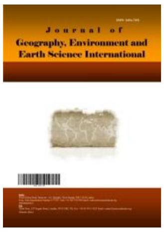

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Chemical Contaminants Assessment Influencing the Proper Funcntioning of the Waste Water Treatment Plant in a Brewing Factory: Case of SABC Yaounde -Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

The present study were carried out in the brewing factory of Cameroon (SABC) Yaoundé focuses on the evaluation of chemical contaminants influencing the wastewater treatment plant.
Standard methods of analysis of physicochemical parameters of wastewater in anaerobic sludge were done according to Waterleau [1].
The information collected made it possible to evaluate chemical contaminants according to the use of water, water solubility and dangerousness.
It was found that, chemical contaminants are mostly disinfectants (30%) and cleaning products (15%). Nevertheless, there are others used for pH regulation, such as beer stabilizers, etc. The wastewater treatment plant has shown overall good yields. The temperature that varies between 31°C and 32°C, characterise an optimal temperature for the metabolism of microorganisms. The pH oscillates between 7 and 10 characterise majority the alkaline waters. This study shows that the presence of chemical contaminants in discharge water which came from different part of the factory and were other chemical are used, influences microorganism area and can affect their health of purification microorganisms by acting on the physico-chemical parameters of wastewater and sludge.

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Keywords: Chemical contaminants; wastewater; sewage treatment plant; brewing plant.

1. INTRODUCTION

Water is a vital resource for man, his survival and his food. It is also essential for its agricultural, industrial and tourist activities and the quality of its environment Dahou and Brek [2]. Wastewater discharges are increasing annually due to industrialization and the rise in the standard of living of the population Zeghoud [3]. One of the most alarming phenomena is the increasing accumulation of recalcitrant substances which are difficult to biodegrade in water. The situation is worsened by the lack or insufficiency of an adequate water treatment system capable of reducing the concentration of toxic substances which represent chronic chemical risks Chebli [4]. Beverage production industries generate large volumes of wastewater on a daily basis Sawadogo (2018). From the above, it is necessary to set up wastewater treatment before discharge into the receiving environment. This treatment is primarily aimed at reducing the pollutant load, in other words Biochemical Oxygen Demand (BOD), Suspended Solids (SS) and nitrogen and phosphate pollution Kay et al. (2007). The general objective of this work was to assess the chemical contaminants likely to influence the proper functioning of the WWTP in a brewing plant. Specifically, it was a question of: Inventorying the chemicals used in the various workshops and found in the wastewater at the WWTP; Classify chemical contaminants according to the potential hierarchy of danger (Pareto diagram); Measure the physico-chemical parameters of wastewater and sludge from the Pool.

2. MATERIALS AND METHODS

2.1 Material Used

Waste water and sludge are the main material used in the present work. To analyse samples, several chemical reagents were then used .various equipment sample analysis were also used and some of them are shown Fig. 1.

2.2 Methods

The chemicals were inventoried using survey sheets distributed to operators in each part workshop of the SABC plant in Yaoundé. The physicochemical parameters of wastewater and anaerobic sludge were analyzed using standard methods of analysis of Waterleau [1]. Wastewater and anaerobic sludge samples were collected using an automatic and manual sampler. The samples were taken every day at six in the morning, then stored and transported in a refrigerating chamber at a conservative temperature of 4°C over a short distance to the laboratory, in order to reduce the variation of the parameters. physico-chemical.

The temperature and the pH were measured in situ and in the laboratory respectively using a Humeau brand Waterproof multiparameter and a WTW Inolab pH meter.

Fig. 1. Samples of wastewater (A) taken at the entrance to the WWTP in the buffer basin (BT), the anaerobic effluent channel (EA) and at the WWTP outlet (SS) and anaerobic sludge from the UASB reactor (B)

The probe was introduced vertically at 2/3 of the water column. After 2 to 3 minutes the number displayed on the screen was read and expressed in degrees Celsius (°C).

The SS contents were determined by the indirect method which consists in weighing the 0.45 µm filter papers (B), then filtering a sample of waste water of known volume by suction with a vacuum pump, and finally drying the filter paper containing the residues in an oven at 105°C for 2 hours. Weigh the dry sample (A) again. The value in mg/L is given by the formula [1].

