CHEMICALLY ENHANCED PRIMARY TREATMENT (CEPT) SYSTEM

16.1 OVERVIEW

PURPOSE

The ferric chloride ($FeCl_3$) and polymer makeup systems (in combination, referred to as the CEPT system) increases the efficiency of the primary clarifiers by adding flocculants to the incoming wastewater, thereby increasing the total suspended solids (TSS) and particulate biochemical oxygen demand (PBOD) removal. The polymer injection system was installed to optimize the flocculant addition and reduce chemical ($FeCl_3$) demand.

Enhanced TSS and PBOD removal assists in the overall treatment process by reducing the organic load on the secondary treatment system. Further benefits include reduction of sulfides which can cause odors and better dewaterability of the anaerobically digested sludge. These systems were installed as an interim measure to gain capacity in the secondary treatment process, but their continued use will allow the plant the flexibility to treat peak flows and optimize the anaerobic digestion process.

DESCRIPTION

The ferric chloride and polymer storage and metering systems consists of the following components:

1. Ferric Chloride storage tank
2. Ferric Chloride feed pump skid
3. Ferric Chloride feed lines
4. Polymer storage tote
5. Polymer makeup system
6. Polymer storage feed lines

The ferric chloride storage tank, pumps, and feed lines are shown in Figure 16-1 Ferric Chloride System Schematic. Bulk ferric chloride is pumped from a delivery truck into the storage silo. The ferric chloride is pumped through feed lines to inlet channels for the grit removal basins.

The polymer solution feed system is shown in Figure 16-2 Polymer System Schematic. The neat solution of polymer is pumped from the storage tote and activated through mechanical mixing with utility water before being injected into the effluent channel of the grit removal basins.

The injection points are designed to allow the ferric and polymer solution to mix with the incoming wastewater and develop a fully developed floc. After reaching the primary clarifiers, the floc then assists with “sweeping” the TSS and PBOD to create larger aggregated particles that settle much faster. The process is referred to as Chemically Enhanced Primary Treatment or CEPT.

FERRIC CHLORIDE STORAGE TANK

Bulk ferric chloride ($FeCl_3$ solution) is delivered to a storage tank located adjacent to the headworks facility on the north. The tank is 10 feet in diameter with a capacity of approximately 6,000 gallons. At a typical concentration of 42 percent, the silo will hold approximately 35 tons of ferric chloride solution (14.7 tons of $Fe\ Cl_3$). A reverse level device provides a visual level indicator. The tank is also equipped with a level transducer that reports tank level to the chemical supplier to assist with scheduling chemical delivery. The chemical supplier's device is accessible through the internet. Download the application "Smartank" by SkyBitz Tank Monitoring Corp. This is a Chicago based company (888-826-5546) to access the tank level via smart phone or computer.

The tank is single-walled and contained within a concrete basin with 7,000 gallons of secondary containment should there be a catastrophic failure of the holding tank.

POLYMER STORAGE TANK

The neat anionic polymer solution is delivered and stored in a 250-gallon tote located in the headworks building electrical/mechanical room. The polymer solution is periodically mixed to keep the polymer in suspension, using a surface mounted agitator type electric mixer. The tote is connected to the polymer dosing pump through a flexible tubing connection.

FERRIC CHLORIDE FEED PUMPS

Ferric chloride is pumped by redundant mechanically actuated diaphragm metering pumps. The feed rate is controlled by variable speed drives. In its configuration at installation, the pump is rated for flows up to 17.5 gallons per hour with a turn down of approximately 100:1.

The pumps are located on a pump skid, which contains all components necessary for calibrating or replacing the pump without modifying the piping outside of the skid. The skid has pulsation dampeners, which reduces pressure fluctuations caused by the positive displacement action of the pumps. The skid is also equipped with a pressure relief valve, which prevents ruptures in the feed lines in the event of a blockage, and a pressure gauge for monitoring the feed line pressure.

FERRIC CHLORIDE FEED LINES

The ferric chloride feed lines are installed to feed the chemical to the inlet of the grit basins. Lines traverse from the tank or tote to the feed pumps and through the screen room. Drop points to the two channels feeding the basins have automatic isolation valves (FV-24-101, 201) to select one or both injection points.

POLYMER MAKEUP SYSTEM

The polymer makeup system is a self-contained skid (ProMix) equipped with a peristaltic neat polymer pump, polymer mixing chamber, calibration column, system control panel and associated valving and piping.

