# USE OF RESPIROMETRY TO ASSESS THE ECONOMIC AND ENVIRONMENTAL IMPACT PRODUCED BY THE INTRUSIONS OF UNCONTROLLED CLEAR WATER IN WASTEWATER TREATMENT FACILITIES OF SMALL POPULATIONS

Juan M. Luque Moreno[1]; Jorge Lara Vega[2]; Jorge Vargas Zueco[3]

[1]Joca Ingeniería y Construcciones, S.A. – Avdª Sinforiano Madroñero, 24-26 – 06011 Badajoz ( jluque@joca.es)

[2] Sistemas de Automatismo y Control, SA – Avdª Sta. Marina, 7–Entreplanta 1º B-06005 Badajoz (jlara@saconsa.es)

[3] DBO5 S.L. - C/ Manufactura, 8. Plta 1ª. Mód 6. Edificio Boudere 1. Polígono Industrial de servicios del Aljarafe (PISA) – Mairena del Aljarafe 41927 Sevilla (jvz@dbo5.com)

## ABSTRACT

Experimental research based on respirometric techniques to assess the economic and environmental impact that the intrusion of uncontrolled clear water produces in the facilities of wastewater treatment in small populations. Applied to five specific plants.

## Keywords

Respirometry, clear water, wastewater treatment plant, small populations

## INTRODUCTION

The receiving uncontrolled clear water into the collectors originates an additional cost of operation and a deterioration of the flow quality that is necessary to know to properly manage the problem.

Joca, SACONSA and DBO5, S.L. , have carried out a range of tests in real samples of raw water coming into the wastewater treatment plants and using respirometric techniques they have assessed how this affects the performance of the facilities and how much is the additional economic cost caused by uncontrolled clear water in the wastewater treatment.

## METHODS

It has been taken pre-treated raw water incoming from five wastewater treatment plants that are currently managed by Joca and SACONSA – Vegas Altas (Badajoz); Navalvillar de Pelas (Badajoz); Molinicos (Albacete); Nerpio (Albacete) y Jarandilla de la Vera (Cáceres) – and which have a typically urban composition in summer and in winter are affected significantly by the presence, in dry weather, of uncontrolled clear water from channelled streams to the sewerage, sumps and spring, etc.

During the period in which the raw water has not been affected by the intrusion of clear water to the sewerage, it has been taken water in a working day that has been sent to the laboratory for being analysed.

Once the samples were in the laboratory, it has been undertaken different dilutions (20,40,60,80,100%) using a respirometer with 8 channels; it has been determined the kinetic constants that regulate the growth of biomass (Ks, Ki, growth, maximum growth, YH (yield), etc) to different dilutions, as well as the characteristic parameters of water (nutrients, COD, BOD etc). In all the cases it has been used filtered water, adding 50 mg/l of sludge. Batch tests were performed.

The obtained kinetic data have been applied to a predictive mathematical model, marked by Rozich AF

$$t^* = (1+\alpha)\left[\left[\frac{\mu^{\max}}{1+1\sqrt{\frac{K_s}{K_i}}}\right]\left[1+\frac{\frac{\alpha X_R}{Y_t}}{S_i+\alpha S_R-(1+\alpha)\sqrt{K_s K_i}}\right]^{-K_d}\right]^{-1}$$

Where

$\alpha$ = Recirculation rate

This model determines the necessary retention times to remove a certain amount of COD, using, in addition to the usual parameters, a kinetic constants indicator of biomass growth in the tested water. These kinetic constants are assumed in the designs as constants for typical urban waters, and as we have checked when it comes to diluted waters it is not apply. The use of this model has allowed to establish different degrees of effluent quality at different retention time.

Once it has been evaluated the impact that the incorporation of dilution water has on the purification, it has been collected, from the operation reports, all the economic costs from the five real populations (removal of waste, electricity consumption, sludge production, smells etc).

Finally, it has been determined the environmental and economic cost applicable to each dilution degree and the designing of the wastewater treatment plant.

## RESULTS AND DISCUSSION

These are the obtained average results:

| | Dilution degree% | | | | |
|---|---|---|---|---|---|
| Parameters | 20 | 40 | 60 | 80 | 100 |
| $\mu$ max (hour-1) | 0.138 | 0.15 | 0.07 | 0.08 | 0.068 |
| $K_s$ | 48.4 | 53 | 93 | 96 | 359 |
| $K_i$ | 1181 | --- | --- | -- | -- |
| Y (mg/mg) | 0.5 | 0.44 | 0.35 | 0.34 | 0.29 |
| Ox | 1.3 | 1.59 | 1.4 | 1.4 | 1.4 |
| RT (hours) | 0.1 | 0.8 | 2.9 | 3.8 | 5.9 |

RT= retention time to remove 100 mg/l of COD

## CONCLUSIONS

Dilution water that comes to a wastewater treatment plant improves the biomass growth, which results in a reduction of the necessary time to remove the same amount of COD in the biological tank.

The above-mentioned increased growth is not compensated with the lower retention time produced by the arrival of more flow, so, at the end the water from the effluent is less purified.

The increased growth is produced by a reduction in water pollution that produces the dilution.

In addition to the impact on the effluent it also produces an additional cost of purification, that has been assessed in the report and that depends on the size of the facility and the origin of intrusion (streams, groundwater, saline water etc)

The dilution of water improves the growth of biomass per unit of provided COD, which comes into a faster degradation; so, to remove 100 mg/l of COD we need 6 minutes when the water is diluted to 20%, and 6 hours when the water is not diluted.

## REFERENCES

Respirometry in control of the activated sludge IAWQ
Design and Operation of activated Sludge Alan F Rozich
Use of respirometry to determinate the effect of nutrient enhancement on JP8. Christian T. Totten. Air force institute of technology
Activated Sludge model n° 1 IAWPRC
Saneamiento y depuración de aguas residuales urbanas. Análisis de costes. Virgilio Llorente Martínez. Canal Isabel II
Mantenimiento y explotación de una EDAR. P. Simón
Adelburg EA Doudoroff M an Stanier RY The Microbial Word, Prentice-Hall INc Englewood
Doce n° L133/106 (OCDE 303A París 1981). Ensayo de simulación con lodo activo