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Madison, South Dakota WWTP Aerobic Digestion System Case Study

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History and Objectives

Madison Wastewater Treatment Plant (WWTP) in Madison, South Dakota currently operates an Ovivo Airbeam™ cover aerobic digestion system and was commissioned on April 2009.

Madison WWTP previously operated an anaerobic digestion system. The anaerobic digestion system previously had odor problems due to high ammonia concentrations as well as foaming issues. In addition, the system had operation and maintenance issues associated with storing, disposing, and handling methane and anaerobic gas vents freezing during winter climate. In order to eliminate the operation and maintenance and odor issues at the Madison facility it was proposed to convert the anaerobic digestion system to an aerobic digestion system. Banner & Associates was contracted by the City of Madison, SD to design an aerobic digestion system.

Madison, SD WWTP Aerobic Digestion System Design

Banner Engineering proposed to retrofit the two existing aerobic digestion tanks with an Ovivo Airbeam cover aerobic digestion system to minimize odors and operating and capital costs. This system would also provide maximum mixing and aeration efficiency of primary and waste activated sludge while using minimum energy requirements and provide optimum temperature control to improve digestion of sludge. Covering the aerobic digester tanks physically controls odors and also provides faster kinetic reactions in the system resulting in shorter solids retention time in the existing tanks to obtain Class B stabilized sludge which prevented the construction of new tanks.

Each aerobic digester tank was designed with an Airbeam cover integrating Ovivo's Multi-Eductor Draft Tube (MEDT) Aeration System. The MEDT allow the diffusers to be submerged several feet above the bottom of the tank floor reducing the blower discharge pressure resulting in lowering energy requirements of the aerobic digestion operations. Primary sludge (PS) and waste activated sludge (WAS) enter the two aerobic digesters which are operated in series where they reside until stabilized to Class B requirements. Figure 1 below describes the general process flow of the Madison, SD WWTP Aerobic Digestion System.

Figure 1: Madison, SD WWTP Aerobic Digestion System Process Flow Diagram

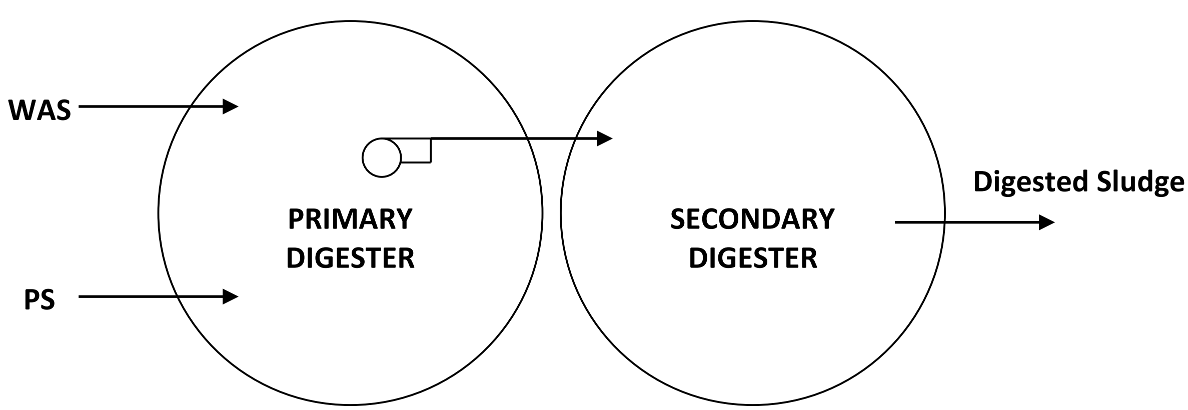

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Figure 2: Multi Eductor Draft Tube Airbeam™ Cover Aerobic Digestion System

Airbeam™ Cover Aerobic Digestion System

MEDT Aeration Equipment Under the Airbeam™ Cover

Results of the Madison, SD WWTP Airbeam™ Cover Aerobic Digestion System

Data from the Madison, SD WWTP Aerobic Digestion system was collected from January 2012 to June 2014. A discussion of these results is highlighted below.

Temperature Control

Temperature control is essential to a successful aerobic digestion process. The Airbeam cover design for each aerobic digester tank in the aids in temperature control primarily during winter operations. Temperatures between 20°C to 35°C provide the most favorable aerobic digestion conditions. Temperatures lower than 10°C inhibit nitrification and can create odor issues, while temperatures greater than 37°C create thermophilic conditions. The aerobic digesters were able to sustain temperatures no lower than 17°C from 2012 to 2014. Figure 3 shows the temperature maintained in each aerobic digester tank and shows the tanks consistently maintained a temperature that achieves optimum aerobic digestion performance.

