Methanol usage in Wastewater Treatment

NRRRF –City of Raleigh

Nitrification Process in Wastewater Treatment

Nitrification is a critical biological process in wastewater treatment that involves the conversion of ammonia (NH_3) to nitrate (NO_3^-) by specific bacteria under aerobic conditions. It is typically a two-step process and is part of the larger nitrogen removal strategy, which often includes **denitrification** as a subsequent step.

Key Steps in Nitrification

Ammonia Oxidation (Nitritation)

- **Reaction:** $NH_3 + 1.5\ O_2 \rightarrow NO_2^- + H^+ + H_2O$
- **Carried out by:** *Ammonia-oxidizing bacteria (AOB)* e.g., *Nitrosomonas*

Nitrite Oxidation (Nitratation)

- **Reaction:** $NO_2^- + 0.5\ O_2 \rightarrow NO_3^-$
- **Carried out by:** *Nitrite-oxidizing bacteria (NOB)* e.g., *Nitrobacter*

Methanol is used in wastewater treatment primarily as an external **carbon source** to enhance **denitrification**, a biological process that removes nitrogen from wastewater. Here's a breakdown of how and why methanol is used:

Purpose of Methanol in Wastewater Treatment

1. Denitrification

Denitrification is the microbial reduction of **nitrate (NO_3^-)** to **nitrogen gas (N_2)**, which is released harmlessly into the atmosphere.

This process requires a **carbon source** to provide energy for the denitrifying bacteria.

In many wastewater treatment plants (WWTPs), especially those with low carbon-to-nitrogen (C:N) ratios, the wastewater doesn't contain enough biodegradable organic matter.

Methanol (CH_3OH) is added to supply this missing carbon.

How Methanol is Applied

Point of Addition: Usually added to an **anoxic zone** in the treatment process (where oxygen is absent but nitrate is present).

Dosing Control: Methanol dosage is carefully controlled based on:

- Nitrate concentration
- Flow rate
- Desired level of nitrogen removal

Advantages of Methanol

- Readily biodegradable by denitrifying bacteria
- Predictable and controllable results
- Relatively low cost compared to some alternatives
- Easy to handle and store

Considerations and Challenges

Overdosing can cause:

- Increased oxygen demand
- Unwanted biological growth
- Residual methanol in effluent

Safety: Methanol is flammable and toxic, requiring proper storage and handling.

Cost: Though inexpensive, cost can accumulate at large-scale plants.

