REUSE OF GREY WATER BY MEMBRANE BIOREACTORS (MBR)

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ABSTRACT

In this investigation a compact system for grey water recycling has been developed in order to obtain regenerated water with reuse quality. By means of a prototype combining a biological treatment with membrane technology, grey water generated in an industrial plant has been treated. Regenerated water obtained has an excellent quality complying with most restrictive requirements in Spanish RD 1620/2007 which refer to urban residential use.

Keywords: Membrane Bioreactors, MBR, water reclaim, water reuse, grey water, ultrafiltration

INTRODUCTION

Spain is one of the European countries with greatest water deficit and, in spite of reusing much more water than other countries, the water reuse potential in Spain is around 10 times more than the current level, for which reason it is necessary to develop and implement recycling procedures. With appropriate treatment of the waters obtained, regenerated waste water constitutes a reliable source in both quantity and in quality, while allowing a reduction in consumption from other water sources.

Within the waste water as a whole, grey water offers very favourable characteristics for reuse in a local environment, including social acceptance, Hills et al., (2002).

The technologies available for the regeneration of grey water can be classified under two major headings: physical/chemical processes and biological processes. In the first case, the process is carried out in two stages: filtration, usually in a sand bed followed by a disinfection process, either by means of UV radiation or by chemical reagents. In the biological processes, in which oxidation of the organic matter takes place in a biological reactor, membrane bioreactors (MBR) are found. The MBR are systems wherein an activated sludge reactor is combined with a filtration system employing membranes that allows an effluent to be assured that is of better quality and pathogen-free. Asano et al., (2007)

REMOSA, within the framework of the SOSTAQUA project (CENIT project) has developed a compact treatment unit for regeneration of grey water that meets the strictest quality requirements set in the RD 1620 (2007) corresponding to urban residential use.

METHODS

The regeneration treatment of grey water by MBR designed by REMOSA comprises the following stages:

Screening: separation of any debris that could damage the membranes.
Biological oxidation: the decomposition of the organic matter takes place in the bioreactor like in conventional activated sludge process(CAS).
Filtration: the solid/liquid separation is produced by means of ultrafiltration membrane technology. A suction system applies a vacuum pressure in the membranes and creates an inward flow whereby the water penetrates through the membranes while solids and bacteria are retained in the external wall.
Chlorination and accumulation: the regenerated water is chlorinated by adding a small quantity of sodium hypochlorite (< 1 ppm of free chlorine) allowing the sanitary properties to be conserved and, subsequently, it can be stored in the accumulation compartment. The reduced concentration of organic compounds in the regenerated water limits the generation of organochlorinated compounds.

The system was designed to operate automatically; following permeate extraction cycles according to the water levels inside the prototype in order to assure the water supply.

The prototype was started up in February 2008 and fed for 300 days with the grey water coming from the showers and wash-hand basins of the REMOSA production plant changing facilities. The maximum regeneration capacity of the prototype, 900 L/day, could satisfy the water needs for recharging the WC cisterns of a housing estate with 40 residents.

To determine the net efficiency of the equipment, exhaustive analytic tracking was carried out on both incoming grey water and regenerated water. The parameters studied were divided into: physical/chemical (temperature, pH, conductivity, turbidity, matter in suspension (SS), BOD5, COD, surfactants, N-total and P-total) and biological (Escherichia coli, faecal coliforms, total coliforms, nematode eggs). In addition, microscopic inspection was carried out of the reactor sludge, as well as the content in free chlorine and total chlorine of the accumulated chlorinated regenerated water.

RESULTS AND DISCUSSION

The suspended solid (SS) and turbidity, shown respectively in Figures 1 and 2, are two very important parameters, not only because they are stipulated in the RD 1620 (2007) but also because they are the parameters most easily noticed by the end user. The effluent has an average value of 1.3 mg/L and 1.2 NTU respectively for SS and turbidity, both values well below the requirements set in the RD 1620 (2007), which is 10 mg/L and 2 NTU. Both parameters remained constant from start-up independently of the variability of intake water values. In this sense, the small pore size of the membranes guaranteed retention of the particles and, therefore, compliance of these two parameters.

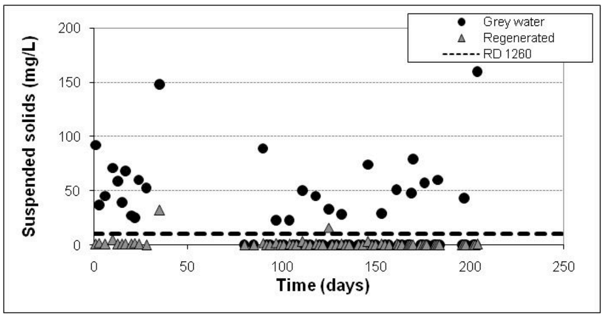

Figure 1. Evolution of the SS in the grey water and regenerated water.

Figure 2. Evolution of the turbidity in the grey water and regenerated water.