The organic matter present in the sample was analyzed using the method of Waterlau [1] with a standard quantity of potassium dichromate. The excess of this reagent after complete oxidation is measured with a photometer and converted directly into mg O2/L of COD. 2 ml of each sample previously diluted so as to respect the reading range according to the load of each, were taken and introduced into COD tubes in the range 0-150 mg O2/L for EA and SS, and 0- 1500mg/L.

3. RESULTS AND DISCUSSION

3.1 Characteristics of Inventoried Chemical Contaminants

In waste water treatment, there are several chemicals contaminants which are often used and some of them are shown in Fig. 2.

This results shows that, 20 chemical contaminants of different quality, at risk for the health of the microorganisms of the station, were counted as follows: 30% of disinfectants, 15% of cleaning products, 10% for pH adjustment, 10% of beer stabilizer, 10% anti-foam products, 5% bottle shine products, 5% label sticking products, 5% calcium hardness products, 5% lubricating products and finally 5% products for oxidation processes.

3.2 According to their Solubility in Water

The contaminents solubility in water results were shown in Fig. 3.

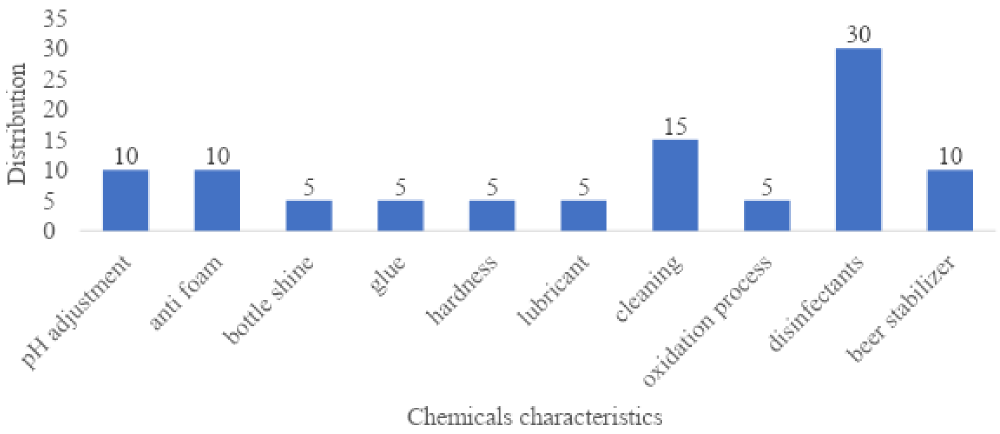

Fig. 2. Different types of hazardous chemicals inventoried within the Yaoundé SABC according to their use

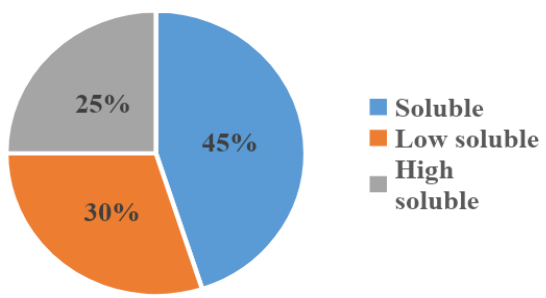

Fig. 3. Distribution of chemicals according to their solubility in water

We can say here that, the contaminants or chemicals according to water solubility reveals that, 45% are soluble in water, 30% are poorly soluble and 25% are very soluble in water. This solubility provides information on the path followed by chemical contaminants to the treatment station, because the more soluble a contaminant, the more mobile it is and can easily reach the WWTP via process wastewater. The soluble products having a tendency to disappear in the wastewater can still allow a modification of the reaction medium in which the microorganisms live. Thus, the health impact of these microorganisms in the reactor can reduce the efficiency of the treatment of the related organic matter.

3.3 Classification of Chemicals Dangerousness

The classification of chemical products or contaminants according to their dangerousness reveals an unequal distribution. The results are shown in Fig. 4.

This classification made according to the potential hierarchy of hazards shows that, 50% of contaminants are irritant, 20% corrosive, 10% biocides / flammable, 5% toxic, 5% harmful and 10% harmless. The potential prioritization of chemical contaminants in contact with water was carried out using the Pareto diagram grouping the frequencies of use and cumulative frequencies of the chemical contaminant (Fig. 4). This assessment made it possible to highlight the different characteristics of chemicals that are able to harm the microorganisms in the WWTP. The chemical contaminants, which are found in the water, in the direction of the WWTP, sometimes react by complexation phenomena, thus giving rise to very dangerous elements for these microorganisms but also by the formation of monomers, which can increase the quantity of nutrients in the environment and cause nuisance.

