Car wash wastewater reclamation. Full-scale application and upcoming features

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Recent features on car wash wastewater reclamation and results obtained in a full-scale car wash wastewater treatment and recycling are reported. The technique employed comprises a new flocculation-column flotation (FCF), sand filtration and final chlorination. Water usage and savings audits (20 weeks) showed that almost 70% reclamation was possible, and less than 40L of fresh water per wash was attained. Wastewater and reclaimed water were fully characterized by monitoring chemical, physicochemical and biological parameters. Results were discussed in terms of reclamation aesthetic quality (water clarification and odour), health (pathological) and chemical (corrosion and scaling) risks. Noteworthy, this work showed a high count of fecal and total coliforms both in the wastewater and in the treated water, making the need of a final disinfection mandatory. The cost-benefit analysis shows that, for a car wash wastewater reclamation system in Brazil, at least 8 months were needed for the FCF-SC equipment amortization, when considering a demand over 30 washes per day. It is believed that the discussions on car wash wastewater reclamation criteria may assist alerting wash cars units and institutions to create laws in Brazil and elsewhere.

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1. Introduction

The car wash industry appears today to be more conscious of the need for wastewater treatment and water reclamation. Worldwide environmental legislation and guidelines concerning this specific issue have been released. Examples show that in Queensland, Australia, it is mandatory the use of at most 70L of fresh water in a single car wash, and in Europe some countries restrict the water consumption to 60–70L per car and/or impose reclamation percentage (70–80%) (QWC, 2008a,b; Boussu et al., 2007).

Reclaimed (reuse, recycling) water is here defined as the wastewater that has gone through various treatment processes to meet specific water quality criteria—fit for purpose principles (Metcal and Eddy, 2006). Although some research effort has been made (Table 1) and distinct technologies have been tested/employed, there are no well defined (accepted) criteria for the quality of car wash reclaimed water yet.

The development of an overall criterion (with sound scientific regulations/standards) should establish limits related to specific practices which would minimize detrimental effects without affecting the benefits. Approaches vary between high technology/high cost/low risk and low technology/low cost/controlled risk (Anderson et al., 2001). Nevertheless, compliance with public acceptance is imperative. Jefferson et al. (2004) reported aspects of public acceptance for urban water recycling in the UK. Their research revealed a broad willingness to accept urban wastewater recycling as long as public health is not affected. Regarding car wash application, results demonstrated that low turbidity is fairly acceptable considering aesthetic characteristic.

According to Brown (2000), car wash wastewater reclamation requires the separation of grit, oils and greases prior to be reused. Additional treatment processes can be employed to strength the usefulness (quality) of reclaimed water to be used in the different washes stages (pre-soak, wash, rocker panel/undercarriage, first rinse, and final rinse). Some of these process/technologies that have been proposed and tested are: reverse osmosis and nanofiltration (Brown, 2000; Boussu et al., 2007); ultrafiltration (Jönsson and Jönsson, 1995); ultrafiltration–activated coal adsorption (Hamada and Miyazaki, 2004); electrochemical oxidation (Panizza and Cerisola, 2010) biological treatment; flocculation–sedimentation and flocculation–floatation (Rubio et al., 2007).

Some of these alternatives are fairly costly (investment, operation and maintenance), often require large foot-print, and/or show poor efficiency. Floation has shown advantages and appears to broaden its potential amongst these technologies. Surprisingly, not many studies include disinfection processes and the analyses of coliforms in the recycled water.

Rubio and Zaneti (2009) have developed and applied the flocculation column-floatation (FCF) technique for vehicles wash...
wastewater reclamation in Brazil, and reported a high turbidity and colour removal (>90% and 75%, respectively). Main features observed were the low surface tension (as a result of residual surfactant concentration) of the wash wastewater which facilitates the generation of microbubbles (Féris et al., 2001); the presence of oil and grease yielding light flocs, and a fairly low suspended solids concentration.

Herein, a new technique was studied in a full-scale car wash wastewater reclamation system, where the wastewater and reclaimed water were fully characterized. Main objectives were to establish operating parameters and reclaimed water quality. Results were discussed in terms of the low technology/low cost/controlled risk approach.

