EXPERIENCE WITH BIOLOGICAL ODOR CONTROL AT THE PADRE DAM MUNICIPAL WATER DISTRICT SANTEE, CALIFORNIA

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ABSTRACT

The Padre Dam Municipal Water District operates a 2 million gallon per day (mgd) water recycling facility at the north end of the Santee Lakes Recreation Preserve in Santee, California. The climate in the region is Mediterranean with very few nights below 0^oC temperatures. Odor control is provided at the treatment plant and at the influent pump station three miles away.

The first odor control system was installed about 10 years ago at the influent pump station. A packed tower chemical scrubber using caustic and hypochlorite provided effective odor removal. However this system required considerable attention to maintain, and required a costly water softener system to pre-treat makeup water. Odor control at the water recycling facility was achieved by collecting off gases from the primary clarifier and using them as the air supply to the aeration process where the biological process consumed the H_2S.

In 2002 a biofilter was installed at the WRF to treat odors from the primary clarifiers. This unit was a ZABOCS Model 8000, which utilized an inorganic mineral media to treat 1500 cfm of odorous air with inlet H_2S concentrations averaging 50 ppm, and peak concentrations over 200 ppm. The ZABOCS biofilter has performed well for 3 years, with minimal maintenance required. Based on the experience with the ZABOCS 8000, PDMWD agreed to pilot a ZABOCS-BTF biotrickling scrubber with the intention of investigating a technology for possible replacement of the chemical scrubber at the influent pump station.

The results from the pilot test at the IPS showed that there was better than 99% H_2S removal at H_2S concentrations averaging 10 ppm, and with peak concentrations to 50 ppm.

The new ZABOCS BTF biotrickling filter is now installed and operating at the influent pump station. It is designed for a maximum air flow capacity of 2,500 cfm. Normal operation is expected to be 1800 cfm. Initial performance data show better than 99% H_2S removal at an average inlet concentration of 10 ppm.

KEYWORDS

Padre Dam Municipal Water District, odor control, ZABOCS, ZABOCS-BTF, biotrickling filter, biofilter.

INTRODUCTION

The Padre Dam Municipal Water District provides water, wastewater, recycled water and recreation services to 125,000 residents in eastern San Diego County, including the communities of Santee, El Cajon, Lakeside, and Alpine. Of the 5.2 million gallons of commercial and residential wastewater collected, roughly 60% is discharged to the San Diego Metropolitan Wastewater System, and the remainder is sent to the Padre Dam Water Recycling Facility. The Padre Dam Water Recycling Facility (WRF) treats 2 million gallons per day of wastewater, providing recycled water for irrigation and industrial use, and for the Santee Lakes Recreation Preserve, one of the premier public park and recreation facilities in San Diego County.

The Santee Lakes Recreation Preserve, a corridor about a block wide and 2 miles long, is located in a residential section of Santee. The influent wastewater pumping station is located at the South end of Santee Lakes, and the Water Recycling Facility is located at the North end of the complex, approximately 3 miles from the IPS. Because of the proximity of the IPS and plant to residents and parks, odor control is of prime importance.

A chemical scrubber system has been in use at the IPS for the last 10 years, providing acceptable odor control, but requiring considerable maintenance, and cost for softening of makeup water. On occasion, failures of chemical metering pumps, pH probes, flow meters and other instrumentation have resulted in odor emissions and fines from the San Diego Air Pollution Control District. In 2005 PDMWD installed a ZABOCS-BTF bio-trickling scrubber to control odors from their influent pump station.

For years the odor control system for the WRF had been achieved through collecting air from the primary clarifier head space, ant using it for aeration of the activated sludge biological wastewater treatment process. Because of corrosion control problems associated with using this method, the process was discontinued in 2002, and a ZABOCS biofilter was installed to provide H_2S removal and odor control at the Water Recycling Facility.

The ZABOCS biofilter is a 2-stage inorganic media biofilter treating 1,500 cfm of foul air from the primary clarifiers. The hydrogen sulfide concentrations average 50 to 60 ppm, with peaks up to 250 ppm. The 2-stage biofilter consists of an inorganic mineral media as the first stage, and a specially formulated carbon media as the second stage. At the average odor load, the first stage provides better than 99% odor removal. At periods of peak inlet concentrations, the second stage provides additional capacity to prevent odor releases.

