Evaluation of the anoxic denitrification process by BM Respirometry

SURCIS

BM-Respirometry

SURCIS

BM Respirometry
a state of the art technology

BM Respirometry is a technology where traditional and more advanced respirometry techniques are brought together in an exclusive design developed by the company SURCIS.

BM Respirometry makes use of one or two reactors, where sample and sludge volumes, pH, temperature and others can be programmed into the test configuration, at any time.

BM respirometers use powerful software that provides a series of automatic measurements and calculations of decisive parameters used to manage, design and research the biological processes of wastewater treatment under different conditions.

With this technology, Surcis has developed a series of respirometry applications that cover the main areas of biological wastewater treatment processes, both in terms of organic matter and biological nitrogen removal.

BM-Respirometry System

1. Automatic pH control
2. pH sensor
3. Dissolved oxygen sensor
4. Stirring motor
5. Homogenization peristaltic pump
6. Double chamber Reactor
7. Automatic tempering system
8. Leds for devices control
9. Oxygen and temperature controller
10. Automatic pH controller system
11. PC + BM software

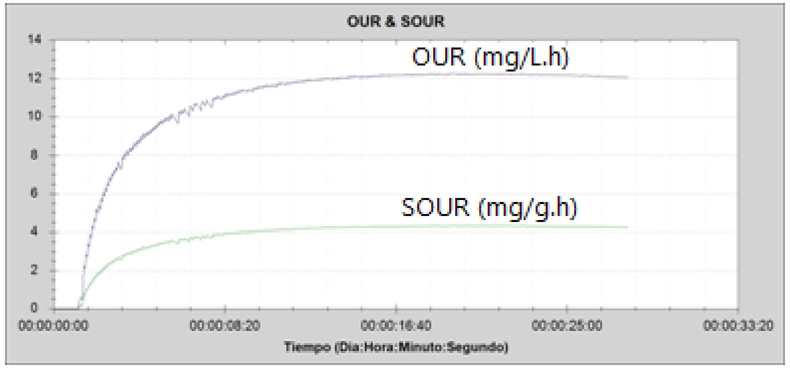
BM- Advance Multipurpose Respirometry System model

Operation modes and automatic parameters in the BM Respirometry

OUR & Cyclic OUR modes

OUR: **Oxygen Uptake Rate** (mg O_2/l.h)
It measures the oxygen uptake rate for only one measurement or serial o measurements.

SOUR: **Specific OUR** (mg O_2/g VSS.h)
Specific OUR related to MLVSS. SOUR = OUR / MLVSS



OUR & SOUR respirograms

R mode

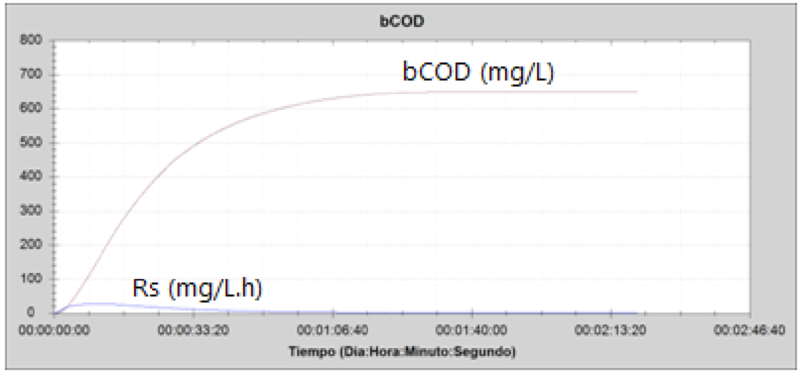
Rs: **Dynamic Exogenous Respiration Rate** (mg O_2/l.h)
It measures the oxygen uptake rate from the mixture of the activated sludge and certain amount of wastewater sample or compound within a continuous chain of measurements.

