Characterization of the residual sludge from the wastewater treatment plant of JERADA.

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ABSTRACT :

The wastewater treatment plant of the city of JERADA is an aerated lagoon type, it is located in the west of the city of JERADA, It was put into service in 2016 and it is part of the national Moroccan liquid sanitation program, which requires an increasing of the rate of wastewater treatment. Indeed, said STEP generates on the one hand a clean sanitized water with an average flow of 2500 m³/d, which is discharged into the receiving environment without any environmental damage, and on the other hand a huge quantities of residual sludge 1740.24 kg/d.

The most suitable technique for the management of sewage sludge of the JERADA STATION is their valorization in agriculture after their composting. Such a process requires beforehand a physico-chemical and biological characterization of the station residual sludge.

1. INTRODUCTION

The strengthening of Moroccan infrastructure is accompanied by the establishment of several treatment plants, which produce on the one hand treated, clean, healthy water ready to be discharged into the receiving environment or to be reused, but on the other hand large quantities of sludge, considered as waste.

Environmental and sanitation managers have not yet incorporated the sludge into their programs or management plans. Whereas the production of sludge without treatment on its final destination is a direct nuisance to human health and the environment. The sludge generated must be well quantified and characterized.

The water consumed or used by humans on a domestic or industrial scale inevitably generates waste, this wastewater is

collected by the sewers and directed to the treatment plants in order to be treated before their reintroduction into the natural environment. Their treatment in STATION makes it possible to separate purified water from a secondary residue, sludge, which has the characteristics of an organic amendment well provided with organic matter, nitrogen, phosphorus as well as with trace element.

The wastewater treatment plant of JERADA with the aerated lagoon type is located in the west of the city, It was put into service in 2016. The STEP generates clean sanitized water with an average flow rate of 2500 m³/d which is discharged into the receiving environment without any environmental damage, and on the other hand a considerable quantity of residual sludge. [13]

The sludge from municipal or industrial waters is subject to evacuation or recycling constraints, obliging to set up volume reduction treatments or either odor and microbiological nuisances reduction. The sludge is first characterized according to the origin or its physicochemical properties.

The main objective of our work is to first proceed with a typology based on the physico-chemical and biological characterization of the residual sludge. Then make a comparison with the other sludges of the other STATIONS in order to make a link between the types of treatment and the typology of the sludges, by

following these characteristics we can consider the most effective treatment and recovery process for these sludges.

2. MATERIALS AND METHODS

2.1. Study site

○ Administrative framework:

The town of Jerada is located 60 km southwest of Oujda. It belongs to the province of Jerada which is administratively belongs to the eastern, the region contain a prefecture (Oujda-Angad) and six other provinces (Taourit, Nador, Driouch, Jerada, Figuig and Berkane).

Figure 1 : Geographic location of the city of Jerada

○ Study site

The urban municipality of Jerada is spread over an area of 18.34 km². It the north and the high plateaus in the south, the town of Jerada is strewn over altitudes varying between 1000 and 1400 m. [3]

suffers from unfavorable physical and natural conditions, it is wedged between the Horsts massifs in

From a climatology point of view, the city of Jerada is characterized by an arid to semi-arid climate, it is subjected to all climatic events that characterize the mountains and high plateaus where

the thermal amplitude is very marked, with very cold winters and scorching summers. Often these high plateaus are swept by strong winds of chergui, and light precipitation varying from one year to another between 80 and 150 mm; [3]

The city of Jerada is a creation of the Jerada coal mining company (Société chérifienne des charbonnages de Jerada). Indeed, from the beginning of the exploitation of coal deposits in 1932, the number of workers and managers was 490, after that, the population knew a linear increase, this increase is mainly due to the positive migratory balance, which experienced the city of Jerada since the start of coal mining, this linear evolution will last until 1994. [3]

However, the rate of population growth, which was higher than the national rate (59,367 inhabitants in 1994) has experienced a considerable decline caused by the closure of the Jerada mines. The main cause which was behind the settlement of the city, becomes a source of its depopulation (43,506 inhabitants in 20014). The city's estimated population for the current year of 2019 is 43,599. [3]

The city of Jerada is supplied with drinking water from 4 boreholes with

an overall flow rate of 240 l/s, the number of drinking water subscribers in the city is 11,533 in 2019 while the number of sanitation subscribers in the end of 2019 is set at 11,288 subscribers.

