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Study of the Operation of an Industrial Water Treatment Plant of the Northern Soft Drink Company Fez, Morocco

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ABSTRACT

In order to verify the operation of the NSDC company's industrial water treatment plant and to optimize the quality of the liquid discharges by coagulation and flocculation, we carried out the physico-chemical characterization of these liquid discharges and optimized the elimination of the organic matter. The results show that the abatement rate of the parameters SM, COD and BOD_5 of the step are respectively 67%, 66% and 89% during November 79% 81% 89% during December and 69% 82% 89% during January. The treated wastewater showed that the WWTP is working properly, but in the coagulation flocculation treatment step instead of using a large amount of Dekfloc alone. We tried to optimize the dose of a plant powder as bio flocculant injected with Dekfloc as coagulant, which will increase the removal rate of organic matter. The tests of coagulation flocculation show that the application of the combination between Dekfloc and the powder of the cactus allows to increase the rate of abatement of COD to 54%, of BOD_5 to 67%, of TSS to 80%, and therefore the reduction of microorganisms.

Keywords: industrial water, NSDC, Dekfloc, cactus powder, coagulation flocculation.

INTRODUCTION

In Morocco, the issue of environmental protection has become a major priority in all development strategies drawn up in both the private and public sectors. Among the anteriorities is the preservation of water resources [Chaouki, 2013]. Water is an essential engine for life, necessary for all human activities (agricultural, industrial...), it is becoming the scarcest and most valuable resource on Earth given the increasing demand to meet the needs of population growth, urbanization and industrialization [El Ghammat & Temsamani, 2017] Environmental awareness and compliance with legislation have led NSDC to work with respect for its surroundings. Within this context, it has launched a project to build a wastewater treatment plant to treat its wastewater before it is discharged into the sewerage system of the city of Fez. The ultimate objective of this Step, which receives a daily hydraulic flow of 240 m^3/d [Khammar, 2013], is to produce a purified water of good quality to be used for irrigation and for reuse. The aim of this study is to study the efficiency of the NSDC WWTP and to improve the pollution removal rate by optimizing the coagulation flocculation.

MATERIALS AND METHODS

General presentation of the step

The wastewater collected from the NSDC undergoes: A pre-treatment by screening to eliminate

bulky waste, followed by a sieving which allows to retain bodies of dimension superior to 1mm which harm the functioning of the installations.

The water is then directed to the homogenization basin, which is equipped with several air diffusers to avoid decantation. The water is then transferred to the distribution chamber where the pH is adjusted to between 7 and 8 (with sulfuric acid) and the nutrients necessary for the development of bacteria are injected. These bacteria perform their role of degradation of pollutants in the biological reactors. The effluent is then sent to the flocculation tank where a flocculant is injected to agglomerate the particles into flocs, which will facilitate the separation of the purified water in the flotation tank (clarifier). Finally, the purified water is directed to the disinfection basin to eliminate pathogenic germs with bleach, and then discharged into the natural environment. The resulting sludge is either stored in a sludge tank for dewatering treatment or recirculated to the bireractor to maintain the purifying biomass (Figure 1).

Sampling technique

Sampling is carried out during 3 months (November, December and January), at the level of the compartment of the treatment plant:

- the entrance of the basin;
- before the flocculation basin;
- the exit of the basin.

Materials used

- pH-meter type HANNA instruments.
- Jar-test system type VELP SCIENTIFICA (JLT6),
- UV-Visible spectrophotometer, type Hach lange DR 3900,
- Software graphpad prism 2007.

Flocculant used

Materials used were Dekfloc RI-705 and Cactus powder (*opuntia ficus indica*).

Analysis methods used

The different physico-chemical parameters were analyzed according to standard methods [AFNOR, 1999] (Table 1).