Figure 1. ZABOCS Biofilter at Padre Dam Water Reclamation Facility

The ZABOCS-BTF is a bio-trickling scrubber utilizing polyurethane foam cubes as the biological support media. Because of the low pressure drop and high surface area to volume of the media, the ZABOCS-BTF can operate effectively at higher flow rates, and smaller footprint compared to the ZABOCS Biofilter. This feature enabled the new bio-trickling scrubber to be installed within the existing containment area with an overall footprint comparable to the chemical scrubber it replaced.

Figure 2: Biotrickling filter odor control system at Influent Pumping Station

ZABOCS BIOFILTER at WRF

The ZABOCS-8000 biofilter treats 1500 cfm of odorous air from the covered primary clarifiers. The ventilation rate is approximately 3 to 4 air changes per hour. H_2S concentrations range from 20 to 200 ppm, with a diurnal average of approximately 50 ppm.

The ZABOCS process swchematic is illustrated in Figure 3.

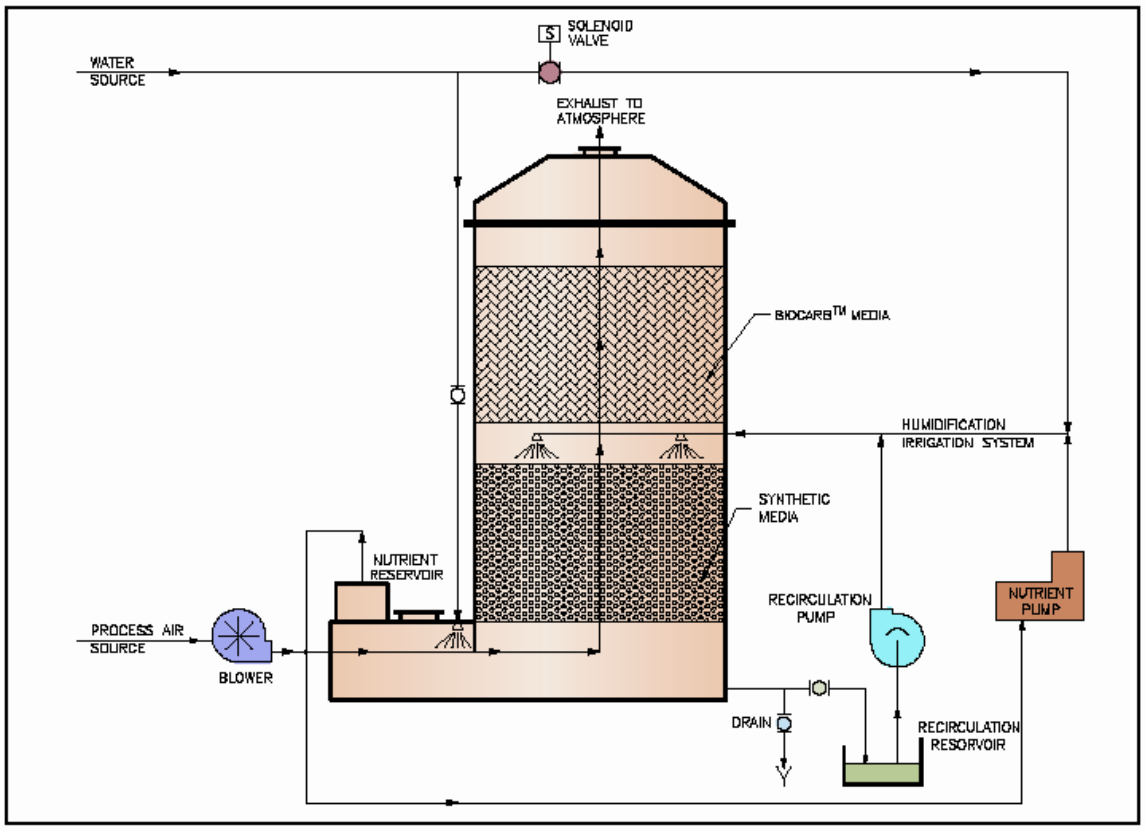


Figure 2: ZABOCS Biofilter Process Schematic

The ZABOCS biofilter has a rectangular cross section, providing a small footprint, and low profile. Figure 3 shows a photograph of the installation at Padre Dam WRF. It is a two stage biofilter, utilizing an expanded clay media in the first stage, and a specially formulated biological carbon media in the second stage. Both stages are biologically active. Under average loadings, Stage 1 removes 99% of the H_2S. Stage 2 picks up the slack under peak loads, and helps eliminate VOCs and other odorous contaminants.

