



WICHITA WATER UTILITIES

Sewage Treatment Plant
2305 E. 57th St. S.
Wichita, KS 67216

2016

Solids Processing

This simplified manual focuses on the operating variables and the troubleshooting guides needed to facilitate the operation of our facility in a cost-efficient and effective manner. It is not meant to cover every aspect of our equipment. It is a quick reference, designed to be used as a working tool for both new and experienced operators. It is also available in electronic format for editing, as the need arises, to keep it always current.

Process Description



The solids processing system consists of waste activated sludge (WAS) pumping, aerobic digestion, sludge thickening with a gravity belt thickener (GBT), and sludge dewatering with a centrifuge. WAS is pumped from the final clarifiers to either of two aerobic digesters. The sludge is then withdrawn from the digesters, thickened through the gravity belt thickener, and thickened sludge is transferred back into the same digester from where it was withdrawn. This process is referred to as recuperative thickening, and the digesters are intended to be operated between 1.5%-2% total solids (TS). Mixing using diffused air is difficult to achieve in digesters operating above 2% TS. It is not recommended to operate the digesters in excess of 2% TS unless mechanical mixing is installed. Air is provided to each digester by positive displacement blowers and each tank contains a fine-bubble, tube diffuser grid. A summary of major equipment and capacities for the solids processing system is provided in Table I-3.

SLUDGE WASTING

WAS can be transferred from the final clarifiers to either aerobic digester by opening/closing various valves in the Sludge Handling Building basement. Digester #1 and Digester #2 represent approximately 60% and 40% of the total digester volume, respectively. Sludge should be wasted at approximately that same ratio to each tank to provide similar solids retention time (SRT) in each digester. The valve configurations for the two wasting scenarios is shown in Table I-1.

Table I-1: Valve Configuration for Wasting Scenarios

Valve No.	Valve Name	WAS to Digester #1	WAS to Digester #2
1	New Valve #1	OPEN	CLOSED
2	New Valve #2	CLOSED	OPEN
3	GTV-33018	CLOSED	OPEN
4	GTV-33019	OPEN	OPEN

RECUPERATIVE THICKENING

The aerobic digesters are designed to be maintained at an in-tank total solids concentration between 1.5-2% TS. As WAS is pumped into either digester, the TS concentration in that digester will decrease. To keep the digester at the design TS concentration, sludge must be pumped from the digester to the GBT, and the thickened sludge must be pumped back into the digester until the target solids concentration is achieved. The daily run time required for recuperative thickening is dependent on the initial solids concentration in the digester being thickened, the performance of the GBT (solids concentration leaving the thickener), volume and TS concentration in WAS entering digester, and volume of sludge withdrawn for dewatering.

To initiate thickening of a digester, the process valves must be properly configured to allow pumping from the desired digester to the GBT, and then pumping thickened sludge from the GBT discharge back

to the desired digester. The valve configurations required for various recuperative thickening schemes are shown in Table I-2. *Note that the suction and discharge valves surrounding the duty pump(s) must be open. Leaving duty pump suction and/or discharge valve(s) closed may cause permanent damage to pump, piping, or valves, and may pose safety risk to operator.*



Table I-2: Valve Configuration for Thickening Scenarios

Valve No.	Valve Tag	Recuperative Thickening – Digester #1 ^a	Recuperative Thickening – Digester #2 ^a	Thicken Digester #1 to Digester #2 ^a	Thicken Digester #2 to Digester #1 ^a
1	New Valve #1	CLOSED	OPEN	OPEN	CLOSED
2	New Valve #2	OPEN	CLOSED	CLOSED	OPEN
3	GTV-33018	OPEN	CLOSED	CLOSED	OPEN
4	GTV-33019	OPEN	OPEN	OPEN	OPEN
5	GTV-33020	OPEN	CLOSED	OPEN	CLOSED
6	GTV-33021	CLOSED	OPEN	CLOSED	OPEN
7	GTV-33032	CLOSED	CLOSED	CLOSED	CLOSED
8	GTV-33034	OPEN (CLOSED)	OPEN (CLOSED)	OPEN (CLOSED)	OPEN (CLOSED)
9	GTV-33039	CLOSED	OPEN	OPEN	CLOSED
10	GTV-33040	CLOSED	CLOSED	CLOSED	CLOSED
11	New Valve #3	CLOSED (OPEN)	CLOSED (OPEN)	CLOSED (OPEN)	CLOSED (OPEN)
12	GTV-33201	OPEN	OPEN	CLOSED	CLOSED
WAS Conditions					
-	Can WAS be sent to Digester #1?	No	Yes	Yes	No
-	Can WAS be sent to Digester #2?	Yes	No	No	Yes