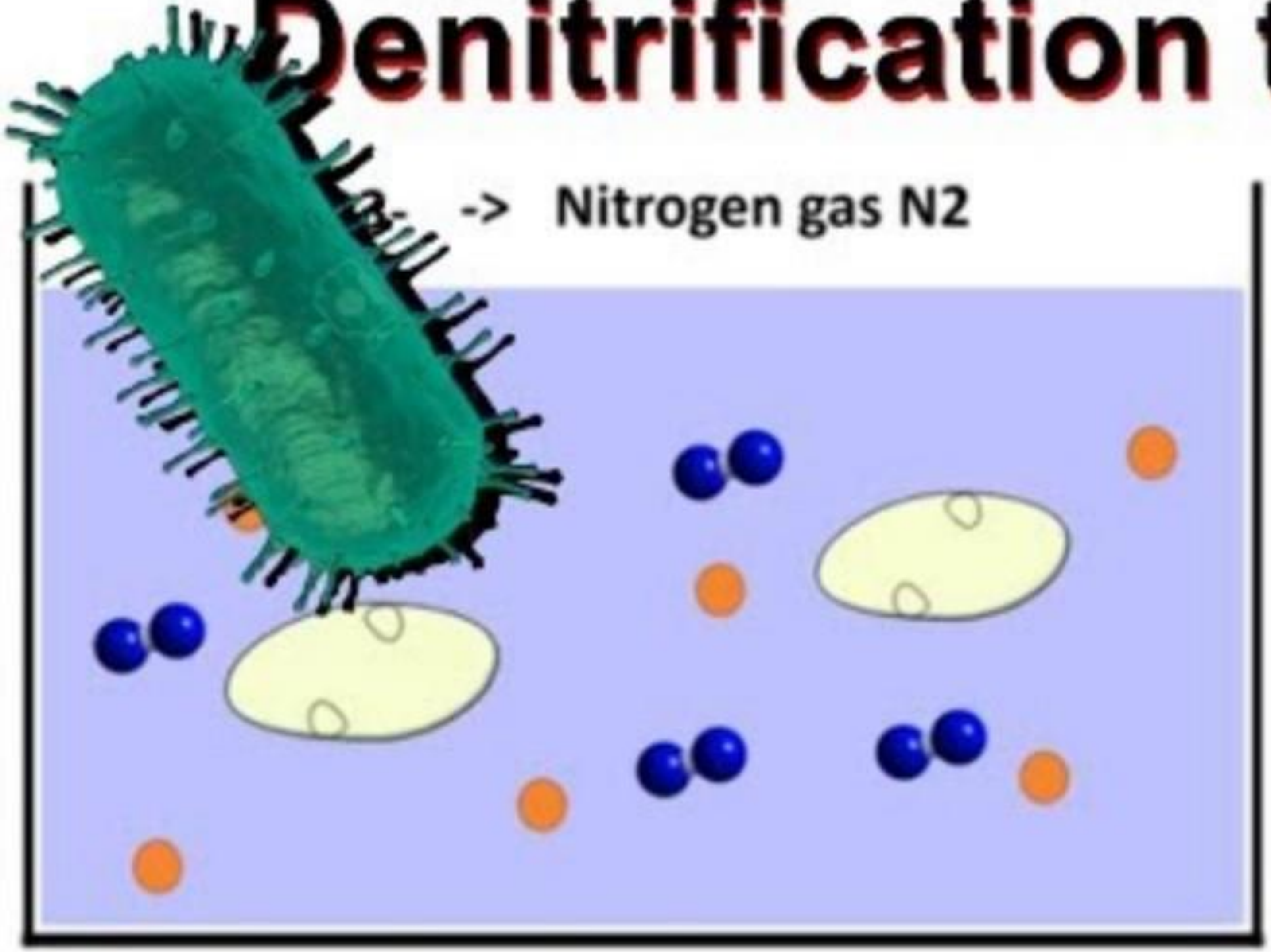
Prevents Eutrophication

Excess nitrogen (mostly as nitrate and ammonia) released into rivers, lakes, and coastal waters can fuel **algal blooms**.

These blooms deplete oxygen when they decompose, leading to **hypoxic zones** (dead zones) that can't support aquatic life.

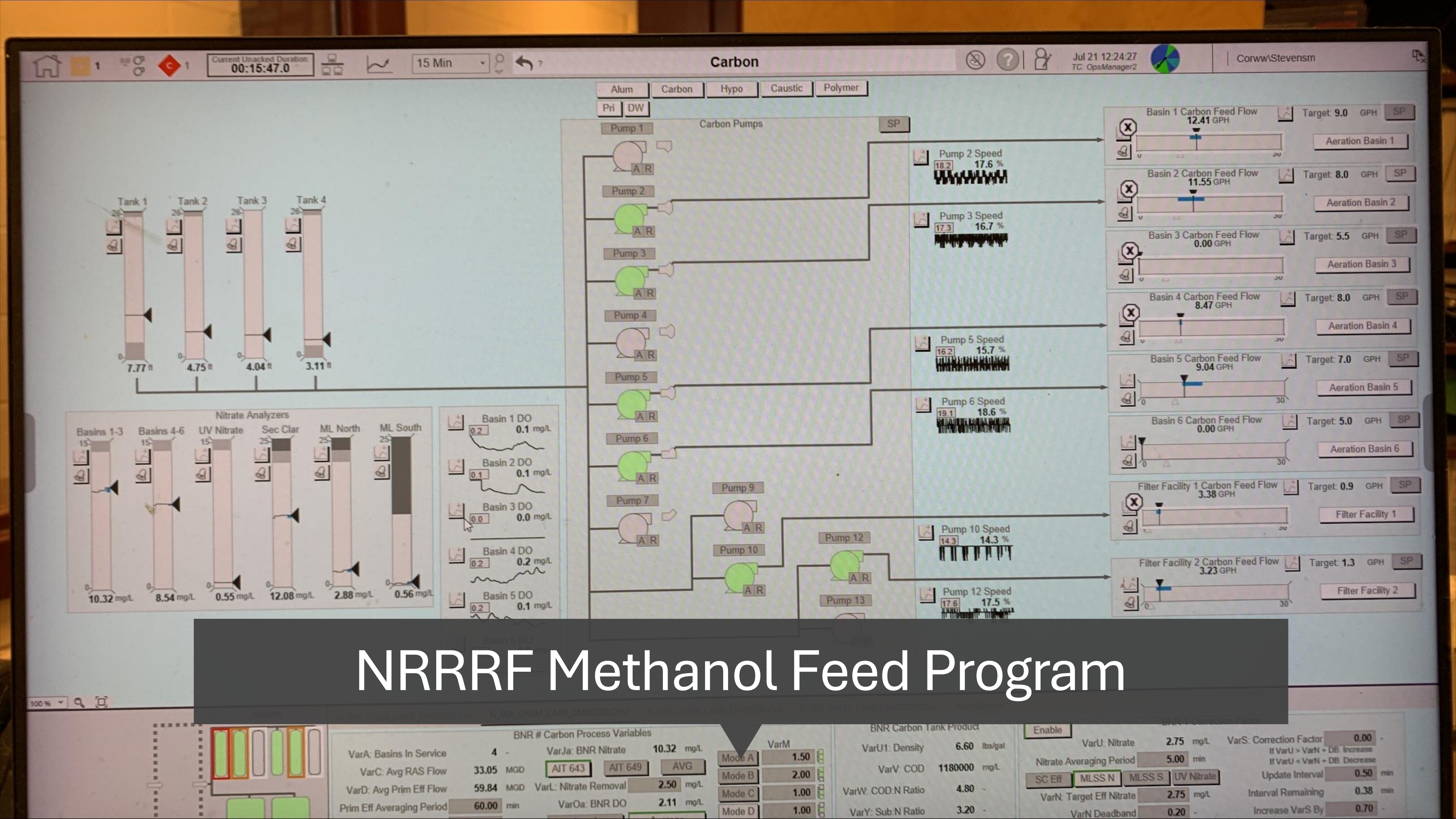
Example: The **Gulf of Mexico dead zone** is a direct result of nutrient pollution, including nitrogen.

