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Evaluation of the Removal of COD and BOD in Wastewater from Bus Washing Using Coagulation, Flocculation and Aerobic Biological Treatment

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Wastewater treatment is a complex task, especially when it is understood that it is used for multiple uses; one of the uses in which a large number of pollutants are used is for washing cars, especially buses and trucks use a large amount of solvents, detergents and soaps of different compositions, which are difficult to remove from water , especially because they act as emulsifiers between substances not soluble in water and the water that dissolves and eliminates them together with the internal and external dirt of buses and trucks. In Colombia, the implementation of a standard that has made the amount of contamination, that residual water can carry is more restrictive, before being poured into a sewer collection pipe, this is evaluated in terms of chemical oxygen demand (DQO) and biological oxygen demand (BOD5), these parameters define the quality of the water to be collected. The University of Santander provides scientific and technical consultancy services to the community of companies in the Santander region and the company PARBER is a local consultant, which is in search of solutions for the environmental problems of the wastewater from the laundries of cars, for this study agreements were made between the parties to search for wastewater treatment systems, which can be used by car wash industrialists and to be able to comply with the standards established in the new legislation; For this purpose, a sampling methodology for wastewater, jar tests and a water aeration device were developed that simulate the processes consecutively and also independently, to determine the capacity of removal of COD and BOD5 from wastewater. ; the scenario used was a car wash, which is a client of Industrias PARBER, which facilitated the tributary water for all the tests and also provided its facilities for the assembly of a prototype of aeration, to perform the aerobic biological treatment test ; composite samples of 4 hours of laundry were taken, which has a 24-hour service, with higher flow rates in the morning hours, in which the analyzed samples were taken; the analyzes were carried out in the water laboratory of the University of Santander, to determine the degree of contamination, also jars tests were performed, to simulate the operations of coagulation, flocculation and sedimentation, as part of the possible treatment to be applied to the waters residuals of the laundry of cars..

1. Introduction

The use of water for car wash services is an important part of pollution in Colombia; This type of wastewater does not have a category in the legislation, it is only found in a generic part in the national regulation (Resolution 0631 Ministry of Environment and Sustainable Development, 2015).
In the search for a suitable technology for the treatment of a bus and truck laundry, in the metropolitan area of Bucaramanga, the company “Industrias PARBER”, conducted a scientific technical consultancy with the University of Santander, in which the University supports the study, with a professor and a student of Environmental Engineering, in this objective this study was carried out that tested the ability of coagulation, flocculation and sedimentation, on the one hand and another treatment was defined with the combination of an aerobic system, with the characteristics of an oxidation ditch and the physical-chemical treatment already named, to establish its ability to remove COD and BOD5. Aerobic treatment strategies are based on the ability

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of microorganisms to consume dissolved solids in water and transfer part of this matter to their cell mass in growth (Ertola R., 1994) (Huoqing Ge, 2013).
Bus wash water is a complex mixture, which includes hydrocarbons, detergents, soaps, silicones and many other products used in automotive beautification (Hanmin Zhang, 2011); This generates two types of pollutants, which are dissolved solids and suspended solids (Bruce Rittman, 2001), the former are difficult to separate from water, but the latter can be separated by physical-chemical processes, such as coagulation, flocculation, sedimentation and filtration; To perform this work, aluminum polychloride (PAC) was chosen as coagulant, which has the ability to break the stability of suspended solids (Doka, G., Life, D., & Assessments, C., 2007), as those that generate turbidity and color in the water, and perform a complexing in floc's, and then make them precipitate in a settler (Hanmin Zhang, 2011); This process will be reviewed by testing pitchers; alternatively, an aeration of the water from a preliminary car wash treatment system is carried out; This water is passed to aeration tanks and the jug test is performed to determine if they can remove water contamination.

2. Materials and methods

To carry out this work, we worked on two forms of water treatment, the first one is expressed in the following graphic.