2. Materials and methods

2.1. Materials

Fig. 1 shows the car wash wastewater reclamation system, installed in a washrack, in Porto Alegre–South Brazil. To comply with local regulations, a single three stage oil/water separator was employed after car wash pit. Reclaimed water, fresh water and total water usage were monitored using single-jet water meters. In the wash procedure a neutral and an alkali detergents were employed; both with dodecyl benzene sulfonate – \(\text{CH}_3\left(\text{CH}_2\right)_n\text{C}_6\text{H}_4\text{SO}_3\text{Na} \) – as the main surface active agent. FCF (flocculation-column flotation) process is depicted in Fig. 2.
The reagent employed in the flocculation was Tanfloc SL, a tannin derivative, at a concentration of 80–350 mg L⁻¹. Fang (2007) characterized and evaluated Tanfloc SL as a coagulant/flocculant, and has reported it as tannin based medium-to-high molecular weight polymer, containing 10% alum. Charge neutralization, polymer bridging, and sweep flocculation are described by this author as the main operating mechanisms. Sodium hypochlorite, containing 4–6% available free chlorine, was utilized as disinfectant.

2.2. Methods

Reclaimed water was employed in the pre-soak, wash and first rinse. Fresh water was utilized in the final rinse, before the cars being dried. The system ran in two rounds (10 h) per day along 20 weeks. The study was divided in Campaign 1 (6 weeks) and Campaign 2 (14 weeks). Campaign 1 includes results from car wash wastewater treatment by FCF + sand filtration (FCF-S); and Campaign 2, results from FCF + sand filtration + chlorination (FCF-SC). Sodium hypochlorite was standardized weekly and dosed in low concentration after sand filtration (0.5 mgCl₂ L⁻¹). Between Campaign 1 and Campaign 2 (4 weeks gap), the car wash system operated conventionally with no water reclamation. In both Campaigns wastewater treatment process was operated semi-automatically. Water level in the reclaimed water tank was monitored with an electric level sensor; therefore the treatment process was turned-on automatically.

Wastewater and reclaimed water had 21 parameters analysed according to APHA (2005)—see examination methods in Table 5. Wastewater samples were collected after oil/water separation, and reclaimed water after chlorination (Fig. 1). Single and composite (4 aliquots in 2 h) samples were collected once a week, on Mondays mornings. Single samples were analysed by pH, oils and grease, phenol, total and fecal coliforms; and composites by COD; BOD₅; total, dissolved, and suspended solids; chloride; sulphate; sodium; manganese; turbidity; conductivity; hydrogen sulphide; phosphorus; nitrogen; tannin and surfactants.

The build-up of some substances concentrations, as a function of the water cycles, was monitored. One water cycle was considered to occur when the total water volume used in the washes overcomes the storage capacity of the system (10 m³ – Fig. 1).

According to Montgomery (1991), regression methods are frequently used to analyze data from unplanned experiments, which might arise from observation and uncontrolled phenomena or historical records. Data fitting using linear regression by least squares was applied for processing the results of the wastewater and reclaimed water as a function of time (weeks). Equations employed for linear regression (1) and for coefficient of determination (2) were the following.

\[ y = b_0 + b_1 x, \]  
\[ R^2 = \frac{S_{xy}^2}{S_{xx} S_{yy}}, \]

where “y” was the observed result (parameter value); “b₀” and “b₁” fitting parameters; and “x” was the independent variable (time).

The following hypotheses were considered:

- \( H_0: R^2 < 0.7 \) – the evaluated water parameter is not dependent on time (water cycles);
- \( H_1: R^2 \geq 0.7 \) – the evaluated water parameter is considered to be a function of time. In this case, the coefficient \( (b_1) \) of the time variable dictates if the data increases \( (b_1 > 0) \), decreases \( (b_1 < 0) \), or get stable \( (b_1 = 0) \).

A cost–benefit analysis of the water reclamation practice for car washes in Brazil was proposed, considering results found in the present study, as water demand, reclamation percentage and wastewater treatment costs (chemicals, energy consumption, fresh water and sludge disposal). Regarding the fresh water supply, it was considered the water costs for commercial activities in two cities in Brazil: Porto Alegre (basic price of US$ 2.69–5.83 m⁻³) and São Paulo (Table 2).

The market value for a FCF-SC equipment with a treatment capacity of 500 L h⁻¹ is estimated in US$ 8687.50 (quoted value along with a private company in Brazil).