3.4 Physico-chemical Characteristics of Wastewater

Physico-chemistry of the wastewater from the SABC Yaoundé was determined and the average values of the various parameters are presented in Table 1.

Temperature: The water temperatures of the different basins (BT, EA and SS) vary slightly from one basin to another. The lowest average value of 31 ° C was recorded in EA and then in SS and the highest of 32°C in BT (Fig. 6). The temperature values vary slightly from one basin to another. They fluctuate between 31 and 32°C. This low thermal variation could be explained by the fact that the water temperature depends on the sun Rodier (2009). It would also be linked to that of the ambient temperature of the reaction medium (endothermic and exothermic reactions of the microorganisms in the reactor).

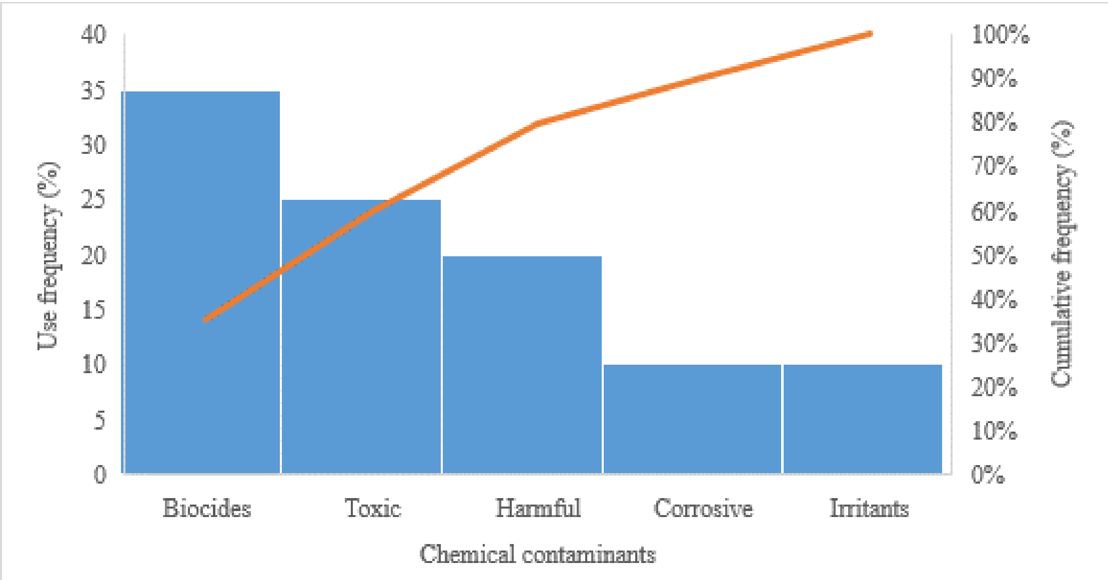

Fig. 4. Potential prioritization of the hazards of chemical contaminants in contact with water (Pareto diagram)

Table 1. Average values of some physico-chemical parameters of wastewater from the Yaoundé SABC during the month of June

Parameters	BT	EA	SS
pH	10	7	8
Temperature (°C)	32	31	31
MES (mg/L)	167	77	65
AGV (mg/L)	321	121	-
COD (mg O_2/L)	1 464	223	196
BOD_5 (mg O_2/L)	1 200	170	125
Nitrogen (mg N/L)	18	9	-
Phosphate (mg P/L)	45	27	-
Biodégradability	1,22	1,31	1,57

This result is similar to that of Zhang [5] asserting that when the temperature of the reactor is below 30°C, the activity of methanogenic bacteria is greatly reduced. Therefore, to ensure proper operation, mesophilic UASB reactors must operate at a temperature between 30 and 35°C. The study by Chou et al. (2004) showed that UASB reactors operating at 30°C develop larger granule sizes than reactors operating at 25°C.

