Effluent Polishing
Dissolved Oxygen
NPDES Permit
Stream Discharge
Energy Savings

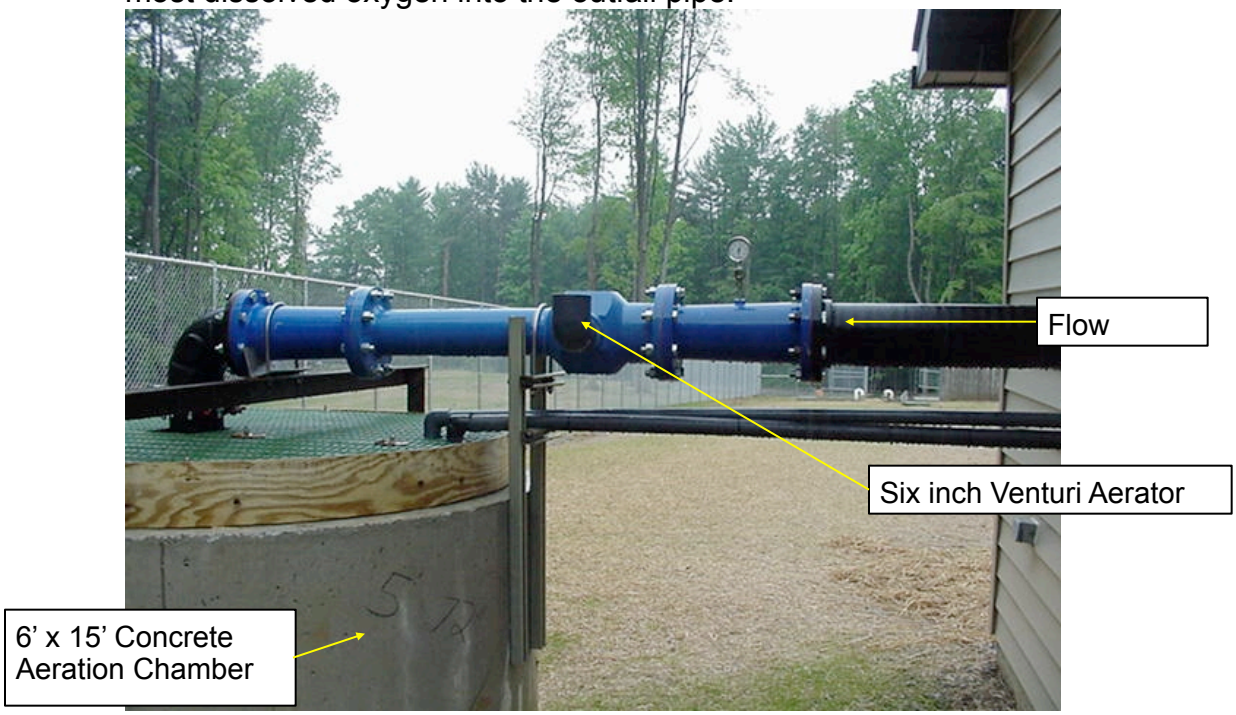
Adding Dissolved Oxygen to WWTP Effluent to Comply with Revised NPDES Permit

As part of the upgrades to a small rural 1.2 mgd wastewater treatment plant in north central Pennsylvania a revised NPDES permit was issued with a requirement to maintain a >6.0 mg/L level of dissolved oxygen (DO) in the effluent discharge. The effluent flows into an adjacent stream and the DO requirement is to support biota in the stream. To comply with this residual DO requirement the design engineer selected a Venturi Aerator system to add the required dissolved oxygen. The venturi aerator was selected because of it's simple design. What was unique about this installation is the ability of the venturi aerator to be adapted to an existing pump so no additional horsepower was required.

The plant used an existing pump with 20 hp motor to pump the effluent into an 8" diameter 200' long outfall pipe that flowed down the side of a hill where it emptied into the receiving stream. This effluent contained almost no residual DO due to the dechlorination process. Therefore it would not be incompliance with the revised permit. To adapt the venturi aerator, the effluent discharge piping needed to be configured to add a new connection to the existing 200' outfall pipe that would be in a 6' diameter concrete manhole. This concrete manhole would become the aeration chamber. Its dimensions are 15' high by 6' wide. The invert for the outfall pipe connection would be at the 7' elevation off the bottom with freeboard of 8 feet above that. This configuration would hold ~1400 gallons in the aeration chamber.

The venturi aerator adds DO to water by aspirating ambient air into the water. The aspirated air is mixed under partial pressure in an internal mixing zone in a highly turbulence flow of air and water. Water exiting the venturi nozzle expands into large macro droplets that are surrounded by 2.2 volumes of air that is aspirated [25 psi and 75' TDH]. It is both the mixing action and partial pressure in the venturi device that transfers oxygen from ambient air into the water. The amount of oxygen transferred depends on flow, temperature and pressure. At the Treasure Lake WWTP the effluent flow is 800 gpm at 20 psi. While this will normally transfer between 5.0 and 7.5 mg/L of DO that is not sufficient to ensure that the plant will comply with the 6.0 mg/L or > requirement. To ensure that the effluent meets the discharge permit, the plant effluent out of the venturi aerator is discharged into the standing water in the manhole. The kinetic energy and velocity of the discharge from the venturi unit creates a "plunge," "splash" and "roll" effect which pulls in additional oxygen contained in air in the headspace of the aeration chamber. Therefore, air lying at the air/liquid interface is then pushed and pulled down in to the standing water. As additional liquids are discharged they overflow

from the uppermost liquid volume of the aeration chamber where they have the most dissolved oxygen into the outfall pipe.



Using this venturi aerator configuration the Treasure Lake WWTP is able to maintain DO levels of >10.0 mg/L in the cooler winter months when oxygen is more soluble in the colder water, while in the summer months they consistently exceed 7.0 mg/L when the air and water are warmer. This is in excess of their 6.0 NPDES permit and keeps them above their discharge permit requirement.

While this configuration is appropriate for the Treasure Lake WWTP and other a small flow plants it might not be appropriate for a larger WWTP. At larger WWTP with higher volume effluent separate pumps would be required. However, multiple venturi aerator units can be manifolded, and where this would not be sufficient the venturi aerator can be used to aspirate pure oxygen from either an onsite PSA Oxygen generator systems or it can be connected with a LOX tanker or onsite cryogenic dewer/tank supplying pure Oxygen from a merchant gas vendor. Whatever the situation, the venturi aerator system is flexible enough to fit into a wide variety of design configurations.