

# STATE OF COLORADO

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Colorado Department  
of Public Health  
and Environment

June 12, 2014

Andrea Nifong  
Work Water Works  
4000 SW 113th St.  
Oklahoma City, OK 73173

Subject: Acceptance of the DEMON® Anammox Centrate Treatment Process as an Alternative Technology for Use in Domestic Wastewater Treatment Works in Colorado  
ES Project No. ES.14.TECH.00650

Dear Ms. Nifong:

The Water Quality Control Division (the Division) has received and reviewed information for the DEMON® Anammox Centrate Treatment (DEMON®) process in accordance with Section 1.8.0 of *Design Criteria for Domestic Wastewater Treatment Works Policy WPC-DR-1* (Wastewater Design Criteria). The DEMON® process design is accepted for use as an alternative technology subject to the design criteria in Table 1. This acceptance is not intended as a third-party certification of the technology.

This acceptance addresses the following item:

- DEMON® Anammox Centrate Treatment process creating a specialized environment for deammonification using anaerobic ammonia oxidizing bacteria (AMOX). The process includes centrate flow equalization, batch treatment reactor, DEMON® hydrocyclone for biomass sludge separation, and associated pumps, blowers, sensors, and DEMON® Controller.

This acceptance applies only to the DEMON® Anammox Centrate Treatment process and does not constitute construction approval for installation in domestic wastewater treatment facilities. **Review and approval for the design of any domestic wastewater facility proposing to use this technology will be further reviewed on a site-specific basis by the Division** as required by Section 22.11(1) of the *Site Location and Design Approval Regulations for Domestic Wastewater Treatment Works 5CCR 1002-22* (Regulation 22) and the Colorado Water Quality Control Act (Act), Section 25-8-702, C.R.S. which states in part that: “No person shall commence the construction of any domestic wastewater treatment works or the enlargement of the capacity of an existing domestic wastewater treatment works, unless the site location and the design for the construction or expansion have been approved by the division.”

Any modifications to the physical attributes or characteristics of this treatment technology must be submitted to this office for review and acceptance by the Division prior to sale in Colorado. This condition includes changes made to the DEMON® equipment or process mechanisms. For any changes to the process or equipment following the issuance of this letter, the Division will review any additional third party verification reports and issue a revised acceptance letter, or denial, as appropriate.