Suspended matter: The MES profiles vary from one basin to another in a decreasing way from the entry to the exit of the WWTP. The lowest mean value of 65 mg / L was observed in SS and the highest of 167 mg / L in BT. These results are slightly different with those of Driessen and Yspeert, (1999) who show that the SS of brewery wastewater is also high and the values oscillate between 200-1000 mg / L, characteristic of a strong presence of organic matter. This could be explained by the fact that the cleaning of the water lifting pits was indeed effective on a short-term basis (every day).

The pH: During the study period, the average pH values varied between 7 and 10 from one basin to another. The lowest mean pH value of 7 was recorded at the AE level and the highest of 10 at the Buffer Tank level. At SS, a value of 8 was recorded (Fig. 7).

The pH plays a key role in the bacterial growth of the species present in the anaerobic granule. The wastewater analyzed has a pH values ranging between 7 and 10 This basicity this could be explained by the fact that, the water from the welded ash is constantly discharged into the pipes of de WWTP but but also floor cleaning products. This remark is made by the high values at the entrance to the WWTP. Here is the receptacle of all the wastewater from the brewery forming a homogeneous mixture and possible complexing reactions of dissolved contaminants. More stable values in the other basins could be explained by the fact of having regulated the pH at the entrance to the WWTP by adding hydrochloric acid. These results corroborate with those of Zhang [5] who assert that the pH of brewery water is influenced by waste water from cleaning and welded baths.

3.5 The Chemical Oxygen Demand

The COD varied between 1464 and 196 mg O_2 / L of the LV from the inlet to the outlet of the WWTP. The lowest value of 196 mg O_2 / L was observed at the WWTP outlet and the highest of 1464 mg O_2 / L was observed in the BT. In EA, 223 mg / L of COD was recorded (Fig. 8).

The COD values fluctuate decreasingly from the WWTP inlet to the outlet. These values could be explained by the abundance of organic matter (spent grain, kieselguhr, etc.) at the entrance to the WWTP and the lowest by the metabolic activity of microorganisms in the degradation process. These results are in the same direction as those of Driessen and Vereijken [6], who find high values of COD, for example 1200-6000 mg O_2 / L in brewery wastewater. The organic COD load recorded in the UASB reactor of 18 kg COD / day is similar to that obtained by Driessen and Yspeert [6], which explains that given the high concentrations of sludge in the reactor, the applicable organic load is l 'order of 15 to 18 kg COD.j-1 depending on the type of effluent to be treated.

3.6 The Biochemical Oxygen Demand after 5 Days

The BOD_5 profile showed a decreasing variation from 1200 to 125 mg O_2 / L, from entering to leaving the station. The lowest value of 125 mg O_2 / L was observed at the WWTP outlet and the highest of 1200 mg O_2 / L was observed in the

BT. In EA, 170 mg O_2 / L BOD_5 was recorded (Fig. 8).

The values of biodegradability (COD / BOD_5) vary between 1.22 and 1.57. The lowest value of 1.22 was recorded in the BT and the highest of 1.57 at the exit of the WWTP. In EA a value of 1.31 was obtained, see Table 1. Likewise, the values of BOD_5 and DCO have a similar evolution. The BOD load obtained in the reactor being 11 kg BOD.per day. This result is in agreement with the work of Driessen and Yspeert [6] and those of Zhang [5] show that the applicable organic load is of the order of 9 to 12 kg BOD.per day.

3.7 Nutrients (Nitrogen and Phosphate)

The nitrogen decreases from BT to EA. Its values vary from 18 to 9 mg N / L. The lowest value was recorded in the EA and the highest in the BT (Fig. 8).

The phosphate profile decreases from BT to EA. Its recorded values vary from 45 to 27 mg P / L respectively in EA and BT as shown in Fig. 8.

As for the nutrients, namely nitrogen and phosphorus, the values fluctuated between 10 and 17 mg N / L and 25 and 42 mg P / L. This nutritive presence would be due to nitrogen and phosphate compounds from upstream chemical contaminants such as certain cleaning products (detergents) but also beer stabilizers while adding those of process water. The results obtained corroborate with those of Rao et al. (2007) who obtain orthophosphate values between 10 and 50 mg P / L. Zhang [5] shows that anaerobic bacteria mainly need a source of nitrogen in organic form (ammoniacal nitrogen or urea) and a source of phosphorus (orthophosphates). These nutrients are used for the synthesis of living matter and for the storage of energy produced during biological reactions.