The production of electrical energy is ensured by the Jerada Thermal Power Plant in 1972. l'O.N.E.E. (National Office of Drinking Water and Electricity) -Electricity branch ensures the supply to the centers of the province in electricity. The amount of electrical energy produced by the thermal power plant reached 1,143,097,000 kW. [18]

2.2. General information on JERADA Wastewater Treatment Plant

The wastewater treatment plant of Jerada is an aerated lagoon type, which was executed as part of the national liquid sanitation program. It was put into service on April 21, 2016, this station occupies a total area of ten hectares and is located 3km southwest of the city on the right bank of Oued Agaya. [13]

The said station was dimensioned at the base of a saturation horizon of 2025 and a nominal start of 2500 m³/d. [13]

It is capable of treating a polluting load of the order of 1260 kgBOD₅/d and it supports discharges of 51250 E.H. [13]

Figure 3. The wastewater treatment plant in the city of Jerada, aerated lagoon

2.3. Sampling

In order to characterize the waste sludge of the Jerada STATION from a physico-chemical point of view, we have:

- Collected the sludge from the wastewater treatment plant. Each composite sample is made from different samples taken from the different depths of the three anaerobic basins that are mixed, and a representative sample of 5kg is taken.
- Kept the sludge samples in accordance with the general guide for the conservation and treatment of samples.

2.4. Characterization physico-chemical and bacteriological of the sludge:

The physico-chemical and bacteriological analyzes of the sludge in this study were carried out at the laboratory:

- Laboratories of the Higher School of Technology in Sale;
- Chemistry laboratory within the Agronomic and Veterinary Institute-Rabat;

First the pH and the temperature were determined by a pH meter, provided with a probe measuring the temperature, The electrical conductivity was measured by a conductimeter (WTW LF90), for the dry residue, a certain amount of the sludge is evaporated in a crucible, the residue is dried at 105 °C and then weighed while, and the calcined residue (mineral matter) is determined after calcination at 525 °C of the dry residue obtained, and the organic matter is calculated by the difference of the two residues (dry and calcined). [14]

Organic carbon is determined by the Anne method [24]. Finally, the nutrients (potassium, nitrogen, and phosphorus)

were determined at the Agronomic and Veterinary Institute-Rabat.

Then, the indicators of faecal pollution, the methods are based on positive or negative tubes, results in a statistical estimate of the most likely number (MPN) of germs present in a given volume of the sample of two indicators:

- Total and faecal coliforms: inoculation of a quantity of sample in a test tube containing the lactose broth with purple Bromocresol + durham bell jar, the positive tubes are determined after incubation then the confirmation of the results is done by the inoculation from the positive tube into a tube containing BLBVB medium.
- Total and faecal streptococci: Inoculation of a quantity of sample in a test tube containing Rothe medium, the positive tubes are determined after incubation then the confirmation of the results is done by inoculation from the positive tube in a tube containing the Litsky medium.

3. RESULTS AND DISCUSSIONS

The pH of waste sludge is close to neutral, it is 7.56 which is similar to the value found in the Baraki region of Algeria [2].

By comparing the pH value, the dryness and the conductivity of the waste sludge of Jerada with the values of other works we notice that the sludge from the city of Jerada has larger values (pH = 7.56, conductivity = 1691 ms / cm and dryness = 23.58) compared to sludge from other regions, namely: Marrakech, Nador, Setif, and Oran in Algeria, Quebec in Canada [15,19,20,21,22].

The results of analysis of the sludge from the Jerada station, showed that this sludge

is very rich in organic carbon (CO = 46%), so that this concentration remains higher than that found in the sludge of the regions: Achares in France; Marrakech and Nador in Morocco; Setif, Oran and Baraki in Algeria[2,11, 19,15,22].

