Treatment of Urban Wastewater by Infiltration Percolation on a Bed of Phosphate

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Abstract

The wastewater treatment by infiltration percolation is based on the principle aerobic biological filtration through fines granules. The water is uniformly distributed on the surface of the filter not covered. This study is conducted to demonstrate through a realization of pilot testing the feasibility of the process of infiltration percolation on a bed of phosphate. Therefore, the passage of water, that has undergone one day settling, on a bed of 15 cm thick with a flow rate of 0.5 l/h and a residence time of almost 2 hours, we get an abatement rate satisfying the main indicators of pollution parameters, with a 99% removal of suspended solids, 86% for chemical oxygen demand and 80% of the biological oxygen demand. These results are very interesting for the quality of treated water obtained on a support based on phosphate.

Key words: purification, phosphate, wastewater, treatment, infiltration percolation.

1. Introduction

Human activities negatively affect the quality and quantity of existing freshwater resources. Since these resources are limited, it is necessary to preserve and to turn to the use of unconventional resources [1], such as wastewater treatment. Indeed there are several methods of water treatment systems including soil treatment, sand filters [2], systems of infiltration into the soil [3], and intermittent sand filters buried [4].

The infiltration - percolation is a process that involves passing the water slowly through a granular mid with a sequential mode of delivery which alternates feeding periods and resting periods.

Studies of wastewater treatment in the field and laboratory have obtained excellent performance by infiltration [5]. With removal rates of COD, BOD5, TSS, and the virus more than 80% [6-8], this is the result of infiltration, percolation, adsorption [9], chemical reaction, and biological pathway, predation and absorption mechanisms plants or purification process [10, 11]. But in order to improve this performance we opted for use of the natural phosphate by comparing the purifying power of rock phosphate with sand usually used [12].

2. Materials and methods

a. The wastewater

Before using, the pretreated wastewater undergoes a primary settling for 1 day, which can significantly reduce the pollution load.

Pollution parameters that were analyzed are; turbidity using a turbidimeter WTW according to NF T 90-053 standard, suspended solids with a set of vacuum filtration according to NF T 90-105 the chemical oxygen demand (COD) according to NF T 90-101 and this standard with a reactor VELP Scientifica, biological oxygen demand (BOD) using a WTW Oxytop and NF T 90-103. Table 2 summarizes the results of pollution parameters studied:

<table>
<thead>
<tr>
<th>Settings</th>
<th>Raw water</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>8.10</td>
</tr>
<tr>
<td>Conductivity (µs/cm)</td>
<td>3.39</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>312</td>
</tr>
<tr>
<td>MES (mg/l)</td>
<td>776</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>1034</td>
</tr>
<tr>
<td>BOD5 (mg/l)</td>
<td>833</td>
</tr>
</tbody>
</table>

Table 1 : Characterization of waste water pretreated
b. Porous media

The materials used in this study are the phosphate of Khouribga city the sand of the Casablanca's sea. To remove impurities, the media were thoroughly washed with distilled water. This process was repeated several times until the removal of impurities [5], and then dried in an oven at 105 °C.

Samples were characterized by X-ray diffraction using a Siemens D500 powder diffractometer. The scanning electron microscope SEM (Zeiss DSM950) was used to determine the morphology of materials. The specific surface area was determined by the BET method using a Micromeritics ASAP2420. The size of the porous media was determined by the laser particle size Cilas. Table 1 summarizes the results:

<table>
<thead>
<tr>
<th>Settings</th>
<th>Phosphate</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dm (Åm)</td>
<td>238,30</td>
<td>121,54</td>
</tr>
<tr>
<td>D10 (Åm)</td>
<td>136,86</td>
<td>5,12</td>
</tr>
<tr>
<td>D90 (Åm)</td>
<td>358,61</td>
<td>250,02</td>
</tr>
<tr>
<td>Uniformity coefficient</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>SEM</td>
<td>irregular or rounded grains</td>
<td>irregular or rounded grains</td>
</tr>
<tr>
<td>DRX</td>
<td>Fluorapatite, SiO₂; CaMg(CO₃) ; CaCO₃</td>
<td>SiO₂; CaMg(CO₃) ; CaCO₃</td>
</tr>
<tr>
<td>Surface area (m²/g)</td>
<td>12,74</td>
<td>1,58</td>
</tr>
</tbody>
</table>

3. Results and discussion

a. Hydraulic study

The variation of the pressure drop as a function of time gives a curve with a slight curve upwards; this is explained by the fact that the elimination of a portion of the impurities takes place in depth [15].

