Bacta-Pur®

The Natural Solution
when only the best will do

Nitrification / Denitrification in Wastewater Treatment© 2012

ECOPROBIOTICS®, of the Bacta-Pur® System, are beneficial communities of natural bacteria, which have been on earth for millions of years and have been selected for their synergistic ability to biodegrade pollutants and to improve water quality. ECOPROBIOTICS® increase biodiversity. Just as people take probiotic yogurt for its' ability to assure the presence of the optimal community for digestion and immunity, ECOPROBIOTICS® improve ecosystem health. EVERY PRODUCTION of Bacta-Pur® products is analyzed and cleared for shipment ONLY after passing all performance tests and being CERTIFIED PATHOGEN FREE using techniques from the food industry. ECOPROBIOTICS® are purely natural and beneficial; they NEVER contain added chemicals such as surfactants, emulsifiers or enzymes…, nor do they contain genetically modified (GMO) or deliberately mutated organisms. ECOPROBIOTICS® are safe and beneficial. Bacta-Pur® microorganisms are not subject to TOSCA (USEPA) and are listed on the DSL of Environment Canada.

Summary

SYMPTOMS	TREATMENT BENEFITS
• effluent levels of ammonia, nitrite and/or nitrate exceed permit	• meet target concentrations in effluent
• slow to recover nitrification/denitrification from toxic shocks	• rapid recovery from toxic shocks & loadings
• no / or poor nitrification/denitrification in the system	• implant and maintain nitrification / denitrification
• no nitrification in winter or in cold water	• obtain nitrification even under ice
• plant approaching or exceeding pollutional loading capacity	• increase pollutantional loading capacity
• plant difficult and expensive to manage	• facilitate and improve operational efficiency, save money

Requirements for Efficient Nitrification / Denitrification

Two principle factors influence the efficiency of the nitrification / denitrification processes: the biological community and the water physico-chemistry. Nitrification requires specific conditions (Table 1), and treatment must follow an ordered procedure. Reduction of carbonaceous BOD (cBOD) is a preliminary requirement for nitrification; cBOD can inhibit nitrification. Best results are achieved when the cBOD is < 30 mg/L. The sooner that the cBOD is removed, in the treatment process, the sooner nitrification can begin. This is critical in systems with limited hydraulic retention time and in cold weather, when microbial activity is slower.

TABLE 1. Physical / chemical requirements for nitrification, lack of inhibitors is also essential.

PARAMETERS	OPTIMUM (ACCEPTABLE)
Temperature (°C) (°F)	30 (2-35) 86 (33-95)
pH	7-8 (6-8.5)
Dissolved oxygen	> 3 mg/L
Alkalinity	> 100 mg/L
BOD (carbonaceous)	< 20 mg/L
CO_3: NH_4-N: o-PO_4 ratio	≥ 30:6:1
Salinity (‰)	0-35

Biological Community — Two bacterial strains are involved in nitrification; *Nitrosomonas* converts ammonia into nitrite, and *Nitrobacter* converts nitrite into nitrate. Nitrifying bacteria are very sensitive to environmental conditions; this is particularly true of *Nitrobacter*. Many factors can inhibit these bacteria including excessive soluble organics and even light. A balanced population of heterotrophic bacteria is essential to control levels of soluble organic pollutants and for denitrification. Lack of any member, of the essential communities will stop or reduce the efficiency of the processes.

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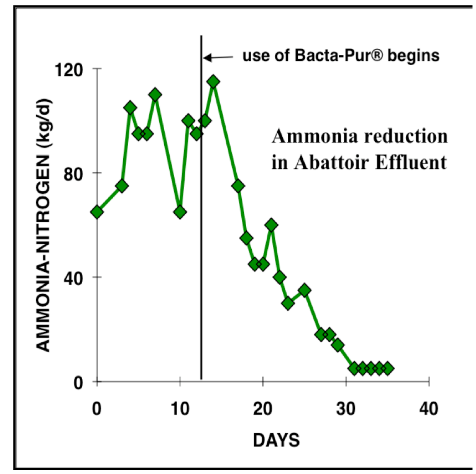
Nitrifiers occur in the surface layers of the soil as well as in surface waters. Freezing eliminates runoff of nitrifiers entering combined sewers. Similarly, sealed or just sanitary sewers or septic systems do not contain nitrifiers. They do not come from digestive tracts.