3. Results and discussion

3.1. FCF process

Main equipment design and operating data of the FCF, during both Campaigns, are summarized in Table 3. The sludge removed from the column flotation was accumulated in a sand bed and disposed off safely in landfill. The total volume of dry sludge generated during the entire study (20 weeks) was 0.4 m³.

FCF main features are the hydraulic flocculation system employed, the bubbles generator (centrifugal multiphase pumps), the size of the bubbles and flocs and the separating column. The flocculation stage employs an in-line plug flow device–the flocs generator reactor (FGR, Carissimi et al., 2007), which provides an efficient flocculation at a high velocity gradient (G) and short residence time (Grohmann et al., 1981; Gregory, 1987), therefore reducing the Camp Number \( (G \times t) \) and consequently the energy.
consumption. More, this plug flow flocculator promotes a rapid and efficient flocc/bubble contact (Finch, 1995; Rosa and Rubio, 2005; Carissimi and Rubio, 2005), generating the so-called aerated flocs (Oliveira et al., 2010).

With the bubbles being generated by a centrifugal multiphase pump, Lee et al. (2007) reported that they are more cost-effective than the conventionally applied saturator vessels, besides being safer and easy to operate. Rodrigues and Rubio (2003) and Rubio and Zaneti (2009) have measured the bubbles formed by these pumps in the presence of surfactants. Results showed that a Sauter mean diameter of 75 μm could be attained, configuring microbubbles (<100 μm), somewhat higher than those used in conventional DAf operations.

Microbubbles/particles (flocs) main accepted interactions mechanisms are: adhesion through hydrophobic forces; microbubbles nucleation phenomena at solid surfaces; microbubbles entrapment or physical trapping inside the flocs; and aggregates entrainment (Rodrigues and Rubio, 2003; Oliveira et al., 2010). According to the authors, the very rapid rising rate exhibited by these aggregates depends on the number of bubbles attached or entrapped inside the flocs, and this “aeration degree” is a function of the aggregates characteristics (hydrophobicity). The high average rise rate, reported in Table 3, is in agreement with those mechanisms, once aerated flocs generated during wash wastewater treatment are exposed to adsorption/co-precipitation of surfactant.

Applications of column flotation are increasing in the environmental area, especially in the treatment of oil and grease (removal from water), metal ions, de-inking, and suspended solids removal (Finch, 1995; Filippov et al., 2000; Capponi et al., 2006). This device facilitates the prompt rise of the aerated flocs to the top (surface) of the column. Its high hydraulic-load and flux pattern (plug flow) are the main observed advantages. The float layer at the surface of the column consists of a mixture of foam and aerated flocs.

3.2. Reclamation system

In the present work, the wash type was a source of conveyor (Brown, 2000), where employees wash the cars using a handheld house with no automatic equipments. Table 4 shows results of water usage and saving during both Campaigns 1 and 2. Nearly 2000 cars were washed, during the 20 weeks of operation, with the mean water volume per car being about 120L. This consumption is lower than the reported by Ghisi et al. (2009) which have considered a water demand of 150–250L per wash when evaluating the potential for potable water savings by using rainwater for car washing in petrol stations in Brasilia, Brazil.

Water usage in car wash relies on wash type. Brown (2002) shows a water consumption difference of more than 50% when comparing tunnel (268 L per car) and self-service (45 L per car), in Phoenix, USA. These variations in water usage are function of wash equipment and schedule (steps). Al-odwan (2006) have reported a water consumption of 185–370L per car wash when utilizing in-bay wash type in Kuwait. According to Boussu et al. (2007), in Belgium, due to a high capacity of washes, the automatic car washes are the most widespread, and the average water consumption is close to 400 L per wash.

The total used volume of water in Campaign 1 was 7 times the storage capacity (10 m³ – see Fig. 1), configuring 7 water cycles. In Campaign 2, total used volume was 15 times the storage capacity (15 water cycles).

The percentage of water to be reclaimed was close to 70% (Table 4), and limitation on reclamation seems to be more related to employees training and skills, rather than to the water quality, despite a final rinse with fresh water be imperative. According to Boussu et al. (2007), nearly 15% of the Belgian carwash-already reuses 55% of the wastewater by using different techniques such as sand filtration, adsorption or biological treatment. Brown (2002) reported that 34% of the professional car washes distributed in Orlando, Phoenix and Boston (USA), reclaim water. Reclaimed ranged from 9% to 82% of total water used in the washes and the overall average percentage of recycled water was 51%.

