RECLAIMED WATER AT COSTA BRAVA CONSORTIUM FACILITIES: A PROPOSAL FOR A MICROSCOPICAL OVERVIEW

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INTRODUCTION

Scanning electron microscopy (SEM) coupled with energy dispersion X-Ray spectroscopy (EDX) mapping contributes to obtain qualitative information about shape, size and chemical composition of particles in secondary effluent and reclaimed water (Asano, 1998). At microscopic level, SEM images can help to understand removal of particles and gel (a portion of effluent organic matter) due to water reclamation processes. These images can also help prevent fouling when a membrane process is required in a water reclamation plant, either if this is for salinity removal, for groundwater recharge using direct injection wells or for indirect potable reuse. Water reclamation plants in Costa Brava have a diversity of treatments (Sala, 2009) which was used to apply SEM-EDX analysis on the filtered matter obtained both from secondary effluent and from reclaimed water.

METHODS

Influent and effluent water grab samples from four water reclamation plants (WRP) of Consorci Costa Brava (Colera, Cadaqués, Torroella de Montgrí, and Tossa de Mar) were taken on peak touristic season (August 17th, 2005), and they were filtered using 0.45 µm membrane filters to analyze morphological and chemical composition of retained particles. Colera and Cadaqués water reclamation plants have an in-series filtration process, Torroella de Montgrí water reclamation plant consists only of a UV-chlorine disinfection step of the N/DN secondary effluent, and Tossa de Mar WRP uses a Title 22 treatment (coagulation, flocculation, lamellar settler, and deep-bed upflow continuous backwash filter prior to UV-chlorine disinfection). To analyze membrane filters a scanning electron microscopy ZEISS DSM960A associated to X-Ray microanalysis equipment LINK ISIS L200B were used at the Technical Research Services of the University of Girona. Acceleration potential used was 20 kV and electrical intensity was $1.5x10^{9}$ A (Goldstein, 1981).

RESULTS AND DISCUSSION

The samples analyzed for this study were taken on the peak of the touristic season, when the wastewater treatment plants were at full capacity. Of the four plants chosen, three of them had conventional activated sludge reactors (Cadaqués, Tossa de Mar and Colera), whereas the other one (Torroella de Montgrí) had an extended aeration reactor.

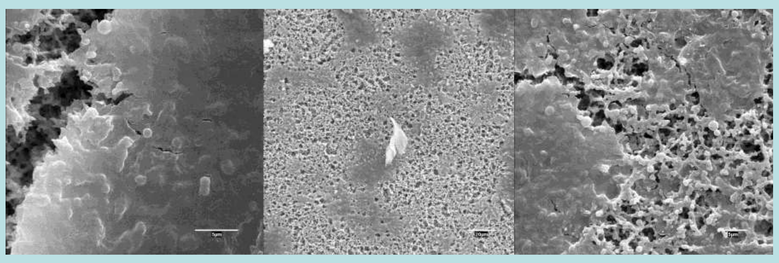

Figure 1. Influent (left), effluent (centre), storage tank (right) WRP Cadaqués

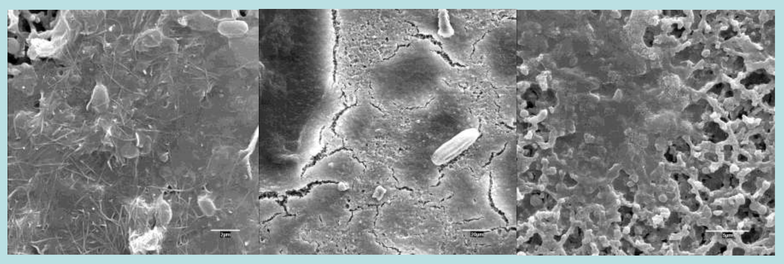

Figure 2. Influent (left), after settling (centre), after sand filtration (right) WRP Tossa de Mar

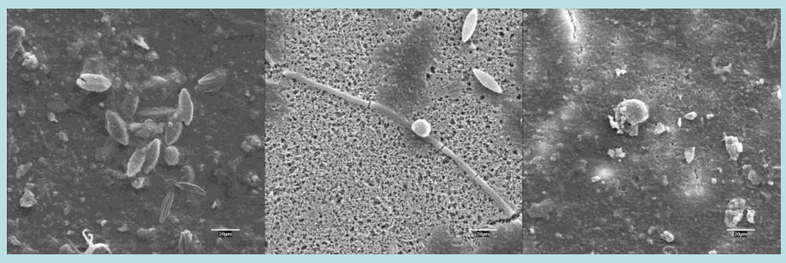

Figure 3. Influent (left), effluent (centre), storage tank (right) WRP Colera

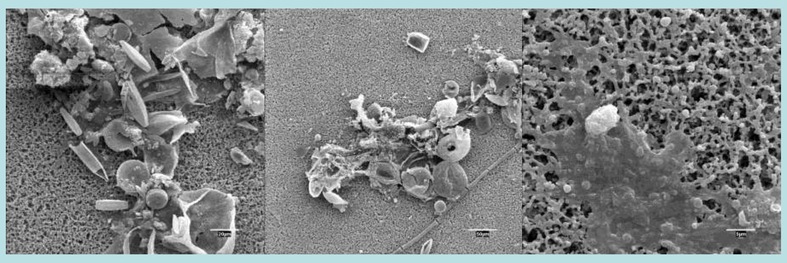

Figure 4. Secondary effluent (left), after UV (centre), storage tank (right) WRP Torroella de Montgrí

On that specific day, Cadaqués WWTP was overloaded, which also affected to the WRP. SEM images from the influent at Cadaqués WRP showed organic matter with bacteria cells forming a cake layer on the membrane filter. After the in-series filtration, some areas still displayed the same material, just as on samples taken at the reclaimed water storage tank (see Fig 1). SEM images from Tossa de Mar WRP showed high organic matter with bacterial and algae cells forming a cake layer on the membrane filter in the influent, a lower density of material after the lamellar settling step, and only some gelatinous material after sand filtration and before combined disinfection (see Fig 2). SEM images from the Colera WRP showed a pattern similar to that of Cadaqués WRP but with lower organic matter with bacterial and algae cells, forming a cake layer on membrane filter in the influent, less density after in-series filtration, but a higher biological and organic matter content in samples taken from the reclaimed water storage tank (see Fig 3). SEM images from WRP Torroella de Montgrí showed only broken algae and collapsed protozoa material with low density before and after UV disinfection, and gel matter on samples from the reclaimed water storage tank (see Fig 4).

Physicochemical treatments in the WRP of Cadaqués, Tossa de Mar and Colera were able to remove particles and the general trend was that samples only presented a gelatinous particle shape. These gelatinous particles were observed again in samples from the reclaimed water storage tanks. In Torroella de Montgrí, algal and protozoan material was observed according to the good quality of secondary effluent; however, samples taken in the storage tank showed again gelatinous particles.

CONCLUSIONS

Particle removal including gelatinous particles was observed by scanning electron microscopy (SEM) of water samples, showing the differences between influents and effluents of water reclamation processes. In general, all samples from influent formed a cake layer with bacterial cells and organic matter. This cake was thicker on the effluents from conventional activated sludge reactors than in the effluent from the extended aeration reactor, which states the importance of having the best possible biological treatment before the secondary effluent enters the WRP. After the three physicochemical treatments, only gelatinous particles were observed. The influence of the storage tank on the reclaimed water quality was little according SEM images, but in some samples gelatinous material showed up again.

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