The system uses the polymer pump to feed the neat polymer into the mixing chamber where primary dilution water is added to allow activation of the polymer. Post-mixing, secondary dilution water is combined with the activated polymer to allow for the desired solution strength for delivery to the grit separator effluent channel. The manufacturer's O&M manual for the system is contained in Attachment C.

POLYMER FEED LINES

The activated polymer feed lines are installed to feed the chemical to the grit basin effluent channel to allow mixing prior to being discharged into the primary clarifiers. Polymer feed tubing traverse from the polymer mixing skid, through the electrical room, up through a pipe penetration in the ceiling over to the grit removal effluent channel where the chemical is discharged.

16.2 PROCESS CONTROL

The dose rate for both the ferric chloride and polymer can be controlled by the plant SCADA system. The system is designed to take the set-point dose and flow pace the injection rate based on plant effluent flow. Effluent flow is monitored by a Parshall flume downstream of the disinfection process. Set point dose is determined by jar testing and observed performance of the system.

FERRIC CHLORIDE DENSITY

The density of ferric chloride is a function of its concentration. The safety data sheet for ferric chloride can be found in Attachment A. Normally, the ferric delivered to the plant will be between 40-42%. The density at this concentration is 12.1 pounds per gallon. Minor variations to this density with changes in temperature but are insignificant with respect to calculating chemical dose.

POLYMER DENSITY

The density of the emulsion polymer is a function of its solution chemical properties as supplied by the manufacturer. The safety data sheet for the neat polymer currently in-use at the plant can be found in Attachment C. Normally, neat polymers for use in wastewater have densities of 1.03 to 1.10 grams / cm^3.

FERRIC CHLORIDE PUMP OUTPUT

The ferric chloride dosing rate is a function of the stroke frequency and stroke volume setting on the mechanical diaphragm pump. System pressure, in this case, is simply due to line loss since the discharge is essentially to gravity. Ideally stroke and frequency should be between 20 and 70 percent to ensure highest accuracy. The system is fitted with a calibration column in order to verify pump output. Calibration instructions are contained in the pump and calibration cylinder sections of the manufacturer's O&M materials (see Attachment B). The pump should be recalibrated every month to ensure diaphragm integrity and consistent dosing.

CALCULATIONS

$$\text{Ferric requirement} = \frac{\text{plant flow} \times 8.34 \times \text{ferric dose} \times}{\text{density of ferric chloride} / 24}$$

Where:

	ferric dose	(mg/l as $FeCl_3$)
	density of ferric chloride	(12.1 lbs./gal)
	plant flow	(MGD)

Example:

$$\text{Ferric requirement} = \frac{6.0 \text{ mgd} \times 8.34 \text{ lb./gal} \times 10 \text{ mg/l} \times 0.42 \text{ lb./lb.}}{12.1 \text{ lb./gal} \times 24 \text{ hr./day}}$$

Ferric requirement = 0.72 gal/hr (45 ml/min)

POLYMER MAKEUP SYSTEM OUTPUT

Polymer dosing rate to the plant varies between plants, polymer types and mixing and activation effectiveness, with installation specific trials used to determine the most effective/economical rates. Typically activated polymer concentrations between 0.3 to 1.5mg/l are used for CEPT.

The ProMix polymer mixing skid in controlled by the plant SCADA to pace the polymer injection to total plant flow. Example polymer metering pump speed calculations are shown below. Additional instructions are contained in the manufacturer's O&M materials (see Attachment D).

CALCULATIONS

Plant Flow Conversion (M L/Gal)	= A * 3.78541 L/Gal
Polymer Density Conversion (M mg/Gal)	= B * 1000 mg/g * 1000cm^3/L * 3.78541 L/Gal * 0.0000001 M L/L
Polymer Dosing (Gal/Day)	= (plant flow (M L/Gal) / polymer density conversion (M mg/Gal)) * C
Polymer pump speed (%)	= Polymer Dosing (Gal/Day) / D * 100%

Where:

A = plant flow (MGD)
B = polymer density (g/cm^3)
C = polymer dose (mg/L)
D = polymer max pump speed (Gal/ Day)

Example:

A= 4.90 MGD
B = 1.043 g/cm^3
C = 1.30 mg/l
D = 15.70 GPH

Plant Flow Conversion (M L/Gal)	= 4.90 * 3.78541 = 18.548 L/Gal
Polymer Density Conversion (M mg/Gal)	= 1.043 * 1000 * 1000 * 3.78541 * 0.0000001 = 3.94818 M mg/Gal
Polymer Dosing (Gal/Day)	= 18.548 / 3.94818 * 1.3 = 6.1072 Gal/Day
Polymer pump speed (%)	= 6.1072 / 15.70 * 100% = 38.89%

ROUTINE MONITORING

When the ferric and polymer system pumps are in operation, check at least weekly for leakage at the pump assembly, for excessive system pressure at pressure gauge; and for leaks at the pressure release valve.