RESULTS AND DISCUSSION

Physicochemical characteristics of wastewater received by the treatment plant

The results of the physico-chemical analyses of the raw wastewater received at the inlet

Table 1. Methods of analysis used

Studied parameters	Methods
pH	pH meter
Temperature	Thermometer
SM	Filtration method with suction pump
COD	Spectrometric method with the Hach lange DR 3900 spectrometer
BOD_5	Respirometric method

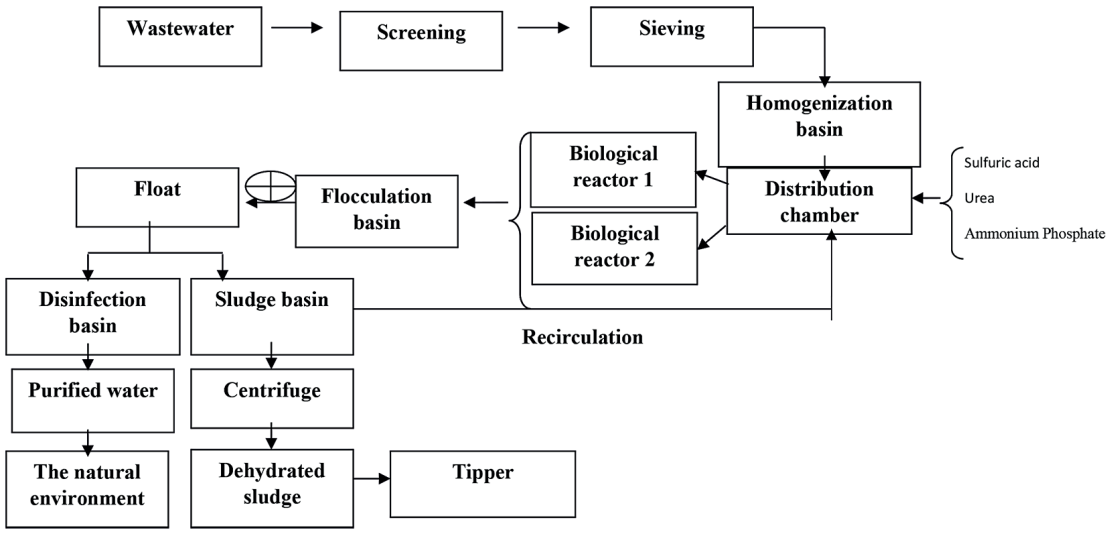

Figure 1. General diagram of the NSDC wastewater treatment plant

of the CBGN WWTP and at the outlet, determined from the samples taken in November, December 2019 and January 2020, are shown in Table 2. The pH values of the wastewater at the inlet are between 11.40 and 11.96, which could be due to the injection of soda during the washing of the bottles (Fig. 2). These values recorded undergo a decrease at the exit of the station between 7.76 and 8.37 (reference term of the technical study). These results corroborate that of Khamar [2013], which showed the reduction of pH after treatment.

Temperature evolution

The temperature values of the wastewater recorded, are lower than 30 °C considered as the limit value of direct discharge into the receiving environment (Fig. 3) [Ministry of the Environment of Morocco, 2002].

Evolution of the SM

The SM content at the entrance of the plant varies between a value of 404 December and 159 mg/L in January (Table 2). These contents undergo a decrease at the exit of the plant and pass towards 82 mg/L in December and 48.2 mg/L in January meeting the Moroccan discharge standards.

COD evolution

The COD content recorded at the Step inlet is between 1673 and 2015 mg/L (Table 2). These contents are strongly reduced during treatment: 316 mg/L and 564 mg/L at the step outlet.

