

# Online measurement of redox potential for the real-time control of disinfection efficiency in water reclamation

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## INTRODUCTION

Reclaimed water requires an adequate microbiological quality and disinfection is a key process. Reliability of treatment is essential and routine analysis do not provide the certainty that the required quality levels are met at all times. So, online controls are increasingly being used as a tool to increase safety and minimize health risks. Parameters to be chosen are required to be reliable and its measurement robust, cost-effective and of easy maintenance.

Chemical disinfection is usually based upon the addition of oxidizing substances. The continuous measurement of the redox potential values of the water where these disinfectant agents are added has been tested as a tool for this online control of disinfection performance in full scale water reclamation facilities.

## MATERIAL AND METHODS

The study was carried out in 7 water reclamation plants in Catalonia, NE Spain, that had a disinfection step using chlorine, either alone or in combination with UV light. The efficiency of UV light as a disinfectant agent was also been assessed independently.

Around 200 samples were taken and used for the monitoring of redox potential values, concentration of total residual chlorine and concentration of *Escherichia coli*.

## RESULTS AND DISCUSSION

The relationship between redox potential values and the disinfection efficiency has been analyzed according to the concentration of *Escherichia coli* in the final water. A positive relationship has been established between the *Escherichia coli* levels and the redox potential values.

Using different types of water (raw wastewater, secondary effluent, reclaimed water), lab tests have proven that the addition of chlorine and the subsequent increase of redox potential values can be used to adequately predict the concentration of *Escherichia coli* in water (See Figure 1).

If a discriminant analysis is performed between the redox potential values, the concentration of the microbiological indicator and the three kinds of water (raw wastewater, secondary effluent and reclaimed water), 92.4% of the samples for *Escherichia coli* are correctly classified.

Redox potential values have been segregated in two categories, one for *Escherichia coli*  $\geq 100$  cfu/100 mL and the other one for *Escherichia coli*  $< 100$  cfu/100 mL, since significant differences have been observed between them. The first category gives a ratio of  $\text{Redox } 100 = 191.196 - 16.6017 * \text{Escherichia coli}$  (in log units), with a correlation coefficient of -0.321 and a p value of  $< 0.05$ , which means that there is a weak but significant relationship. The second category renders a ratio of  $\text{Redox} = 368.299 - 129.763 * \text{Escherichia coli}$  (in log units), with a correlation coefficient of -0.564 and a p value of  $< 0.01$ .

Data from this study have proven that if a threshold value of 230mV was reached, the concentration of *Escherichia coli* never exceeded the value of 100 cfu/100 mL. This study also proves that an excess of chlorine was used in 28% of the samples, which indicates that accurate chlorine dosing is important not only for the reliability of disinfection but also to save chemicals dosed unnecessarily

## CONCLUSIONS

- A relationship between the redox potential values and the concentration of *Escherichia coli* in three types of water (raw wastewater, secondary effluent and reclaimed water) from 7 reclamation plants.
- The addition of chlorine and the subsequent increase of redox potential values can be used to adequately predict the concentration of *Escherichia coli* in water.
- According to lab tests, if a threshold value of 230mV was reached, the concentration of *Escherichia coli* was always below 100 cfu/100 mL and chlorine could be saved in 28% of the cases.
- The system based on the online measurement of redox potential for the

## CASE STUDY: CASTELL-PLATJA D'ARO WATER RECLAMATION PLANT

The Castell-Platja d'Aro Water Reclamation Plant (1998) is located in Costa Brava, NE Spain. It receives secondary effluent from the conventional activated sludge plant (1983) located nearby, and it produces reclaimed water suitable for both landscape and agricultural irrigation, according to Spanish regulations (RD 1620/2007). Treated volumes range between 800,000 and 1,000,000 m<sup>3</sup>/year (approx. 20-25% of secondary effluent produced).



The required degree of compliance of regulation limits (90%) and the variations in quality observed after the UV system made necessary to regulate the final chlorination step in order to achieve: i) reliability in reclaimed water quality; ii) an online monitoring system that could stop the supply in case of non-compliance; and iii) the right dosage of sodium hypochlorite, avoiding the problems of fixed doses.

Because of the experimental work previously reported, online measurement of redox potential, coupled with the hypochlorite dosage pump and set to achieve a certain threshold level has been chosen as the tool to achieve the desired goals. As shown in the below figures and graphics, the maintenance of redox potential values between 310 and 370 mV has ensured that the concentration of *Escherichia coli* has been below 100 cfu/100 mL in all the analyzed samples (n=51), with 88% of values below detection level ( $< 1$  cfu/100 mL) and a highest measured value of 22 cfu/100 mL.

