

Inhibition of unwanted nitrification

SURCIS S.L.

Respirometer

The respirometer utilized in this study corresponds to the BM-Advance model, with the following main features:



BM-Advance

- Compact analyzer, with very low maintenance and user friendly operation
- Direct oxygen measurements from a maintenance-free oxygen sensor
- No oxygenation restriction during test performance
- Full control and results by means a powerful software already loaded in the PC
- Automatic software update versions from internet
- Capacity for test conditions setting and modify them throughout the test performance.
- Three different operation modes: R, OUR and Cyclic OUR
 1. R mode: Automatic measurements of R_s (exogenous respiration rate), CO (consumed oxygen), bCOD (biodegradable and readily biodegradable COD), U (COD utilization rate) and q (specific U)
 2. OUR mode: OUR (oxygen uptake rate) & SOUR (specific OUR)
 3. OUR cyclic: OUR & SOUR within a continuous sequential chain of measurements
- Last, minimum, maximum and moving average results at any time during the test
- Several results at any time during the test and option to see them simultaneously on tabular or graphic modes
- Option to open several stored tests and compare their results
- Automatic temperature control integrated in the own console
- pH monitoring and automatic control system
- Option for ORP monitoring, simultaneously to pH
- Package of measurements at any moment during test performance
- Capacity for different respirograms and their simultaneous overlying
- BM respirometers measure data that can be directly input into modeling – simulating software
- Option for a special reactor assembly for moving beds bio-films (MBBR)

Preliminar

The maintenance staff responsible for control of the wastewater treatment plant of the factory informs that the process often has a deficiency of the nutrient N and they try to control this deficiency throughout the regular addition of ammonium chloride. For this reason often occurs an unwanted nitrification which consequently led to a poor efficiency in the process performance, excessive dissolved oxygen consumption and its logical impact on the energy expenditure.

Result, Surcis reaches an agreement to carry out a demonstration of Respirometría BM on-site targeting this type of application.

Objective

The objective of the demonstration / study is to analyze the influence of pH on nitrification for current conditions and see if a progressive controlled descent of pH level is able to inhibit nitrification without significantly affecting the degradation of organic matter.

1. BM Respirometry

The BM respirometry tests were carried out in R mode, where a DO base line is fixed from an endogenous respiration activated sludge and then added a certain amount of substrate to get the appropriate results.

Once the base-line is fixed and stored, we go ahead on the second step by adding the volume of sample we had set in the settings board and starting a graphical diagram (respirogram) of continuous exogenous respiration rates (R_s)

The trajectory of the respirogram will follow the actual state of substrate degradation along the time until its depletion.

1.1. Nitrification on different pH levels

In this kind of R test, the substrate was the ammonium chloride on equivalent enough ammonia concentration to maintain a Rs plateau as a reference for the different pH levels we were setting during the test performance.

Manual pH settings during test
6,9 → 7,1 → 6,6 → 6,5 → 6

The screenshot shows the 'New Test' dialog box with the following settings:

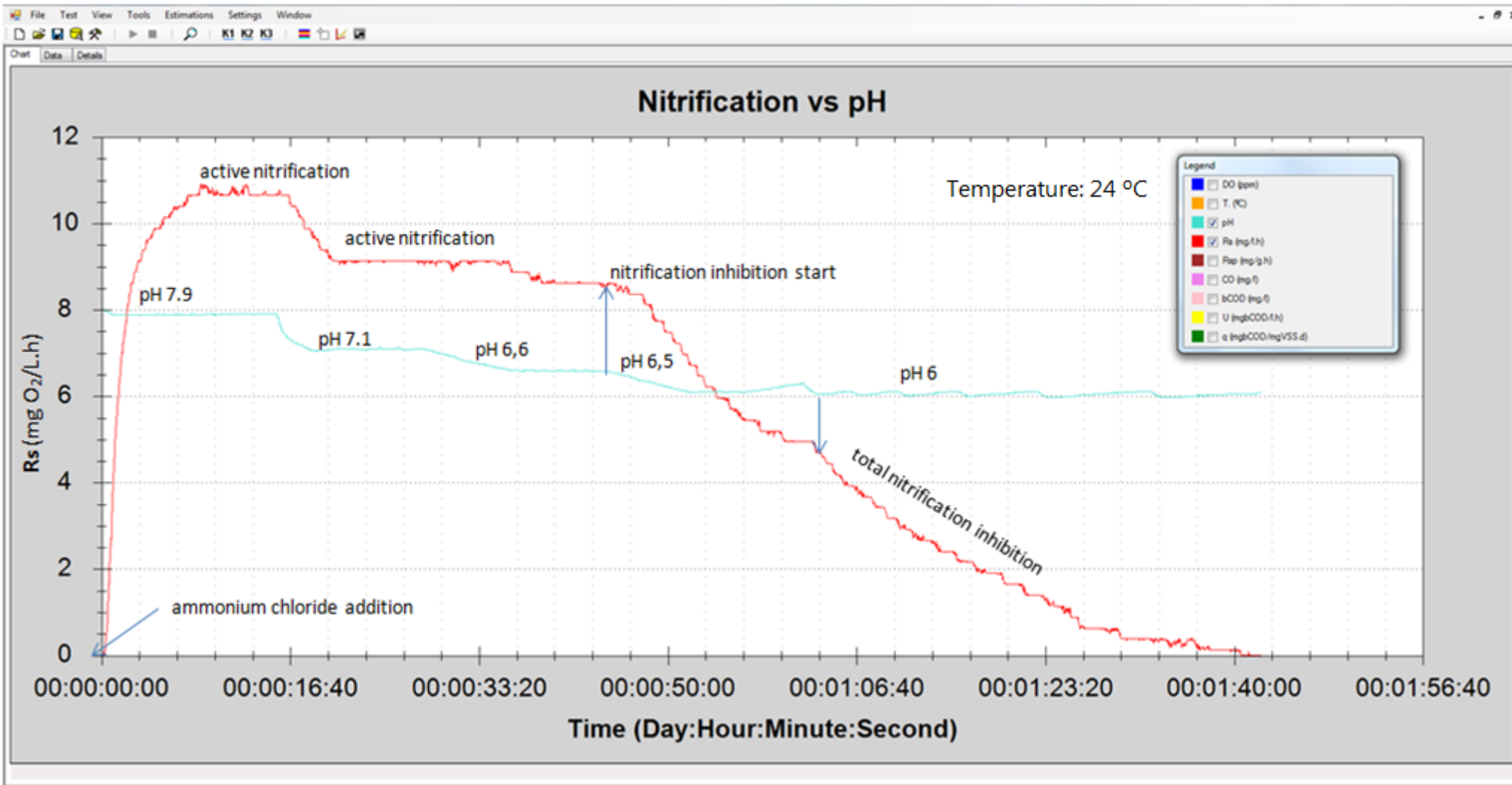
- Test type:** R (selected), OUR, Cyclic OUR
- Name:** Nitrification vs pH
- Operator:** JXS
- Filename:** C:\Users\emilio\Documents\Respirometr (with Search button)
- Data interval:** 2 s
- Vf:** 1000,00 ml
- Solids:** 2,35 g/L
- CO:** 126,05
- Vm:** 70,00 ml
- Y:** 0,67
- DO Low:** 2,0
- fd:** Auto (dropdown), 15,28571
- Readings < 0
- DO High:** 6,0
- Force Cb : 0,00

Board control settings during test:

- Temperature control:** 20,00 (with slider), OFF/ON
- PH Control:** (with slider), Hysteresis: 0,02, OFF/ON
- Peristaltic pump:** 2 (with slider), OFF/ON
- Aeration:** 55 (with slider), OFF/ON

Buttons: Cancel, Accept

Test settings board



Rs respirogram due to nitrification vs pH

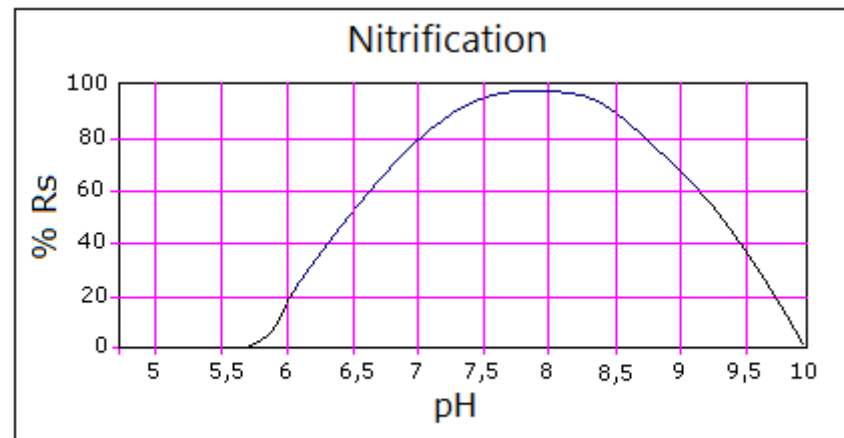
Analysis of the nitrification R_s respirogram vs pH

The exogenous respiration rate due to nitrification, and therefore the corresponding nitrification rate, decreases from its maximum value (at pH 7.9) as the pH settings are gradually lowering.