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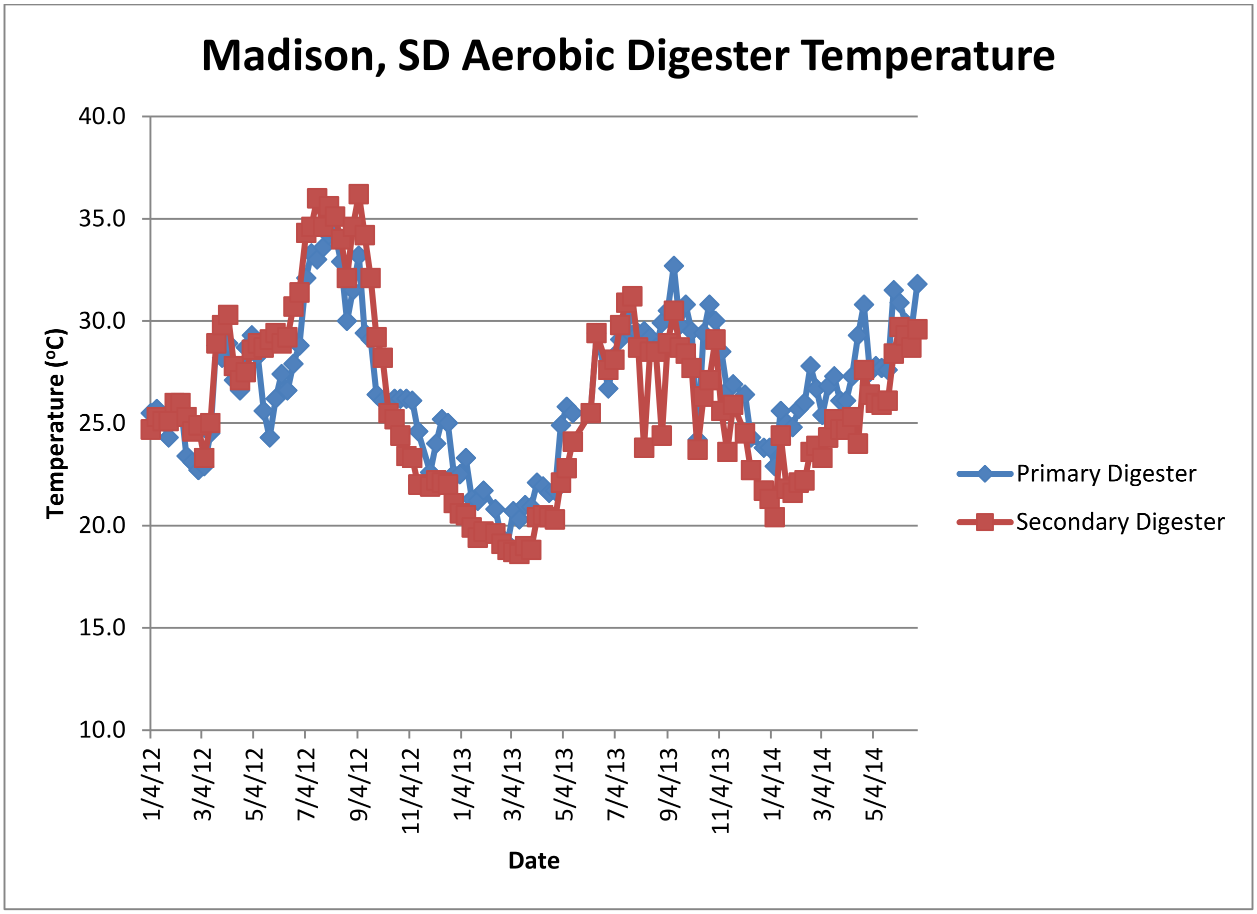
Figure 3: Madison, SD WWTP Aerobic Digestion Temperature Data



Improved VSR and Sludge Minimization

Solids at this facility were greatly minimized. The raw primary and secondary sludge enters the aerobic digesters at solids concentrations typically between 2.5% to 4%. After the sludge is digested in the aerobic digestion system it is reduced between 1.5% to 2% solids when transferred out of the second stage digester. The solids reduction typically ranged between 45% and 60% (average of approximately 51%).

Excellent VSR is achieved at this facility by maintaining outstanding temperature control maintained in the aerobic digester tanks as noted above. VSR typically ranges between 40% and 60% (average of approximately 49%). The solids reduction data is shown in Figure 4 below, while VSR data is shown in Figure 5 below.