During the 20 weeks of the study, the wastewater was discarded only once (between the two Campaigns), which along with the water saving compose a substantial environmental gain of this washrack system.

During both Campaigns 1 and 2, the FCF-SC FCF-SC processes were applied and wastewater and reclaimed water characteristics

Table 3
FCC car wash wastewater reclamation process (1 m³ h⁻¹ flow rate); operating parameters and constructive characteristics.

<table>
<thead>
<tr>
<th>Bubbles generation unit (CPU)</th>
<th>Full-flow saturation</th>
<th>Yes</th>
<th>Recycle-flow, %</th>
<th>0</th>
<th>Saturation pressure, atm</th>
<th>20–40</th>
<th>Bubbles diameter range, μm</th>
<th>5–250</th>
<th>Bubbles Sauter diameter (Dₛ), μm</th>
<th>75</th>
<th>Needle valve, m</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floculation unit (FCR)</td>
<td></td>
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<tr>
<td>Pipe diameter, m</td>
<td>0.0254</td>
<td></td>
<td>Total length, m</td>
<td>12</td>
<td>Retention time (tr), s</td>
<td>22</td>
<td>Head loss, atm</td>
<td>0.85</td>
<td>Velocity gradient (G), s⁻¹</td>
<td>660</td>
<td>Camp number</td>
<td>14,520</td>
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<td></td>
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<td></td>
<td></td>
<td>Tanfloc SL mg L⁻¹</td>
<td>80–350</td>
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<td>Dosing pump</td>
<td></td>
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<td>Diaphragm</td>
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<tr>
<td>Aerated flocs characteristics</td>
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<td></td>
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</tr>
<tr>
<td>Average diameter, μm</td>
<td>880–1600</td>
<td></td>
<td>Theoretic average strength (σ), N m⁻²</td>
<td>45–82</td>
<td>Fractal dimension (Dₛ)</td>
<td>1.64</td>
<td>Rise rate, m⁻¹</td>
<td>45–165</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Flotation unit (column)</td>
<td></td>
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<tr>
<td>Diameter, m</td>
<td>0.4</td>
<td></td>
<td>Height, m</td>
<td>1.8</td>
<td>Retention time (t), s</td>
<td>814</td>
<td>Hydraulic load, m⁻¹</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| a | Measured according to the technique reported by Rodrigues and Rubio (2003). |
| b | Measured as in Rubio and Zaneti (2009). |

Table 4
Water usage and savings.

<table>
<thead>
<tr>
<th></th>
<th>Total used water volume, m³</th>
<th>Number of water cycles in the system</th>
<th>Number of washes</th>
<th>Average total volume, L/vehicle⁻¹</th>
<th>Average fresh water volume, L/vehicle⁻¹</th>
<th>% Reclamation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campaign 1</td>
<td>73</td>
<td>7.3</td>
<td>617</td>
<td>119</td>
<td>49</td>
<td>58</td>
</tr>
<tr>
<td>Average and totals</td>
<td>158</td>
<td>15.9</td>
<td>1380</td>
<td>115</td>
<td>38</td>
<td>67</td>
</tr>
</tbody>
</table>
were fully monitored (Table 5). The process efficiency in removing/reducing total suspended solids (TSS) and turbidity are high for both systems, and no significant difference in reclaimed water clarification was observed. FCF-SC treated water had always turbidity and TSS below 15 NTU and 15 mg L\(^{-1}\), respectively. Boussu et al. (2007), when monitoring a car wash water reclamation system in Belgium with a hydrocyclone and a sand filter have reported a TSS concentration always higher than 60 mg L\(^{-1}\). On the other hand, Hamada and Miyazaki (2004) employed a flocculation followed by ultrafiltration system to handle 0.05 NTU reclaimed water. Therefore, FCF-SC observed results in car wash wastewater clarification are much higher than some physico-chemical proposed systems, and less efficient than sophisticated membrane systems. Flocculation– flotation effectiveness in removing TSS and reducing turbidity is well discussed elsewhere (Bratby et al., 1977; Edzwald, 1995; Rubio et al., 2002), and here the formation of aerated flocs was probably facilitated by the mixing characteristics of the plug-flow flocculator (FGR), the polymeric bridges expected to occur when using Tanfloc SL as coagulant/flocculant agent, and the suspended solids surface hydrophobicity (Carissimi and Rubio, 2005).