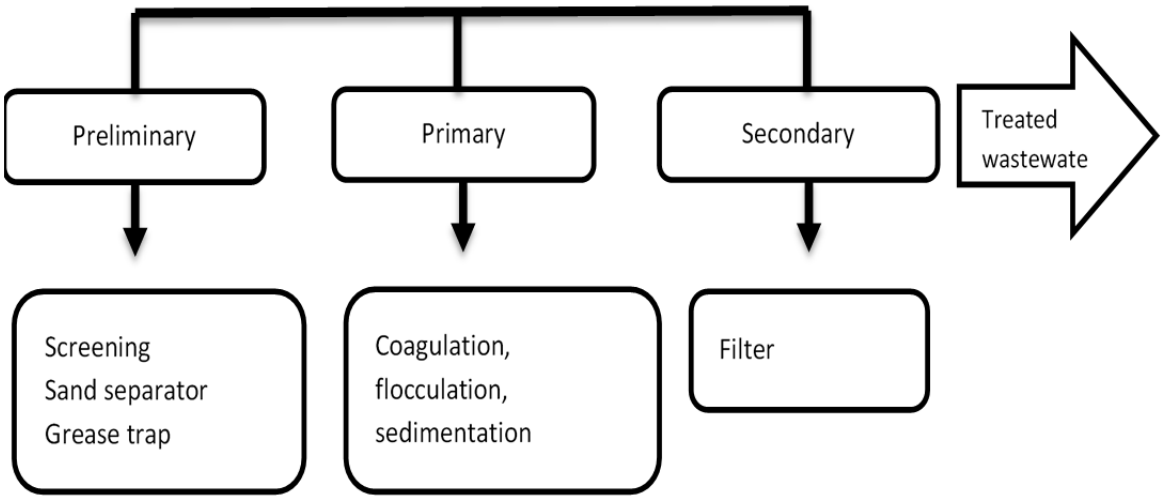

Figure 1: Process 1 Physical-chemical treatment

In this treatment it is taken into account that the laundry in which the activity is being carried out, has a preliminary treatment structure, which is composed of a sieve, a sand trap and a grease trap (RAS 2000 TITLE C, 2000); After this the water is taken to take it to the jar test where coagulation, flocculation, sedimentation and additional filtering is simulated (ASTM, 2008), to determine if this physical-chemical treatment is sufficient to comply with the Colombian standard of wastewater discharges (Resolution 0631 Ministry of Environment and Sustainable Development, 2015).
After this treatment, a prototype is prepared to be tested, which is provided with an aeration unit, with a 0.5HP blower, which supplies the air to a pipe with fine bubble diffusers, which transfer oxygen to the water; After this, a test of jugs of the outgoing water of the aerobic reactor is carried out, with this procedure it is determined if the application of the aerobic treatment can improve the removal of COD and BOD from the washing water of buses and trucks.
To determine the removal capacity, composite samples were taken and COD and BOD analysis of the water at the entrance and exit of each of the treatments; the analytical techniques and the sampling were carried out by means of the established in the Standard Methods (American Public Health Association., 1995).

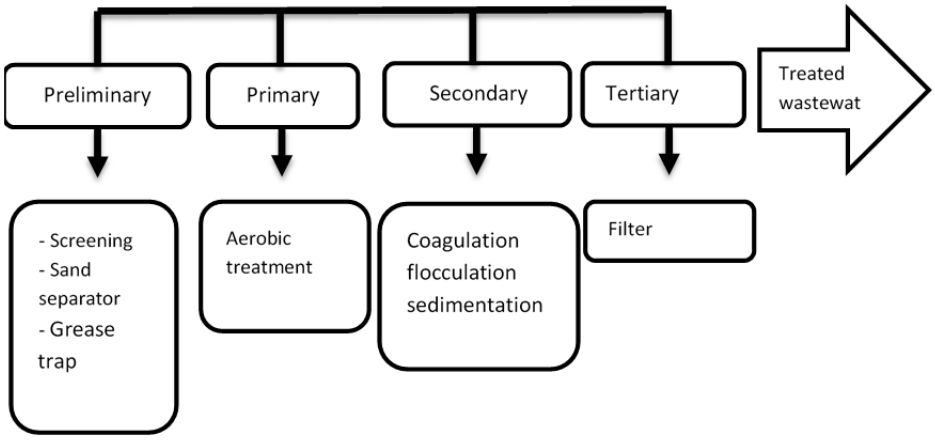

Figure 2: Process 2 Water treatment with aerobic reactor included.