The ZABOCS biofilter uses an intermittent water spray, with nutrient injection to provide the proper environment for the bacteria, and to rinse out the byproducts of the biological reaction. The mineral media is ideal for selectively growing autotrophic bacteria, such as

Thiobacillus thioxidans, which break down the H_2S and other sulfides to provide energy for growth. This biological process using mineral media is patented by Veolia OTV SA (US Patent Number 5,858,768) and is offered in the U.S.A. under exclusive license through USFilter.

The ZABOCS-8000 system has been in place for three years. During that time maintenance has been limited to addition of nutrients every two weeks, and periodic (semi-annual) inspection of fan belts and lubrication of bearings. Operation has been trouble free, with no unscheduled downtime.

Figure 3. ZABOCS Biofilter at Padre Dam WRF.

ZABOCS BTF BIOTRICKLING FILTER at IPS

The ZABOCS BTF system is installed at the Influent Pump Station, where it treats odors from the wet well. H_2S concentrations typically range from 3 to 30 ppm, with a diurnal average of about 10 ppm. During periods of peak flow concentration spikes of up to 60 ppm have been observed. The odor control system normally extracts 1,800 cfm from the wet well, providing a ventilation rate of approximately 12 air changes per hour. The ZABOCS BTF system is designed to treat up to 2,000 cfm if needed.

The ZABOCS BTF system is a biotrickling filter that uses a high capacity, low pressure drop polyurethane foam cube media as the substrate for growing sulfur-oxidizing bacteria. This enables a high air flow capacity in a relatively small footprint. The system installed at Padre Dam MWD is six foot diameter, with 9 feet of media in a 20 feet tall tower. The light weight media is supported by fiberglass grating resting on an internal fiberglass bracket bonded to the vessel wall.

The design parameters are presented in Table 1.

Design Parameter	Value
Air Flow Rate	2,500 cfm max, 1,800 cfm normal
Tower dimensions	6 ft diameter x 20 ft high
Nutrient tank capacity	150 gallons, 30 days
Liquid Recirculation Rate	20 gpm
Recirculation pH	2.0
Makeup water rate	1-2 gpm
Media depth	9 ft of EDT Filtren PUF foam cubes
Media Contact time	8.5 seconds
Head loss across media	0.25 in WC
Stack exit velocity	3200 fpm max, 2300 ft/min normal

Figure 4. ZABOCS BTF Bio-tower at Padre Dam WRF.

Single Stage Operation

The ZABOCS-BTF system is capable of operating as either a single stage or two stage biotrickling scrubber. In single stage mode the sump liquid in the bottom of the tower, containing (bacteria, nutrients, and bio-waste products) is continuously recycled over the

entire media bed. This provides an abundance of nutrients, and takes advantage of the biological activity of the bacteria living in the liquid. The sump liquid is diluted by a constant makeup water stream which maintains the sump pH in the 2 to 3 range. The low pH liquid selectively grows specific acidophilic sulfur-oxidizing bacteria which are highly efficient at oxidizing H_2S. This process is illustrated in Figure 3.

