Characterising different sources of grey water for reuse in hotel facilities

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Abstract
Grey water (all domestic water flows except from toilets) is an important alternative water source, particularly in dry Mediterranean areas. Characterisation of grey water is important step towards proper selection and design of treatment technology prior to its reuse. In this paper we present an experiment for characterisation of synthetic grey water based on real water sampling at hotel facility. Two types of GW, showers and laundry, were characterised for modelling purposes. Results present some differences to what is typically reported in literature showing higher fraction of easily biodegradable matter for GW, which only includes water from showers and hand washing basins.

Keywords
grey water, grey water characterisation, membrane bioreactor, water reuse

INTRODUCTION
Separating and reusing grey water (water from showers, hand washing basins, laundry and kitchen) not only represents additional water source, but also a way towards sustainable urban water systems. There are several obstacles toward more extensive implementation of GW systems, most important being: gaps in current legislation regarding GW, existing infrastructure, and variable nature of the composition of the GW causing difficulties in selection of appropriate treatment technologies and reuse systems. Literature reports values of COD between 13-550 mg/l, BOD5 90-360 mg/l total nitrogen 0.6-74 mg/L and total phosphorous 4-14 mg/l (Erikson et al, 2002). These differences come from different types of GW and different use of detergents, soaps and other personal care products. In this paper we focus on characterising biodegradability of GW from hotel facilities for modelling purposes. Biodegradability was evaluated in a pilot membrane bioreactor (MBR) for both (1) synthetic GW at lab-scale and (2) real GW at the hotel premises.

MATERIALS AND METHODS
Hotel Samba (Lloret de Mar, Spain) is a large 3 star resort with 441 air conditioned rooms, green areas and exterior pools, conference rooms, bar and restaurant. To reduce water consumption, grey water is separated and reused for toilet flushing. Two sampling campaigns of GW have been performed in the high season and in the low season. Based on the results from the sampling campaigns synthetic GW recipes were used to feed a pilot MBR during three months and observe the biodegradation capacity. Measurements of COD, BOD, TSS, N and P species were taken at the input, output and in the reactor. The reactor was operated with parameters shown in Fig 1. COD fractions were determined based on the measurements at the inflow (_inf) and outflow (_eff) as follows:
- Inert soluble COD (S_I) = 0.9*COD_eff;  
- Readily biodegradable COD (S_S) = BOD5_inf –S_I- BOD5_eff  
- Slowly biodegradable (X_S) = BOD20 - S_S;  
- Inert particulate matter (X_I) = COD_inf –S_I – X_S- S_S
RESULTS
Using the methodology described above we obtained COD fractions of the GW as presented in Table 1. There is a difference between rapidly biodegradable part for the GW from showers and hand washing basins and the GW from laundry, the latter being lower by 19%. Compared to literature, both types of GW, but particularly the GW from the showers have bigger fraction of easily biodegradable COD. Results are being used for model-based optimization of the MBR at the hotel.

Table 1: Characterisation of synthetic GW and comparison to literature values

<table>
<thead>
<tr>
<th></th>
<th>SAMBA hotel-shower</th>
<th>SAMBA hotel-laundry</th>
<th>Grey (Hocaoglu et al., 2010)</th>
<th>Domestic (Tas et al., 2009)</th>
<th>Black (Hocaoglu et al., 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total COD, CT, mg/L</td>
<td>179.5</td>
<td>168.3</td>
<td>275</td>
<td>450</td>
<td>1145</td>
</tr>
<tr>
<td>Biodegradable COD, CS/CT, %</td>
<td>95</td>
<td>94</td>
<td>93.5</td>
<td>77.3</td>
<td>95.1</td>
</tr>
<tr>
<td>Readily biodegradable COD, S S/CT, %</td>
<td>51</td>
<td>32</td>
<td>29.3</td>
<td>22.2</td>
<td>14.7</td>
</tr>
<tr>
<td>Slowly biodegradable COD, X S/CT, %</td>
<td>44</td>
<td>62</td>
<td>64.2</td>
<td>29.3</td>
<td>50.7</td>
</tr>
<tr>
<td>Soluble inert COD, S 1/CT, %</td>
<td>4</td>
<td>8.3</td>
<td>5</td>
<td>7.1</td>
<td>3.7</td>
</tr>
<tr>
<td>Particulate inert COD, X 1/CT, %</td>
<td>1</td>
<td>1</td>
<td>1.5</td>
<td>15.6</td>
<td>1.1</td>
</tr>
</tbody>
</table>

CONCLUSION
GW systems offer a good opportunity for alternative water sources, however designing such systems still includes many uncertainties, such as the variable nature of the GW composition. Experiments were performed for synthetic and real GW from hotel facilities by using an MBR pilot at lab scale for synthetic GW and at the hotel, for real GW. Results show different biodegradability from what is typically found in literature, due to separation of GW from showers and laundry. Results are being used to feed a model for optimization of the operation of the MBR at the hotel.

REFERENCES