Below pH 6.5 the active nitrifying experiences a significant fall, as a clear sign of inhibition. This inhibition is strengthened gradually, ending up becoming a total inhibition when reaching a pH below 6.

Support from bibliography

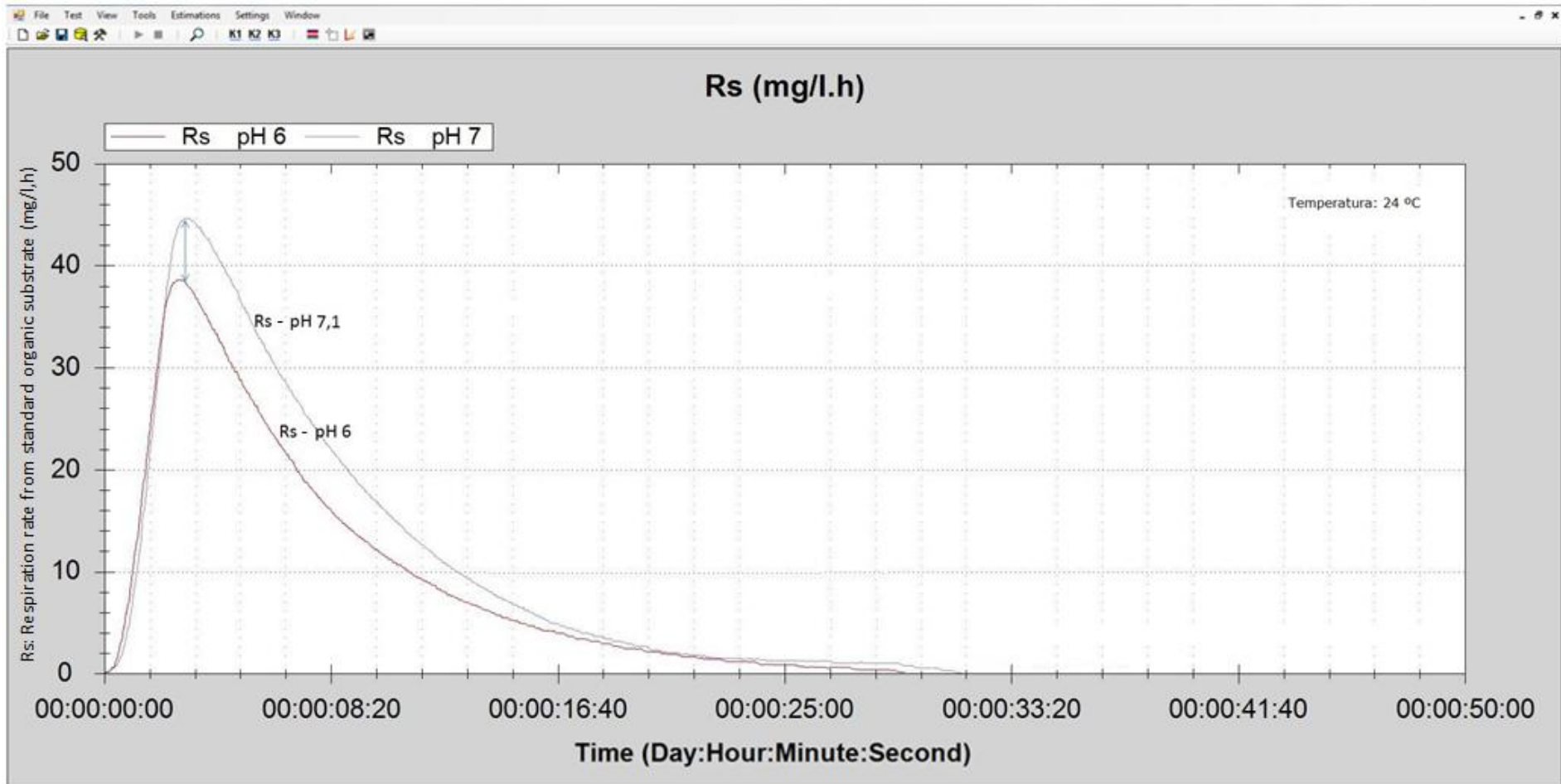
The R_s respirogram due to nitrification we have got in the test fits with the technical literature on this subject.