The monitoring of each water treatment was carried out by determining the COD and BOD5 at the entrance of the primary treatment, this is the data identified as the entrance to the process, the output was analyzed in the same way, and is compared with the standard provided for this type of water, the measured parameters and their limit values are shown in tables 1 and 2.

Table 1: Parameters measured in the process.

Parameter	Units	Analytical technique
pH		Standar Methods 4500 H+
COD	mg/l O_2	Standar Methods 5220
BOD	mg/l O_2	Standar Methods 5210 B

Table 2: Values of standard 631 of 2015.

Parameter	Units	Value límit
pH		6 – 9
COD	mg/l O_2	225
BOD	mg/l O_2	75

3. Results and discussion

The COD and BOD5 removal capacity showed activity with the two treatments applied to the wastewater of the bus and truck laundry, as shown in the graphs.
The pH was within the norm, since all the values were between 7 and 7.5, and the norm considers an interval between 6 and 9, which indicates that in both processes the standard is fulfilled.

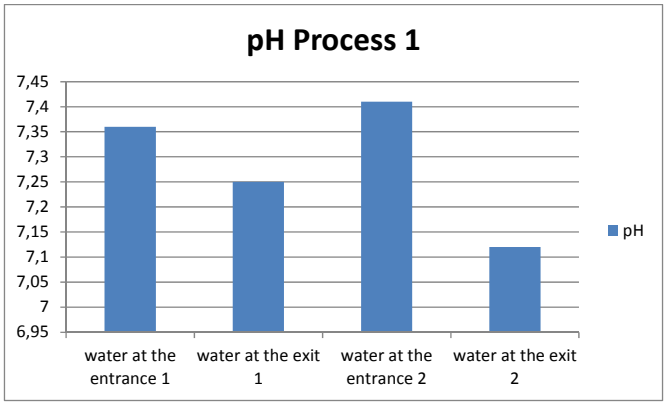

Figure 3: pH measurement in process 1.

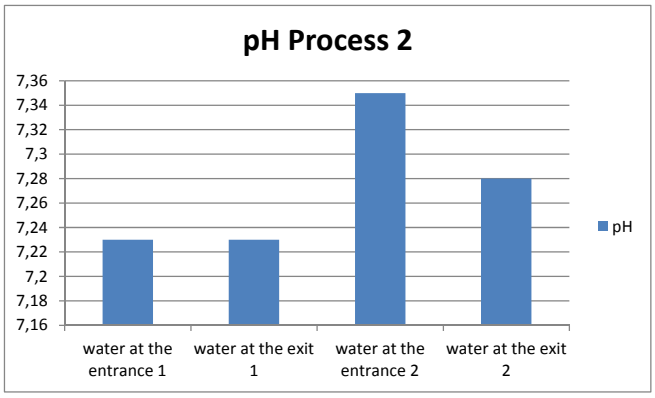

Figure 4: pH measurement in process 2.

The behavior of the results in the COD and BOD5 were different, since in graphs 3 and four the results of the first process are shown, first in COD and then in BOD5.
Figure 5 shows that the physical-chemical treatment was enough to remove the COD and meet the standard to satisfaction.

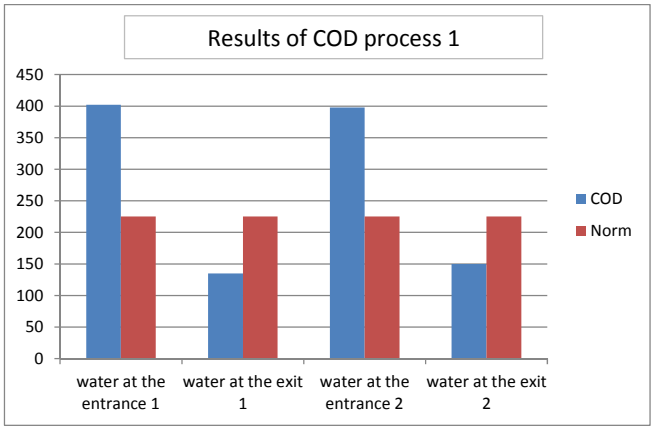

Figure 5: COD results of process 1

Figure 6 shows that the results of BOD5 were not satisfactory, because the results at the exit of process 1 presented values higher than the norm that is 75 mg / l of O2.