Referring to the degradation of organic matter, figures 3 and 4 show the evolution of the COD and the BOD_5, respectively. A substantial reduction is observed in the removal of organic matter, with averages of 90% for the COD and of 95% for the BOD_5. This high, stable reduction is enhanced because the membranes allow working with higher concentrations in the reactor and, in turn, guarantee retention of biomass and part of the organic and inorganic matter. In the absence of limits for COD and BOD_5 parameters in the RD 1620 (2007), the reference regulation is the European Directive 91/270 EC, which sets the discharge limits of purified water: 125 mgO_2/L for the COD and 25 mgO_2/L for the BOD_5 are shown for comparison. In all cases output values are guaranteed to be substantially below the limits.

Finally, as example for biological parameters, the results for Escherichia Coli and Nematode Eggs are shown in figures 5 and 6, whose limits are specified in the RD 1620 (2007).

In the case of E. Coli, it is observed that although there is a considerable presence in the inlet water, of the order of 10^4 ufc/100ml, in the regenerated water, even before chlorination, the figures are always, except in one case due to external contamination, below the detection limit of the analytic method: 5 ufc/100ml. The ensuing chlorination of the regenerated water assures the absence of E. Coli, and conserves the microbiological quality of the water with time. In the case of nematode eggs, in spite of carrying out the tracking exercise from start-up, only the results from day 150 are representative since it was not until then that the analytic method was adapted to work with a sample of 10L. The results prior to this date were determined by extrapolation from a sample of 1 L. The final results revealed the absence of nematode eggs both at the inlet and output water.

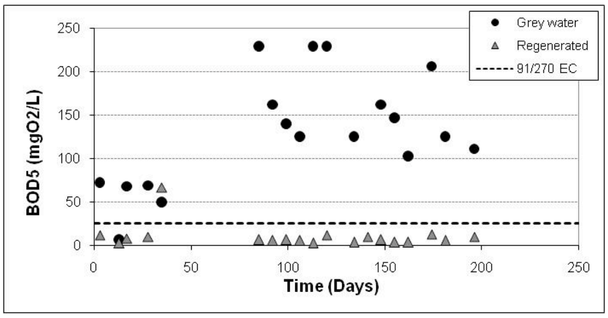

Figure 3. Evolution of the COD in grey water and the regenerated water.

Figure 4. Evolution of the DBO_5 in grey water and the regenerated water.

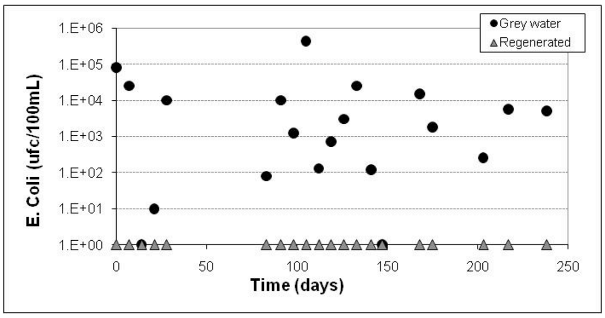

Figure 5. Evolution of the Escherichia Coli in grey water and the regenerated water.

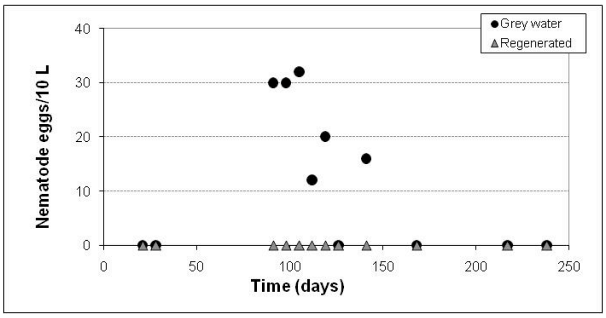

Figure 6. Evolution of nematode eggs in grey water and the regenerated water.

A parameter not contemplated in the RD 1620 (2007), but interesting for the present study, is the level of surfactants. A high removal efficiency of anionic surfactants, defined as Sodium Lauryl Sulphate, is observed, with an average of 98%, with stable values in the output below 0.2 mg/l, independently of the incoming water figures.

CONCLUSIONS

The MBR system of REMOSA for the regeneration of grey water allows an effluent of excellent quality to be obtained meeting the requirements of the RD1260, (2007) for the most restrictive use (urban residential use).

The physical separation by membranes assures that the effluent quality in MIS, turbidity, and E.Coli is maintained with time, independently of the variations in flow and contamination of the incoming water, as well as the sedimentability of the sludge.

The use of membranes allows the biomass to be retained and concentrated in the reactor and, as this increases and matures, the removal efficiency of organic matter (COD and BOD5) also increases.

REFERENCES

1. Asano, T., Burton, F.L., Leverenz, H.L., Tsuchihashi, R., Tchobanoglous, G. (2007). Water Reuse. Issues, technologies and applications. Metcalf & Eddy. New York, U.S.A.
2. Hills, S., Birks, R., McKenzie, B. (2002). The Millenium Dome "Watercycle" experiment: to evaluate water efficiency and customer perception at a recycling scheme for 6 million visitors. Wat. Sci. Tech. 46, 233-240.
3. RD1260, (2007). Real Decreto 1620/2007 de 7 de diciembre, por el que se establece el régimen jurídico de la reutilización de las aguas depuradas. BOE n° 294, 8 de diciembre de 2007.