HIGH SOLIDS CENTRIFUGE EXPERIENCE AT THE OSHKOSH, WI WASTEWATER TREATMENT PLANT

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INTRODUCTION

High solids dewatering centrifuges were installed as part of a two-phase upgrade of the wastewater treatment facility serving the City of Oshkosh and several adjacent sanitary districts. The centrifuges dewater anaerobically-digested primary and waste-activated sludge and were commissioned in March of 1997. Dewatered sludge is transported from the treatment facility and land applied by a private farmer / contractor. The City of Oshkosh owns a dewatered sludge storage facility that is rurally located adjacent to agricultural land owned and cultivated by the contractor. Information concerning the Oshkosh treatment facility, costs associated with construction and operation of the centrifuge dewatering units, and general experience from the first six months of dewatering facility operation are included below.

TREATMENT FACILITY DESCRIPTION

The Oshkosh Wastewater Treatment Plant is located between Dempsey Drive and Campbell Road, adjacent to Campbell Creek, in the City of Oshkosh. The plant is a 20 MGD activated sludge treatment facility with phosphorus removal and nitrification requirements. The solids handling system includes waste-activated sludge air-floatation thickening, primary and waste-activated sludge storage, two-stage mesophilic anaerobic digestion, centrifuge dewatering and agricultural land application. Treatment facility design loads and effluent requirements are shown in Table 1.

TABLE 1

OSHKOSH WWTP

TREATMENT FACILITY CHARACTERISTICS

Design Flow Rate, mgd	
Dry Weather	12.9
Average Wet Weather	20.0
Influent Loads, lb/d	
BOD	20,800
TSS	16,400
TKN	5,335
P	515
Solids to Anaerobic Digestion, lb/d	27,300
Solids to Dewatering, lb/d	23,400
Effluent Requirements:	
BOD, mg/L	30
TSS, mg/L	30
NH_3-N, mg/L	(seasonal) 6
Fecal, col./100 ml	400

A municipal wastewater treatment plant has been located at the existing plant site since 1937 when a trickling filter, anaerobic digestion and sludge drying bed facility was operational. A more sophisticated wastewater treatment plant, which employed comminution, influent pumping, aerated grit removal, primary sedimentation, activated sludge secondary treatment, effluent disinfection, and thermal sludge conditioning, vacuum filter dewatering and landfill sludge disposal, was commissioned in 1975. Since 1937, land surrounding the treatment plant has gradually developed into a mixed use commercial and residential area which includes a supermarket, senior citizens center, and university athletic fields.

FACILITIES PLANNING, DESIGN AND CONSTRUCTION

The City of Oshkosh completed a facilities plan in 1992 to address general improvements required at the plant as it neared 20 years of service and to address the requirement for seasonal nitrification. Through facilities planning, it was resolved that energy consumption, dewatered sludge cake solids content, solids handling system recycle streams and plant odor control were key site specific issues that had to be addressed. In order to address these needs, it was determined that improvements would be required to both the wastewater treatment and the solids handling portions of the facility. It was also determined that the required improvements would be undertaken in two phases. The first phase would address mainly wastewater treatment needs, and the second phase would address solids handling and other general facilities needs.

Phase 1 design and construction addressed head works modifications including new climber screens, an additional raw wastewater pump, and side wall extensions in the aerated grit chamber area to address hydraulic concerns. Improvements to the activated sludge area included an additional aeration blower and sidewall extensions on the mixed liquor inlet channels of the rim flow final clarifiers. Disinfection modifications included new evaporators, chlorinators and a sodium bisulfite dechlorination system. The construction cost for phase one improvements was $2.3 million.

Concurrently with the first phase of improvements, the City of Oshkosh undertook a 20-year privatization effort for transportation and land application of dewatered solids from the treatment facility. This privatization would include both the existing dewatered thermally conditioned sludge and the dewatered anaerobically digested sludge that would be produced after planned improvements were completed. The city paid purchased a rural sludge storage structure and is currently paying $10.88 per wet ton for transportation, storage activities and land application of dewatered sludge.

Phase 2 design and construction addressed new air addition, polymer and internatant recirculation systems for the dissolved air floatation thickeners; new gas recirculation mixing compressors for the sludge storage tanks; new anaerobic digesters to replace the thermal sludge conditioning system; a new centrifuge dewatering and loading facility; and reconfiguration of areas within the existing administration and solids handling buildings for improved maintenance, laboratory and office spaces. The cost for Phase 2 construction, which is currently nearing completion, is $16.3 million. The construction cost associated with the digestion and dewatering facilities was $11.62 million. The solids handling construction cost was split as follows among the different components: anaerobic digestion facility—$5.40 million; centrifuge dewatering and loading facility—$5.39 million; tunnel extension—$0.38 million; and site work—$0.45 million. The installed cost for the centrifuges and manufacturer provided power and control systems, was $1,177,000.

CENTRIFUGE CHARACTERISTICS AND PERFORMANCE

The centrifuges installed at the Oshkosh treatment plant are Alpha-Laval DS 706 high solids machines. Two units were installed as part of the Phase 2 improvements, and space for a third unit was provided. The centrifuge bowl speed is 2,800 rpm and the relative conveyor speed is variable from 1 to 26 rpm. The main drive motor is rated at 300 horsepower, and a 100-horsepower conveyor back drive is provided. The back drive is used to slow the conveyor and functions as a generator which feeds power back into the electrical system. The net nominal operating horsepower of each operating centrifuge is on the order of 130 to 150 horsepower.