Table 2. Physico-chemical parameters analyzed in the raw wastewater received by the WWTP of the company CBGN (the inlet of the step)

Parameters	November values	December values	January values
pH	11.54	11.96	11.40
Temperature (°C)	20.5	19.8	16.3
SM (mg/L)	229	404	159
COD (mg/L)	1673	2015	1799
BOD_5 (mg/L)	502	510	599

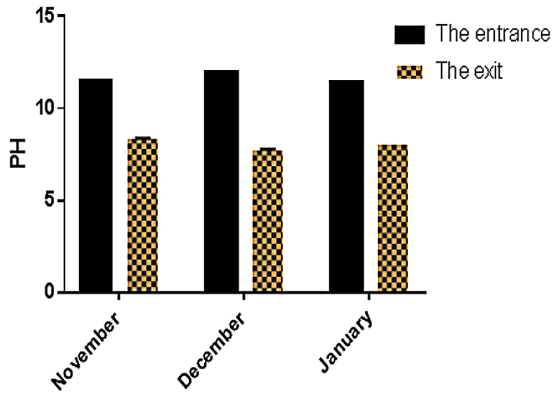

Figure 2. The evolution of the pH before and after treatment

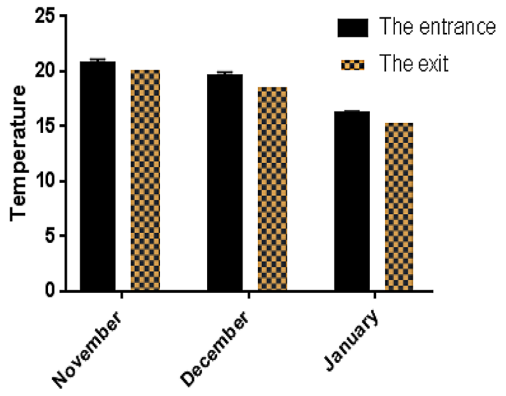

Figure 3. The evolution of the temperature before and after the treatment

Table 3. Physico-chemical parameters analyzed (step outlet)

Parameters	November values	December values	Values January
pH	8.37	7.76	8.03
Temperature (°C)	20.4	19	15.8
SM (mg/L)	75	82	48.2
COD (mg/L)	564	368	316.4
BOD_5 (mg/L)	52.5	52	62.3