3.8 Physical Quality of Wastewater

3.8.1 Waste water volume

The volumes of wastewater entering the treatment plant were recorded from June 1 to 20, 2020. Using the pumps installed in the lifting pits of the various compartments of the Yaoundé plant (Production Center, Short Field and Carbonated Beverage Factory), the recorded water volumes are shown in Fig. 5.

The observation shows that, the curve varies in a saw tooth. The volumes of wastewater fluctuated between 1281 and 3441 m^3 with an average of 2277.25 m^3. The lower and upper targets mark the acceptable limits of the wastewater entering the treatment plant for good treatment efficiency.Wastewater collection depended on the condition of the grids in the gutters and the pumps in the various lifting pits on the production sites. The above results reflect the multiple malfunctions observed during the month of June on the pumps submerged in the lifting pits. The same is true for the water flows, which correlate with the volumes of water entering the treatment station. These results are in agreement with the work of Alphenaar (1994) who showed that, the quantity of wastewater arriving in the WWTP depends on the upstream activities. The same author explains that the combination of a high inlet effluent flow rate and a short hydraulic residence time (35 h) was beneficial to the granulation process in UASB reactors. When the volume of wastewater entering the WWTP decreases, this directly implies a drop in flow. This observed decline could also be explained by the shutdown of the beer / BG production lines for several hours following various malfunctions.

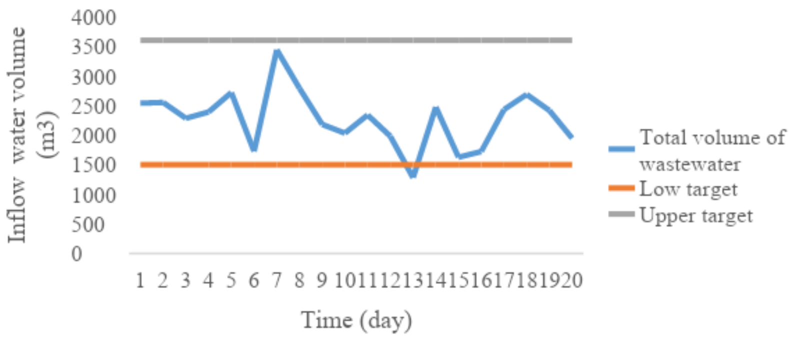

Fig. 5. Curve of variation of the volumes of wastewater entering the WWTP

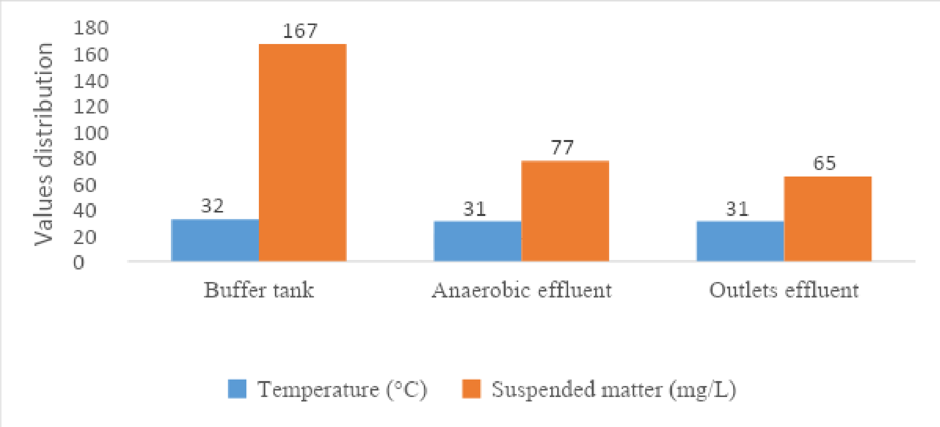

Fig. 6. Variation of physical parameters of wastewater in BT, EA and SS basins

3.8.2 Chemical quality of wastewater from the Yaoundé SABC

Evaluation of chemical present in the used water is presented in Fig. 7.