Notes:

- a After running thickening processes, the feed lines to the digester receiving thickened sludge may be partially filled with sludge with TS between 4%-6%. If WAS pumps have trouble starting up following thickening process, running a flush procedure directly after thickening may help reduce the initial operating pressure for WAS pumps. The configuration of valves (in parentheses) above are positions required to conduct a flushing procedure. *Note that discharge valves (GTV-33037 and GTV 33038) on GBT discharge pumps need to be closed to prevent backflow into GBT discharge hopper.*

Table I-3: Sludge Processing Major Equipment & Capacities



System Component	Description	Capacity
WAS Pumps	Manufacturer: Haywood Gordon Type: Screw Centrifugal Model: XCS4-B Quantity: 2	Design Flow: 200 gpm Design Head: 8 feet
GBT Feed Pumps	Manufacturer: Moyno Type: Progressive Cavity Model: 1H175G1 Quantity: 2	Design Flow: 500 gpm Design Head: 50 feet Design Speed: 305 RPM Variable Speed
Gravity Belt Thickener	Manufacturer: Ashbrook Model: 2-Meter Aquabelt 85 Quantity: 1	Design Flow: 500 gpm (max) Design Loading: 2,500 lbs/hr Discharge Solids: 4-6%
GBT Discharge Pumps	Manufacturer: Moyno Type: Progressive Cavity Model: 1G115G1 Quantity: 2	Design Flow: 250 gpm Design Head: 25 feet Design Speed: 224 RPM Variable Speed
Digester Loadout Pump	Manufacturer: Moyno Type: Progressive Cavity Model: 1H175G1 Quantity: 1	Design Flow: 500 gpm Design Head: 50 feet Design Speed: 305 RPM
Aerobic Digester #1	Tank Diameter: 75 feet Maximum Operating Depth: 15.5 feet Working Volume: 512,200 gallons Depth to Top of Diffusers: Approx. 14.5 feet	2,100 lbs WAS/d ^a
Aerobic Digester #2	Tank Diameter: 60 feet Maximum Operating Depth: 15.5 feet Working Volume: 327,800 gallons Depth to Top of Diffusers: Approx. 14.5 feet	1,400 lbs WAS/d ^a
Aerobic Digestion	Total Volume: 840,000 gallons	3,500 lbs WAS/d ^a
Centrifuge Feed Pump	Manufacturer: Boerger Type: Rotary Lobe Model: PL200 Quantity: 1	Design Flow: 115 gpm Design Head: 70 feet Design Speed: 270 rpm
Dewatering Centrifuge	Manufacturer: Westfalia Model: CF 466 Quantity: 1	Design Feed TS: 1.6% Design Flow: 115 gpm Design Load: 920 lbs/hr Design Cake TS: >20% Design Loadout: 75 ft ³ /hr
Cake Conveyors	Manufacturer: Keystone Conveyor Conveyor #1 Length: 6'-9" Conveyor #1 Pitch: 15° Conveyor #2 Length: 30'-0" Conveyor #2 Pitch: 30°	Design Capacity: 100 ft ³ /hr Conveyor #1 Speed: 23 rpm Conveyor #2 Speed: 38 rpm

Notes:

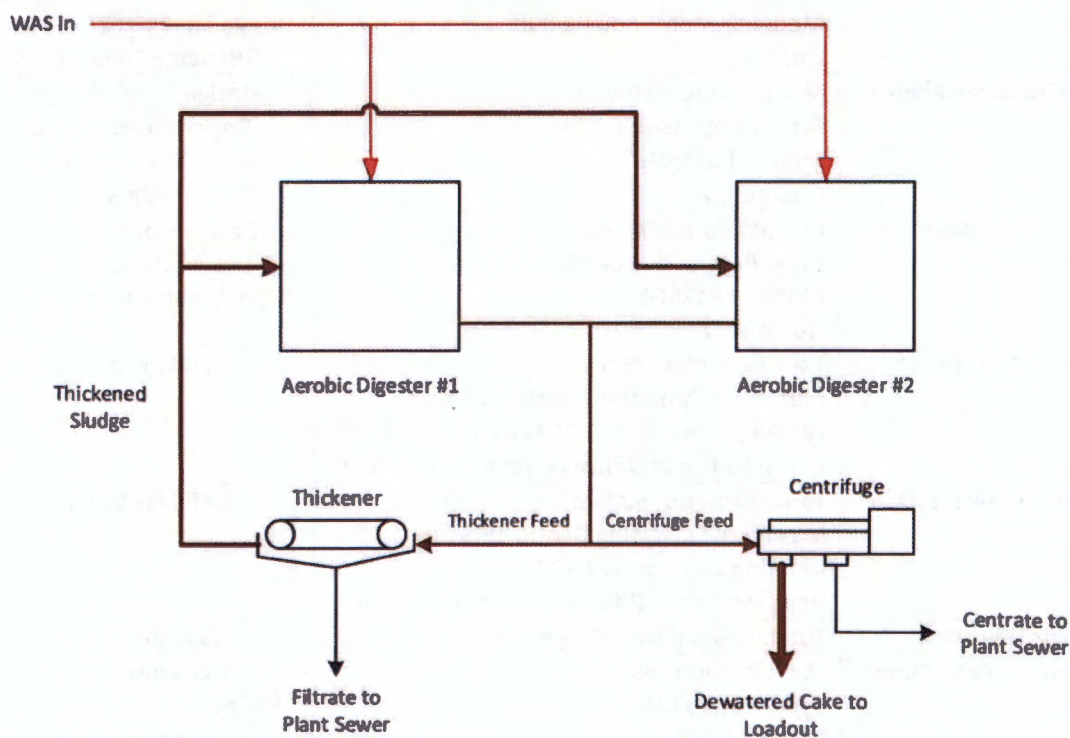
- a Digester capacity varies based on feed sludge characteristics and site specific process kinetics. Capacities stated are based on meeting 60-day SRT at 15°C assuming typical volatile solids destruction. Process monitoring required to establish actual

capacity and confirm produced biosolids conform to USEPA Class B requirements (if applicable) for pathogens and vector attraction reduction (VAR).

DIGESTER MANAGEMENT

Effective operation of the aerobic digestion system relies on managing the volume of each digester relative to planned WAS loading, desired digester TS concentration, and planned sludge withdrawal to the dewatering system. The aerobic digesters should be maintained at a TS concentration up to 1.5%-2% when solids loading approaches the design capacity of the digesters.

Figure I-1: Flow Diagram for Solids Processing System



The only incoming flow to the solids processing system is WAS pumped from the final clarifiers. Daily wasting volumes may vary and are dependent on WAS TS concentration. The outgoing flows include GBT (thickener) filtrate and centrifuge feed (dewatered cake and centrate). Managing volumes entails developing a weekly schedule for each digester that includes incoming WAS volume, dewatered cake production and planned centrifuge run time, and thickener operating time and approximate filtrate volume required. *Operating depths should be monitored frequently to make sure that neither digester exceeds a depth of 15.5 feet.* Refer to the interactive spreadsheet to aid in developing weekly solids processing schedule. The parameters shown in

Table I-4 should be routinely monitored to help develop run times and establish digester performance.