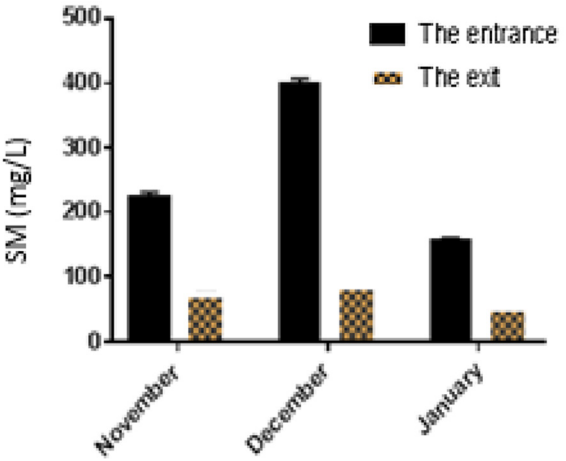

Figure 4. The evolution of the SM before and after treatment

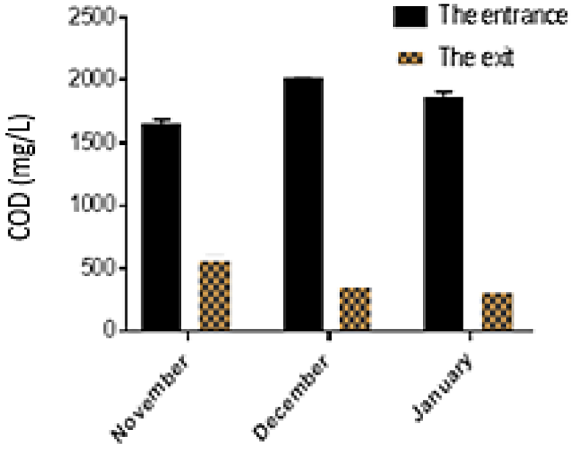

Figure 5. The evolution of COD before and after treatment

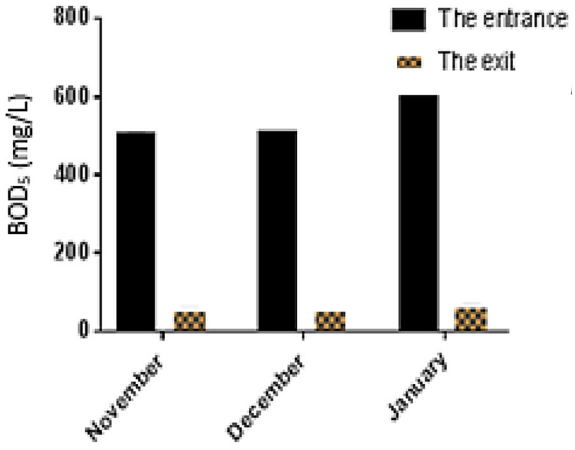

Figure 6. The evolution of BOD_5 before and after treatment

Evolution of BOD_5

The degree of pollution and the richness of the water in biodegradable organic matter is evaluated by the biochemical oxygen demand [Djermakoye, 2005]. It should be noted that the water at the plant inlet has a BOD_5 value that varies between 502 and 599 mg/L. The latter exceeds the discharge standards for treated wastewater (500 mg/L) [Chaouki, 2013]. In addition, the treated water has a BOD_5 value in the range (52–62 mg/L) (Table 3). The efficiency of the treatment was assessed visually and analytically by monitoring the removal rate of TSS, COD and BOD_5 (Figs. 4–6). The calculation of the removal rate of a parameter

Table 4. Variation in abatement rates

Parameters	Abatement rate (November)	Abatement rate (December)	Abatement rate (January)
SM	67%	79%	69%
COD	66%	81%	82%
BOD_5	89%	89%	89%