Denitrification tutorial



Try to oxidize available BOD

Has the ability to strip oxygen from Nitrate



NRRRF Methanol Feed Program
Carbon
Current Unacked Duration 00:15:47.0
15 Min
Jul 21 12:24:27
TC: OpsManager2
Corww\Stevensm
Alum
Carbon
Hypo
Caustic
Polymer
Pri
DW
Carbon Pumps
SP
Pump 1
Pump 2
Pump 3
Pump 4
Pump 5
Pump 6
Pump 7
Pump 9
Pump 10
Pump 12
Pump 13
Tank 1
Tank 2
Tank 3
Tank 4
7.77 ft
4.75 ft
4.04 ft
3.11 ft
Nitrate Analyzers
Basins 1-3
Basins 4-6
UV Nitrate
Sec Clar
ML North
ML South
10.32 mg/L
8.54 mg/L
0.55 mg/L
12.08 mg/L
2.88 mg/L
0.56 mg/L
Basin 1 DO 0.1 mg/L
Basin 2 DO 0.1 mg/L
Basin 3 DO 0.0 mg/L
Basin 4 DO 0.2 mg/L
Basin 5 DO 0.1 mg/L
Pump 2 Speed 17.6 %
Pump 3 Speed 16.7 %
Pump 5 Speed 15.7 %
Pump 6 Speed 18.6 %
Pump 10 Speed 14.3 %
Pump 12 Speed 17.5 %
Basin 1 Carbon Feed Flow 12.41 GPH
Target: 9.0 GPH
Aeration Basin 1
Basin 2 Carbon Feed Flow 11.55 GPH
Target: 8.0 GPH
Aeration Basin 2
Basin 3 Carbon Feed Flow 0.00 GPH
Target: 5.5 GPH
Aeration Basin 3
Basin 4 Carbon Feed Flow 8.47 GPH
Target: 8.0 GPH
Aeration Basin 4
Basin 5 Carbon Feed Flow 9.04 GPH
Target: 7.0 GPH
Aeration Basin 5
Basin 6 Carbon Feed Flow 0.00 GPH
Target: 5.0 GPH
Aeration Basin 6
Filter Facility 1 Carbon Feed Flow 3.38 GPH
Target: 0.9 GPH
Filter Facility 1
Filter Facility 2 Carbon Feed Flow 3.23 GPH
Target: 1.3 GPH
Filter Facility 2
BNR # Carbon Process Variables
VarA: Basins In Service 4
VarC: Avg RAS Flow 33.05 MGD
VarD: Avg Prim Eff Flow 59.84 MGD
Prim Eff Averaging Period 60.00 min
VarJa: BNR Nitrate 10.32 mg/L
AIT 643
AIT 649
AVG
VarL: Nitrate Removal 2.50 mg/L
VarOa: BNR DO 2.11 mg/L
VarM
Mode A 1.50
Mode B 2.00
Mode C 1.00
Mode D 1.00
BNR Carbon Tank Product
VarU1: Density 6.60 lbs/gal
VarV: COD 1180000 mg/L
VarW: COD:N Ratio 4.80
VarY: Sub:N Ratio 3.20
Enable
VarU: Nitrate 2.75 mg/L
Nitrate Averaging Period 5.00 min
SC Eff
MLSS N
MLSS S
UV Nitrate
VarN: Target Eff Nitrate 2.75 mg/L
VarN Deadband 0.20
VarS: Correction Factor 0.00
If VarU > VarN + DB: Increase
If VarU < VarN + DB: Decrease
Update Interval 0.50 min
Interval Remaining 0.38 min
Increase VarS By 0.70