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Figure 4: Madison, SD WWTP Aerobic Digestion System Solids Data

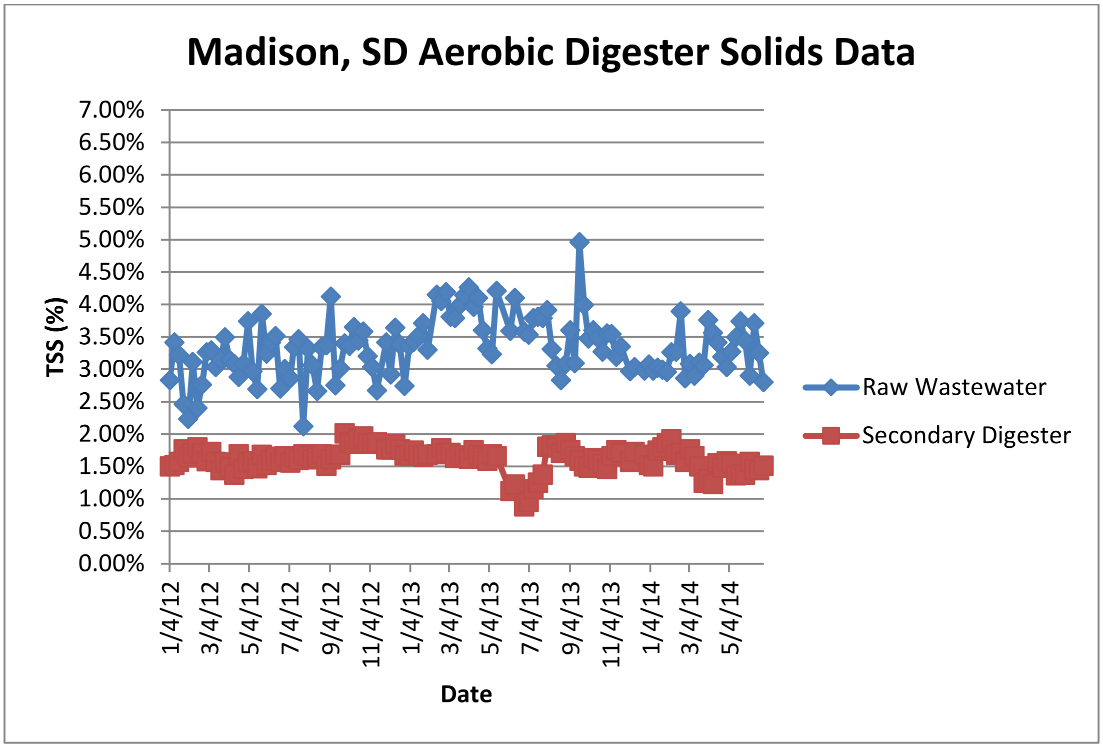
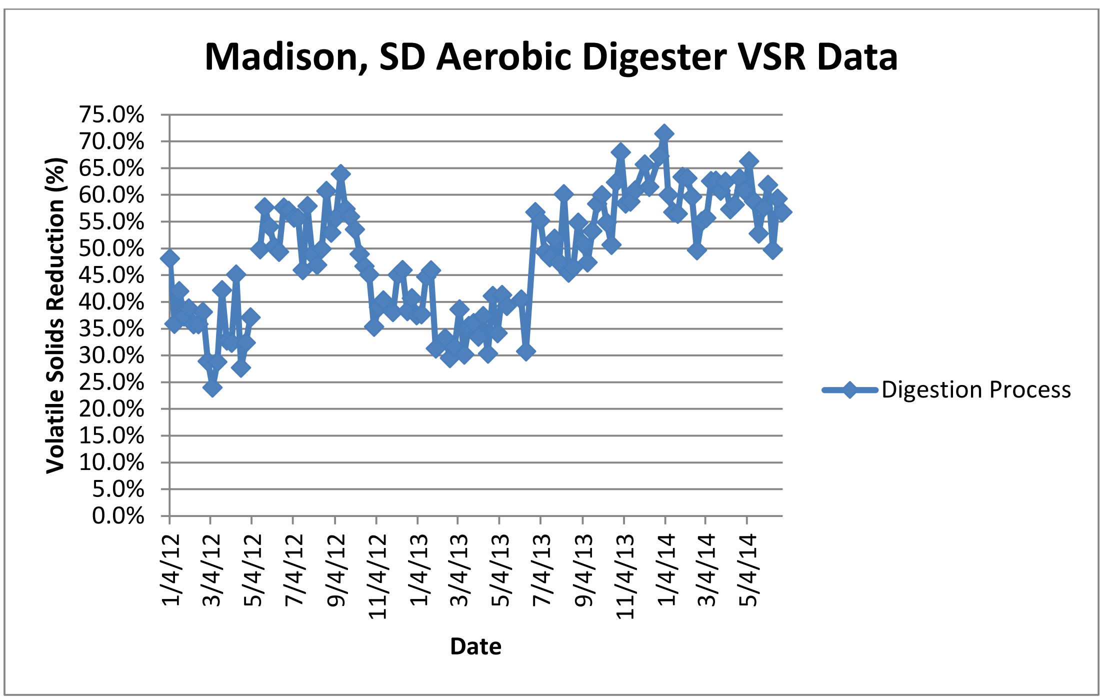