Rsp: **Dynamic Exogenous Respiration Rate** (mg O_2/g VSS.h)
Specific Rs referred to MLVSS. Rsp = Rs / MLVSS

bCOD: **Biodegradable COD** (mg O_2/l)
Biodegradable or soluble readily biodegradable COD fraction, based on Rs measurements integration from a mixture of activated sludge and biodegradable sample.

U: **COD removal rate** (mg COD/l,h)
Speed at which the COD is being removed.

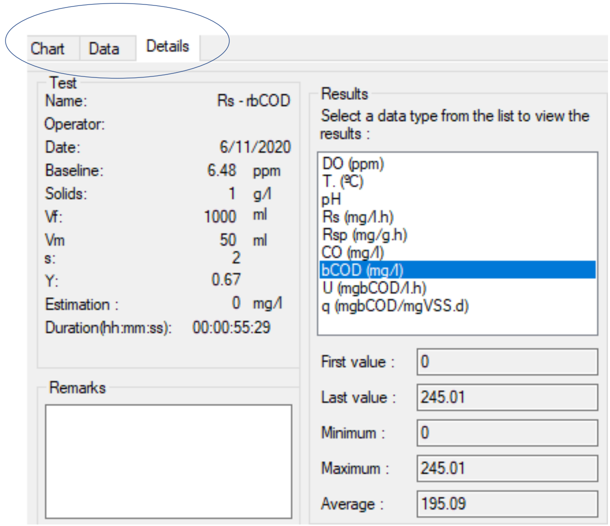
q: **Specific COD removal rate** (mg COD/ mg VSS.d)
Specific U referred to MLVSS concentration.



Rs & bCOD respirograms

Different modes of results presentation at any time in all operation modes: Chart, Data, Details

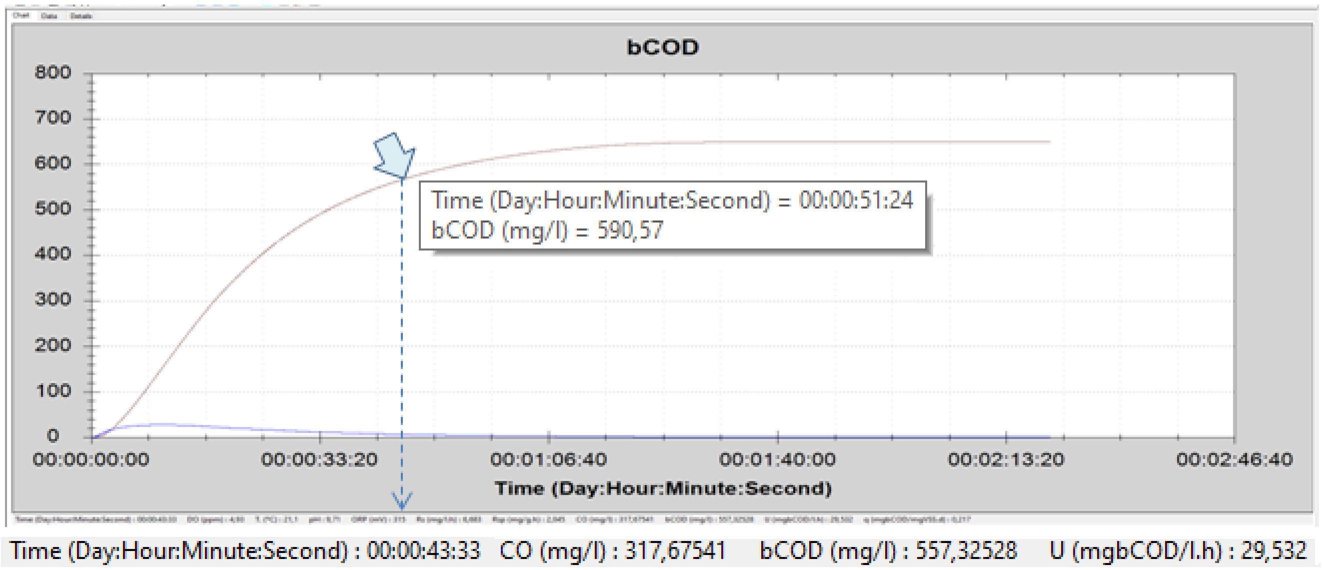
All results in one click on the respirogram, at the end, and/or during the test



