BM Respirometry for Actual Oxygen Requirements in the aeration system of activated sludge processes

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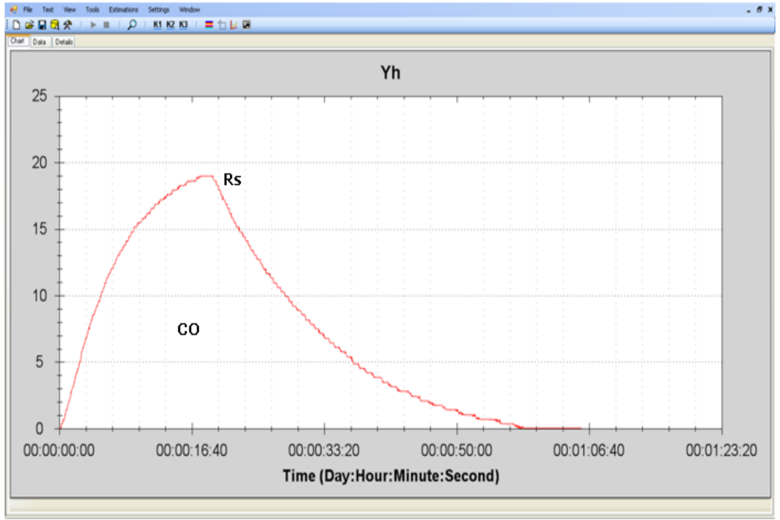
1. Yield coefficient (Y_H) for heterotrophic biomass

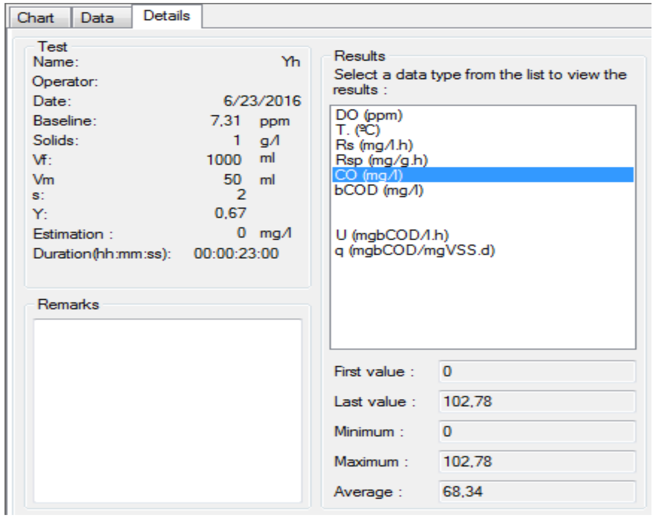
First thing is to make a solution of 400 mg of sodium acetate in 1 litre of distilled water. For this solution, we must obtain (from the lab.) the actual COD value ($COD_{ac} \approx 300$ mg/l

We carry out an R assay in order to determine the consumed oxygen (CO)

CO: Consumed oxygen = ΔO_2 (mg/l)
We can make use of sample volume in between 50 and 100 ml. and pump speed to 2



Rs respirograma for CO determination



CO result

$Y_{H,COD} = 1 - CO / COD_{ac}$ → $Y_{H.VSS} = Y_{H.CO} / 1{,}42$ → $Y_{obs} = Y_{H.VSS} / (1 + 0.06 * SRT)$

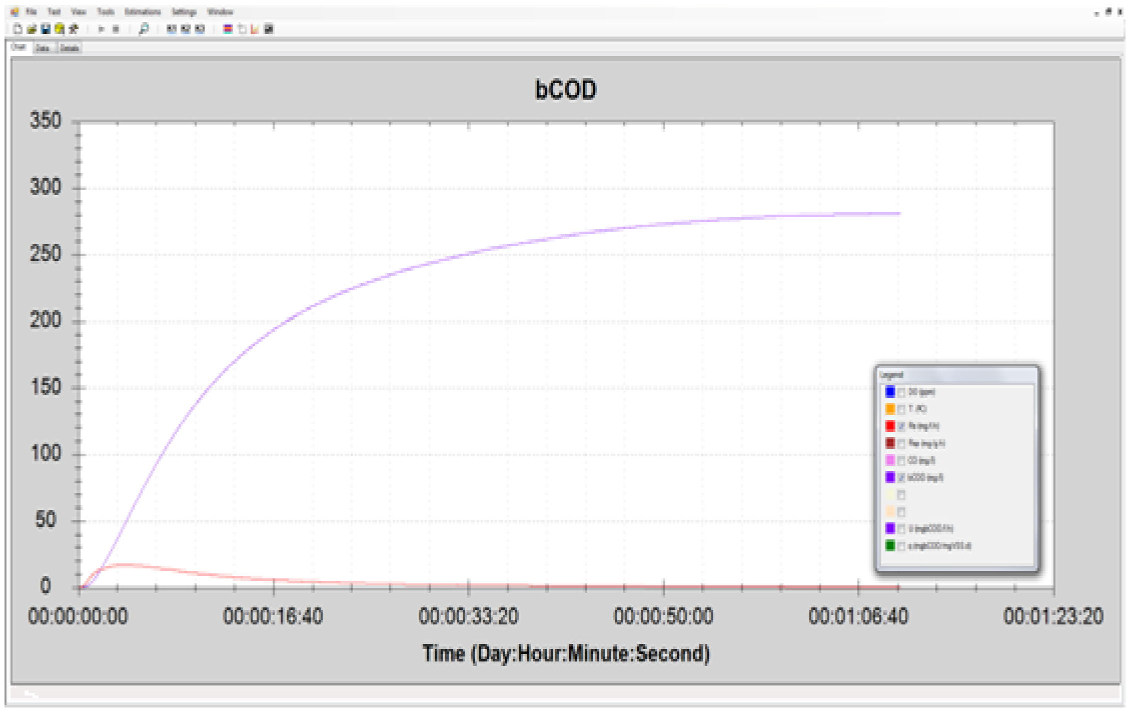
$Y_{H,COD}$: Heterotrophic yield coefficient referred to oxygen demand (mg O_2/mg COD)
$Y_{H,COD}$: Heterotrophic yield coefficient referred to MLVSS (mg VSS/mg COD)
Y_{obs}: Observed yield (mg VSS/mg COD)
SRT: Sludge age (d)