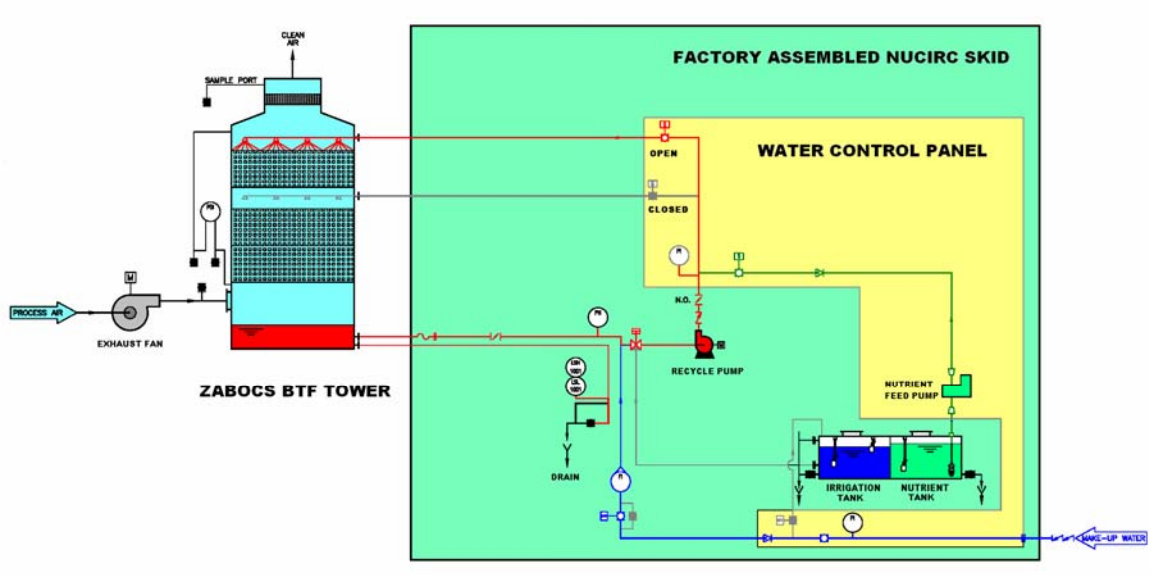


Figure 3: ZABOCS BTF – Single Stage Operation

2-Stage Operation

In the two stage mode, the sump liquid is recycled over the media in Stage 1, but not Stage 2. Once each hour, for a period of 3-5 minutes, makeup water (neutral pH) and nutrients are sprayed over the top of Stage 2. This maintains the second stage at a neutral pH and selectively grows different types of bacteria. The humidity from Stage 1 prevents the Stage 2 bed from drying out between dosings. The Stage 2 irrigation also helps to dilute the sump liquid and maintain pH in the desired range. The bacteria that develop in Stage 2 will include sulfur-oxidizing bacteria that feed on any remaining H_2S and organic sulfur compounds. They will also include some heterotrophic bacteria which cannot survive at the low pH in Stage 1. The heterotrophic bacteria improve the VOC and organic sulfur removal in Stage 2.