Bacta-Pur® use rapidly decreased ammonia by about 100 times

Simply adding bacteria to a wastewater plant does not guarantee that they will achieve the targeted task. It is essential to provide the cultures with the conditions required for their growth.

Water Physical-Chemistry — The first step to achieve efficient nitrification is to establish the conditions required for this process. Ammonia and nitrite are only sources of nitrogen for nitrifying bacteria. Other nutrients including carbon, phosphorus and trace elements are also essential. Carbon must be inorganic and is measured as carbonate alkalinity, the alkalinity due to carbonate and bicarbonate. Nitrifiers prefer stable they are slow to return to active growth.

BACTIVATOR®Ⓓ LSN1500
with external reservoirs and activated carbon filter.
The BACTIVATOR®Ⓓ family of onsite incubators was designed to provide a continuous supply of active nitrifiers and to overcome problems including toxic shocks and wash outs.

Sodium bicarbonate (baking soda) is commonly used to increase the alkalinity. The alkalinity should always be at least eight times the level of ammonia. Water with more than 100 mg $CaCO_3$/L is normally adequate for low levels of ammonia. Lack of carbonate alkalinity will stop nitrification.

The alkalinity provides pH buffering. The optimal pH for nitrification is near 8.0. Values outside of 6.0 - 8.5 can be expected to reduce nitrification efficiency. *Nitrosomonas* produces acid during its growth; the pH must be monitored and adjusted.

Nitrifying bacteria absolutely require adequate oxygen. At least 3 ppm of oxygen should be maintained. The optimal temperature for nitrification is about 30°C; the rate can be expected to be cut in half for every decrease of 10°C. Thus a WWTP or biofilter working at 30°C (86°F) may remove the same amount of ammonia as one twice as large but operating at 20°C (68°C).

Denitrification largely occurs in anoxic conditions, which can even occur within bacterial floc even in environments with measurable oxygen. Denitrification increases the pH and regenerates alkalinity. The denitrifiying bacteria require an electron donor. Products used for this purpose vary from starches to methanol amongst others.

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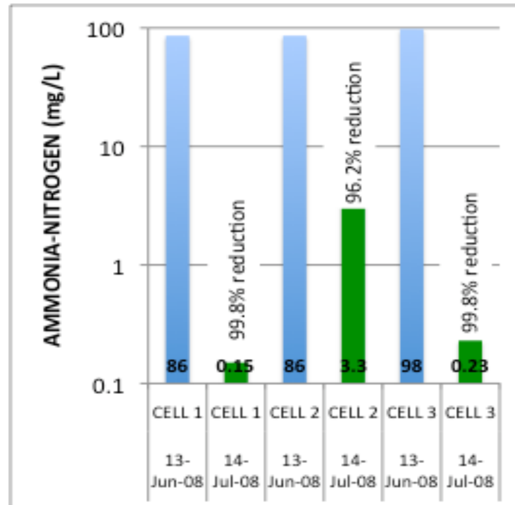
Nitrification in wastewater with the Bacta-Pur® System

The first step to achieve efficient nitrification is to establish the conditions required for this process. Bacta-Pur® XLG provides the optimal community of beneficial microbes, which eliminate cBOD (and chemicals that can inhibit nitrifiers. Bacta-Pur® XLG provides the conditions to permit nitrification and will also remove ammonia by assimilation. The sooner, in the treatment, that required conditions for nitrification are obtained, means more time, within the treatment system is available for nitrification. The process of reducing cBOD can even begin upstream, before the WWTP, with the use of the BACTIVATOR® LS models. This maximizes the time within the WWTP for nitrification.



Bacta-Pur® use decreased ammonia over 99% in 24 hr

Bacta-Pur® N3000 assures the presence of a balanced community of nitrifying / denitrifying strains. All packaged products must be dormant to have shelf life. Bacta-Pur® N3000 has a 5-year shelf life from bottling. Dormant cultures, particularly nitrifiers, can be very slow to activate; the BACTIVATOR® LSN models overcome and simplify the activation process. The BACTIVATOR® LSN models continuously (24/7) add active nitrifiers to wastewater system. The product use rates of the BACTIVATOR®s are adjustable for changing conditions:

- Commercial models — 1.0 to 1.5 L / day,
- Industrial models — 10 to 40 L Bacta-Pur® N3000/ day, 10 to 50 L Bacta-Pur® XLG/ day

Treatment of batches can be accomplished with manual preactivation, instructions available.

