Phased Isolation Ditch Systems

The BIO-DENITRO® is a unique wastewater treatment process developed by Krüger. The process combines functional design with an outstanding flexibility and highly adaptable operation.

In its basic form the process consists of two identical and interconnected process tanks. The system is operated by sequentially alternating the flow and the process conditions in the reaction tanks. As a consequence, the volume for nitrification and denitrification can be adjusted to fit the actual conditions. The result is a system with outstanding flexibility that continuously uses the reaction volume in an optimum way allowing for the best possible treatment.

Advantages

- The effluent quality is one of the best that can be achieved today at minimum operating costs
- The process combines functional design with an outstanding flexibility
- Highly adaptable operation
- The interplay of the two process steps is time-controlled (or on-line controlled)
- The process has successfully been implemented on more than 300 installations worldwide with plant capacities up to 750,000 PE.
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**Process Description**

The BIO-DENITRO® process can best be illustrated by following the nitrogen removal in one of the process tanks over a full operating cycle from phase A through D. Naturally, the progression of the phases is optimised for each specific plant during running-in. Furthermore, additional phases than those shown are available in order to optimize the operation even further.

**Phase A**

The wastewater is led to tank II where it is kept mixed in an anoxic environment. At such conditions the micro organisms are forced to use the nitrate present from the previous phase as oxygen source while they degrade the organic compound and nitrogen is released to the atmosphere (denitrification). As raw wastewater enters the tank, a corresponding volume of water and activated sludge leaves tank II and flows to tank I. In tank I oxygen is introduced (aerobic conditions) leading to a biological degradation of the remaining organic matter and a conversion of the wastewater’s ammonia content to nitrate (nitrification). In this and the following phase, the treated wastewater flows from tank I to the final settling tank.

**Phase B**

Phase B is a brief intermediary phase where the wastewater is lead to tank I into which oxygen is introduced (aerobic conditions). Oxygen is also introduced into tank II in this phase. The purpose of this phase is to reduce the content of ammonia in tank II before the wastewater is discharged from this tank.

**Phases C and D**

These phases correspond to the phases of A and B, except from the fact that the wastewater influent, effluent, and the process conditions in the tanks are interchanged. Once phase D is completed, the operation cycle will start again with phase A.
Advantages

A characteristic feature of the BIO-DENITRO® process is that the interplay of the two process steps (nitrification and denitrification) is time-controlled (or on-line control). This offers maximum flexibility to the optimisation of the nitrogen removal. Furthermore, the raw wastewater is always introduced to a tank with denitrification which normally eliminates the need for an external carbon source. Consequently, the effluent quality from a BIO-DENITRO® system is one of the best that can be achieved today at minimum operating costs.

Today, a number of treatment systems are available based on the BIO-DENITRO® process. The systems consist of 2 to 4 process tanks, with or without biological phosphorus removal and with either internal settling or external settling. All of the systems demonstrate the unique advantages of the BIO-DENITRO® process.

Krüger’s systems based on the BIO-DENITRO® process

<table>
<thead>
<tr>
<th>No. of process tanks</th>
<th>Internal settling tank</th>
<th>External settling tank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Bio-P</td>
<td>With Bio-P</td>
</tr>
<tr>
<td>2</td>
<td>System D</td>
<td>BIO-DENITRO® – Double</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO-DENITRO® – Double1</td>
</tr>
<tr>
<td>3</td>
<td>System T</td>
<td>BIO-DENITRO® – Triple</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO-DENITRO® – Triple1</td>
</tr>
<tr>
<td>4</td>
<td>System Q</td>
<td>BIO-DENITRO® – Quattro</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO-DENITRO® – Quattro</td>
</tr>
</tbody>
</table>

Systems based on 2 process tanks

- System D
- BIO-DENITRO® - Double
- BIO-DENITRO® - Double1

Systems based on 3 process tanks

- System T
- BIO-DENITRO® - Triple
- BIO-DENITRO® - Triple1

Systems based on 4 process tanks

- System Q
- BIO-DENITRO® - Quattro
- BIO-DENITRO® - Quattro1
Construction of a BIO-DENITRO® Plant with brush aerators

1. The influent distributor is a motor operated gate that changes position from left to right approx. every 2 hours. In the phase of the BIO-DENITRO® operating cycle (above), the distributor is directing the influent and RAS to Ditch 2. This supplies the required carbon source for denitrification.

2. Low-speed submersible mixers impart the velocity to maintain the biosolids in suspension during the anoxic phases of the process. The mixers also supplement the rotors as needed in response to automatic DO control during oxic phases of the process.

3. The motor-operated effluent weir changes position from raised to lowered, or vice versa, approx. every 2 hours. In this phase of the process, the weir in Ditch 2 is raised.

4. Denitrified mixed liquor flows from Ditch 2 to Ditch 1 due to the hydraulic gradient set up by the influent distributor and effluent weir.

5. A probe monitors the Dissolved Oxygen concentration in the mixed liquor and transmits a signal to the control panel, which controls the operation of the rotors via a custom programmed PLC.

6. Brush aerators (rotors) maintain oxic conditions within the mixed liquor during the nitrification phases of the process. The rotor bridge eliminates noise and aerosols, while providing access for equipment maintenance.

7. The effluent weir in Ditch 1 is lowered to allow the discharge of mixed liquor from the process. The discharging weir also controls the submergence of the rotors.