**Table 1. DEMON® Anammox Centrate Treatment Process Design Criteria:**

Design Criteria
<p>1. The DEMON® process design capacity shall be based on an operating plan and schedule that incorporates anticipated centrifuge operating schedule, centrate production rates, and DEMON® process operating schedule such as 8 hrs x 5 days, 24 hrs x 5 days, 24 hrs x 7 days, etc. During the site-specific design review, calculations shall be submitted to justify the basis of design.</p> <p>2. Provisions for pretreatment of centrate shall be provided if centrate characterization includes any of the following conditions:</p> <ol style="list-style-type: none"> <li>a. Organic material (BOD5) greater than or equal to the ammonia concentration</li> <li>b. Average total suspended solids (TSS) greater than 1,000 mg/L</li> <li>c. pH less than 6 and greater than 8</li> <li>d. Presence of anti-foaming agents upstream of DEMON® reactor</li> </ol> <p>3. Equalization volume shall be provided in a tank or tanks prior to the DEMON® reactor and having an operating capacity adequate to hold the volume of centrate produced during the times when the centrifuge and/or DEMON® reactor are not operating as determined in the operating plan and schedule. The equalization tank(s) shall include mixing equipment or an appropriate plan for cleaning and solids management. The reactor feed pump(s) must have sufficient capacity to transfer the volume of centrate in the equalization tank to the DEMON® reactor during the times when the DEMON® reactor is treating as determined in the operating plan and schedule. The design shall consider struvite formation potential and the process design report (PDR) shall describe the expected potential and any needed design or operating measures.</p> <p>4. The PDR shall justify the design average TKN loading rate to the DEMON® reactor within the range of 0.4 to 0.8 kg-N/m<sup>3</sup>/day and the peak loading shall not exceed 1.0 kg-N/m<sup>3</sup>/day. If the operating period (including react, mix, settle, and decant cycles) will be less than 24 hours during a day, the calculated loading rate must be adjusted accordingly to determine the loading rate during the operating period.</p> <p>5. The DEMON® reactor must meet the requirements for sequencing batch reactors in section 7.6.0 of the wastewater design criteria (Policy WPC-DR-1), except for the scum removal, decanter, and PLC program requirements. The cyclone feed pump design shall include provision for capacity to waste mixed liquor during the react/mix phase at rate up to 25% of the daily centrate flow rate. The reactor tank(s) shall include mixing equipment with a mixing energy of 10 to 19 w/m<sup>3</sup>. During the site-specific design review, calculations shall be submitted to justify the basis of design of the decanter.</p> <p>6. Aeration Equipment. The actual oxygen rate (AOR) for the blower design shall be at least:</p> $\text{AOR} = \frac{(\text{TKN load lbs/day} \times 0.57 \times 3.42 \text{ lb O}_2/\text{lb TKN}) + (\text{CBOD}_5 \text{ load lbs/day} \times 1 \text{ lb O}_2/\text{lb CBOD}_5)}{(\text{aeration time of 70\% operating time once established} \times \text{hours active/hours cycle})}$ <p>The average daily design loading will be determined based on site-specific conditions and operating plan as noted in item 1. Blower design and standard oxygenation rate (SOR) must be demonstrated in the PDR to be adequate size and capacity based on site-specific conditions and treatment requirements including, but not limited to, alpha factor, diffuser efficiency, elevation, temperature (e.g., seasonal, air, wastewater), pipe sizes, bends, etc. The blower design shall include provisions to provide variable air flow rates.</p> <p>7. The hydrocyclone feed design shall include provisions to maintain constant feed pressure at variable flow rates. The design shall document that the hydrocyclone overflow and underflow are free from back pressure.</p>

8. The process design report shall include a description of the flows from the DEMON® process being directed to other unit processes including the DEMON® reactor effluent and the hydrocyclone overflow. The design for the receiving processes must be evaluated for hydraulic and treatment impacts and provisions must be included to mitigate impacts from the DEMON® return flows, as needed. The process flow description shall include methods for handling flows such as gravity flow, use of pumps, etc. and identify connection points.
9. Treatment Credit. The PDR shall justify the design removal rates for ammonia and total inorganic nitrogen. A facility with the treatment technology designed in accordance with the loading rates in item 4 above and these criteria will receive credit for no more than 90% removal of ammonia and 80% removal of total inorganic nitrogen from centrate. Removal credit may be less based on site-specific design conditions such as alkalinity, temperature, loading, etc. No phosphorus removal credit is granted for the treatment technology.
10. Temperature Considerations. Maintenance of an adequate temperature is essential to the treatment process and design provisions must be included to ensure sufficient temperature of 25 °C for design. If the design temperature is less than 25 °C, the PDR shall justify a reduced kinetic design rate for the design temperature. The PDR shall either identify a less efficient ammonia and total inorganic nitrogen removal rate or may compensate for the reduced kinetic rates through design modifications, such as lower basin loading rates. The equalization tank and DEMON® reactor shall include provisions to retain heat within the water to maintain the design temperature (e.g., floating blanket, cover, insulation). The design shall include provisions for the capability to heat the centrate flow to the design temperature prior to the DEMON® reactor.
11. Alkalinity. The wastewater must be shown to have sufficient alkalinity in item 2 above or include chemical treatment (i.e., alkalinity addition) or reduce treatment credit based on the available alkalinity. The capability to add alkalinity is recommended even for designs expecting sufficient alkalinity. The centrate is considered to have sufficient alkalinity when the following relationship is satisfied: Alkalinity as CaCO<sub>3</sub> greater than or equal to  $[300 + (3.6 \times \text{TKN})]$  mg/L.
12. Micronutrients. The treatment process can be sensitive to availability of micronutrients necessary for adequate biological growth, as noted in section 7-3 of Metcalf and Eddy 2003, Wastewater Engineering: Treatment and Reuse, 4<sup>th</sup> Edition. The design shall include methods and any necessary equipment to add micronutrients should they be needed.
13. Alarm. Process malfunction alarms must be provided including equalization tank level, DEMON® reactor level, oxygen, pH, and temperature. The design must identify conditions activating alarms and how the alarm signal will notify operators of alarm activations, when the facility is attended and unattended.
14. Redundancy. In addition to redundancy requirements in the wastewater design criteria, firm capacity (i.e., largest unit out of service) for aeration and pump capacity shall be installed to provide design requirements (e.g., enable the design oxygen transfer). In some designs, the Division may consider, based on design basis provided in the process design report, the backup unit to be an uninstalled unit, provided the installed unit can be easily removed and replaced (i.e., “shelf spare”) for the hydrocyclone feed pump, pH probes, and decanter air compressor. A spare programmable logic controller for the DEMON® controller containing the operating software shall be available at the World Water Works manufacturing facility in Oklahoma City, Oklahoma and the set point settings available at the site. A single hydrocyclone is permissible; multiple units are encouraged when feasible. The design shall include at least two reactor trains, each with a design flow of at least 50 percent of the total design capacity or the PDR must justify a single train by: 1) documenting equivalent measures or redundant emergency plans that include, but not limited to, adequate methods to retain biomass for a period of at least 6 days during reactor maintenance and emergency repair and 2) include alternate operating procedures for the main liquid stream process if necessary to meet effluent limits at the permitted design capacity.

