

# Beyond Nitrogen

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# Challenges with Onsite Nitrogen Removal

- Biological processes
- Wastewater characteristics
- Process monitoring and operation

**University Curriculum Development  
for Decentralized  
Wastewater Management**

**Onsite Nitrogen Removal**

Stewart Oakley  
September 2004  
FINAL

Given the nature of biological nitrification/denitrification and the inherent variability of onsite wastewater characteristics, all technologies for onsite nitrogen removal, whether proprietary or not, will require some degree of monitoring and operational adjustment for site specific conditions.

Even assuming  
adequate monitoring and operation,  
Total-N removal might be poor  
not as a result of a particular technology,  
but as a result of wastewater  
characteristics

# Biological Nitrogen Removal





# Process Monitoring

For monitoring of the nitrification process,  $\text{NH}_4^+$  levels should be as close to zero as possible.

Ammonia Nitrogen  
+ Organic Nitrogen

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Total Kjeldahl Nitrogen (TKN)

# Organic Nitrogen

Samples with high suspended solids will have higher organic nitrogen levels although ammonia levels should not change.

Poor sampling technique can greatly increase TKN levels.

For compliance monitoring always analyze for ammonia along with TKN.

# Biological Nitrification

It is a living system

Some limitations for nitrification:

- Oxygen
- Temperature
- pH
- Alkalinity
- Inhibitors

# Effect of Dissolved Oxygen Concentration on Nitrification

As dissolved oxygen increases, nitrifier growth rate increases up to DO levels of about 5 mg/L.



**Rule of Thumb:**  
Maintain dissolved oxygen concentration at 3.0 mg/l or higher for optimum nitrification.

# Temperature and Nitrification

30 C (86 F)	Optimal temperature
16 C (60.8 F)	50% of rate at 30 C
10 C (50 F)	20% of rate at 30 C
<5 C (41 F)	Nitrification ceases

# pH and Alkalinity

- The optimum **pH** range for nitrification is **6.5 to 8.0**.
- **Nitrification consumes alkalinity and lowers pH**
- **In low alkalinity wastewaters there is a risk that nitrification will lower the pH to inhibitory levels.**
- **Maintain **alkalinity** levels of no less than **50 mg/L as CaCO<sub>3</sub>** to insure adequate buffering**

# Nitrification

*Nitrosomonas*



*Nitrobacter*



# Nitrification

The two-step reactions are usually very rapid and hence it is rare to find nitrite levels higher than 1.0 mg/L in water. **NOT TRUE**



2008/12/17

# Alkalinity and Nitrification

Date	Alkalinity	NH <sub>4</sub> <sup>+</sup> -N	NO <sub>2</sub> <sup>-</sup> -N	NO <sub>3</sub> <sup>-</sup> -N	TKN	Total N
04/13/09	2	11.9	29.80	2.80	13.3	45.90



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# Alkalinity and Nitrification

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04/13/09	2	11.9	29.80	2.80	13.3	45.90
05/26/09	52	0.6	27.45	0.6	6.5	34.60
06/09/09	200	0.8	8.26	1.12	4.9	14.28
06/30/09	255	0.3	0.73	17.37	5.5	23.60
07/21/09	215	<0.2	0.00	17.80	2.5	20.30
11/23/09	255	<0.2	0.02	19.85	0.2	20.05



06/28/2002





2010/06/22





2013/04/24











2010/12/08



2010/12/08