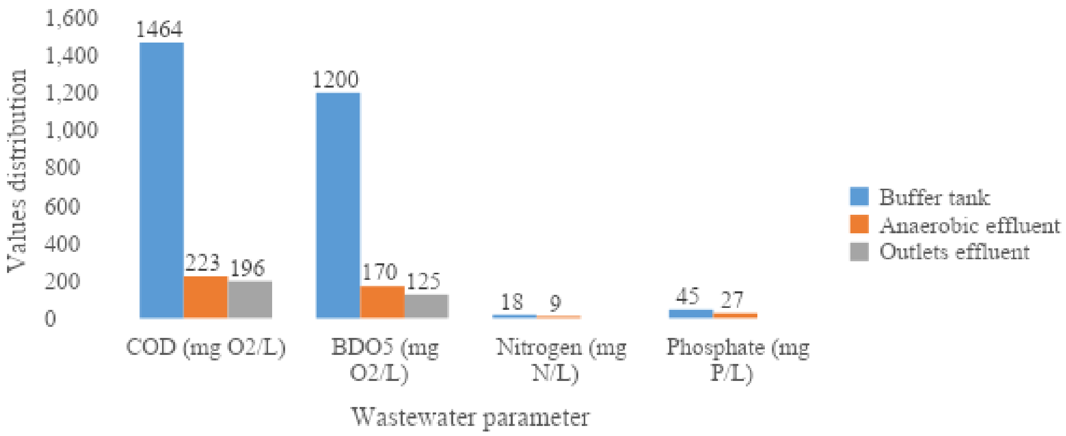

Fig. 7. Profiles illustrating the concentrations of COD, BOD_5, nitrogen and phosphate in wastewater in the different basins

The WWTP receives a load of 132 kg COD / day on average. This load undergoes a considerable reduction following the presence of microorganisms which degrade organic matter for their metabolism at a quantity of 18 kg COD / day at the WWTP outlet. That is to say an abatement percentage at the WWTP exit of 87%. Likewise, the quantity of BOD_5 recorded at the WWTP entry was 108 kg BOD/day on average and at the WWTP outlet 11 kg BOD/day. That is to say a percentage reduction in the BOD at the WWTP output of 90%.

3.8.3 Volatile fatty acids

The volatile fatty acids which were measured in two basins reveal an average value which decreases from the inlet to the outlet of the WWTP, and the results are combined in Fig. 8.

The low of 121 mg / L obtained in EA and the highest of 321 mg / L in Buffer Tank. The results are shown in Fig. 7. olatile fatty acids represent an important part of the substrates converted by methanogenic bacteria and also constitute a threat for the production of methane. The recorded values fluctuated between 121 and 321 mg / L following a change in pH output / input STEP characteristic of an optimal diet. These results are in agreement with those of Waterleau [1] who fixes the value of Volatile Fatty Acid lower than 150 mg / L. If the Volatile Fatty Acid concentration is greater than 250 mg / L, it is advisable to reduce the feed,

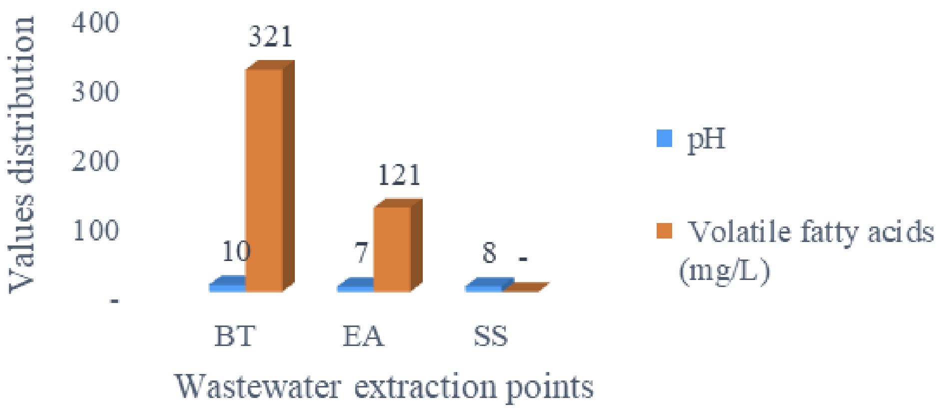

Fig. 8. Variation in the concentration of Volatile Fatty Acids and the pH of the different basins

and if it is greater than 500 mg / L, it is necessary to stop feeding the station. Because the risk is acidosis and could be caused by a substrate that is too abundant and too fermentable (high activity of hydrolysis and acidogenesis, therefore accumulation of Volatile Fatty Acid). In the same way, Zhang [5] shows that ,the regulation of effluents pH at the inlet of the anaerobic reactor makes it possible to promote the ionization of volatile fatty acids.