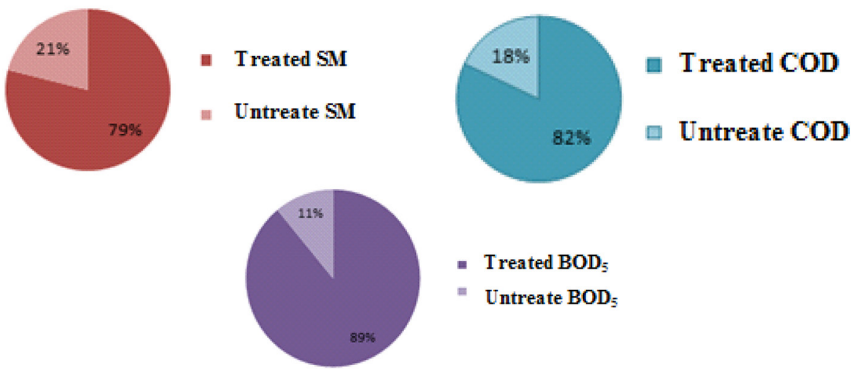

Figure 7. Parameter abatement rate after treatment

Table 5. Characterization of raw effluent

The sample	Measured parameters		
	SM	COD	BOD_5
1	240 mg/L	1472 mg/L	535 mg/L

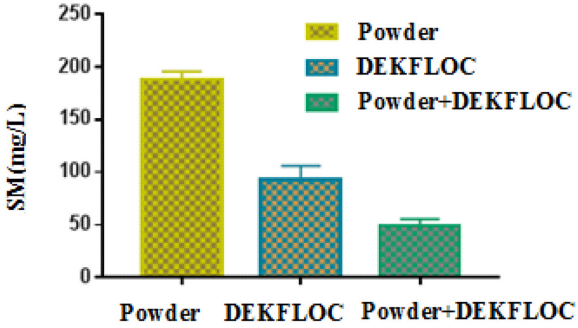

Figure 8. The effect of different flocculants on the SM

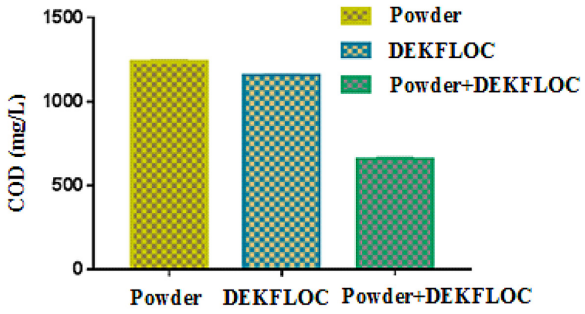

Figure 9. The effect of different flocculants on the COD

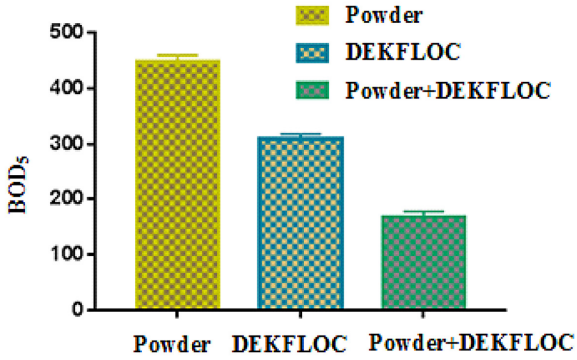

Figure 10. The effect of different flocculants on the BOD_5

Table 6. Effect of industrial and natural flocculants

Flocculants used (g/L)	Measured parameters			Abatement rate		
	SM	COD	BOD_5	SM	COD	BOD_5
Dekfloc (2 g/L)	82	1148	298	65%	AR=22%	AR=44%
Cactus powder (5 g/L)	179	1226	434	AR=25%	AR=16%	AR=18%
Dekfloc (2 g/L) + Cactus powder (5 g/L)	42	652	158	AR=82%	AR=55%	AR=70%

X, expressed as a percentage, is based on the following formula:

- *Ci* – initial concentration of X in the water without treatment;
- *Cf* – final concentration of X in treated water.

The purification yields of COD and BOD_5 are more or less satisfactory with rates of 89% for BOD_5 and 82% for COD (Table 4). These values are almost 90% which is a value that characterizes an efficient purification according to Rejsek [2002].

Improvement of the treatment by coagulation and flocculation

The table represents the effect of treatment with different flocculants, repeated 4 times on samples taken before the flocculation basin. According to the results grouped in Table 6 and Figure 8, 9 and 10, in the case of using cactus powder and Dekfloc we observe a very interesting reduction of SM, COD and BOD_5 and subsequently a better abatement of the parameters compared to the treatment by Dekfloc alone. The

use of the powder has shown a great power of elimination as they had shown [Sakr et al. 2015, Bilbahloul et al. 2014, Benalia et al. 2017, Abid 2009, Abid et al. 2009]. In case of using Dekfloc alone, we will have a risk of contamination of the sludge with compounds containing ammonium sulfate that could cause serious consequences on the environment. On the other hand, in the case of using the powder and Dekfloc; we will interfere with a sludge consisting simply of biodegradable organic matter.

CONCLUSIONS

The effluents of the NSDC company present values of the parameters SM, COD and BOD_5 that relatively exceed the general limit values of direct and indirect discharges, which generate an environmental imbalance, hence the need to treat these effluents. The objective of this study was to evaluate the efficiency of the CBGN company's wastewater treatment plant and to evaluate the efficiency of using a biomaterial (cactus cladode), which is available, biodegradable and less expensive for the treatment of these industrial discharges.

The obtained results allow to conclude that the physico-chemical analyses of the treated water are in conformity with the standards of rejection in the natural environments. The WWTP allows to reduce more than 67% of SM, 66% of COD and 89% of BOD_5 in November. 79% of TSS 81% of COD and 89% of BOD_5 in December and 69% of SM 82% of COD 89% of BOD_5. It would be interesting to make an optimization of the injected flocculant dose to further improve the treatment. The combination between the cactus powder and Dekfloc presents a very good alternative to improve the treatment of industrial liquid discharges in order to reduce the concentration of dekfloc used per month by 50 kg in half and thus reduce the risk on the environment. In addition, it would be interesting to optimize the dose of coagulant injected to further improve the treatment.

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