Treatment of Leachate by Sorption in Continuous Mode Using Low Cost Material

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***Abstract*—** The aim of this experimental study is to test a natural sorbent obtained from cereals by-products as decontaminant of leachate from a landfill site (CET) existing in Constantine, Algeria. The lagoon is the treatment currently in action at the CET by three lagoons placed successively. Based on experimental results and after a physicochemical characterization, the lagoons are effective in reducing the minerals compounds but not sufficiently organic compounds. The adsorption treatment in continuous mode using the cereal by products calcined at 600°C, and carried out on laboratory montage for a period of 24 hours, shows good retention of pollution. However, we have an important reduction of odor, color, turbidity :from 100 to 28 NTU (92%), nitrites : from 1.29 to 0.05 mg/l (96%), nitrates : from 35.52 to12.93 mg/l (64%), DCO from 3480 to 3651mg/l (4.6%), DBO5 : from 450 to 12 mg/l (97.33%), phenol : from 150.92 to 11.71 mg/l (92%) and the microbial load (GFC) from 300 to 50 GFC (83.33%).

The leachate treated by continuous adsorption with cereal by-products as adsorbent gives water which may be used for irrigation

***Keywords*—** Leachate, adsorption, natural adsorbent, DBO, DCO, Treatment.

I. Introduction

IN this work we tried to treat leachate from the CL (Central landfill) EL HARYA in Constantine, to reduce pollution by making it acceptable to the receiver settings. For this we test the cereal by-products calcined at 800 ° C, as sorbent which is an abandant material in Algeria. The support was explored in three modes: fixed bed, continuous and Bach. The three models are tested at the laboratory scale by considering the phenol as a model pollutant. Continuous mode gives the better efficiency of elimination.

The parameters considered for characterization of leachate in this study are:.

1. Conductivity
2. Turbidity
3. pH
4. Chemical oxygen demand COD
5. Biological oxygen demand BOD
6. Nitric concentration
7. Nitrate concentration
8. Phenol concentration

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Biological characterization by establishing a balance of the microbial load of the three lagoons, we are interested specifically in Total Aerobic Mesophilic Flora (FTAM), because the temperature of the three basins promotes mesophilic microbial life.

II. Material And Method

For continuous mode we tried to make a montage of continuous filtration on a fixed bed, for this we have followed the steps below:

- Claim 5 g of adsorbent as a fixed bed in a cartridge;
- Add 1 liter of phenol at 50mg /L ;
- Implement the solution circulating in a closed after attachment of the support in the form of a fixed bed by varying traffic flow loop.
- Analyze the filtrate spectrophotometer type schimadzu DR 2000

Fig.1 mounting of adsorption in continuous mode

1. Back transit:

Here we did replace a light bulb to count with a capacity of one liter. This volume will be borne by the pollutant to be treated.

2. Adsorbent cartridge:

It is the seat of the adsorbent. It is to be stabilized as a fixed bed. For this we used a cartridge that is usually used in domestic water system to reduce lime scale in the pipes. The latter is emptied of its contents and has disposed therein a membrane that prevents the escape of adsorbent in the circuit, under the effect of the current.

http://dx.doi.org/10.15242/IICBE.C0615007

Fig.2: filter compartment

A. Organoleptic parameters

1. Aspect

After treatment with continuous mode, we collected leachate solutions of three lagoons and we compared it to those before.

Before After

Fig.3: Aspect of the lagoon 1 before and after treatment

Before After

Fig.4: Aspect of the lagoon 2 before and after treatment

Before After

Fig.5: Aspect of the lagoon 3 before and after treatment

We had a big difference between our color samples before and after treatment and this clearly appear in the preceding figures. In addition we also note that pond treatment decreased the intensity of the color. But the treatment by continuous adsorption on our support prepared in the laboratory makes almost clear leachate solution.

2. Smell

Lagoon 1: The smell of the sample after treatment is much lower than in the raw sample.

Lagoon 2: The smell has almost disappeared from the sample of the second lagoon after treatment.

Lagoon 3: The smell after treatment has completely disappeared.