Periodically check pump output using the calibration columns and adjust flowrate setting as needed.

Visually check for leaks in the storage tank.

Visually check the chemical feed outlet to ensure proper placement to achieve adequate mixing.

LABORATORY CONTROL

The following items should be checked daily:

1. Primary clarifier TSS removal rate. Feed rates should be adjusted to optimize ferric/polymer dose and TSS removal

163 CONTROL SYSTEMS

FERRIC METERING PUMP

Refer to the manufacturer's O&M information for manual operation of the ferric metering pumps. The pumping systems can be switched between manual and automatic (auto) operation. In auto, the pumps are controlled by the plant SCADA system and paced automatically based on the plant effluent flow. The dosage rate can be adjusted from SCADA and will match variations in plant flow. For a full description of the pump controls, to include installation, and input and output configuration, please refer to the manufacturer's O&M manual.

ALARMS

Ferric Tank High Level	(Based on the level transducer)
Ferric Tank High-High	(Based on float switch in ferric tank)
Pump(s) Fault	(See Attachment B for troubleshooting)
Pump Leak	(Indicates rupture in pump diaphragm or tube)
Disable	(Output contact is disabled)

FIELD MANUAL CONTROL

Press SELECT RUN MODE button until Manual Speed/Stroke Adjust is displayed. From this menu, configure the pump output speed (as a percent of max speed) using UP, DOWN, RIGHT buttons. Save changes with ENTER. The START button will start the pump at the selected speed. See manufacturer's O&M manual for additional configuration and control options.

REMOTE MANUAL CONTROL

Select the desired Metering Pump from the main WonderWare display. With the MAN/OFF/AUTO switch in the MAN position, input the pump speed.

REMOTE AUTOMATIC CONTROL

Select the desired metering Pump from the main WonderWare display. With the MAN/OFF/AUTO switch in the AUTO position, input the dosing setpoint (SP), auto-run flow minimum, ferric concentration, and metering pump max flow rate.

EQUIPMENT PROTECTION

The leak failure system triggers when moisture is detected in the pump head and indicate a leak in the diaphragm or peristaltic tube. The sensitivity of this alarm is operator-adjustable.

Replacing the diaphragms and tubes on the manufacturer's recommended schedule will reduce the likelihood of rupture.

WONDERWARE DISPLAY

Effluent Flow (MGD)
Dosing Setpoint (mg/L)
pH meter
Ferric chloride Pump Status:
- Control Value (CV)
- Process Value (PV)
- CALL
- MAN/OFF/AUTO
- Flow Rate
- FAIL
- LOW PH SHUTDOWN

POLYMER MAKEUP SYSTEM PUMPS

Refer to the manufacturer's O&M information for manual operation of the polymer makeup system. The polymer system can be operated in manual and automatic (auto) operation. In auto, the neat polymer pump speed is paced automatically by the plant SCADA based on plant effluent flow. The total dosage rate is calculated using SCADA to establish the neat polymer pump rate relative to the dilution flow rates. For a full description of the pump controls, to include installation, and input and output configuration, please refer to the manufacturer's O&M manual.

ALARMS

Pump Fail (See Attachment D for troubleshooting)

16.4 OPERATION

The ferric chloride pump system is powered from the Panel LP D, circuit 22 located in the lower level of the headworks.

The following procedures assume that the initial startup of the system has been completed, that all operating parameters have been adjusted for normal operation.

Shutdown

1. Stop the metering pumps using either local or field control.

2. Turn the power to the pump off at the drive.

3. Close the metering pump suction and discharge isolation valves.

If the system is to be shut down for an extended period perform the following:

Ferric Pumps – Completely flush the metering pump lines with water.

Polymer Makeup – Completely flush mineral oil through the pumping and mixing system.

Startup

1. Inspect all piping, and valves prior to starting up the metering pump**.**

2. Verify adequate ferric chloride in the storage tank.

3. Perform a pump calibration on all pumps.

3. Activate the metering pump using either local or field control.

16.5 PREVENTIVE MAINTENANCE

The following is a summary of the maintenance requirements for the ferric chloride and polymer systems. Please refer to the manufacturer's O&M manual for detailed maintenance instructions.

Pulsation Dampener

- Check precharge pressure monthly.
- Replace bladder annually.