Figure 5: Madison, SD WWTP Aerobic Digestion System VSR Data



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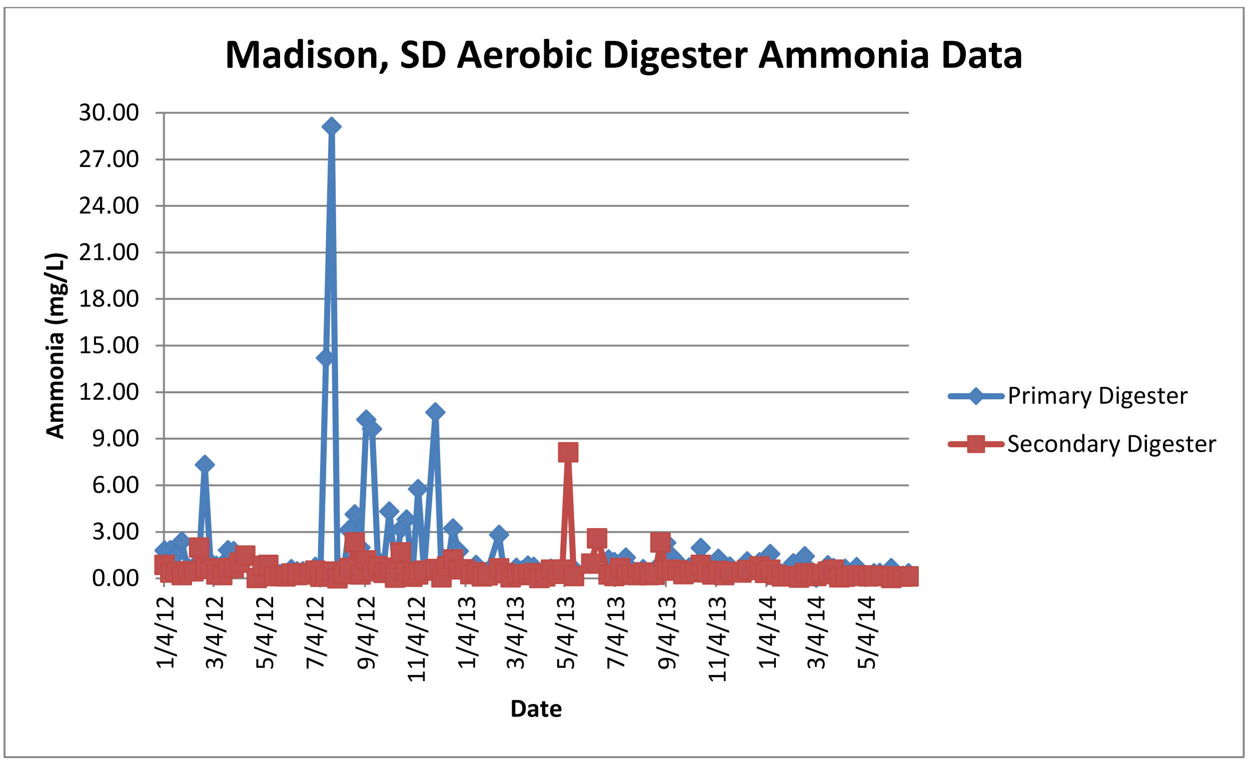
Excellent Ammonia Control

Processing solids with concentrations greater than 3% causes concerns with adequate oxygen transfer and mixing for an aerobic digestion system. If there is insufficient aeration and mixing in an aerobic digestion system, ammonia a product of the biological process of an aerobic digestion system cannot be oxidized into nitrates which will continue to accumulate. Ammonia accumulation is problematic in an aerobic digestion system because it is toxic to microorganisms and also creates odor problems. Excellent ammonia control is maintained in the aerobic digesters at this facility. As seen in Figure 6 below ammonia concentrations are almost always below 2 mg/L in the primary digester and typically below 1 mg/L in the secondary digester. The maximum ammonia concentration from 2012 to 2014 in the primary digester was 29.1 mg/L and 8.12 mg/L in the secondary digester. The ammonia results indicate adequate oxygen transfer and mixing in the system as well as minimum ammonia accumulation.

Figure 6: Madison, SD WWTP Aerobic Digestion System Ammonia Data



Conclusions

Based on the data collected from 2012 to 2014 the Airbeam cover aerobic digestion system at the Madison, SD facility has achieved outstanding VSR, solids minimization, and ammonia control results.