B. The physico-chemical parameters:

After adsorption treatment in continuous mode we collected the filtrate and we carried out the following measures:

1. Conductivity

TABLE I
RESULTS OF CONDUCTIVITY AFTER TREATMENT IN CONTINUOUS MODE

Lagoon / parameter	Conductivity (ms/cm^3)		rate of change
Lagoon 01	before	11.10	**59.49 %**
	after	4.5	
Lagoon 02	before	4.94	**56.47 %**
	after	2.15	
Lagoon03	before	0.12	**33.33 %**
	after	0.08	

Based on the results extras above table, we see a large decrease in conductivity for three lagoons. The rate of change exceeds half for the first two lagoons and it is just pre-third for the third. These values confirm that the adsorption capacity increases with the initial solute concentration. What we can say here is that the mobility of chemical ions decreased significantly after adsorption continuous process. This reflects the disappearance of a large number of chemical elements in the form of ions.

2. Turbidity

TABLE II
RESULTS OF TURBIDITY

Lagoon / parameter	Turbidity (NTU)		rate of change
Lagoon 01	before	100	**20 %**
	after	80	
Lagoon 02	before	60	**33%**
	after	40	
Lagoon 03	before	38	**26%**
	after	28	

Turbidity is the result of the presence of suspended solids. From the table we notice that our material is an effective filter for suspended material. It is seen that the yield reaches 25% for the three lagoons.

3. pH

TABLE III
RESULTS OF PH AFTER TREATMENT IN CONTINUOUS MODE

Lagoon / parameter	pH		rate of change
Lagoon 01	before	5.84	**34.24 %**
	after	7.84	
Lagoon 02	before	6.39	**30.24 %**
	after	8.37	
Lagoon 03	before	6.54	**11.31 %**
	after	7.28	

4. Chemical oxygen demand DCO

The results of oxygen demand show no significant change after adsorption treatment.

The same observation is noted in the case of the characterization of raw leachate in the three lagoons, where the value of COD was almost identical in the three basins.

TABLE IV
DCO VALUES AFTER TREATMENT IN CONTINUOUS

Lagoon / parameter	Chemical oxygen demand (mg/L)		rate of change
Lagoon 01	before	3480	**5%**
	after	3500	
Lagoon 02	before	2545	**28%**
	after	3261	
Lagoon 03	before	3524	**3.6%**
	after	3651	

5. Biological oxygen demand DBO5

TABLE V
DBO5 RESULTS AFTER TREATMENT IN CONTINUOUS MODE

Lagoon / parameter	Biochemical oxygen demand (mg/L)		Rate of change
Lagoon 01	before	450	**98%**
	after	6	
Lagoon 02	before	2450	**99%**
	after	13	
Lagoon 03	before	950	**98%**
	after	12	

The results presented in the table above show remarkable reduction in the biochemical oxygen demand. This indicates a more than important removal of biodegradable organic matter. We can say that this natural support has a significant effectiveness vis-à-vis the organic matter. What we can say here that lecheate after treatment in continuous mode has a value of BOD_5 varies between 6 and 19 mg / L. it meets the discharge standards required 70mg / l (for a station effective treatment BOD_5 value is between 20 and 40mg / l). So the leachate can be discharged into the natural environment without any constraint.

6. Concentration of nitrite and nitrate

From the two tables 6 and 7, we see that the rate of nitrite and nitrate has decreased after treatment by adsorption. But nitrites are better than eliminate nitrates. One notices a yield of 87.5% for nitrite but only a yield of 44.19% for the nitrates in the same lagoon, which is the third. This natural adsorbent is selective.

TABLE VI
VALUES OF NITRITE CONCENTRATIONS

Lagoon / parameter	Concentration en nitrite (mg/L)		Rate of change
Lagoon 01	before	1.29	**77.51 %**
	after	0.29	
Lagoon 02	before	0.55	**70.90 %**
	after	0.16	
Lagoon 03	before	0.4	**87.5 %**
	after	0.05	

TABLE VII
VALUES OF NITRATE CONCENTRATIONS

Lagoon / parameter	The concentration of nitrate (mg/L)		rate of change
Lagoon 01	before	35.22	**38.50 %**
	after	21.66	
Lagoon 02	before	28.16	**41 %**
	after	16.61	
Lagoon 03	before	23.17	**44.19 %**
	after	12.93	

