Hacini Zineb, Ameri Shohir and Kaharache Karima
Follow-up of the physical and chemical properties of treated wastewater using an adsorbent column Made of gravel, sand and charcoal
Journal International Sciences et Technique de l'Eau et de l'Environnement,
Vol. (viii), No.3, December 2023, pp.17-23
ISSN Online: 1737-9350; ISSN Print: 1737-6688, Open Access
www.jiste.org
Scientific Press International Limited
Received: Received: 10 October 2023 / Revised: 13 October 2023 / Accepted: November 2023/ Published: December 2023

Follow-up of the physical and chemical properties of treated wastewater using an adsorbent column Made of gravel, sand and charcoal

Hacini Zineb[1], Ameri Shohir[2], Kaharache Karima[3]

1. University Kasdi Merbeh Ouargla Water and environmental engineering laboratory in the desert center (GEEMS).
2.3 University Kasdi Merbeh Ouargla

Abstract:

The purpose of this study is to identify the absorptive capacity of a column consist of two layers of gravel and sand, in addition to one layer of charcoal to purify sewage. By the physiochemical analysis of water after treatment, we obtained the following results as they reached 94.53% for DCO, 93.08% for DBO5, 99.49% for MES and 98.21% for phosphorous. The treated water apply to the Algerian and International (OMS) standards for wasted water.

Key Words*:* waste water, treated, physical and chemical properties, gravel, sand, charcoal.

Suivi des propriétés physiques et chimiques des eaux usées traitées à l'aide d'une colonne adsorbante composée de graviers, sable et charbon de bois

Résumé

Le but de cette étude est d'identifier la capacité d'absorption d'une colonne constituée de deux couches de gravier et de sable, en plus d'une couche de charbon de bois pour épurer les eaux usées. Par l'analyse physico-chimique de l'eau après traitement, nous avons obtenu les résultats suivants puisqu'ils atteignent 94,53% pour le DCO, 93,08% pour le DBO5, 99,49% pour le MES et 98,21% pour le phosphore. Les eaux traitées répondent aux normes Algériennes et Internationales (OMS) relatives aux eaux usées.

Mots clés : eaux usées, traitées, propriétés physiques et chimiques, gravier, sable, charbon de bois.

متابعة الخواص الفيزيائية والكيميائية لمياه الصرف الصحي المعالجة باستخدام عمود ماص مصنوع من الحصى والرمل والفحم

ملخص

: الهدف من هذه الدراسة هو معرفة القدرة الإدمصاصية لعمود مكون من طبقتين من الحصى والرمل و طبقة واحدة من الفحم على تنقية المياه الملوثة. من خلال التحاليل الفيزيوكيميائية للمياه بعد المعالجة تحصلنا على نتائج حيث بلغت بالنسبة 94,53% DCO, 93,08% بالنسبة DBO5, 99,49% لـ MES المياه المعالجة.بالنسبة للفسفور 98,21% و الخاصة بالمياه المستعملة. وهذا يدل على فاعلية هذا النظام, فهو صديق للبيئة (OMS) تلبي المعايير الجزائرية والعالمية واقتصادي لمعالجة مياه الصرف الصحي.

الكلمات المفتاحية: المياه مستعملة، المياه المعالجة، خواص فيزيائية وكيميائية, الحصى,الرمل, الفحم

[1] Corresponding author: zn.hacini@gmail.com

1.INTRODUCTION

Water is at the heart of sustainable development, it is essential for socioeconomic development such as energy, food production, ecosystem integrity and mankind survival. Add to that water also at the core of climate change adaptation process, as it play a link between society and environment.

Water is a fundamental requirement in life, through which it depends on it in all life forms, as well as, men *(mankind/ human)* fate connection to it. According to the Almighty saying ' and we made every living thing of water', despite that, the human did not operated correctly that resulted in irrational consumption in agricultural activities and industrial, a long with its daily needs, which lead to its pollution. Thus, water pollution has become the most important subject that interests the researchers.

Water pollution is defined as the occurrence of physical or chemical change in the quality of water in direct or indirect way, that affects the living organism negatively, and make it unfit for use. Plus water pollution impact significantly the individual life like family and society. Therefore water is an essential requirement for human and all living things. Besides water pollution could cause end of life. So in this article we will introduce you to a traditional methods used by the pharaohs to purify water, yet the science has not proven its effectiveness.

2. Methods and materials

2.1.Samples and area of study

The sample of this study *(sand and gavel)* was taken from the south of Algeria in a far region about 2.000 Km labeled Djanet. And I chose this late due to its sand qualification in terms of purity and quality, as for polluted water it taken from Touggourt region. And the analysis of this study was conducted by: laboratory of the national office of disinfection with ONA in Touggourt *(physiochemical analysis)*.

2.2. The components of gravel and its physical and chemical properties

Use fine gravel with a diameter between 2-5 mm. The following table shows its components, the physiochemical properties.