2. Influent biodegradable COD (S_o)

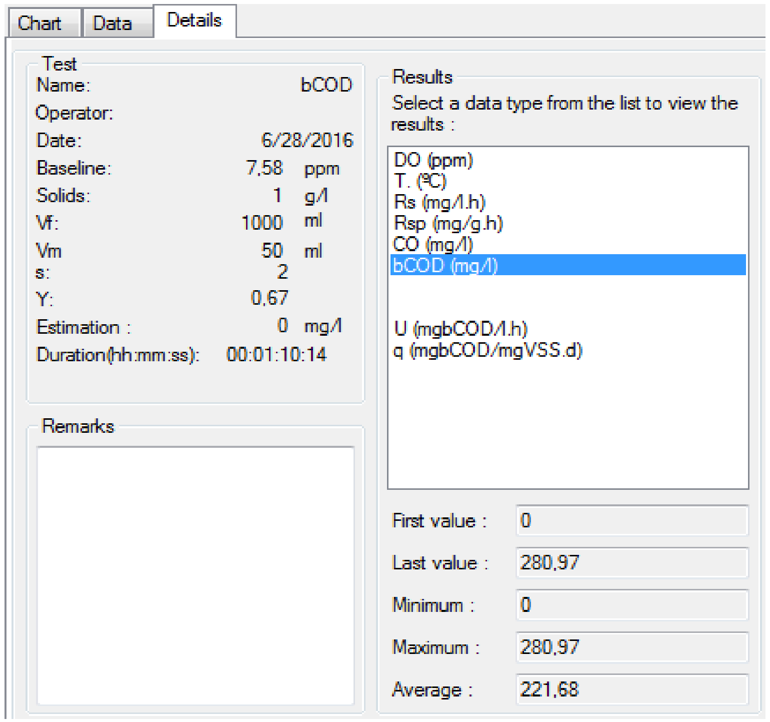
The BM respirometer automatically calculates the total biodegradable COD (bCOD) of the influent wastewater by means a R test with influent wastewater to the biological reactor and endogenous sludge. To do this, it integrates of the exogenous respiration rate (Rs) to calculate the consumed oxygen (CO) and apply the yield coefficient ($Y_{H.COD}$):

$$bCOD = CO / (1 - Y_H)$$

<u>Only in case the process has nitrification</u>, you must add a dose o Allyl Thiourea (ATU) to the endogenous sludge (stirring and aerating it) ½ hour before the test (2 to 3 mg ATU / g VSS)



bCOD and Rs respirograms



Result

3. Effluent biodegradable COD (S_e)

$S_e = COD_e - iCOD$

CODe: Effluent COD (mg/L)
iCOD: Innert COD (mg/L) = $COD_o - S_o$
CODo: Infuent COD (mg/L)

4. Actual Oxygen Requirement (AOR)

Here we have to distinguish between process without or with nitrification-denitrification.

4.1. Actual Oxygen Requirement (AOR) calculation in a process without nitrification

Carbonaceous AOR

$AOR_S = Q (S_o - S_e) / 1000 - 1.42 * P_X$

Q: Influent flow to aerobic biological reactor (m^3/d)
$S_o - S_e$: bCOD performance in the actual process (mg/L)
P_X: Sludge production (kg VSS/d) = $Y_{obs} * Q (S_o - S_e) / 1000$

$AOR = AOR_S$

AOR: Total oxygen requirement (kg O_2/d)

4.2. Actual Oxygen Requirement (AOR) calculation in a process with nitrification-denitrification

AOR = Carbonaceous AOR (AOR_S) + Ammonium-nitrogen AOR (AOR_N) – Oxygen credit from denitrification (AOR_{DN})

AOR: Total actual oxygen requirement (kg O2/d)

Carbonaceous AOR

$AOR_S = Q\ (S_o - S_e) / 1000 - 1.42 * P_X$

$S_o - S_e$: bCOD performance in the actual process (mg/L)
P_X: Sludge production (kg VSS/d) = $Y_{obs} * Q\ (S_o - S_e) / 1000$
Q: Influent flow to aerobic biological reactor (m^3/d)

Ammonium-nitrogen AOR

$AOR_N = Q * 4.57 * S_N / 1000$

S_N: Ammonium-nitrogen concentration to nitrify (mg $N\text{-}NH_4/L$)

Oxygen credit from denitrification

$AOR_{DN} = 2.86 * Q * S_N$

We assume that all the ammonium is converted into nitrate

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