The Dry Residue of the sludge is 44.9%, it is close to the value found in the sludge of the Baraki region in Algeria (Dry Residue = 48.51%) [2].

To value this residual sludge in agriculture, we consider it as agricultural fertilizer because it contains the nutrients necessary for the growth of a plant (N, P, K); the sludge analyzes's results of the nutrients showed that these elements are very present in the mud (K = 1.04%, P = 6.8% and NH = 212.8%, NO = 14.62%) by comparing with the sludge results from the Setif region to Algeria [15] (K = 1.7%, P = 0.9% and NH = 0.26%, NO = 0.14%). This promotes their reuse in agriculture.

For the sludge organic matter content from the Jerada station, we note that this sludge is less rich in OM (23.73%), this percentage remains lower than the values found in the sludge from different regions (Marrakech and Nador in Morocco, Setif and Oran in Algeria, Quebec in Canada [15,19,20,21, 22]).

The FC concentration in the sludge is 72.104CF / 100ml, while The FS concentration in the sludge is 24.104SF / 100ml, and the FC / FS ratio tells us that the pollution origin is of human origin as well the results can be explained by the multiplication of bacteria during the biological treatment of raw wastewater, which shows more that the origin of the pollution is purely of human origin.

with:

FC: fecal coliforms;

SF: faecal streptococcus;

Table 1 : Comparison of the physico-chemical analyzes results of residual sludge

regions Parameters	Results of our study	Parent, 1976	setif, Algeria (R. salahdine, 2005)	Baraki, oued el hanch, Algeria (B,Drirdi and C,Toumi 1998)	Achéres, France (M,Robert et al. 1994)	Marrakech, Morocco (Soumia Amir, 2005)	Quebec, Canada (V. Perron and M. Hébert 2007)	Oran, Algeria (Ramdani Nadia 2007)	Nador, Morocco (M,Sbaa and Z,Zerrouqi 2007)
pH	7,56	5,85	6,88	7,56	-	7,4	7,1	6,89	6,92
Conductivité (ms/cm)	1691	-	-	-	-	2,1		2,7	4,55
Siccité(%)	23,58	4,5	-	-	-	-	5	-	
Carbone organique(%)	46	38,8	31,5	16,07	-	18,1		40,05	14
Matière organique(%)	23,73	57,2	63		-	31,3	42	80,1	24,05
Matière Minérale (%)	21,17	-	-	-	-	-	-	-	-
Résidu sec (%)	44,9	-	-	48,51	-	-	-	-	-
Potassium (%)	1,04	-	1,7	-	0,18-0,5	5,4	0,2	0,43	-
Phosphore (%)	6,819	5,8	0,9	2,2	3,7-6,7	2,6	4,5	0,9	-
NH (ppm)	212,8	-	0,26	-	-	-	-	-	-
NO (ppm)	14,62	-	0,14	-	-	-	-	0,2	-
T°C	17	-	-	-	-	-	-	-	-

CONCLUSIONS

in order to promote waste sludge valorization from Jerada without any danger to human health and the environment, we must start with the characterization and the choice of a treatment process if necessary.

The physico-chemical characterization (dryness, conductivity, organic carbon and pH) of Jerada's residual sludge revealed the highest concentration of all the parameters analyzed compared to the other residual sludges studied, either Moroccan or foreign, in the except for the organic matter content which remains quite low compared to other sludges.

Likewise, this residual sludge from the Jerada wastewater station shows its richness in nutrients (N, P and K) capable to be valued in agriculture. If the standards of the contents of all the elements necessary for the survival of a plant are met, the use of this sludge as a fertilizer may be authorized. The bacteriological analyzes of waste sludge from Jerada have shown that their concentrations of FC des and FS are of the order of the values found in wastewater. As well as, the valorization of domestic waste sludge whose the quantity shows an increase, remains an ultimate solution in order to reduce the quantity of this sludge and preserve the environment.

However, to be able to definitively decide the answer on the effect of domestic sludge on the plant-soil system question, it is necessary to ensure a culture follow-up with different concentrations of residual sludge which has not undergone any prior treatment in order to generalize the agricultural valorization of sludge for all types of residual sludge.

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