Specified performance requirements for each centrifuge are shown in Table 2. It should be noted that for performance condition 1, hydraulic loading rates govern unit operation due to the relatively lower solids concentration in the feed sludge. For performance condition 3, the solids loading rate to the machine governs operation, which reduces the sludge flow rate to the machine at this higher feed sludge solids concentration. The design feed sludge was specified to have a volatile solids fraction of 50 percent. A 0.75 percentage point reduction in the cake solids content of the dewatered sludge was allowed for each 2.0 percentage point increase in volatile feed solids content.

TABLE 2

OSHKOSH WWTP

CENTRIFUGE DEWATERING FACILITY

PERFORMANCE REQUIREMENTS

	Condition		
	1	2	3
Feed Solids Concentration, %	2.0	2.64	3.75
Feed Rate, gpm	325	325	229
Dry Solids Loading, lb/hr	3,253	4,300	4,300
Cake Solids Content, %	27	27	27
Solids Recovery, %	95	95	95
Polymer Dosage Rate, lb	20	18	16
$ / Dry Ton	40	36	32

Performance testing was conducted in mid August 1997. Testing was conducted over a three day period, with each of the machines run for two of the three days. Testing results are summarized in Table 3. The performance test was conducted on a feed sludge that had a lower total solids content than that specified in the performance criteria. This initially concerned by the equipment manufacturer, however, all performance requirements were met during acceptance testing. The centrifuges were operated by City of Oshkosh personnel during acceptance testing.

TABLE 3

OSHKOSH WWTP

CENTRIFUGE ACCEPTANCE TESTING

	Unit No. 1	Unit No. 2
Feed Rate, gpm	325	325
Feed Solids, %	1.81	1.80
Volatile Solids, %	58.4	58.0
Cake Solids, %	24.5	24.7
Solids Capture, %	98.1	97.8
Polymer Dosage, lb/ton	20.1	20.8
Polymer Cost, $ / ton	31.1	32.2

Centrifuge operators at the plant have achieved significant improvement in polymer cost for dewatering since startup. At startup, a significant inventory of anaerobically digested sludge had to be moved out of the plant in order to avoid a final period of operation of the thermal sludge conditioning system. Consequently, the priority at startup was on solids capture and sludge feed rate, rather than polymer optimization, and a high polymer operating cost was incurred. Optimization by the operators has resulted in a current cost for polymer that is 33 percent of that used during the early weeks of operation. Operating changes that have been made include changing polymers, allowing a slightly reduced solids capture, using less polymer for sealing the centrifuge upon initial daily operation, and reducing the polymer feed rate more rapidly once the machine is sealed. Periodic cost data taken from the centrifuge operators' log books are presented in Table 4.

TABLE 4

OSHKOSH WWTP

CENTRIFUGE DEWATERING POLYMER COST

Period (1997 Week)	Cost ($ / Ton)
3 - 10	68.80
3 - 31	51.57
4 - 28	33.48
5 - 26	33.38
6 - 30	32.79
7 - 28	36.20
8 - 18	42.77
8 - 25	25.60
9 - 02	23.02

Currently, one of the two centrifuges is operated 12 to 16 hours per day and 3 to 4 days per week. Operating costs for the centrifuge dewatering system are running at approximately $40 per ton dry solids fed to the units. This operating cost is comprised of $23 per ton for polymer, $12 per ton for labor and $5 per ton for electrical power. Since commissioning the new anaerobic digestion and centrifuge dewatering solids handling system, electrical power costs at the plant have been reduced by roughly 23% due to the reduced power required for solids handling and side stream treatment.

OPERATION AND MAINTENANCE INPUT

Design and startup of the centrifuge dewatering system involved a significant commitment by the plant operating and maintenance staff. Their effort was not limited to learning operating and maintenance routines, but also included optimizing the system to improve function and cleanliness.

Their comments regarding startup of the system and their efforts to improve operation are summarized in the remaining paragraphs.

The Robbins and Myers centrifuge feed pumps are operating as designed and the high and low pressure shut down feature is appreciated. Plant staff did modify the packing water, flushing box arrangement.

The BTG solids concentration meters on the centrifuge feed sludge stream were field tested prior to design and found to be more precise than the nuclear density meters previously installed at the treatment plant. Weekly calibration of the high solids BTG meter has not been found to vary more than 0.5 % total solids. The meters are considered to be a valuable tool for controlling dewatering unit polymer costs.

The Stranco dry polymer feed system is a “jewel” from the operators’ perspective. The operators learned rapidly and feel very comfortable with the principles of its operation. Polymer batches are replicated very closely, and the operators have not experienced variations in centrifuge performance due to unadjusted changes in polymer concentration.

The Alpha-Laval, Sharples centrifuges are running smoothly on a 12 to 16 hour per day, 3 day per week schedule. Initial commissioning issues that had to be resolved were limited to replacement of motor overload switches and adjustment of SCADA permissive control switches.

The belt conveyors were messy, upon initial startup, with sludge sticking to rollers and belts when polymer doses were in excess of 40 lb per ton. After polymer doses were controlled to less than 30 lb per ton, performance improved to the point that dry cleanup and doctor blade adjustment is undertaken only once per week. The drop chutes from the conveyors into the hauling trucks were equipped with a small deflection plate designed by one of the operators to direct the cake into the center of the trailer body. The staff refer to these as “Juedes” plates after the operator who conceived their design using scrap aluminum from old street signs.

The Duall two stage odor control system was only operated during the summer months. During other periods, the scrubbers will be bypassed and the building will be exhausted directly to the atmosphere. Recommissioning in May should be accomplished in a matter of hours.

The centrifuge dewatering system at the Oshkosh wastewater treatment plant has been successfully commissioned. Additional operating time will be required to assess the maintenance requirements of the system. Additional progress is also expected with regard to reducing overall operating costs of the system. As the DAF modifications are commissioned, the digester and centrifuge feed solids concentrations are expected to increase. This should reduce the number of centrifuge operating hours required and aid in meeting the goal of continued operating cost improvement.