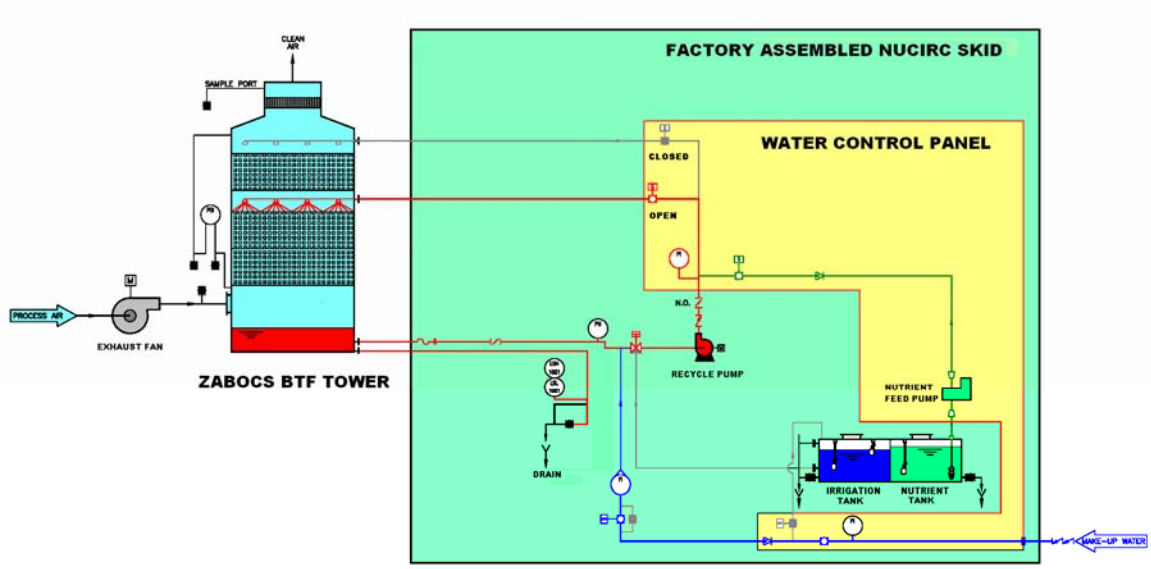


Figure 4. ZABOCS BTF – Two Stage Operation, Continuous Recycle to Stage 1

The two-stage process is illustrated in Figures 4 and 5. Figure 4 shows the operation of Stage 1, and Figure 5 shows the operation of Stage 2. In normal operation, the sump liquid will be recycled over Stage 1 for 55 to 57 minutes per hour. For 3 to 5 minutes per hour the recycle will stop and makeup water will be sprayed over Stage 2, and trickle down through Stage 1. This makeup water helps maintain the pH in the 2 to 3 range. Depending on the H_2S load to the system, additional makeup water may be added during the Stage 1 recycle mode.

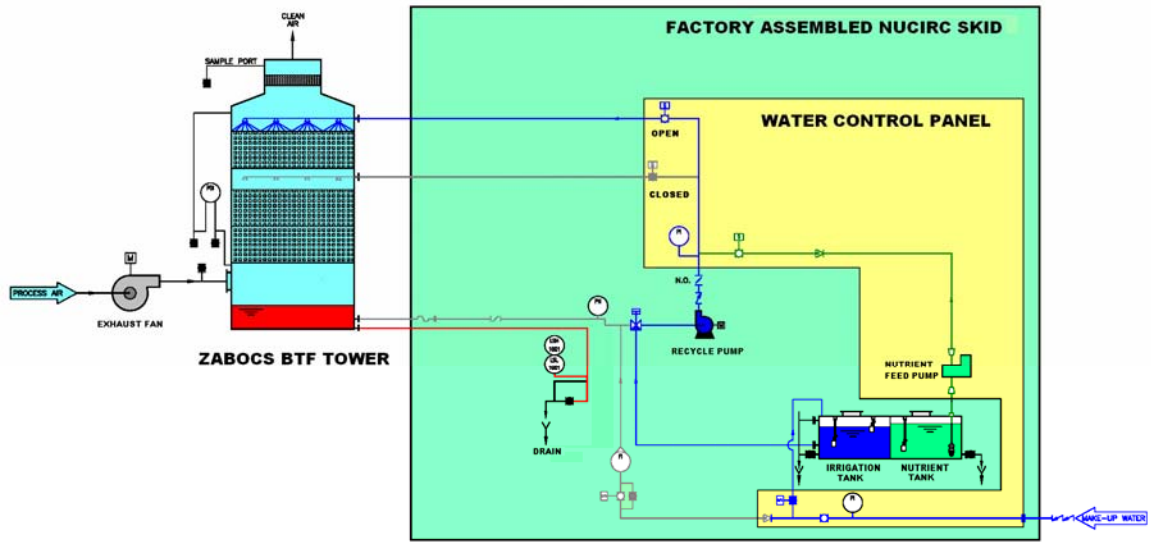


Figure 5. ZABOCS BTF – 2-Stage Operation, Intermittent Irrigation to top of Stage 2

A horizontal, magnetic drive pump is used both to recycle 20 to 30 gpm of sump liquid through the media beds, and to deliver makeup water to Stage 2 for intermittent irrigation. Nutrients are injected continuously into the pump discharge by means of a diaphragm metering pump. The nutrient pump rate is variable over a 100:1 range by manual speed and stroke adjustments.

The ZABOCS-BTF was installed in October 2005, and at the time of this writing has been in operation for one month. It is anticipated that the operation and maintenance will be similar to the ZABOCS-8000, requiring very little operator attention, while providing simple and effective odor control.

To facilitate installation, USFilter provides a factory-assembled "Nucirc" skid which includes storage reservoirs for nutrient and makeup water, the recirculation and nutrient dosing pumps, and all water flow and electrical controls. All pumps, valves and controls are pre-piped and pre-wired. The Padre Dam MWD installation was completed entirely by plant staff in a few days, thereby avoiding the expense of hiring and mobilizing an outside contractor.