The oxygen demand values (Table 5) of the wastewater in both campaigns were below the local emission limit (COD = 400 mg L\(^{-1}\); BOD\(_5\) = 180 mg L\(^{-1}\)). These values are lower than those reported by Pâxeus (1996) and Panizza and Cerisola (2010), but higher than Hamada and Miyazaki (2004) results. It seems that detergents are the most prominent responsible for oxygen consumption in car wash wastewater (Boussu et al., 2007). In Campaign 1, the BOD\(_5\) concentration showed a dependence on time and build-up (Fig. 3 – see its \(R^2\) and fitting parameter – \(b_1\)), even with a feed inlet of 40% of fresh water. Results may be explained by the increase of the BOD\(_5\) dissolved fraction (Odegaard, 2004). Wastewater BOD\(_5\) concentration in Campaign 2 (Fig. 5) did not show build-up. These results can be explained by the oxidation skill of the chlorination process (Metcalf and Eddy, 2006).

Wastewater treatment plants, agricultural runoff and wildlife constitute possible sources of fecal pollution. From most commonly used fecal indicator organisms, fecal coliforms, denote fecal contamination but not whether it is of human or animal origin (Wéry et al., 2010). Some fecal bacteria, such as \(E.\) coli and enterococci, survive, grow, and establish populations in natural environments such as fresh water lakes and streams, sand beach, soils and sediments, and plant cavities. Therefore, it is reasonable that car wash wastewater may experience fecal coliforms contamination.

Table 5 shows that coliforms (total and fecal) counting in wastewater is fairly high, possibly posing some health risk (Metcalf and Eddy, 2006) and showing the need for disinfection. After chlorine was added (FCF-SC), the total and fecal coliforms concen-

![Fig. 3. FCF-S process: wastewater BOD\(_5\) as a function of time.](image-url)
trations were reduced by 95% and 99% (2 log removal), respectively, diminishing this risk.

Brown (2000, 2002) comments odour problems related to the presence of bacteria in car wash waste and reclaim water. Coliform counting is not performed by this author, or comments on the health risk. Hamada and Miyazaki (2004) have performed E. coli counting in car wash wastewater and reclaimed water. According to the authors, E. coli was not detected in these waters, although the results are expressed as <5 CFU mL\(^{-1}\), which is an inconsistent unit for bacteria counting.

Hydrogen sulphide (H\(_2\)S) formation appears to be a result of a microbial process taking place at anaerobic conditions (Hvitved-Jacobsen et al., 2000) and its odour threshold is substantially low –0.41 mg m\(^{-3}\) (Kim and Park, 2008). Mean concentrations (Table 5), measured in wastewater (0.19 mg L\(^{-1}\)) and in reclaimed water (0.02 mg L\(^{-1}\)), reached to about 88% removals (chlorine oxidation) (Boon, 1995). This reduction in H\(_2\)S was sufficient to eliminate odour problems.

Oil might be present in water as free (>150 \(\mu\)m), dispersed (150–50 \(\mu\)m), emulsified (50–0.1 \(\mu\)m), and/or soluble (<0.1 \(\mu\)m) form. Free and dispersed forms are efficiently removed by gravity in oil/water separator devices. Emulsified fraction consists of stable oil droplets, which have to destabilize before removal (Rosa and Rubio, 2005). Páxeus (1996), when evaluating the wastewater of several automatic vehicles washing facilities in Sweden, has observed an oil concentration range of 10–1750 mg L\(^{-1}\) (mean concentration of 291 mg L\(^{-1}\)). According to the author, oil separator devices have no efficiency in removing this oil, due to the formation of stable emulsions in the wastewater caused by detergents used in the cleaning steps of vehicles. On the other hand, Hamada and Miyazaki (2004) and Al-odwani et al. (2006) reported low concentrations (lower than 25 mg L\(^{-1}\)) of oil in automatic vehicles washing facilities in Japan and Kuwait, respectively. Table 5 shows that the oil concentration in wastewater herein was quite low, in average below 10 mg L\(^{-1}\) (emission limit). In this work, wastewater sampling were carry out downstream of the oil separator (Fig. 1). As this gravity device is known to separate free and/or dispersed oil droplets, it could be stated that the detergents used were not responsible for oil stabilization. Besides, phenol concentration was quite small (0.02 mg C\(_6\)H\(_5\)OH L\(^{-1}\)), much lower than the local limit (0.1 mg C\(_6\)H\(_5\)OH L\(^{-1}\)).