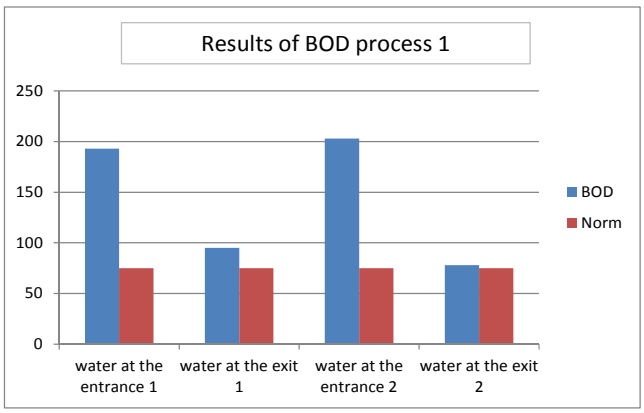

Figure 6: BOD5 results of process 1.

The results of process 2 showed better performance, because between the entry and exit of process 2 the removal met the standard satisfactorily, both for COD and BOD_5.

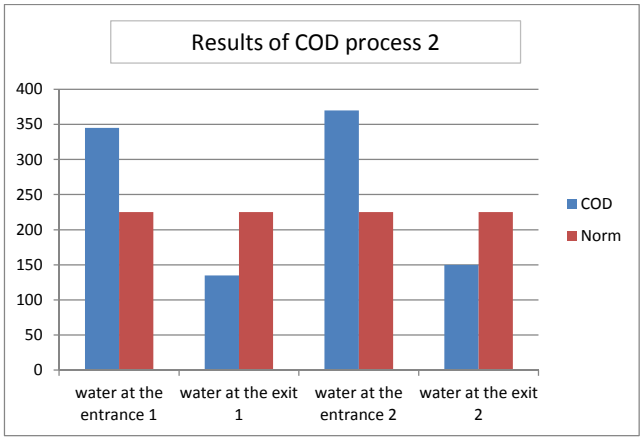

Figure 7: COD results of process 2.

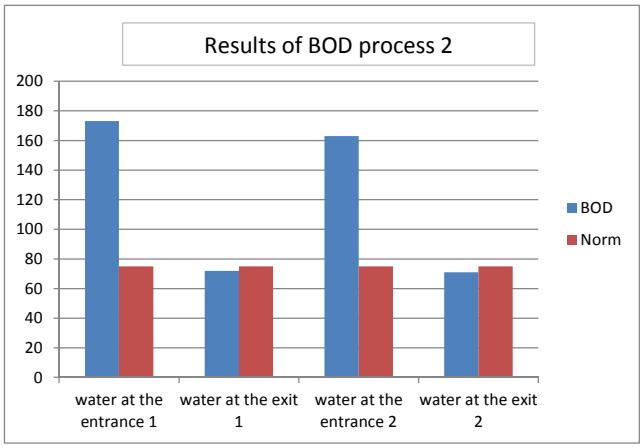

Figure 8: BOD5 results of process 2.

The results of process 2 met the norm both times when they were evaluated, showing similar results on both occasions when they were implemented.

4. Conclusions

Processes 1 and 2 showed no effect on the pH of the outlet water, maintaining the result within the standard established for this parameter, the process also showed no significant changes between the input and output of the processes.

The removal of COD in the two processes was efficient, complying with the norm in both cases, with a notable difference with the value established in the Colombian standard.

The removal of BOD5 was not satisfactory for process 1, on the 2 occasions in which the physical-chemical process was carried out, the norm was never met in any case, despite numerous trials to establish the adequate dose of polychloride Aluminum (PAC).

The removal of BOD5 was satisfactory in the 2 times in which process 2 was measured, however the BOD5 values are very close to the norm, this shows us a need to perform other tests, with a prototype that can evaluate the physical-chemical processes in operating conditions with dosing machines and a work flow.

Acknowledgments

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