7. Phenol concentration

TABLE VIII
PHENOL CONCENTRATION VALUES AFTER TREATMENT IN CONTINUOUS MODE

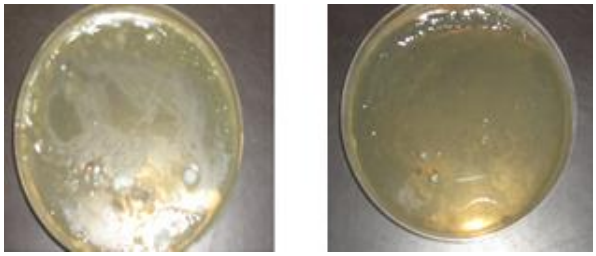
Lagoon / parameter	Phenol concentration (mg /L)		Rate of change
Lagoon 01	before	150.92	**21.72 %**
	after	118.14	
Lagoon 02	before	146	**70.31 %**
	after	43.34	
Lagoon 03	before	46	**74.54 %**
	after	11.71	

The extras on the table above results show that this support provides a good efficiency for the removal of phenol. We got to eliminate more than 70% of the pollutant in the third lagoon.

8. Biological change after treatment

After processing the three lagoons by the continuous method we noted changes in Total Aerobic Mesophilic Flora (FTAM) in the direction of the decrease and sometimes even a total disappearance of a species. We note the following changes based on the incubation of the samples after treatment of leachate from three lagoons.

Lagoon 1

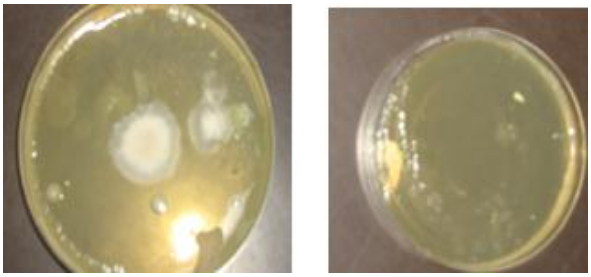


Before treatment after treatment

Fig.5: Microbial bilan in the first lagoon

We note here the disappearance of mold and several colonies of bacteria. Estimates say that the leachates after treatment are under 50 GFC / ml.

Lagoon 2:



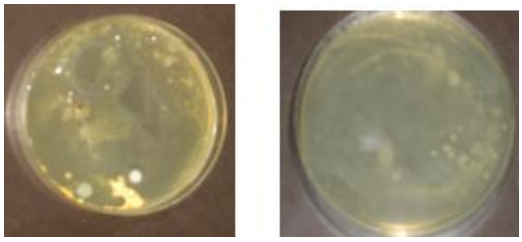
Before treatment after treatment

Fig 6: Microbial bilan in the second lagoon

We note here the virtual disappearance of mold and fungi. Only a few bacteria could have survived after treatment. The leachate is at least 50 CFA / ml instead of 1000 CFA / ml.

Lagoon 3:

Here we see also that the total aerobic mesophilic flora decreased very high rate and this is due to the disappearance of several bacterial colonies. Here leachate contain about 50 GFC / ml.



Before treatment after treatment

Fig. 7: Microbial bilan in the third lagoon

III. Conclusion

TABLE IX
SUMMARY TABLE

Parameters	Treatment	
	Lagoon	Continuous mode
Smell	very strong	odorless
Turbidity (NTU)	100 – 38 (62%)	100 – 28 (72%)
pH	5.84–6.55 (10%)	5.84-7.28 (20%)
conductivity (µs/cm)	11.10-0.12 (98%)	11.10-0.08 (99.28%)
Nitrite (mg/l)	1.29- 0.4 (68%)	1.29-0.05 (96%)
Nitrate(mg/l)	35.52-23.17 (35%)	35.52-12.93 (64%)
DCO (mg/l)	3480 – 3524 (12%)	3480 – 3651 (4.6%)
DBO_5 (mg/l)	450 – 950 (-111%)	450 – 12 (97.33%)
Phenol (mg/l)	150.92 – 46 (70%)	150.92 – 11.71 (92%)
Microorganisms	> 1000GFC/ml	< 50GFC/ml>

Based on experimental results and after a physicochemical characterization, the lagoons are effective in reducing the minerals compounds but not sufficiently organic compounds. The adsorption treatment in continuous mode using the cereal by products calcined at 600°C, and carried out on laboratory montage for a period of 24 hours, shows good retention of pollution. However, we have an important reduction of odor, color, turbidity :from 100 to 28 NTU (92%), nitrites : from 1.29 to 0.05 mg/l (96%), nitrates : from 35.52 to12.93 mg/l (64%), DCO from 3480 to 3651mg/l (4.6%), DBO5 : from 450 to 12 mg/l (97.33%), phenol : from 150.92 to 11.71 mg/l (92%) and the microbial load (GFC) from 300 to 50 GFC (83.33%).

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