CASE STUDY ON THE EVALUATION OF THE AERATION SYSTEM IN THE WWTP OF CIEZA – MURCIA (SPAIN)

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As an example of application of the procedure described in the presentation "New practical procedure for evaluation and followup of diffused aearion systems» a study of the aeration system of the municipal WWTP of Cieza – Murcia (Spain) has been carried out, whose management is in charge of the UTE URDECON SAV DAM, to which we thank its important collaboration both in the contribution of the data of the current process and in the BM Respirometry tests carried out in one of DAM's laboratories.

WWTP of Cieza (Murcia) – Biological reactor

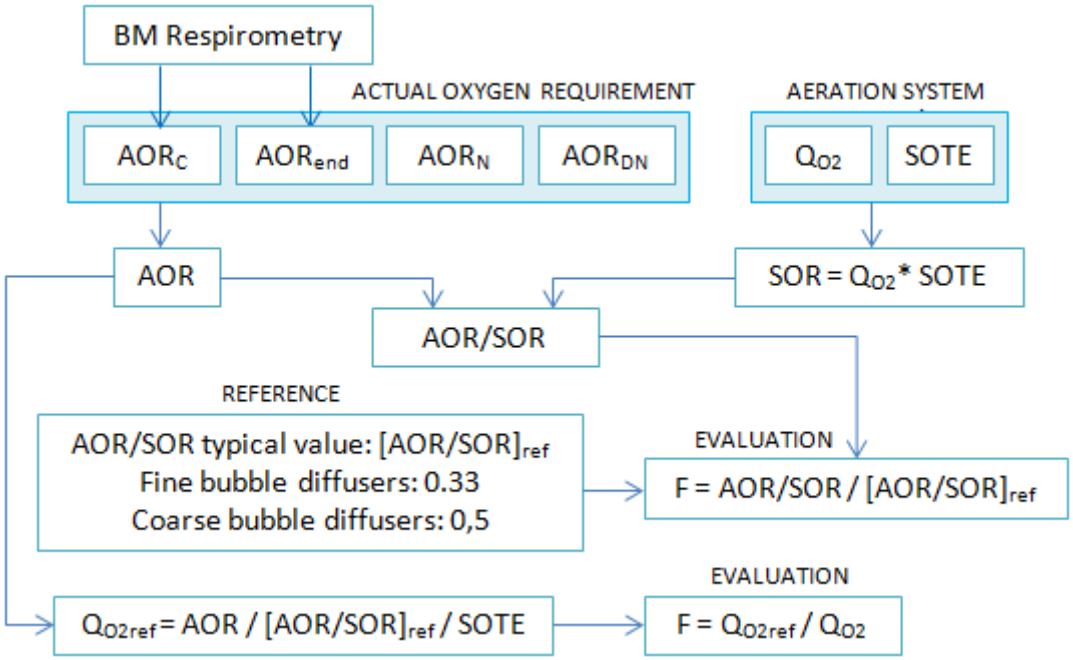
1. Process data

Aeration system	
Data / Parameter	**Value (average) / Description**
Type of diffusers	Flat diffuser AEROSTRIP Q-4, 0-EU – fine bubble
Diffusers depth: h (m)	5 m
Air flow rate: Qair (Nm^3/h)	7560 Nm^3/h
SOTE (%)	36%
Dissolved oxygen in the aerobic reactor: DO (mg/L)	2 mg/L
Date of installation of the diffusers	2022
Date of last cleaning of diffusers	JUNE 2023
Theoretical air flow rate per diffuser	56 Nm^3/h
Number of installed diffusers	132/reactor (two carousels)

Biological reactor	
Dato / Parámetro	**Valor / Descripción**
Process system	Extended aeration with nitrification and denitrification
Biological reactor volume: V (m^3)	8900
MLVSS (mg/L)	3680