15. For systems with more than one DEMON® reactor, adequate flow splitting must be provided to ensure appropriate flow to each unit.
16. Startup considerations needed to meet effluent limits shall be described in the PDR.
17. Maintenance Access. Design shall include provisions that allow the operator to access, operate, and maintain the treatment technology.
18. Manufacturer Review. A review letter issued by the manufacturer indicating the installation was designed in accordance with manufacturer recommendations must be included with the site-specific design submittal. The manufacturer's review may not supersede criteria in this acceptance. The manufacturer's review may not be substituted for all required engineering documentation and calculations stamped and signed by a Colorado licensed Professional Engineer.

#### **Additional Operations and Maintenance Criteria**

1. Design shall include provision for operator training including, but not limited to: start-up operations, normal operations, cleaning, maintenance, hydraulic fluctuations, temperature impacts, sludge monitoring, removal, and residual management.
2. An Operations and Maintenance (O&M) Manual must be provided for all installations. The document should be available for review by the Division during compliance inspections.
3. Certified Operator. The domestic wastewater treatment works with this technology will be required to be under the control of a certified operator with a Class B Domestic Wastewater Treatment Facility Certification in accordance with Regulation 100 Water and Wastewater Facility Operators Certification Requirements.

The owner of the domestic wastewater treatment works is responsible for proper design, operation, and maintenance of the facility to meet permit effluent requirements.

Please be aware that any point source discharges of water from treatment facilities are potentially subject to a discharge permit under Colorado's State Discharge Permit System. Any point source discharges to state waters without a permit are subject to civil or criminal enforcement action.

As part of this review, the Division has evaluated the following documents:

- February 6, 2014 Submittal from World Water Works requesting alternative technology acceptance for the DEMON® Anammox Centrate Treatment Process.
- February 28, 2014 Submittal from World Water Works providing additional requested information for the alternative technology review for the DEMON® Anammox Centrate Treatment Process.
- April 14, 2014 Submittal from World Water Works providing additional requested information for the alternative technology review for the DEMON® Anammox Centrate Treatment Process.
- Various additional correspondences.

Please direct any further correspondence regarding this acceptance to:

David Kurz, P.E.  
Colorado Department of Public Health and Environment  
Water Quality Control Division  
4300 Cherry Creek Drive South  
Denver, CO 80246

If you have any questions or comments, please contact David Kurz at [david.kurz@state.co.us](mailto:david.kurz@state.co.us) or 303-692-3552.

Sincerely,

David Kurz, P.E.  
Lead Wastewater Engineer  
Engineering Section  
Water Quality Control Division  
Colorado Department of Public Health and Environment

cc: CDPHE-WQCD-ES