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

A. Achkoun

Applied Chemistry and Environment Laboratory. University of Science and Technology Settat 577. Morocco.

R. Cherouaki, J. Naja,

Applied Chemistry and Environment Laboratory. University of Science and Technology Settat 577. Morocco.

R. M'Hamdi

Water and Environment Laboratory, Study and Research Center of Mineral Phosphates, Casablanca 25679. Morocco.

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, BOD_5, 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 1 : Characterization of waste water pretreated

Settings	Raw water
pH	8,10
Conductivity (µs/cm)	3,39
Turbidity (NTU)	312
MES (mg/l)	776
COD (mg/l)	1034
BOD_5 (mg/l)	833

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 2 : Characterization of draining materials

Settings	Phosphate	Sand
Dm (Åm)	238,30	121,54
D10 (Åm)	136,86	5,12
D90 (Åm)	358,61	250,02
Uniformity coefficient	2	24
SEM	irregular or rounded grains	irregular or rounded grains
DRX	Fluorapatite, SiO_2 ; $CaMg(CO_3)$; $CaCO_3$	SiO_2 ; $CaMg(CO_3)$; $CaCO_3$
Surface area (m^2/g)	12,74	1,58

c. Description of the pilot:

The treatment will be made on a glass column with 50 cm of height and 10 cm of diameter, the filter media has a height of 15 cm, it is arranged over 3 cm of gravel, everything is laid on a filter worn by a grid allowing the free flow of the treated water. The column is made up in its end by a funnel with a hose, which has 1cm of diameter through which the water outlet is recovered **[13,14]**. The filter medium is crowned with a layer of 3 cm of gravel and a canvas in order to ensure the dispersion of the feed water on the entire bed and to avoid the formation of a preferential path **[13]** (Fig.1). The clarified water is contained in a tank from which it is withdrawn at a rate of 0.5 l/h.

When the pressure drop, turbidity, or both reach their maximum values, the filter was washed in distilled ensuring continuous water supply. Washing was stopped when the turbidity of the inlet water is equal to that of water at the outlet.

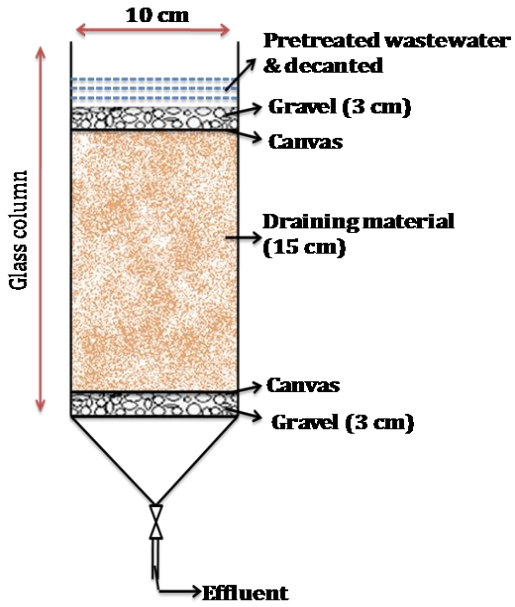

Fig 1 : Drawing of the processing pilot

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]**.

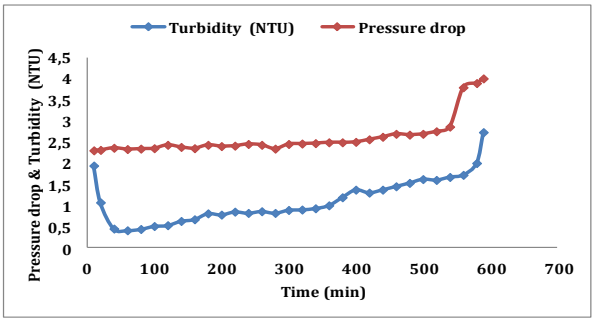

Fig 2 : Variation of the pressure loss and turbidity

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]**.