3.9 Quality of Anaerobic Sludge from the UASB Reactor

The quality of the anaerobic sludge from the UASB reactor provides information on the treatment efficiency of this type of treatment plant. In general, knowing the quality of the sludge from a biological treatment basin involves checking its typically brown color (neither gray or black), its shape (granular), its smell of aerated humus but also not septic not very concentrated in $NH_{4.}$ Two parameters were measured for the determination of the quality of the sludge from the UASB reactor, namely dry matter and ash residue.

3.9.1 Dry matter

The dry matter evaluated as a percentage made it possible to observe a fluctuation in values. The lowest value of 2.88% was recorded at the fourth weighing and the highest of 4% was observed from the start of the weighings in June (Fig. 9). This decreasing percentage would provide crucial information on the evaluation of the organic matter which decreases in the reactor during a specific time but also a good analysis on the settle ability of the sludge according to Choo-Kun [7]. The time required to analyze the sludge being short (results over 08 days), the kg COD removed / (kg DM x day) ratio made it possible to have a value of 0.51, characteristic of a liquid sludge of moderately good quality.

3.9.2 Ash residue

Two parameters were measured to determine the quality of the UASB reactor sludge, namely dry matter and ash residue. The results are shown in Fig. 10.

Te results shows that,the ash residues evaluated as a percentage made it possible to observe a fluctuation in values, the lowest value which of 3.30% was recorded at the fourth weighing and the highest of 7.20% was observed from the start of the weighings of the month of June.This result characterizes an average quality of sludge according to the Waterleau grid [1].

Results alos show here that, a sludge that settles well makes it possible to ensure good (fast and complete) separation between the sludge and the treated effluent. This average quality would be due to the exposure of the sludge to bad weather for long time. Finally, the classic methods of determining the physico-chemical parameters of the waste water and sludge of the Yaoundé SABC and the analysis of the results obtained made it possible to reach a conclusion and this indicates the satisfaction of the results and the achievement of the objectives [8-13].