Table I-4: Recommended Daily Monitoring for Solids Processing System




Parameter	Type / Location	Monitoring Frequency
WAS Total Solids	Grab sample (WAS sample port)	Daily
WAS Volatile Solids	Grab sample (WAS sample port)	Daily
WAS Temperature	Grab sample (WAS sample port)	Daily
Digester Operating Depth (both tanks)	Continuous / Instrument	Continuous during solids processing operations
Digester Total Solids (both tanks)	Grab sample (in tank/access hatch)	Taken daily at beginning and end of operations.
Digester Volatile Solids (both tanks)	Grab sample (in tank/access hatch)	Taken daily at beginning and end of operations.
Digester Temperature (both tanks)	In tank / In place	Daily
Digester pH (both tanks)	In tank / In place	Daily
GBT Cake Total Solids	Grab sample (discharge chute)	Samples taken during equipment operating period.
GBT Filtrate Total Solids	Grab sample (discharge drain)	Samples taken during equipment operating period.
Centrifuge Cake Total Solids	Grab sample (discharge sample valve)	Samples taken during equipment operating period.
Centrifuge Centrate Total Solids	Grab sample (discharge sample valve)	Samples taken during equipment operating period.

CLASS B BIOSOLID PRODUCTION

To achieve a stabilized, Class B biosolid that can be readily land applied for limited surface disposal applications, the sludge leaving the aerobic digesters must comply with the USEPA requirements set forth in 40 CFR Part 503. Biosolids must meet minimum requirements for pathogen removal and vector attraction reduction (VAR). The pathogen testing requirement can be bypassed if the solids can be proved to have been stabilized in a process that qualifies as a Process to Significantly Reduce Pathogens (PSRP).

Assuming a minimum wintertime temperature of 15°C, the aerobic digesters must be operated at a minimum SRT of 60 days to comply with PSRP requirements. The digesters must also be properly mixed and aerated to maintain a minimum dissolved oxygen concentration of 1.0 mg/L. In lieu of qualifying as a PSRP, solids leaving the digester must be monitored for geometric mean fecal coliform density and contain less than 2 million colony-forming units (CFU) or most probable number (MPN) of fecal coliform per gram of biosolids (on a dry weight basis). Based on a 60-day SRT, pathogen testing is anticipated to be required if average solids loading to the aerobic digesters exceeds 3,500 lbs per day.

The VAR requirement can be satisfied in one of three ways:

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1. Volatile solids reduction in the aerobic digester meets or exceeds 38%. This requires monitoring influent and effluent total and volatile solids.
 2. Demonstrating a specific oxygen uptake rate (SOUR) at 20°C that is less than or equal to 1.5 mg of oxygen per hour per gram of total solids.
 3. Demonstrating that volatile solids reduction during bench-scale aerobic batch digestion for 30 additional days at 20°C is less than 15%.

Refer to the USEPA publication *Control of Pathogens and Vector Attraction in Sewage Sludge* for detailed process and testing requirements for producing Class B biosolids through aerobic digestion.

DIGESTER BLOWERS

Each aerobic digester is served by two identical positive displacement blowers: Digester #1 is served by two 75-HP blowers operated at constant speed and Digester #2 is served by two 100-HP blowers operated at variable speed using VFDs.

Digester #1 is designed to operate with one blower operating at full speed to provide adequate mixing. If a dissolved oxygen concentration of 1.0 mg/L cannot be sustained, the second blower may be called on to provide additional air.

Digester #2 is designed to operate with one blower operating at full speed to provide adequate mixing. Since the blowers serving Digester #2 are operated with VFDs, the speed may be adjusted to maintain a minimum dissolved oxygen concentration of 1.0 mg/L with one or two blowers in operation.

The digesters are operated in manual mode. Prior to operating a blower, the discharge valve should be completely opened. If only one blower is in use, the discharge valve for the standby blower should be closed. The pressure relief valves should be routinely calibrated to ensure that they are set to open at approximately 8.5 psig. If the relief valves open at lesser pressures, the diffusers may not see optimum flow and pressure, and hot air will be discharged into the Blower Building.