Figure 6 shows the ZABOCS BTF "Nucirc" skid assembly.

PERFORMANCE TEST RESULTS for IPS SYSTEM

The ZABOCS BTF was fully acclimated after 4 weeks of operation. During the first 3 weeks the air flow rate was increased slowly to minimize odor emissions during acclimation. By the beginning of week 4 the air flow was at the full design flow rate (1800 cfm). Inlet and Outlet H_2S concentrations were monitored using Odalog analyzers starting during week 4. Figure 7 presents the Week 4 data. At the beginning of the week the removal efficiency was about 50-60% (at the new flow rate). However aided by the high H_2S loading over the Thanksgiving weekend the bacteria population grew rapidly, and the efficiency reached 99%+ in a few days.

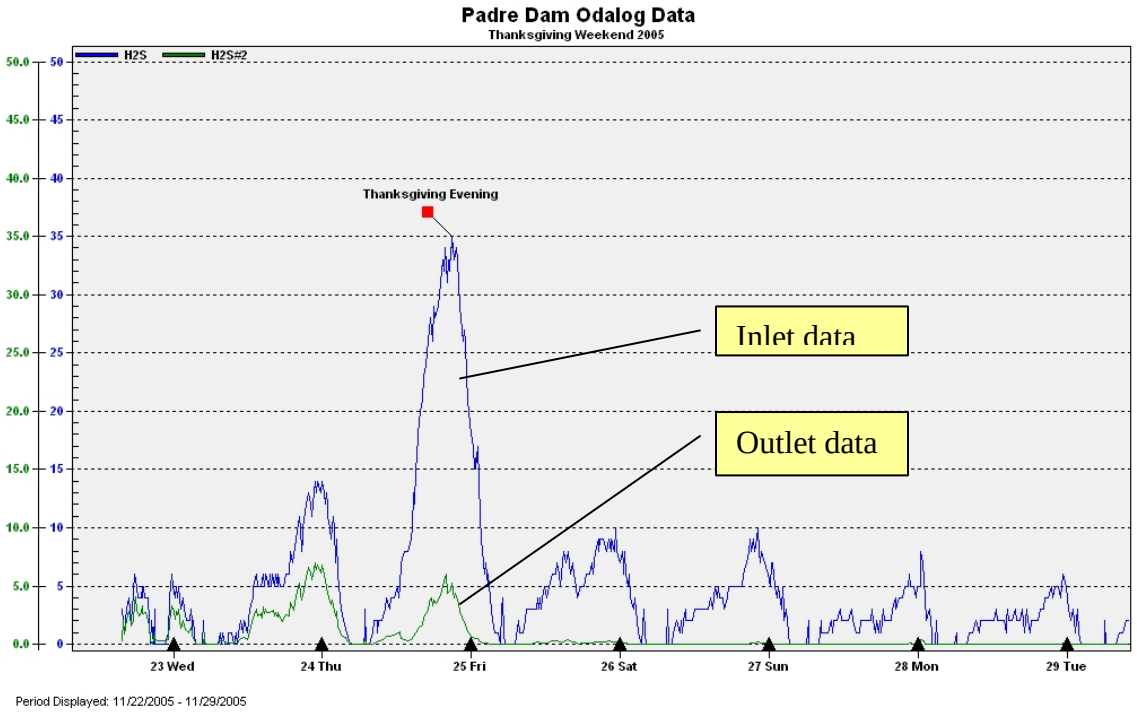
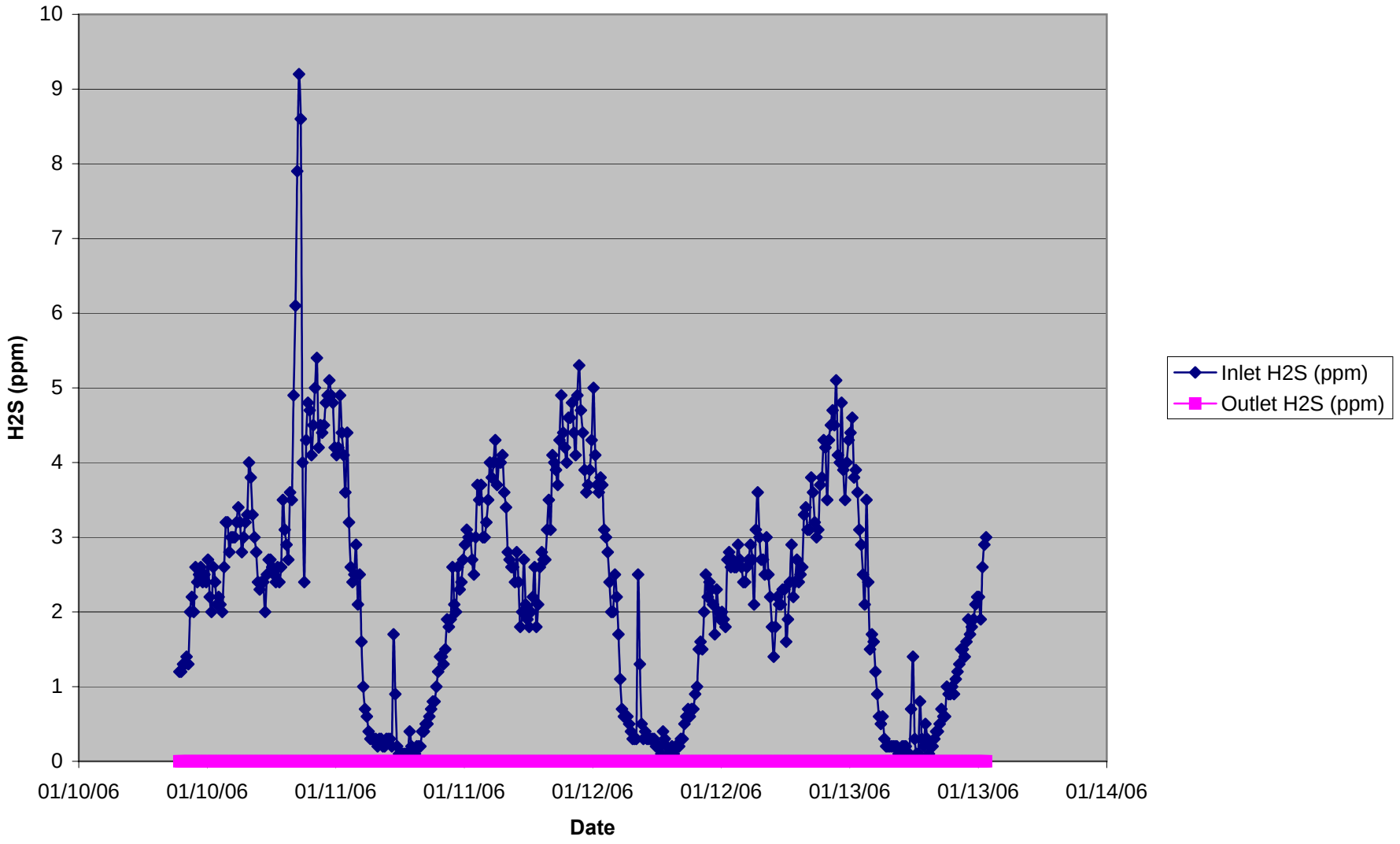


Figure 7: Acclimation data Week 4.

Subsequent weekly Odalog data are presented in Figures 8 and 9 demonstrating steady performance and complete acclimation. Media pressure drop during normal operation with liquid recirculation remained steady at 0.2 “WC.


Padre Dam Data (011006 - 011306)
H2S (ppm)
10
9
8
7
6
5
4
3
2
1
0
01/10/06
01/10/06
01/11/06
01/11/06
01/12/06
01/12/06
01/13/06
01/13/06
01/14/06
Date
Inlet H2S (ppm)
Outlet H2S (ppm)

CONCLUSIONS

The biological odor control systems are functioning properly. They have greatly reduced the maintenance and operator attention that was required for the older chemical scrubber system, while maintaining effective odor control. By simplifying the odor control process, PDWMD has been able to eliminate the cost of chemicals, eliminate the water softening costs, improve system reliability, and reduce the man-hours required for maintenance and troubleshooting.

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