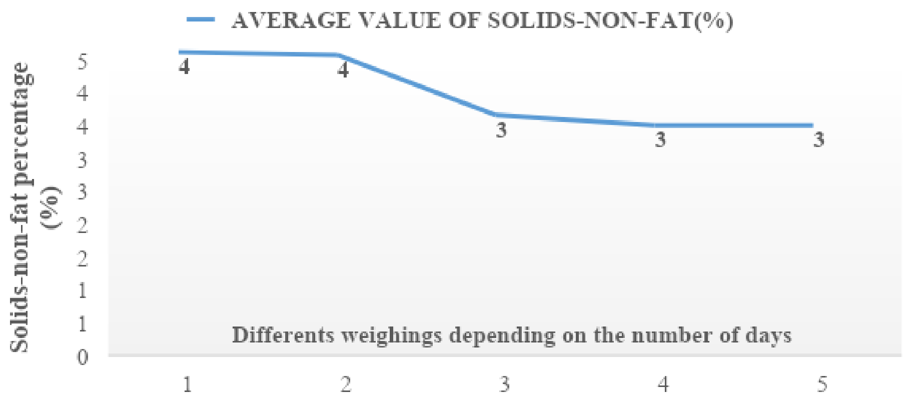

Fig. 9. Percentage of dry matter of analyzed sludge

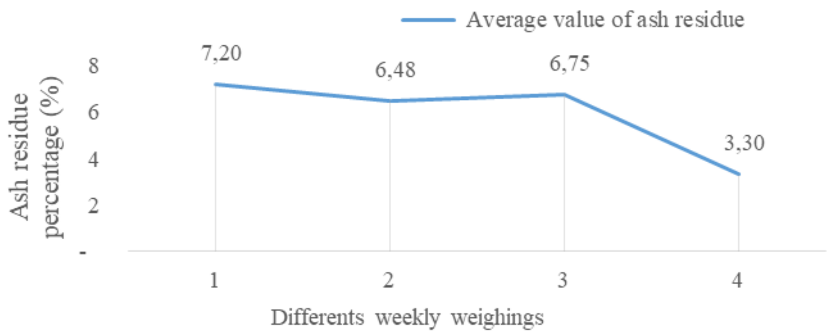

Fig. 10. Percentage of ash residues of analyzed sludge

4. CONCLUSION

The treatment of wastewater before it is discharged into the wild is a major challenge for many countries around the world. The SABC Yaoundé plant manages to remedy this situation by rehabilitating its wastewater treatment plant. This study focused on the evaluation of chemical contaminants likely to influence the proper functioning of this WWTP in order to optimize the start-up has made it possible to acquire a number of results. The assessment of chemical contaminants determined the presence of 30% water disinfection products and 15% cleaning products, in addition to other products. In addition, since these contaminants are mostly soluble in water, this character gives them great mobility and therefore the speed of reaching the WWTP and therefore the generation of nuisances. Then, the classification made according to the potential prioritization of the danger revealed health impacts that could occur on microorganisms. The results of the physico-chemistry showed that the wastewater of the SABC of Yaoundé has an average temperature and pH that vary according to the reactions that take place in the medium oscillating respectively between 31°C and 7.95. These waters are subject to highly biodegradable organic pollution (COD/BOD_5 < 1.5) and alkaline. ake steps to avoid spills upstream that could be harmful to the station by raising awareness among the various operators of good environmental practices, and of the impact of chemical contaminants on the physico-chemical parameters and therefore on the microorganisms of the station.

However, to maintain effective treatment, the following recommendations for the management of the treatment plant need to be put into practice by the leading operators:

- Carry out physico-chemical analyzes of wastewater (affluent and effluent) and sludge analyzes every day for the need for good management of the WWTP;
- Constantly clean the lifting pits in order to have an effective collection of wastewater at the station level or, if necessary, install desanding/oil removal units at the entrance

to each pit in order to retain sandy materials and grease;

- Ensure the reliability of the measuring equipment (device, pH probe, temperature, etc.) of the WWTP, which involves calibrating them every month in order to have reliable results for controlling the STEP.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Waterleau. Herent, Belgium; Global water technology nv-Radioweg 18-3020; 2011. Available:http://www.waterleau.com. STEP Brewery document for internal use.
2. Dahou A et brek A. Aerated lagoon in arid zone purification performance cases of (Ouargla Region) [Master's thesis]. Department of Science and Technology, Ouargla University. 2013;33.
3. Zeghoud M. Study of urban wastewater treatment system by natural lagooning of meghibra village [Master's thesis], Department of Science and Technology. University D'EL–OUED. 2014; 20.
4. Chebli D. Industrial wastewater treatment: degradation of azo dyes by an integrated process combining an advanced oxidation process and biological treatment. THESE PHD. Interface Sci. 2012;62-65.
5. Zhang JB. Anaerobic sludge treatment process and biogas recovery [PhD thesis]. In: Process and Product Engineering, national advanced school of chemistry industry Lorraine. 2011;35-42.
6. Driessen W, Yspeert P. Anaerobic treatment of low medium and high strength effluent in the agro industry. Water Sci Technol. 1999;40(8):221-8.
7. Choo-Kun M. Integration of sludge methanization into an alternative wastewater treatment system based on the A/B process: towards the positive energy treatment plant. Environmental Engineering. [INSA de Lyon]. 2015;26.
8. Agropolis. Chemical or microbial contaminants in food. Health Report Futura-Sciences. 2015;2.
9. Ahn YH. Physicochemical and microbial aspects of anaerobic granular pellets. J Environ Sci Health. 2000;9:1617-35.
10. Belbachir S, Habbeddine S. Study of a wastewater treatment system in the localities of Nedroma and Ghazaouet [Master's thesis]. In: Hydraulics. University Aboubakr Belkaïd– Tlemcen – faculty of technology; 2017.
11. Bouyzrou A, Gorch FE. Study of the performance of the desulfurization unit of the wastewater treatment plant of Marrakech. Bachelor of science and technology. Department of Earth Sciences, Faculty of Science and Technology of Marrakech. 2018;27-29.
12. Chou HH, Huang JS, Hong WF. Temperature dependency of granule characteristics and kinetic behavior in UASB reactors. J Chem Technol Biotechnol. 2004;79(8):797-808.
13. Vincent R, Bonthoux F, Lamoise C. Chemical risk assessment, prioritization of potential risks. Paris, ND: INRS. 2000;2121.

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