Pressure Relief Valve

- Replace diaphragm annually.
- Replace adjustment spring as needed.

Backflow Prevention Check Valve

- Periodically clean the valve of any solid deposits.

Ferric chloride Pump

- Check weekly for signs of leaking, discoloration or corrosion.

Polymer makeup Skid

- Check weekly for signs of leaking, discoloration or corrosion.
- Check every month for mixing chamber motor amperage and fan cover for obstructions.
- Check every 3 months for dosing lines fittings and valves for tightness.

Pressure Gauge

- Check weekly that the feed lines are operating below the maximum pressure. In the event of over-pressurization or activation of the pressure relief valve, check for blockages in the feed lines.

16.6 SAFETY

Please refer to the individual Safety Data Sheets (Attachment A (Ferric) and Attachment C (Polymer)) for a detailed discussion of each chemical's safety requirements.

16.7 TROUBLESHOOTING

Please refer to the Manufacturer's O&M (Attachment B and D) for system trouble shooting guides.

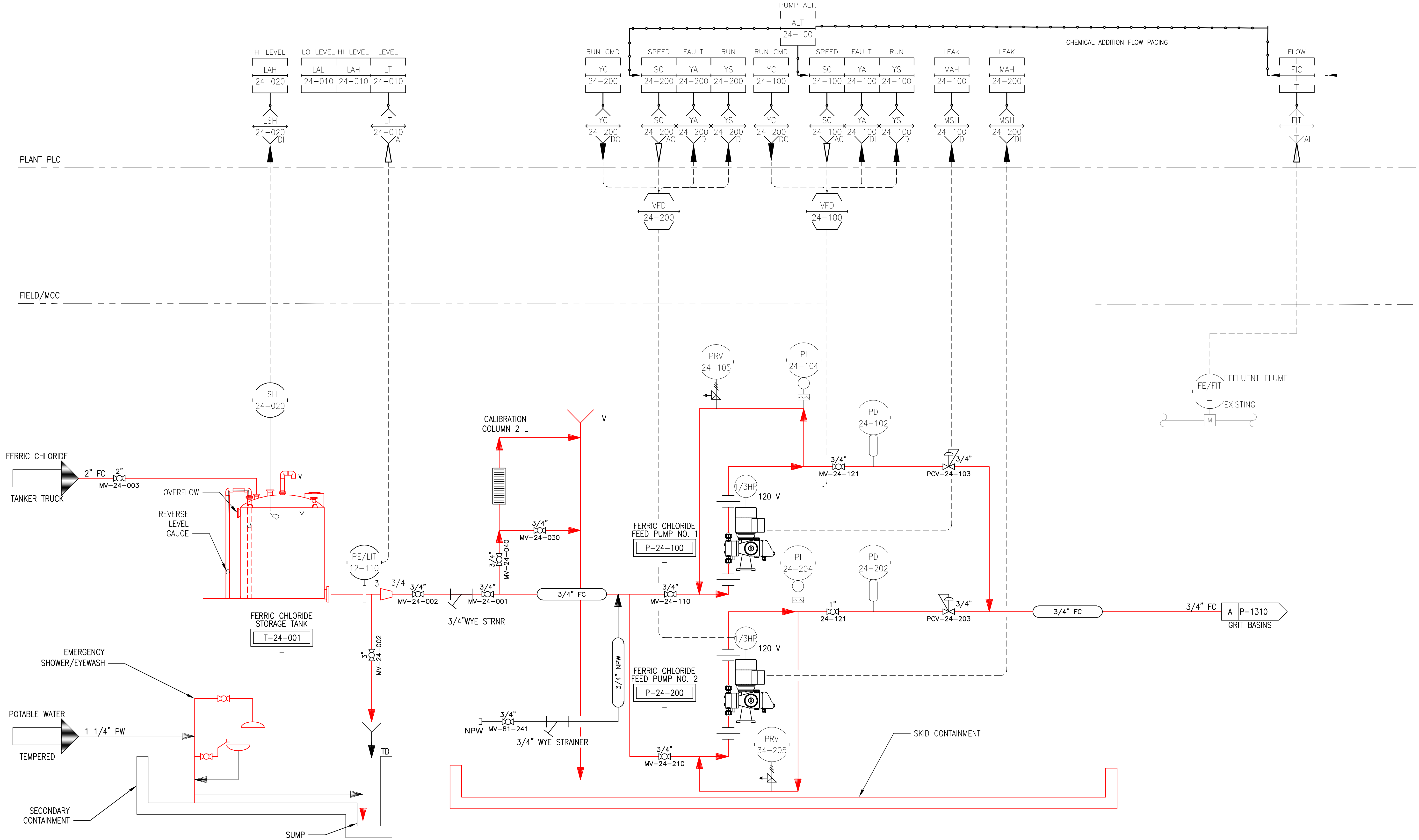
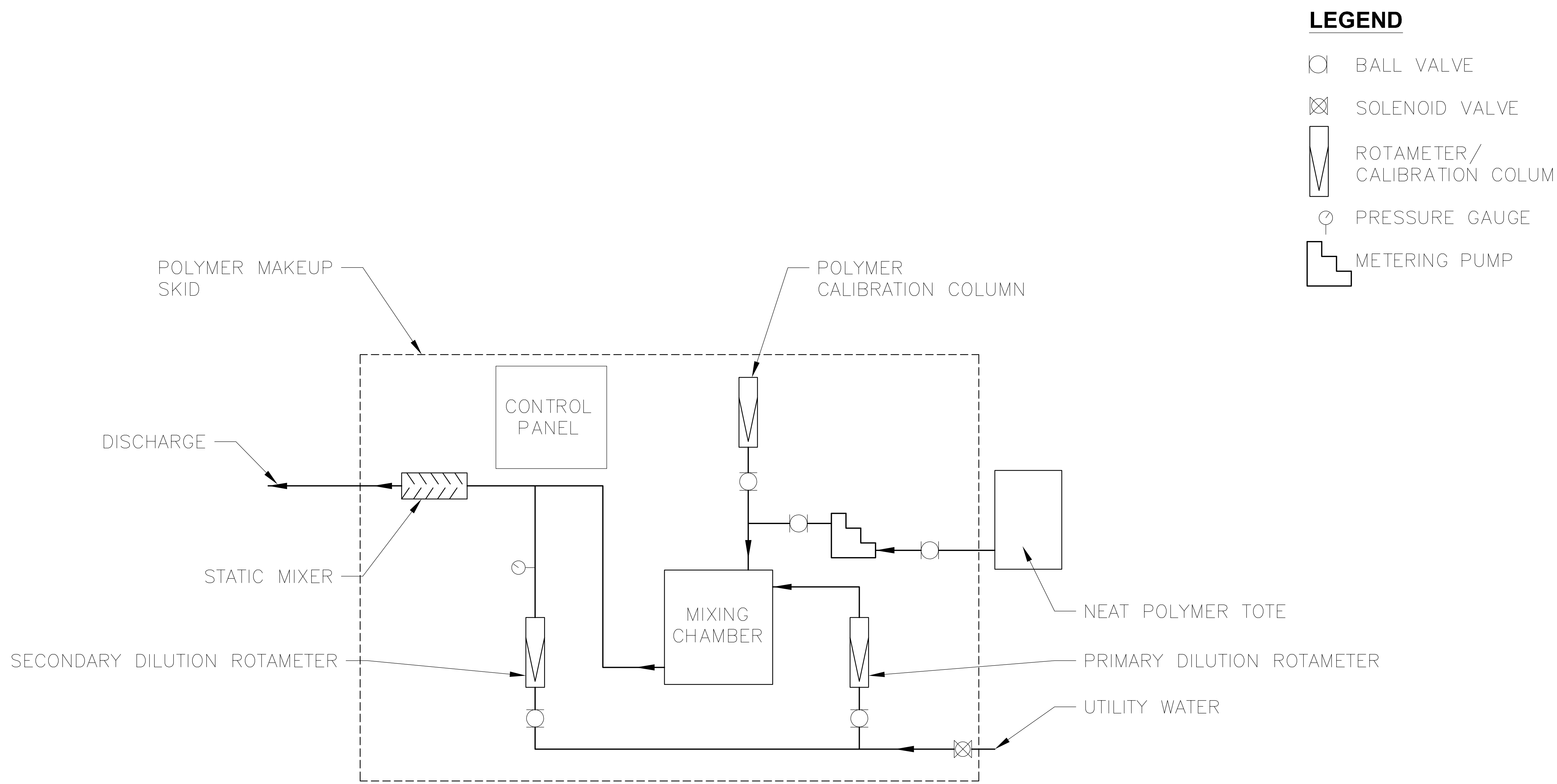


FIGURE 16-1

CEPT FERRIC CHLORIDE
CHEMICAL STORAGE AND FEED SYSTEM



CITY OF PASCO

WASTEWATER TREATMENT PLANT
O & M MANUAL

FIGURE 16-2

POLYMER MAKEUP SYSTEM SCHEMATIC

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