Wastewater – Average values on August 2023	
Dato / Parámetro	**Valor / Descripción**
Infuent flow rate: Q (m^3/d)	5500
Influent COD: CODin (mg/L)	890
Effluent COD: CODef (mg/L)	21
Influent TKN: Nin (mg N/L)	103
Effluent TKN: Nef (mg N/L)	2,2
Nitrate removed: NO_3-Ne (mg NO_3/L)	90

2. Procedure



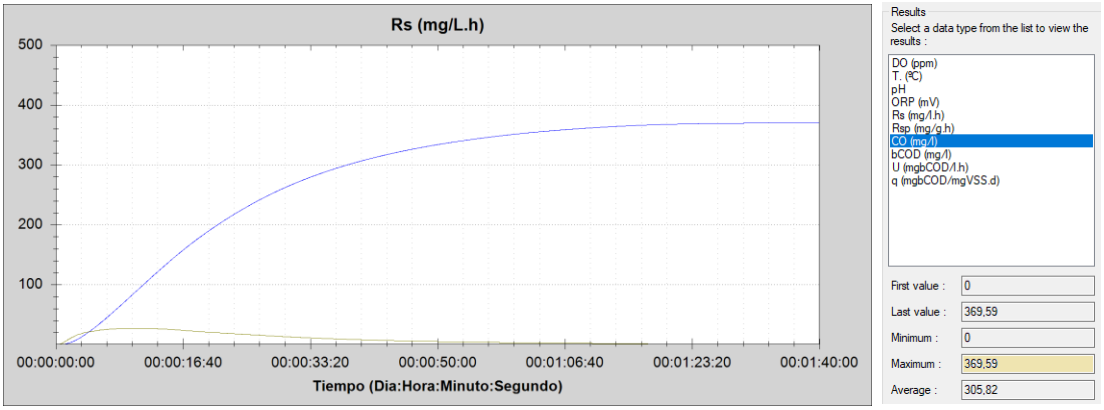
Schematic diagram of the procedure for the evaluation of diffused aeration system

3. Parameters calculation

3.1. Actual oxygen requirement: AOR

Actual oxygen requiremnt for carbonaceous organic matter: AOR_C

The calculation of the AOR_C contains the oxygen consumed (OC) as a priority parameter; and to obtain it, a respirometry test was carried out with a point sample of the inffluent wastewater.



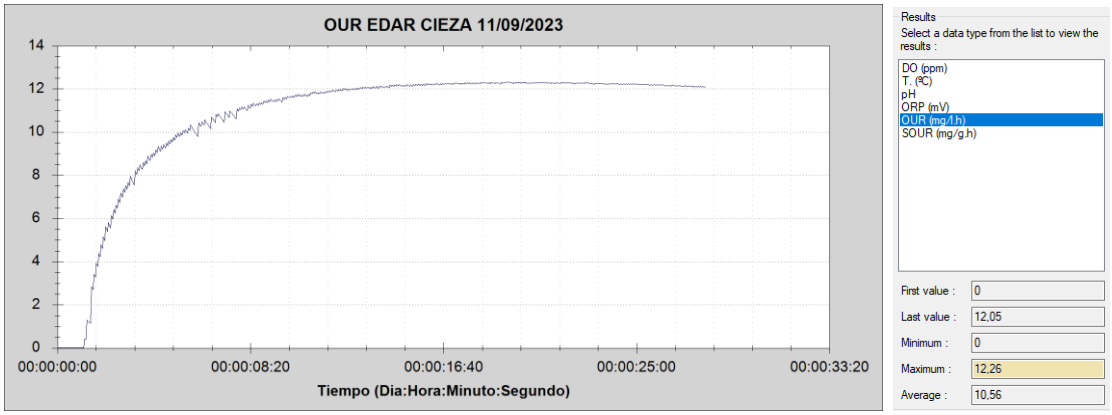
Respirogram and result of the consumed oxygen (CO) of inlet water corresponding to organic substrate obtained on a Surcis BM Respirometry analyzer

OC = 369 mg/L

Applying the corresponding mathematical formula:

$AOR_C = Q * CO / 1000 = 2029$ kg O_2/d

<u>Actual oxygen requirement for endogenous respiration: AOR_{end}</u>



Respirogram y result of the endogenous OUR obtained on a Surcis BM Respirometry analyzer

$OUR_{end} = 12{,}26$ mg O_2/L.h = 0,294 kg O_2/m^3.d

Applying the corresponding mathematical formula:

$AOR_{end} = V * OUR_{end} =$ 2618 kg O_2/d

<u>Actual oxygen requirement for nitrification: AOR_N</u>

From the NTK removed inthe process (NTKe) and applying the corresponding mathematical formula:

$AOR_N = 4{,}67 * Q * NTK_e / 1000 = 2.513$ kgO_2/d

Actual oxygen requirement for denitrification: AOR_{DN}

From the data of the nitrate removed (NO_3-Ne) and applying the corresponding mathematical formula:

$AOR_{DN} = 2,28 * Q * NO_3\text{-Ne} / 1000 = 1128\ kgO_2/d$

The AOR_{DN} enters as a credit (subtracted) in the total AOR.

Total actual oxygen requirement: AOR

$AOR = AOR = AOR_C + AOR_N - AOR_{DN} = 6032\ kg\ O_2/d$

3.2. Oxygen flow rate: Q_{O2}

We convert the air flow rate to oxygen flow rate by multiplying by the conversion factor:

$Q_{O2} = 24 * 0,285 * Q_{air} = 51710\ kg\ O_2/d$

3.3. Standard oxygen requirement: SOR

From the SOTE data of the aeration system and applying the corresponding mathematical formula:

$SOR = Q_{O2} * SOTE = 18615\ kgO_2/d$

3.4. AOR/SOR ratio

Dividing the AOR by the SOR:

AOR / SOR = 0,324

3.5. Reference $[AOR/SOR]_{ref}$

This is the reference value for the AOR/SOR ratio.
In our case, the typical value for a fine bubble diffusion system is used:

Typical value (new diffusers) [AOR/SOR]ref = 0.33.

The normal range can be considered to be between 0.3 and 0.4.
But for comparison purposes, for system evaluation, the typical value of 0.33 will always be used.

3.6. Reference oxygen flow rate: $Q_{O2.ref}$

This is the theoretical flow rate to meet the current AOR in new diffusers:

$Q_{O2.ref} = (AOR / [AOR/SOR]_{ref}) / SOTE = 50774\ kg\ O_2/d$

3.7. Estimated fouling factor: F

The fouling factor F is the parameter indicative of the condition of the actual aeration system.
F is defined as the ratio of the standard oxygen transfer efficiency of the used diffuser system to the standard oxygen transfer efficiency of the new diffuser system.

This ratio is equivalent to

$(AOR/SOR) / [AOR/SOR]_{ref} = AOR/ (Q_{O2} * SOTE) / [AOR/ (Q_{O2.ref} * SOTE)]$

and, consequently, also to the ratio $Q_{O2.ref} / Q_{O2}$.

Therefore, the F-factor can be obtained from both ratios, with identical results:

$F = (AOR/SOR) / [AOR/SOR]_{ref} = 0.98$

$F = Q_{O2.ref} / Q_{O2} = 0.98$

4. Results summary and evaluation

Parameter	Description	Result
AOR	Actual oxygen requirement	6032 kg O_2/d
SOR	Standard oxygen requirement	18615 kg O_2/d
AOR/SOR	Ratio between AOR and SOR	0.324
$[AOR/SOR]_{ref}$	Reference = Typical value AOR/SOR	0.33
$Q_{O2.ref}$	Reference oxygen flow rate	51710 kg O_2/d
F	Estimated fouling factor	**0.98**

1. Assuming that the optimal range of the F-factor is between 0.9 and 1, the result of 0.98 indicates that the aeration system is in optimal condition, which may be due to the recent and efficient cleaning of the diffusers on last June.

2. The coherence of the result of the present study confirms once again the validity of the applied procedure, where the AOR/SOR ratio is the main pillar that sustains the criterion for the evaluation and follow up of the diffused aeration systems.

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