ACTIFLO® Microsand Ballasted High Rate Clarifiers are the Heart of Water Treatment System in the Pacific Northwest, USA

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Introduction:

The ACTIFLO Process of microsand-ballasted clarification has gained increased acceptance as a viable solution for the clarification of drinking water, Combined Sewer Overflows (CSO) and other industrial applications. With unsurpassed overflow rates and the ability to start-up quickly and respond to rapid changes in water quality, the ACTIFLO technology is second to none. The process has proven stable and efficient, meeting water-quality standards even with significant seasonal and weather related variations in turbidity and flow.

There are over 100 operating ACTIFLO installations treating over 2 billion gallons per day. The following will give an overview of one of these operating plants in the Pacific Northwest.

Problem:

As a result of a diminishing groundwater source and population growth in the Pacific Northwest part of the country, the city of Wilsonville, OR determined that it was necessary to build a new 20 MGD water treatment plant. The existing water source consisted of a groundwater aquifer. The aquifer was decreasing by up to 3 ft. per year, which caused the Oregon Department of Water Resources to put the city of Wilsonville on notice to find a new supply. Several options were explored to include: tapping a new aquifer, installing a transmission line from Portland to Wilsonville or using the Willamette River. Cost analyses indicated that the cost of a transmission line or the drilling of a new aquifer would be twice as expensive as using the Willamette River. Many groups in the area believed that the Willamette River was too polluted, thus the new water plant is the most advanced in the state of Oregon. The Willamette River, which is prone to turbidity spikes up to 250 NTU, was pilot tested to ensure treatability. It was important to choose a clarification process, which could manage these high turbidity spikes while maintaining effluent quality. This was a greenfield, design-build project lead by Montgomery Watson Harza and is currently under contract to Veolia Water Operating Services.

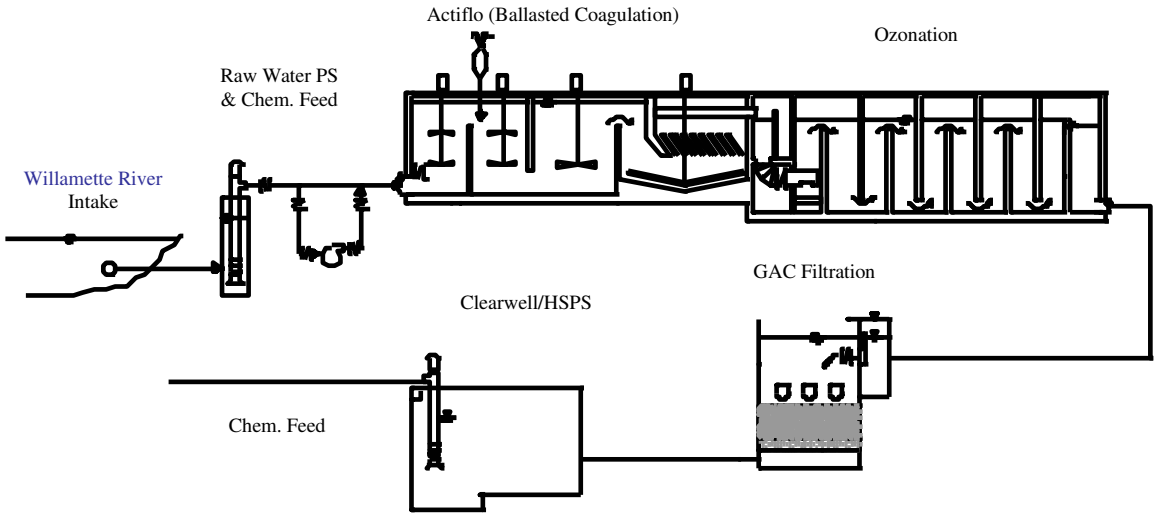
Background:

As part of the overall project strategy, an ACTIFLO pilot study was performed from February through March of 2000 in order to investigate the performance of the process while treating Willamette River Water. Montgomery Watson Harza employed I Krüger, Inc. to perform a pilot study. The study was performed with a

great amount of success and verified design parameters for the ACTIFLO Process. Filter studies were also performed to help determine filter design as well as loading rates.