![Figure 1: Drawing of the processing pilot](image1.png)

Depending on turbidity: the plateau level and duration of the period of use of the filter depends on: Low resistance of the flock; poor settling; increase the surface charge and increasing the thickness of the filter medium [15].

![Figure 2: Variation of the pressure loss and turbidity](image2.png)

b. Pollution parameters

pH:

The pH of the medium is one of the major parameters that control the retention of inorganic substances such as heavy metals, nitrate and orthophosphate [16].
Table 3: Variation of pH

<table>
<thead>
<tr>
<th>Day</th>
<th>Phosphate</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>7.57</td>
<td>7.59</td>
</tr>
<tr>
<td>2nd</td>
<td>7.79</td>
<td>7.73</td>
</tr>
<tr>
<td>3rd</td>
<td>7.56</td>
<td>7.38</td>
</tr>
<tr>
<td>4th</td>
<td>7.62</td>
<td>7.56</td>
</tr>
<tr>
<td>5th</td>
<td>7.84</td>
<td>7.74</td>
</tr>
</tbody>
</table>

The increase of pH in the treated water is the result of the reduction of aerobic decomposition of organic matter along the filter bed, and the accumulation of ammonia in the reaction column to the result of nitrification. [17]

Conductivity

The high conductivity of the pretreated wastewater indicates a high mineralization (3.39 mS / cm) and provides information on the salinity.

Table 4: Variation of conductivity

<table>
<thead>
<tr>
<th>Day</th>
<th>Phosphate</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>1581</td>
<td>1850</td>
</tr>
<tr>
<td>2nd</td>
<td>2390</td>
<td>2430</td>
</tr>
<tr>
<td>3rd</td>
<td>2410</td>
<td>2480</td>
</tr>
<tr>
<td>4th</td>
<td>2480</td>
<td>2470</td>
</tr>
<tr>
<td>5th</td>
<td>2540</td>
<td>2480</td>
</tr>
</tbody>
</table>

These results can be explained by the rejection of highly mineralized industrial wastewater directly into the sewer system [18].

Turbidity

The primary settling of the pretreated wastewater for 2 days removed 62% of the colloidal material and 68% of suspended solids.

Chemical oxygen demand

The concentration average of COD in the input of the filtration system is 1034 mg/l, while the concentrations recorded at the output are approximately 254 mg/l for water treated by a bed of sand and 103 mg/l for water treated by a bed of phosphate.
This sharp reduction in COD could be the result of physical retention of organic matter in the wastewater through the filter and its oxidation by biological processes associated with the bacterial flora [19].

**Biological oxygen demand**

The average of BOD₅ concentration in decanted wastewater, used to the input of the infiltration system is 833 mg/l. The concentration average of BOD₅ for treated water by the bed of phosphate is 82 mg/l. This means that 81% of the biodegradable organic material is removed.

This could be explained by better oxygenation of the filter allowing aerobic bacteria profiling and therefore ensure a better digestion and oxidation of organic matter [20].

4. Conclusion

The analysis of the results indicates a significant elimination of pollution, with both: treatment with a bed of phosphate or a bed of sand.

Moreover, those results reveal a purifying power of phosphate larger than sand with a reduction of 96% for suspended solids, 91% for COD and 81% for BOD₅. As for the sand abatement rates are 86% for suspended solids, 77% for COD and 53% for BOD₅.

These results are in agreement with those obtained in other studies [21-23], where the removal of COD and SS brushed rate of 80% for sand.

5. Bibliography