Details
Last, minimum, maximum and average result

Time (Day:Hour:Minute:Second)	T. (ºC)	pH	CO (mg/l)	bCOD (mg/l)	U (mgbCOD/l.h)
00:00:09:16	21,1	9,66	74,16	130,1	32,4
00:00:09:18	21,1	9,66	74,54	130,78	32,45
00:00:09:20	21,1	9,66	74,93	131,46	32,5
00:00:09:22	21,1	9,66	75,32	132,14	32,56
00:00:09:12	21,1	9,66	73,38	128,74	32,29
00:00:09:14	21,1	9,66	73,77	129,42	32,35

Data - Current data values in a table



....

Chart – Respirogram & Display of the current mesurements

Procedure for calculation of the denitrification rate in the anoxic denitrification process by BM Respirometry

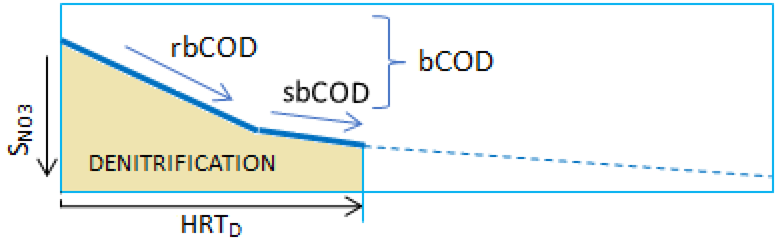
SURCIS

Parameters in play

Symbol	Parameter	Equation, comment
S_{NO3}	Nitrate to denitrfy (mg NO_3-N/L)	Data from the process
bCOD	Biodegradable COD (mg/L)	**Automatically measured in the BM respirometer**
$bCOD_D$	Biodegradable COD used in the dentrification	**Automatically obtained in the BM respirometry test**
CO_D	Oxygen for denitrification	$CO_D = 2{,}86 \,.\, S_{NO3}$
U	Utilization rate of accumulated bCOD used in the denitrification (mg COD/L.h)	**Automatically obtained in the BM respirometry test**
CO	Oxygen consumption corresponding to the bCOD being removed (mg/L)	**Selecting a CO in the results table that corresponds to the CO_D value (previously calculated), from the same row of data, the $bCOD_D$ and U_D are also obtained**
Y_H	Yield coefficient of heterotrophic biomass in aerobic conditions (O_2/COD)	By default: $Y_H = 0.67$
Y_{HD}	Yield coefficient of facultative heterotrophic biomass in denitrification (O_2/COD)	$Y_{HD} \approx 0.83 \,.\, Y_H$ (Muller et al., 2003) By default: $Y_{HD} = 0.55$
r_{O2}	Net oxygen uptake rate from bCOD used in the denitrification (mg O_2/L.h)	$r_{O2} = U_D \,.\, (1 – Y_{HD})$ $(1 – Y_{HD})$ corresponds to the part of the bCOD aimed towards the production of biomass (bacteria)
NUR	Denitrification rate (mg NO_3-N/L.h)	$NUR = (r_{O2} / 2.86) \,.\, K_{OD} / (K_{OD} + DO_D)$
K_{OD}	Coefficient of NUR inhibition due to oxygen in the anoxic zone	K_{OD} = = 0.2 (Henze et al 1996)
DO_D	Dissolved oxygen in the anoxic denitrification zone (mg/L)	It should be < 0.3 mg/L
C_{NO3}	Denitrification capacity (mg NO_3-N)	$C_{NO3} = NUR * HRT_D$ HRT_D (h): Hydraulic Retention Time in the anoxic zone

Basic principles for evaluating anoxic denitrification using aerobic Respirometry

