ANOXIC ACTIVATED SLUDGE MONITORING WITH COMBINED NITRATE AND TITRIMETIC MEASUREMENTS

Gürkan Sin[1], Britta Petersen[1,2], Krist Gernaey[1,2] and Peter A. Vanrolleghem[1]

[1]Ghent University - BIOMATH, Department of Applied Mathematics, Biometrics and Process Control, Coupure Links 653, B-9000 Gent, BELGIUM
[2]Department of Civil, Geological and Mining Engineering, École Polytechnique de Montréal, PO Box 6079, Station Centre-ville Montreal, Quebec H3C 3A7, Canada

Introduction

How do we monitor the anoxic activated sludge processes?

- Respirometric techniques are inappropriate in the anoxic environment
- Traditional analytical methods for nitrate measurement are labour intensive and sampling frequency is often low
- Titrimetric methods are promising but require a priori knowledge of the effect of carbon degradation on the proton balance

Objective

Evaluation of combined nitrate and titrimetric measurements for anoxic activated sludge monitoring.

Methods

The Anoxic Titrimetric Sensor

Nitrate Measurement

High data sampling frequency by Ion selective nitrate electrode incorporating internal electrode calibration

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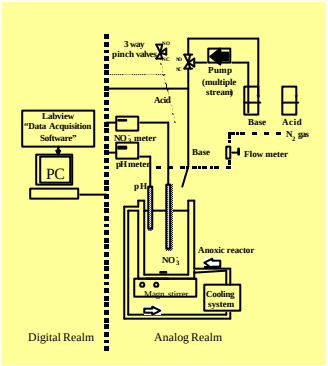
Titrimetry

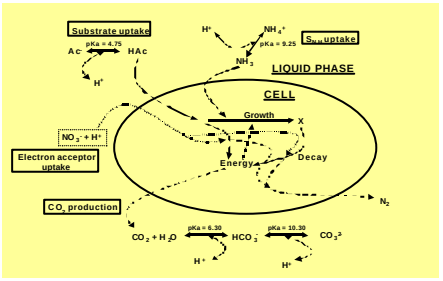
pH controlled at narrow setpoint and cumulative base/acid dosage recorded



The Conceptual Proton Dynamics Model (illustrated for acetate)

processes affecting the proton balance :

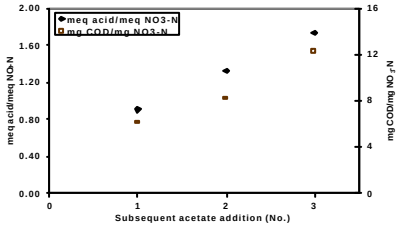
- Substrate uptake
- NH_3 uptake for growth
- Electron acceptor uptake
- CO_2 production



Results & Discussion

Experiments with Excess Nitrate

These experiments provide information to identify the Monod parameters (μ_{maxH} and K_S)



- *Nitrite build-up provoked*
- *Complicated data interpretation*

Figure 1. Problems with varying denitrification stoichiometry in subsequent acetate additions

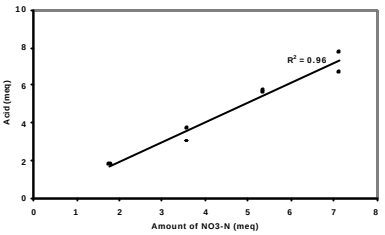
Remark # 1

Build-up of nitrite causes interference with obtained stoichiometric ratios

- Ratio of COD to NO_3-N consumed AND ratio of meq acid added to meq NO_3-N consumed are **NOT** constant
- Correct data interpretation requires additional NO_2-N measurements

Experiments with Excess Carbon Source

These experiments provide information to identify the Monod parameters (μ_{maxH} and K_{NO3})



Linear relationship between cumulative acid addition and nitrate reduction

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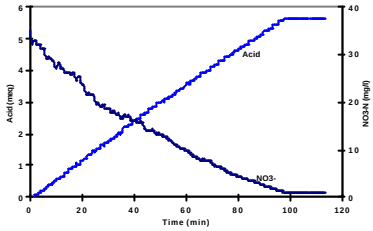
No nitrite build-up interference & Stoichiometric ratio is constant

Figure 2. Cumulative amount of acid dosed versus initial amount of nitrate nitrogen added (acetate as a C-source).

Remark # 2

- Linearity between acid addition and nitrate reduction -> no NO_2-N accumulation
- Experimental design with excess carbon source easier to interpret
- Titrimetric data useful to verify the quality of NO_3-N data and the experiment in general since non-linearity between acid added and nitrate reduction indicates NO_2-N accumulation



- *Acetate induces proton consumption (acid addition)*

Figure 3.Combined titrimetric (cumulative acid dosed) and nitrate measurement (acetate as C-source)

- *Dextrose induces proton production (base addition)*

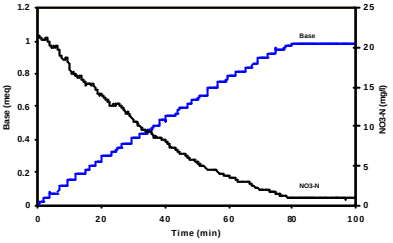


Figure 4. Combined titrimetric (cumulative base dosed) and nitrate measurement (dextrose as C-source)

Remark # 3

- At the given pH, acetate degradation resulted in acid addition and dextrose in base addition
- This is in accordance with the conceptual model since uptake of acetate, unlike dextrose, results in a high proton consumption (acid addition)
- The experimental stoichiometric ratio's were confirmed by the model

TAKE HOME MESSAGES

- A combined nitrate and titrimetric sensor offers an effective tool for monitoring anoxic denitrification process
- The preferred experimental design is with carbon in excess
- It is possible to determine μ_{maxH} and K_{NO3} for denitrifying bacteria
- High data frequency widens the perspective for further model-based data interpretation and kinetic parameter identification
- The proposed conceptual model for titrimetric data predicts the experimental observations well