Table I: the components of gravel and its physical and chemical properties (%)

Insoluble	27.83
Sulfur trioxide *(SO_3)*	0.33
Gypse *($CaSO_4$,$2H_2O$)*	1.82
Carbonates *(C_3SO_3)*	70
Chloride *(Cl^-)*	0.011
Sodium Chloride *(NaCl)*	0.019
Cleanliness for aggregate	0.74

2.3.The components of sand and its physical and chemical properties

The sand used is fire sand *(pyrocastic sables)* of desert sand with red color.

Table II: sand composition

de	'2	₂O₃	₂O₃	gO	CO₃	ther materials
)	8	6.4	1.4	).08	).86	~ 5.0

Table III: Some of the physiochemical properties of sand

Chemical formula	SiO_2
Molar mass *(g/mol)*	60.086
Molar volume *(cm^3)*	22.688

Melting	Insoluble
Solidity	7
Density *(g/cm³)*	2648
Crystallization	Hexagonal triangle
Sparkle	Vitreous-waxy
Transparency	'ranslucent to almost opaque
Refractive index	1.543 - 1.554
Electrical resistance *(µm)*	$4x\ 10^{12} – 2x10^{16}$
Melting point *(° C)*	1703 - 1713

2.4.Charcoal

The coal utilized is pulverized activated carbon*(CAP)*, in the form of particles with dimensions ranging between 10-50 m.

2.5. Experimental gear used

The experimental gear consisted of a column containing two layers of sand and gravel and one layer of coal. We took 147 grams of sand, 147 grams of gravel and 22 grams of coal for each layer of the column. These values were determined based on the study conducted by Hacini and others [1]

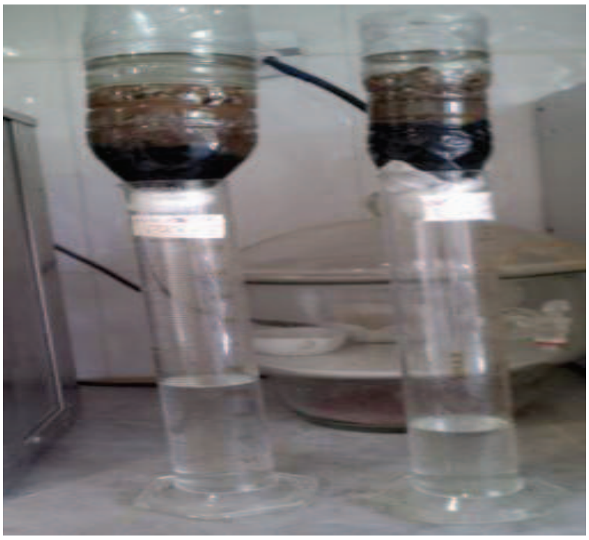

Figure 1: Experimental hardware used

2.6. Physicochemical analyzes

2.6.1. Determination of suspended matter MES by centrifugation

We take 100 ml of the sample and divide it into two tubes of 50 ml from a centrifuge, leave it for 10 minutes until we get a precipitate. Weigh a clean crucible (Capsule) and record its weight as M0.

We pour the precipitate into the extruder and then put it in a desiccator at a temperature of 105 ° C until we get a dry precipitate. Take out the crucible from the dryer and let it cool down. Weigh the crucible with the dry sediment and record its weight M1.

Calculation of the result: MES concentration is calculated from the following relationship:

$$MES = (M1 - M0) \times 1000 / V$$

MES: suspended matter concentration *(mg/l)*.

M0: Weight of the crucible before use *(mg)*.

M1: Weigh the crucible with the deposit after use *(mg)*.

2.6.2. Determination of DCO oxygen chemical demand

The DCO value is determined by (3900 HACH, DR/) device, through using a capsule containing a prepared commercial reagent.

In order to blend the precipitate, the capsule containing reagents should be mixed well. With a clean pipette, we take 2ml of the sample and pour it on the inner wall of the capsule that carry the reagents, so that the capsule is tilted. We close the capsule tightly and shake it well. We put the capsule for 120 minutes at 150 C inside a Thermo-reacteur thermogen. We remove the capsule from the thermo-reacteur and let it cool on a stand for 20 minutes on a normal temperature.
After the cooling time ends, we set the capsule inside the device HACH, DR/3900.
We read the DCO value from the device directly, for a period the results.

2.6.3. Determine the biochemical oxygen demand DBO5

With a graduated flask we measure the amount of sample needed for analysis. We put the magnetic rod inside the flask clean and then pour the sample needed for analysis into the incubation flask. Clean her Nitrification Inhbitor Activator 3 drops. With tongs clean 3 NaOH tablets in the inner cap of the vial, and close the vial in a tight manner. We put the flask on the shaking device at a temperature of 20 ° C and leave it for 5 days, making sure of its equilibrium stability before closing the refrigerator, after 5 days we read the result obtained.
Score Calculation:
We calculate the true DBO5 value by the following relationship.
DBO5 (mgO2 / l) = reading value x coefficient.
Reading value: It is the value obtained from the device.
Parameter: It is determined through the table below, which links the volume required for measuring DBO5 and the resulting biochemical oxygen demand value
[1-4].