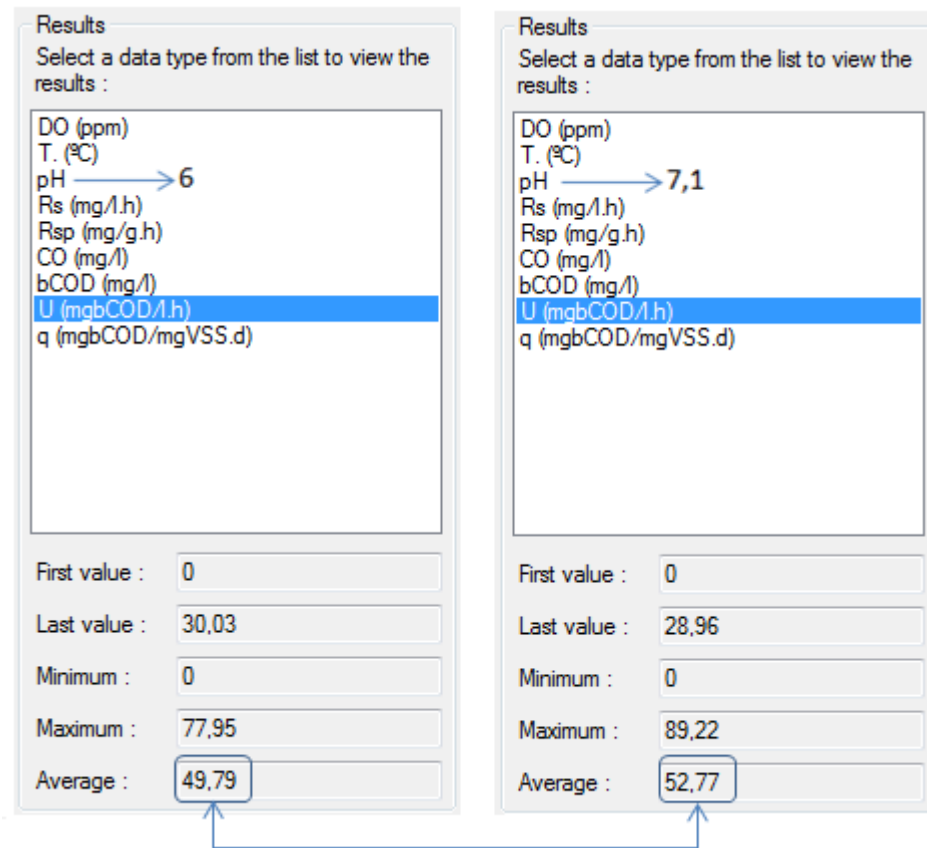
Grunditz & Dalhatmmar, 2001

1.2. Influence of pH on the organic matter degradation

To analyze the influence that pH decrease can cause in the organic substrate removal, two tests R were carried out by using sodium acetate (as a standard substrate) at pH 6 and pH 7.1, where the exogenous respiration rate (R_s) and the biodegradable COD utilization rate (U) were analyzed,



Overlying of the R respirograms due to oxidation of the organic substrate at pH 6 and pH 7,1



Results of the COD utilization rate (U) at pH 6 and pH 7

1.2.1. Analysis of the results on the pH influence in the degradation of the organic substrate

The values of the respiration rate (R_s) in the COD removal experienced a slight decline in the test at pH 6 with respect to the values of pH 7.1. In the respirogram you can see that the degradation time in the organic substrate (sodium acetate) is also a rather lower in the test at pH 7.1 compared with the time on the test at pH 6. However, when we analyze the average of the COD utilization rate (U), we can realize that the difference is only 3 mg DQOb/L.h.

1.3. Conclusions

2. Following the strategy of gradually lowering the pH, there is a break-point for a determined pH value where the nitrification starts to be inhibited.
3. Within the range of pH in which the nitrification suffers the inhibitory effect, the degradation of the organic matter can be perfectly developed with a slight decrease of its biodegradable COD removal rate.
4. Based on the above points, it is noted that, when there is an unwanted nitrification, this could be totally or partially inhibited throughout the control of different pH levels.
5. From the tests and results obtained in this study, the BM respirometry has proven to become a fundamental tool for the control of any biological process of wastewater treatment where it is required to inhibit nitrification by controlling the pH and analyze the possible influence that this pH decrease could get on the COD removal.

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