PLANT OVERVIEW

The Willamette water treatment plant consists of several unit processes which include raw water screening, a raw water pump station, ACTIFLO microsand ballasted clarification, ozone oxidation, (GAC) filtration, a sludge thickening system, waste recirculation, clearwell effluent storage and high service pumps for distribution.



Intake Screens:

Two (2) horizontal, cylindrical screens with 1.75 MM openings supplied with air burst cleaning, protect the plant's pumps from River debris. The screens contain a protective coating called Wearlon, which prevents zebra mussels and other shellfish from attaching to the screen surface.

Raw Water Pump Station:

Four (4) vertical turbines, single-stage pumps make up the raw water intake and pumping station. These pumps move water from the Willamette River to the water treatment plant.

Clarification Process:

The clarification process consists of the ACTIFLO microsand ballasted clarifier to facilitate treatment of the raw water.

The ACTIFLO Process is designed to treat 15 MGD in a 2x7.5 MGD arrangement. Chemicals used include chlorine, aluminum sulfate, LT22S (cationic, dry) polymer, and caustic (as needed for supplemental alkalinity). In the first stage of the ACTIFLO process, aluminum sulfate is added in front of a mechanical in-line mixer prior to entering the coagulation tank. The coagulated water flows from the coagulation tank into the injection basin where microsand and ½ the polymer are dosed together. Treatment continues in the maturation tank where the remainder of the polymer is dosed and the ballasted flocs form and mature. Alum floc generally has a specific gravity of 1.05-1.2, while microsand has a specific gravity of 2.65, thus providing accelerated settling in the settling tank. Ballasted floc settles readily while clean water flows up through lamella tubes, which polish the effluent. Clarified water is collected in stainless steel launders before going to the ozone basins and downstream filters. The average effluent turbidity out of the ACTIFLO Process in the past year was 0.33 NTU. TOC removal is excellent with an average removal efficiency of 35%.

Slurry pumps withdraw the sand/floc mixture from the bottom of the settling basin and send it to hydrocyclones that separate the floc from the microsand. The microsand is recycled back into the ACTIFLO system, where it is reinjected along with polymer in the injection tank. The hydrocyclone overflow solids are sent to the sludge handling system for further treatment and disposal.

The detention time through the ACTIFLO Process at full capacity is less than 25 minutes for a corresponding design treatment rate of 20 gpm/ft2. Each ACTIFLO system was installed with a coagulation/rapid mix basin with a design HRT of 3 minutes, an injection basin with a design HRT of 3 minutes, and a maturation tank with an HRT of 9 minutes. Each ACTIFLO includes 520 square feet of lamella settling tubes for polishing of the effluent. As well, each ACTIFLO train is equipped with 2 hydrocyclone's to process sand/waste sludge. Microsand losses at the plant have been consistently low, at approximately 4 pounds per MG treated.

Sand is added manually once or twice a week. The average use is 8-12 pounds per Million Gallons treated. Clarifier performance is clearly illustrated in Table 1 as well as on the graphs.

Table 1: ACTIFLO Water Quality/Perf.	**Pilot, 2000**	**Plant, 2003**
Average Raw Water Turbidity, NTU	25.7	9.4
Average ACTIFLO Settled Turbidity, NTU	1.11	0.33 (0.1- 0.5)
Average Raw Water TOC, mg/L	NA	1.85
Average ACTIFLO Settled TOC, mg/L	NA	1.19

ACTIFLO effluent is disinfected prior to filtration. Disinfection is provided by ozone oxidation and chlorine.

Ozone Oxidation:

PCI Wedeco provided the ozone generators. The system consists of two (2) 8-stage, counter, co-counter, baffled ozone contact basins, which provide space to further oxidize organics and produce 0.5 log inactivation of *Giardia* and *Chryptosporidium* prior to the filtration step. At maximum design flow (15 MGD), the contact time in the basins is 14.5 minutes. Liquid oxygen (LOX) is used to produce ozone. Two (2) ozone destruct units are installed per basin. Ozone use is shown in Table 2.