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

Day	Phosphate	Sand
1st	7,57	7,59
2nd	7,79	7,73
3rd	7,56	7,38
4th	7,62	7,56
5th	7,84	7,74

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

Day	Phosphate	Sand
1st	1581	1850
2nd	2390	2430
3rd	2410	2480
4th	2480	2470
5th	2540	2480

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.

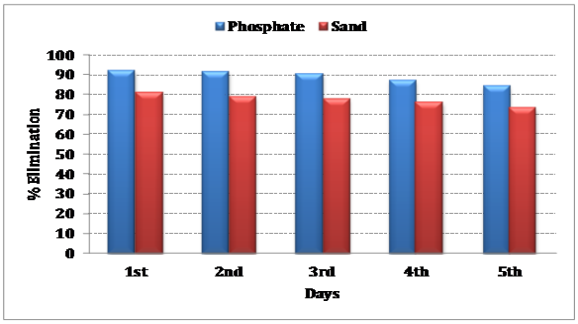

Fig 3 : Variation of turbidity

The average turbidity of the settled wastewater is 312 NTU. But it decreases significantly to 2.02 NTU for treated water by phosphate and 9.53 NTU for the treated water by sand. This decrease is explained by the fact that smaller particles are retained by blockages between the pores, interception and fixing grains, or chemical interaction of Van der Waals type **[17]**.

Suspended solids

The average content of suspended solids in wastewater is 776 mg/l, when the water settled has an average of 592 mg/l. In addition, the content of suspended solids decreases significantly in the treated water to 24 mg/l NTU for treated water by phosphate and 82 mg/l for the treated water by sand.

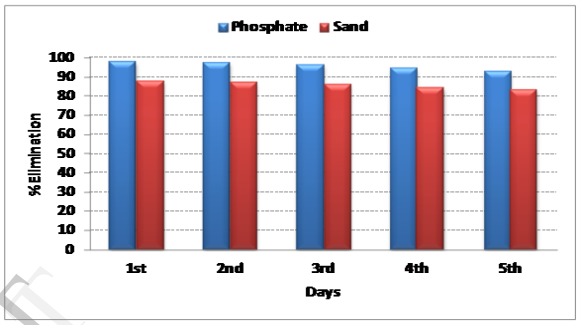

Fig 4 : Variation of suspended solids

Theories applied to granular materials show that sedimentation is the preferred disposal mechanism of suspended particles. The coarse suspended solids are retained on the filter surface by mechanical action. The finest particles are retained by the pores between blocks, interception and fixing the grains, or chemical interaction of Van der Waals type **[17]**.

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.

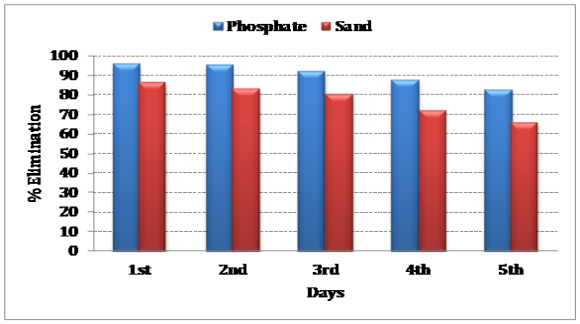

Fig 5 : Variation of COD

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 BOD_5 concentration in decanted wastewater, used to the input of the infiltration system is 833 mg / l.

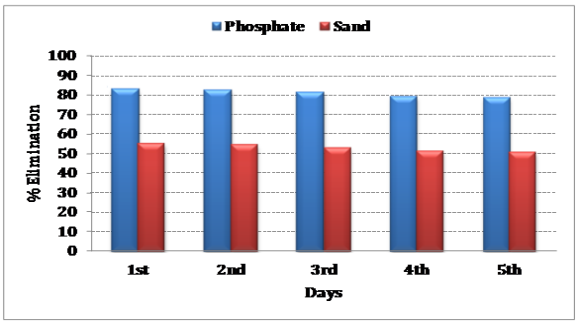

Fig 6 : Variation of BOD_5

The concentration average of BOD_5 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 BOD_5. As for the sand abatement rates are 86% for suspended solids, 77% for COD and 53% for BOD_5.

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.

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