The vacuum pressure should be monitored daily to track degradation of the intake filters due to particulate accumulation. The initial clean filter vacuum pressure should be recorded as a reference point to determine when the intake filter performance begins to degrade to unacceptable levels. The blower supplier recommends replacing the intake filter at least once every six months.

SLUDGE DEWATERING CENTRIFUGE

The centrifuge is configured to allow dewatering of sludge from either digester. A rotary lobe centrifuge feed pump is installed in the basement of the Sludge Handling Building. The suction piping is tied into the digester effluent lines for both Digester #1 and Digester #2. Each tie-in point can be isolated with a plug valve, and the pump is surrounded by a suction valve and discharge valve to allow the pump to be isolated and taken out of service. Dewatered sludge (cake) is discharged from the centrifuge to a series of two shaftless screw conveyors that ultimately discharge cake to a dump truck or roll-off container located adjacent to the east side of the Sludge Handling Building. The maximum allowable volumetric

feed rate to the centrifuge is based on solids loading and varies depending on TS concentration in the digester (Table I-5). The maximum sludge feed rate to the centrifuge is 125 gpm due to pump capacity.



Table I-5: Centrifuge Maximum Feed Rates

Feed TS	Maximum Flow, gpm
1.5%	125
1.6%	115
1.7%	110
1.8%	100
1.9%	95
2.0%	90

The suction and discharge valves surrounding the centrifuge feed pump should always be in the full-open position during normal operation. The centrifuge should be operated to dewater sludge from one digester at a time; if sludge from Digester #1 is to be dewatered, the isolation valve for Digester #2 should be closed, and vice versa.

The centrifuge system includes the feed pump, polymer feed system, centrifuge, conveyor, and flush valves for centrifuge startup and shutdown. The centrifuge control panel is designed to automatically control all system components from startup to shutdown, unless otherwise noted.

The polymer feed system is automated and controlled by the centrifuge main control panel. The polymer feed rate can be set by the operator through the control panel and does not require adjustment unless feed conditions change or centrifuge performance deteriorates.

The centrifuge solids discharge is served by two conveyors. Discharged solids are dropped onto Conveyor #1, which pulls the solids up a 15° incline. The solids are then dropped onto Conveyor #2, which continues to push the solids up a 30° incline out of the building. During startup and shutdown, the solids discharged from the centrifuge are normally too thin to be conveyed up Conveyor #1. During these phases, Conveyor #1 is reversed and all discharges from the centrifuge are diverted to the drain system. To ensure proper drainage of the sludge, a flush valve located near the bottom of the conveyor is automatically opened during startup and shutdown. A manual throttling valve is located directly upstream of the automatic valve to control the flow of flush water. Once this valve is adjusted, it should not require readjustment unless drainage problems are encountered.

During the centrifuge shutdown phase, an automatic flush valve located upstream of the centrifuge influent flow meter is opened. Similar to the conveyor flush valve, a manual throttling valve is located directly upstream of the automatic valve to control the flow of flush water. Once this valve is adjusted, it should not require readjustment unless process issues associated with shutdown are encountered.

Centrifuge performance can be tracked by retrieving samples from the solids discharge chute and centrate chute to measure dewatered cake total solids content, and suspended solids content of the centrate.

Operations Checklist - Centrifuge

I. PRE-START CHECKLIST

Verify that all equipment has been installed in accordance with instructions and drawings contained in the Westfalia Centrifuge submittal package. For equipment that has been stored long term, confirm that the valving, pumps and controls have been stored in a dry, protected area.

II. CENTRIFUGE INITIAL STARTUP

- Refer to the manufacturer provided instruction manual for detailed instructions for commissioning and operation of the dewatering centrifuge.
- Following installation of the centrifuge, it is important that any extraneous material be removed from the unit before it is commissioned.
- Verify that the centrifuge feed pump suction and discharge valves are fully open.
- Verify that the isolation valves for the digesters are properly configured. The centrifuge should be fed from one digester at a time.
- Verify that there is adequate quantity of polymer and that all manual valves for raw polymer, dilution water, and polymer feed are in proper position.
- Verify that flush water manual throttling valves have not been closed.
- Continue to initiate startup as prescribed in manufacturer provided instruction manual.