Dose rates for nitrification*

FLOWING SYSTEMS: Dose rates are calculated, in one of two ways, by daily flow or system volume:

- ppm based on flow — this method is used if flow is greater than 10% of hydraulic retention time (HRT) (< 10 days HRT); Bacta-Pur® is continuously added, with a BACTIVATOR®, based on the flow.
- ppm based on volume — this method is used if flow is less than 10% of HRT (≥ 10 days HRT). If this method is used the dose rate (ppm) is either applied once per week, in a batch, or if a BACTIVATOR® is used, the weekly dose is divided by seven, and this amount is preactivated and automatically applied daily by the BACTIVATOR®.

BATCH TREATMENT: Batches are treated weekly based on their volume. Daily additions can be made with a BACTIVATOR®.

Temperature effects — Eliminating ammonia from municipal and/or industrial sources is more complicated than from natural sources or from aquacultural production. Temperature is a master factor affecting activity of cold-blooded organisms. Activity rates, within the viable range, double with every increase of 10°C and are reduced by 50% for every decrease of 10°C. This applies to the bacteria in a wastewater treatment plant and similarly to fish in a pond. Thus cold water will reduce both bacterial activity and ammonia production in a fish pond. This reduction of ammonia production, however, does not apply to most wastewater

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treatment systems. Cold weather does not reduce ammonia entering the treatment plant; concentrations may actually increase, if people spend more time indoors. The problem is also exacerbated by freezing of surface layers of the soil and lack of runoff.

More cells are required to get a job done at colder temperatures than at warmer ones. This can be accomplished in two ways:

- either with a biofilter sized for winter conditions or
- with a higher dose rate of nitrifiers

Optimal dose rates — three parameters are most important:

- Temperature
- Time available to accomplish the targeted task (HRT) and
- Ammonia concentration

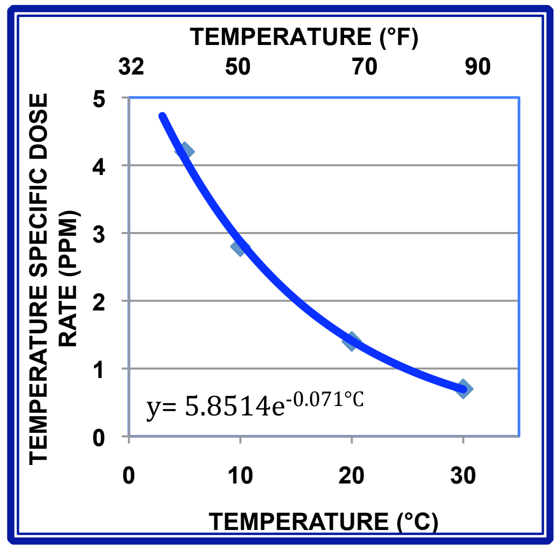

Fig. 1 Temperature specific dose rate (TSDR).

There are three steps to calculate the dose rate:

1. Determine the temperature specific dose rate (TSDR) from Figure 1.
2. Multiply the TSDR by the Concentration Factor.

Ammonia (mg/L) INFLUENT	CONCENTRATION FACTOR
<100	0.8
100 ≤ 1,000	1.0
1,000 ≤ 5,000	1.5
5,000 ≤ 10,000	2.0
> 10,000	2.5

3. Multiply the results above by the time factor.

HRT (DAYS)	TIME FACTOR
<1	2.0
1 ≤ 3	1.5
≥ 3	1.0

EXAMPLE:

- TSDR: for 25°C = **1 ppm**
- Influent ammonia concentration (500 mg/L): Concentration factor = **1.0**
- HRT: 2 days: time factor = **1.5**

Dose rate (to be preactivated) = 1 ppm X 1 (concentration factor) X 1.5 (time factor) = 1.5 ppm

*Every wastewater treatment facility or biodegradation product is unique, with its own set of physical, chemical and biological realities. The dose rates suggested here should be considered a starting point; they can be adjusted as the treatment progresses. Generally speaking larger doses give faster results. It is better to start with higher doses.

Contact IET–Aquaresearch Ltd. or an authorized representative for site-specific dose rates.

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