90% during this period of time. The flushing system consisted of an iron pump, 2"-PVC rigid pipe, siphon flush tank, and open gutter flush. Severe salting occurred during a very dry summer. The level of the 2nd-stage lagoon dropped 3 to 4 feet. Salt buildup occurred in the intake pipe from lagoon to pump, in pump housing, in lines to finishing floor, and in the siphon flush devices. The PVC pipe inside diameter was reduced from 2" to approximately 1/2". The producer solution was to replace the pipe and rebuild pump.

2. Swine finishing facility with 2-stage anaerobic lagoon. The 2-stage lagoon volumes were based on Mid-West Plan Service recommendations for the finishing floor capacity that was built. At the time of the salt buildup, the lagoon was
approximately 4 years old and had never been pumped down. The finishing floor had been kept near 100% capacity. The flushing system was continuous under-slotted floor flushing consisting of an iron pump and 3" PVC rigid pipe. Producer fed a ration that contained magnesium oxide supplement. Severe salting occurred in the pump housing and a salt buildup around pump inlet severely restricted flow into pump. The pump inlet pipe from lagoon had a 1/2" buildup in pipe. PVC pipe elbows downstream from pump had 1/4" salt buildup. Openings of distribution pipe in flush gutter were severely restricted. Producer solution was to replace the pipe and rebuild the pump. Severe buildup again occurred after 6 months. Glacial acid then was used to reduce or maintain a minimum salt buildup.

3. Swine finishing floor with 1-stage anaerobic lagoon. The single stage lagoon volume was based on Mid-West Plan Service recommendations for the finishing floor capacity. The flushing system consisted of PVC rigid pipe, siphon flush, tanks, and pump. The finishing floor was near capacity. The lagoon was filled with waste water from flushing during the winter without filling the lagoon with an initial volume of clean water equal to the minimum design volume. Severe salting of lines occurred and the pump seized due to buildup of salts in the pump housing approximately 9 months after the first flush was drained into the lagoon. The lagoon was not pumped down. Producer solution was pump replacement.

Results of a Survey on Salt Buildup in Recycle Flushing Systems in Other States

A survey of several states (Arkansas, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Missouri, North Carolina, South Carolina, Tennessee, Texas, and Virginia) was made to determine the severity of salt formation in recycle flush-lagoon systems. The problem was found to be widespread and had serious consequences. No pattern in the cause or development of the salt problem was found. The following areas in the flushing system were found to be most troublesome due to the formation of salts.

- Metal components. The crystals are found to form more readily on metal surface; such as, steel, brass bronze, and cast iron which were a part of pumps or screens. There seems to be little difference between metal types. The crystals are tightly bonded to metal surfaces.

- Non-metal components. Crystals have been found to form on plastics, concrete, and fiberglass. The rate of crystal formation, the incidence and the bonding tenacity of the crystals to these surfaces are less than on metal surfaces.

- Formation points in flushing system piping. Crystallization has been found primarily in elbows, fittings and other discontinuities in plastic pipe in flush systems. Crystals have formed in areas where there is an accumulation of grit or where foreign material may lodge. Once crystallization starts at these points, the salt formation process builds on itself and propagates outward along a pipe length and around the circumference.
Cause of the Formation of Magnesium Ammonium Phosphate

The actual initiation of the salt formation cannot be pinpointed or predicted, but the formation seems to be associated with a high concentration of magnesium, ammonium and phosphate ions that are dissolved in the lagoon water. When these concentrations become too high, the ions can precipitate onto a pipe or a pump surface as magnesium ammonium phosphate from the lagoon flush water if an initiation process occurs.

In recycling lagoon water for flushing, a closed system is established in which nutrients from manure, spilled grain, and urine are continuously accumulating. During excessive dry spells, the evaporation of water from a lagoon will reduce the total volume and will concentrate the nutrients. If there is no output, such as regular irrigation of a portion of the lagoon contents, or addition of dilution water to a lagoon, there will be a higher probability of the formation of crystalline deposits in the recycle pipe and pump.

Suggested Management Practices for Reduction of Salt Formation

The following suggestions have shown a reduction in the formation of crystals in some cases. The management practices are ordered in decreasing probability of success.

1. Manage the lagoon properly. Fill new lagoons to the minimum design volume prior to adding the first flush water. Also, start the lagoon in the Spring. Have the ability to add fresh water during extremely dry periods (add roof runoff or use fresh water to flush). Pump down lagoons to the minimum design volume at least once per year. For 2-stage lagoons, pump down the first stage of the lagoon because it contains higher concentrations of the nutrients that will form the crystals.

2. Avoid oversizing pumps. Keep the flow velocities in the pipes in the range of 2-4 feet per second. Use pipes with diameters no smaller than 1 1/2". The pump suction line should be at least one size larger than the discharge pipe in order to prevent pump cavitation. Use flexible plastic pipe and use long sweep elbows for direction changes in order to reduce the number of fittings in the system.

3. Ground all pumps using direct grounding.

Post Salt Formation Treatments

Once salt formation has progressed to the point where the recycle flushing system does not function properly, the primary producer solution has been replacement of the piping and/or the pump. But, if the crystalline formation in the pipe can be diagnosed early, a management technique can be utilized to remove the salt buildup already present in the flushing system. This technique is acid cleaning. Dilute acids have dissolved the salts that have built up on pump and
pipe surfaces. Heavy salt buildups may require successive treatments of acid followed by flushing of the acid and the solids from the system to a lagoon. The flushing pipe and pump must be isolated and drained before the acid solution is put into the system. A more expensive, but more thorough, cleansing of the system is the installation of an acid recirculation loop. PVC and polyethylene pipe can be treated with solutions of muriatic acid (hydrochloric acid) or acetic acid. Up to a 20% solution can be used on these plastics but only a 10% acid solution is recommended on metal parts because acid will dissolve the metal. Acetic acid thought dissolves metals at a much lower rate than muriatic acid. Acid treatments should be used on a periodic basis if salt buildup is found to persist.

Summary

Salt formation in a recycle flush lagoon system is a major drawback; but attention to the suggested management techniques, particularly at the time of construction or renovation, can lessen the impact of crystal formation.

References