III. EMERGENCY OPERATIONS

If the centrifuge exhibits any signs of malfunction or if sludge appears to be spilling from the machine or conveyor, initiate shutdown immediately through local control panel HMI. Conveyors can also be stopped manually with emergency pull cords, if necessary. Refer to manufacturer provided O&M manual for detailed emergency procedures.

IV. SHUTDOWN

- If the centrifuge is not in timer mode, initiate shutdown through the local control panel HMI.
- (Optional) To flush polymer feed line, operate the polymer feed system in manual mode with dilution water only for several minutes.

V. MAINTENANCE

The centrifuge is a mechanically complex piece of equipment. Refer to the Westfalia Lubrication and Maintenance Schedule for list of maintenance work and recommended duration.

Troubleshooting Guide - Centrifuge

Refer to page 92-93 of the manufacturer provided instruction manual for safety information and troubleshooting associated with operational malfunctions, including start-up, bearing, and vibrational issues. Many of these issues require skilled technicians to address. The table below includes additional problems and troubleshooting measures that may be more readily addressed by operations staff.

Problem	Recommended Troubleshooting Measures
Centrate solids concentration too high	<ol style="list-style-type: none">1. Decrease solids feed rate.2. Optimize polymer feed rate or polymer type.
Conveyor draining slowly or overflow of sludge from conveyor(s)	<ol style="list-style-type: none">1. Clean out drain line.2. Decrease solids feed rate.3. Optimize polymer feed rate or polymer type.4. Verify automatic flush valves are operating properly.5. Adjust flush water manual throttling valve.
Centrifuge Feed Pump automatically shutting down.	<ol style="list-style-type: none">1. Verify that pump suction and discharge isolation valves are fully open.2. Verify that digester tie-in valve is fully open.3. Check centrifuge feed line for plugging.

Technical assistance can be had by contacting the local Westfalia representative, Mike Rudy, at (316) 305-7839.

Troubleshooting Guide – Blowers

Refer to the manufacturer provided instruction manual for safety information and troubleshooting associated with operational malfunctions, including start-up, shut down, bearing, and vibrational issues. Many of these issues require skilled technicians to address. The table below includes additional problems and troubleshooting measures that may be more readily addressed by operations staff.

Problem	Recommended Troubleshooting Measures
Elevated discharge pressure (> 8.5 psig, no blow-off)	<ol style="list-style-type: none"> 1. Take blower out of service. 2. Check pressure relief valve for sticking. 3. Remove bonnet and check for damage. Repair as needed. Apply no seize lubricant. Replace bonnet. 4. Perform calibration on pressure relief valve to ensure weights are balanced and valve opens at proper discharge pressure. 5. Contact service technician.
Pressure relief valve blow-off	<ol style="list-style-type: none"> 1. Take blower out of service. 2. Check pressure relief valve for sticking. 3. Perform calibration of pressure relief valve to ensure weights are balanced. 4. If pressure relief valve opens below 8.5 psig, add additional weights to relief valve incrementally until proper discharge pressure set point of 8.5 psig is reached. Blower should be taken out of service prior to each weight addition, and weights should be added one set at a time. 5. If pressure relief valve is opening at or near 8.5 psig, check that discharge valves are fully open and blower piping is unobstructed. Ensure that digester total solids concentration is below 1.5-2%. 6. Contact owner's engineer.
Digester tank does not appear to be turning over/mixing adequately	<ol style="list-style-type: none"> 1. Ensure that blower discharge valves are fully open and that blower piping is unobstructed. Replace blower intake filter if vacuum pressure has increased from new filter condition. 2. Reduce operating total solids concentration below 1.5%-2%. 3. Perform digester diffuser cleaning and/or replacement as needed and according to manufacturer's instructions. 4. Contact owner's engineer.

Technical assistance can be had by contacting the blower supplier, United Blower, at (770) 479-3000. Technical assistance for the digester diffusers can be had by contacting the local EDI representative, Dave McClure, at (816) 522-4594.