Dairy Milk House Wastewater Treatment Research and Demonstration

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Introduction

Many small and mid-sized dairy operations in Minnesota need to upgrade their milk house wastewater handling systems to comply with Minnesota Feedlot Rules (Minnesota Rules Chapter 7020). Producers want systems that perform reliably, meet environmental regulations, fit their management practices, and are economical to install and operate.

The purpose of this project is to demonstrate and evaluate alternative systems for handling milk house wastewater in Carver and Wright counties. A multi-agency collaborative effort is guiding and funding the research. Outreach efforts will provide producers, engineers, Extension educators, and technical staff practical and technical information on the systems used in the study. Performance, cost, and management information gathered will be disseminated statewide.

The multi-agency team obtained grant and matching funds to design and construct eight demonstration systems and monitor their performance in Wright and Carver Counties for two years. Seven systems were installed Fall 2001 and one system was installed in 2002. The systems were installed on working dairy farms varying in size from 50 to 130 cows. There are four different types of treatment systems: two types of aerobic treatment units (ATU) that currently discharge to tile lines; two bark beds; an ATU with a drip distribution system; and a spray irrigation system. All of the systems include a septic tank for primary treatment.

Wastewater flow rates and strength

Wastewater system design depends on flow rates and wastewater strength. Water flow data was collected on 11 farms for one year prior to wastewater system design and installation. Water flow rates ranged from 95 to 441 gallons per day (gpd) or from 2.9 to 6.4 gpd/cow. Before the wastewater systems were designed and installed, five influent samples were collected from each participating farm to estimate wastewater strength. This initial data was summarized and a biological oxygen demand (BOD_5) of 1100 mg/L was used in the design to represent typical BOD_5 levels leaving a septic tank.

Preliminary analysis of effluent leaving the septic tanks in the project had an average BOD_5 of 2220 mg/L, chemical oxygen demand (COD) of 3360 mg/L, total suspended solids (TSS) of 1030 mg/L, and fats, oils and grease (FOG) of 650 mg/L. BOD_5 levels ranged from 76 to 9400 mg/L with similar variability in the other parameters. Three farms had significantly higher than average values. These three farms had significantly higher concentrations of all parameters measured.

The unexpectedly higher wastewater strength in some systems was likely due to greater amounts of milk in the wastewater. Milk has a BOD_5 value of 100,000 mg/L (Wrights and Graves, 1999). Studies have indicated that over half of the solids present in milk house

wastewater are of the colloidal or super-colloidal size (Millen, 1977). Due to the colloidal nature, septic tanks can provide minimal solids separation (Zall, 1972). It is not practical to design milk house wastewater systems to treat waste milk or colostrum. Alternative methods need to be developed to handle waste milk and colostrum.

Wastewater systems

All of the wastewater systems have a septic tank with at least 24 hours of detention time as the first treatment element. Time in the septic tank allows soaps, bedding material, and milk fats to float to the top to form a scum layer and heavier solids including floor lime, dirt, and biomass to settle to the bottom to accumulate in a sludge layer. The septic tanks are emptied once or twice per year to remove accumulated scum and sludge.

Two systems use bark beds with pressure distribution to treat the septic tank effluent. Bark beds are relatively flat areas with a surrounding berm filled with two to three feet of bark. The bark encourages evaporation, microbial activity, and infiltration in cold weather. The beds are sized based on both organic loading rate and hydraulic acceptance of the soil. The recommended distance between the bark bed soil surface and the high water table is 24 inches (NRCS, 1996). The two bark bed systems were placed in wooded areas to avoid using cropland. The bark bed systems have worked without a problem. Water samples from within the beds have not yielded sufficient quantities for analysis.

Three types of aerobic treatment units are being used. In the fall of 2002, two Biomicrobics FAST® and two NCS Nibbler® systems were installed at four dairy farms. These systems were designed with a surface discharge goal of 25 mg/L BOD_5. In 2003, a Pirana® unit was installed in a system to discharge through a drip irrigation field. The aerobic treatment units (FAST® and Nibbler®) had removal efficiencies early in the study for BOD_5, COD, TSS, and FOG ranged from 44 to 94%, 32 to 94%, 61 to 82%, and 71 to 98%, respectively. The ATU systems are reducing BOD_5 levels. The higher than expected wastewater strength may require management changes or system redesigns to achieve the design discharge goals.

The final system was an irrigation system, to surface apply septic tank effluent to a filtration/infiltration area. Two types of irrigation heads were used. An impact head was used in warm weather. Four "wobbler" heads, which are more resistant to freezing, were used in cold weather. The pump is in a screened pump tank downstream and next to the septic tank. A sloped 2-inch line to the sprinkler heads drains back into the pump tank to reduce the potential for freezing in cold weather. Effluent is applied at agronomic rates. The irrigation system did experience some freezing and odor issues but continued to operate through the first winter.

The average equipment and installation cost was nearly $10,000 for the eight systems with a range of $6,200 to $14,400. Cost sharing, experience, and non-research situations are expected to reduce out of pocket costs to producers.

For more information

More information is available on the web at http://www.bae.umn.edu/extens/milkhouse/. Fact sheets are being developed. Tours and workshops will be held in 2004 and 2005. System monitoring will continue into 2005.

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