Once dodecyl benzene sulfonate was employed, the presence of residual surfactant in wastewater was expected (Table 5): 12 mg L\(^{-1}\) (Campaign 1) and 21 mg L\(^{-1}\) (Campaign 2) surfactant-MBAS (anionic). Those concentrations are much higher than the permitted by the local environmental regulation (2 mg MBAS L\(^{-1}\)).

The efficiency of FCF-SC in reducing the surfactant-MBAS (anionic) was about 40%, decreasing the feed concentration of 21 mg L\(^{-1}\), to about 12 mg L\(^{-1}\). Physical carryover by bubbles; adsorption/co-precipitation within the aerated flocs; oxidation by chlorination may be responsible for the surfactant molecule destruction and/or immobilization by adsorption.

Wastewater conductivity dependence on time and build-up were found (Fig. 4) for wastewater in Campaign 1. In Campaign 2, contrary to expectations, no TDS concentration build-up occurred after flotation and chlorination. Both parameters, TDS and conductivity, are higher in Campaign 1 than in Campaign 2, as a result of oxidation of the dissolved constituents by chlorination. Conductivity and TDS values are in the range already reported by Panizza and Cerisola (2010) and Hamada and Miyazaki (2004).

Sulphate, chloride and sodium ions concentrations in both, wastewater and reclaimed water (Table 5), for Campaign 2 were quite close, within the experimental error (about 5%). Conversely, Al-odwani et al. (2006) reported higher ions concentrations in car wash wastewater generated in Kuwait, probably due to the use of desalting water, the water source of that country.

![Fig. 4. FCF-S process: wastewater conductivity as a function of time.](image)

![Fig. 5. FCF-SC car wash reclamation system—economic evaluation as a function of daily washes.](image)

Scaling is commonly characterized by the appearance of an adherent mineral surface deposit (spot) usually composed of calcium carbonate – CaCO\(_3\) (Ghizellaouini et al., 2007). In this work, average calcium ions concentrations reached about 14 mg L\(^{-1}\), yielding almost 35 mg CaCO\(_3\) L\(^{-1}\). According to Metcalf and Eddy (2006), scaling occurrence would begin at an equivalent concentration of 100 mg CaCO\(_3\) L\(^{-1}\).

The economic evaluation (approximate values) considered hypothetical data based on the present study (120 L car\(^{-1}\), 70% of reclamation, car wash wastewater treatment cost of US$ 0.40 m\(^{-3}\), FCF-SC equipment cost of US$ 8687.50).

Economy and FCF-SC equipment amortization as a function of average daily washes is shown in Fig. 5. Considering a car wash wastewater reclamation system in Porto Alegre, with 35 daily washes, the equipment amortization is achieved in 24 months. In São Paulo, due to the higher water prices, a demand of 10 washes per day is sufficient to amortize the equipment in the same period of time. More, in São Paulo–Brazil, when the daily demand reaches 33 washes, less than 10 months are necessary to amortize the equipment investment. Chisi et al. (2009) have considered a range of 15–45 daily washes when evaluating the potential for potable water savings in car washes in Brasilia (BR).

4. Conclusions

A full-scale car wash wastewater treatment by FCF – flocculation-column flotation and water reclamation was monitored during 20 weeks of operation, divided in Campaign 1 (6 weeks) and 2 (14 weeks). Chemical, physical, physico chemical and biological parameters were measured thoroughly. Noticeable, car
wash wastewater and treated [for reclamation] water showed high fecal and total coliforms counting, concluding that no direct reclamation of this water is appropriate without disinfection. Using FCF, sand filtration and chlorination, almost 70% of odorless and clear water was reclaimed. More than 2000 cars were washed during the 20 weeks and no problems regarding the wash service quality were reported. It is believed that results found may assist a future car wash wastewater safe reclamation regulation, at least, in Brazil.

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