- Denitrification takes total biodegradable COD (bCOD) as the source of organic carbon, giving absolute priority to the readily biodegradable COD fraction (rbCOD)



- There is a fixed ratio of the oxygen from the organic source (CO_D) to nitrate removed (S_{NO3}) of 2.86

$$CO_D = 2.86 \cdot S_{NO3}$$

- In the same way, the ratio between the net organic substrate uptake rate [U (1 – Y_{HD})] and denitrification rate (NUR) is also 2.86

$$U\,(1 - Y_{HD})\ /\ NUR = 2.86$$

- The utilization rate of bCOD in the aerobic zone is equivalent to that in the anoxic zone. Therefore, this data, obtained from an aerobic respirometry test, can be used for the determination of the denitrification rate (NUR) and denitrification capacity (C_{NO3})

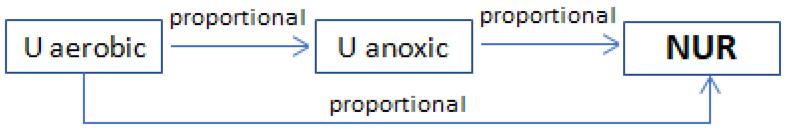
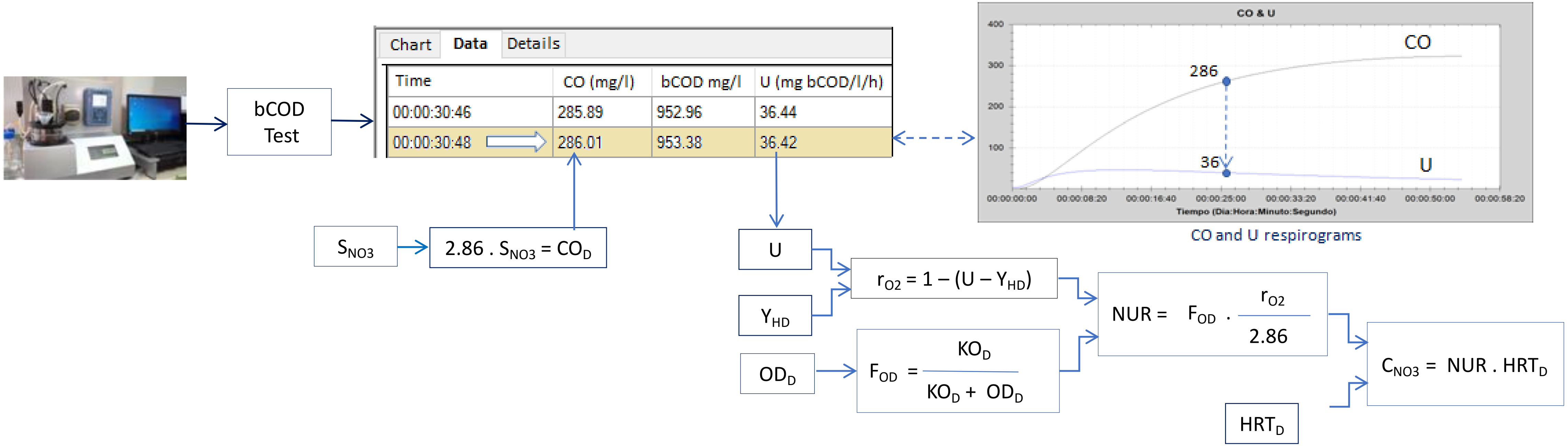


Diagram of the procedure for the denitrification rate (NUR) and denitrification capacity (C_{NO3})



NUR	**Denitrification rate** (mg NO_3-N/L.h)	**$NUR = F_{OD} \cdot r_{O2} / 2.86)$**
C_{NO3}	**Denitrification capacity** (mg NO_3-N)	**$C_{NO3} = NUR \cdot HRT_D$**

BM Respirometry
is not limited

The ability to program parameters, devices and different modes to obtain final and partial results allows the BM Respirometry the possibility of always developing new applications