Table 2: Ozone Use	**Plant**
Dosage, mg/L	0.3-1.0
Energy, kWHrs/MG	28
Average LOX Use, Gal./Mo	2,171
Ozone Transfer Efficiency	92%

(GAC) Filtration:

Four (4) single-bay gravity filters with Leopold underdrains are used for filtration of fine particles and adsorption of organic material.

After disinfection and oxidation of organic material, the treated water is filtered through four (4) single-bay gravity filters, each with 460 sq. ft. of filtration area. Total filtration area with all cells in operation is 1,840 sq. ft. Filter media consists of 72" of 1.4 MM Granular Activated Carbon (GAC) (with an average Empty Bed Contact Time (EBCT) of 6 minutes) and 12" of 0.45 MM sand. The filters were installed with air/water wash capabilities and a filter-to-waste cycle. GAC is sampled quarterly and analyzed for iodine number, particle size distribution, effective size and other parameters, which help to determine wear. Data is illustrated in table 3.

Table 3: Filter Data	**Plant, 2003**	**Design**
Average Filtered Turbidity, NTU	0.03-0.05	
Filtered TOC, mg/L	ND-1.4	
Filtered Particle Counts (#/mL > 2.0 um)	2.0	
Filtration Rate, gpm/ft2	2.3-7.6	2.0-8.0
Average Filter Run Length, hours	50 (48-72)	
Average Filter Headloss, feet	5	
Ultimate Filter Run Volume, UFRV, gallons	12,000	

Filters are backwashed based on time (every 50 hours) rather than headloss build-up. Headloss build-up is minimal even after 72 hours of operation. Filter backwash waste is sent to the Waste Equalization Basin (228,000 gallons) and recycled back to the front of the plant for subsequent treatment through the plant. The plant achieves 2.8-3.2 log removal of particles greater than 2 micron in size in their filtered water. As well, E-coli and Total Coliforms are not detectable in finished water samples tested at the plant.

Sludge Handling:

Waste sludge from the ACTIFLO Process is sent to gravity thickeners designed to treat 2000 #/day at a max loading rate of 2.1 pounds/day/sq. ft. The HRT through the thickener is approximately 6 hours with a rise rate of 0.25 gpm/ft2. Approximately 30,000 gallons of overflow are recirculated through the waste equalization basin to the front of the plant.

Pre-thickened sludge is stored and then pumped to two (2) horizontal scroll centrifuges via two (2) VFD driven pumps. Table 4, below, illustrates the level of thickening achieved through the sludge handling system.

Table 4: Sludge Handling	**% Solids**
ACTIFLO Waste Sludge	0.05-0.1
Gravity Thickener	3-3.5
Centrifuge	28-34
Average Sludge Generated (Wet Ton /Month)	22

Chemical Dosages:

The average chemical dosages for the plant have held true to the design estimates established during the pilot test in 2000. We have illustrated a comparison between average chemical dosages during the ACTIFLO pilot of 2000 and for the full-scale ACTIFLO plant in 2003. Chemical dosages are compared in Table 5.

Table 5: Average Chemical Dosages	**Pilot, 2000**	**Plant, 2003**
Average Alum Dosage, mg/L	16	12.2
Average Cationic Polymer Dosage, mg/L	0.23	0.22
Average Chlorine Dosage, mg/L	NA	0.79
Average Ozone Dosage, mg/L	NA	1.0

Provisions to feed and store carbon dioxide, LOX, aqua ammonia, polyphosphate corrosion inhibitor, anionic polymer for sludge handling, non-ionic polymer to aid filtration and calcium thiosulfate are also included in the plant.

Waste Recirculation:

Filter backwash, filter to waste, and thickener overflow wastes are equalized and pumped to the front of the plant from the waste equalization basin (228,000 gallon capacity) via vertical turbine, two-stage pumps.

Finished Water Storage and Distribution:

Finished water is stored in a buried, reinforced concrete, 2.7 MG clearwell and pumped into distribution via four (4) vertical turbine, 2-stage pumps.

Conclusion:

Thanks to this water treatment plant, the residents and visitors to this area of the Pacific Northwest now enjoy clear, safe, and clean drinking water.

For more information on this plant and other Actiflo installations, please call Kruger, Inc. 919-677-8310.