

# APPLICATION OF CALCIUM NITRATE FOR ENHANCED BOD REMOVAL

## WHY USE CALCIUM NITRATE?

**In an ideal world, wastewater treatment plants (WWTPs) would run smoothly and require very little oversight in order to ensure that permit limits can be met 100% of the time.**

Anyone working in the field of wastewater treatment for a significant amount of time knows this is not the case and that day-to-day problems occur which negatively impact the performance of WWTPs. A common problem, particularly for aerated stabilization basins (ASBs), is oxygen ( $O_2$ ) deficiency.

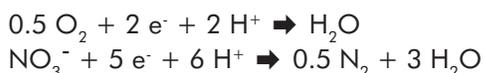
$O_2$  deficiency can arise for a variety of reasons, such as a power outage, aerators being down for maintenance, scavenging of  $O_2$  by chemical compounds containing sulfur, or upstream production spills that increase organic loading to a WWTP. Under  $O_2$  deficient conditions,  $O_2$  supply may not meet  $O_2$  demand, putting Biochemical Oxygen Demand (BOD) permit limits at risk of being violated. When this occurs, it is up to the environmental staff responsible for overseeing the WWTP to respond quickly with a solution to ensure that permit limits can be met. One solution available to correct this problem is the application of a nitrate salt in liquid form such as calcium nitrate (EBS CN-9).

## HOW CN-9 WORKS

During biological wastewater treatment, organic compounds are removed by bacteria using two linked processes: **catabolism and anabolism**. During catabolism, bacteria break down organic compounds and produce energy by transferring electrons from the organic compounds to a terminal electron acceptor. During anabolism, organic compounds are consumed in order to build new bacterial cells using energy produced during catabolism. This entire process, collectively referred to as metabolism, hinges on the availability of a terminal electron acceptor.

If  $O_2$  is available, the bacteria will use it as a terminal electron acceptor since it provides the most energy. However, if  $O_2$  is not available, such as during  $O_2$  deficient conditions, then bacteria are forced to find a new terminal electron acceptor so that BOD removal can continue. After  $O_2$ , the second most energetically favorable terminal electron acceptor for bacteria to use is nitrate ( $NO_3^-$ ). This is why the application of CN-9 can provide a cost-effective solution to an  $O_2$  deficiency problem to help ensure that BOD removal continues at an adequate rate.

The simplified reactions shown below highlight the differences between the use of  $O_2$  and  $NO_3^-$  as a terminal electron acceptor.



As shown, two electrons ( $e^-$ ) are transferred for every 16 g of  $O_2$ , and five electrons are transferred for every 14 g of  $NO_3^-$  when measured as nitrogen ( $NO_3^- - N$ ). Simplifying, this ratio becomes:  $(0.357 e^- / g NO_3^- - N) / (0.125 e^- / g O_2)$ . This means that every one part of  $NO_3^- - N$  is the equivalent of 2.86 parts of  $O_2$ . Therefore, based on the density and percentage of  $NO_3^- - N$  in EBS CN-9, **every 24-ton truckload provides the equivalent of approximately 11,600 lbs of  $O_2$  or BOD removal potential or 3 lbs of BOD removal potential for every gallon applied.**



## THE PAYOFF

The application of EBS CN-9 provides a scientifically-sound solution to help ensure that BOD permit limits can still be met during O<sub>2</sub> deficient conditions. In addition, CN-9 offers supplemental benefits which make this product a suitable solution for when an O<sub>2</sub> deficiency problem arises, including:

- **Safe Handling and Storage** - CN-9 is not an oxidizer and can be stored safely on-site in plastic or fiberglass tanks.
- **Harmless By-Products** - As shown below, the by-products produced by bacteria as they use NO<sub>3</sub><sup>-</sup> are nitrogen gas (N<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), and water (H<sub>2</sub>O), all of which are harmless and odorless.



- **Favorable Chemical Properties** - CN-9 is highly soluble in water, and NO<sub>3</sub><sup>-</sup> is non-volatile, so the NO<sub>3</sub><sup>-</sup> will remain in the wastewater until utilized by the bacteria.
- **Prevents Hydrogen Sulfide (H<sub>2</sub>S) Formation**  
If neither O<sub>2</sub> or NO<sub>3</sub><sup>-</sup> are available, bacteria can use sulfate (SO<sub>4</sub><sup>2-</sup>) as a terminal electron acceptor resulting in the formation of H<sub>2</sub>S as a by-product, which is odorous and corrosive. If NO<sub>3</sub><sup>-</sup> is available, the bacteria will use it over SO<sub>4</sub><sup>2-</sup> as a terminal electron acceptor preventing H<sub>2</sub>S formation as NO<sub>3</sub><sup>-</sup> yields more energy.



For more information on EBS CN-9, contact  
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