2.6.4. Determine the amount of phosphate PO_4^{-2}

Phosphate was quantified by HACH; DR / 3900.
-A capsule containing the reactants is supplied well in order to mix the precipitate.
With a clean pipette, we take 5 ml of the sample and pour it on the inner wall of the tube (capsule) that contains the reaction so that the capsule is tilted. We close the capsule tightly and shake it slightly.
We leave the capsule for 10 minutes, then put it inside the device and read the result directly in mg / L [1-4].

2.6.5. Measuring the amount of dissolved oxygen Odiss

The dissolved oxygen inside the sample was measured by the Oxymétrie device. Rexi HQ30d. We open the device, wash the electrode of the device with distilled water. We take 100 ml of the sample and put it inside a bischer cup, dip the electrode of the device in the bischer and leave it until it settles. We record from the device the results (the amount of dissolved oxygen in the water, the temperature). When fixed, you read it directly from the device [1-4].

2.6.6. PH measurement

PH measured with a pH meter *(HACH; sension1)*.
Turn on a pH meter, washing the electrode with distilled water. We take 100 ml of the sample and put it inside a beaker cup, dip the electrode of the device in the bischer and leave it until it settles, then we read the result directly from the device [1-4].

2.6.7. Temperature measurement

In measuring the temperature, we used the Oxymétrie device. A conductivity meter or a pH meter can also be used. We turn on the device, and we dip the electrode of the device into the sample. We read directly the temperature as it stabilizes on the device .

2.6.8. Measurement of electrical conductivity, salinity and TDS

The electrical conductivity, salinity, and TDS were measured by a multi-parametric analyzer *(HACH; sension5)*.
Turn on the device, wash the electrode with distilled water. Insert the electrode into the beaker cup that contains the sample. We read the value of the electrical conductivity directly from the device when it is stabilized by pressing the Sel or TDS button, and we read a value directly from the device [1-4].

International Journal Water Sciences and Environment Technologies
e-ISSN: 1737-9350 p-ISSN: 1737-6688, | Open Access Journal | *Volume (viii) - Issue 3 – December 2023*
Volume (vii): Water-Drought-Climate'2023

2.7. Calibration

In the framework of processing polluted water and for the sake of knowing the absorbing capacity of a column consists of gravel, sand and coal, we titrated through using a NaOH and H_2SO_4 sulfuric acid solution depending on the following process .

- we prepare a solution of sulfuric acid H_2SO_4 with a concentration of 0.1 mol / L
- we prepare a solution of NaOH 0.1 mol / L
- we empty a H_2SO_4 sulfuric acid solution and place it in a beaker with closure on the column for certain period, and calibrate with shaking by Agitateur utilizing Phenolphthalein as a colored reagent.
- After obtaining a pink color ,we stop the calibration, we register the volume of the valence that we applied in titrating the sulfur acid.

After the closing period is done, we open the column and wait until we get 10 ml of the extract and calibrate it.

The above process is repeated till the equal concentration is fixed.

3. Results and discussion

3.1. Physiochemical analysis results

Throught the physiochemical treatment, we obtained the following results listed in the table below:

Table IV: physiochemical analysis results before and after treatment

Properties	Before treatment	After treatment
The color	Black	colorless
The smell	ll is very unpleasant, similar to the smell of ammonia	odorless
temperature	29.1	23.2
PH	7.45	7.74
Electrical conductivity	6.50	6.48
salinity	3.5	3.5
Dissolved oxygen Odissou	0.12	1.65
Suspended matter MES	11	8
hemical oxygen requirement DCO	201	11
DBO5	130	9
phosphate	8.77	0.157

According to the results mentioned in the above table, and with the simple observation from the human senses (sight and smell) we noted that the water before treatment was black then after treatment became colorless which indicates that there is an enormous lack of contaminated materials. As for the smell changed from unpleasant smell to odorless and this due to tremendous lack of chemical or organic decomposing substances, or to the lack of the bacteria that emit H_2S (the source of unpleasant odor). furthermore, we spotted out a clear decrease in pollution parameters DCO, DBO5, phosphate and MES that are shown in the above table (III).

By calculating the coefficient K in the column we attained $K < 1.5$, which is computed by the following formula (relationship):

K= DCO / DBO K

K: is an index of biodegradability in a liquid of liquid waste medium, and the rate of K in domestic wastewater ranges from 1.5 to 2.5, where:

$K < 1.5$ Sewage is biodegradability

$1.5 < K < 2.5$ sewage is moderately degradable.

$K > 2.5$ Sewage is non- biodegradable

The inference

At last, according to the physiochemical analysis results, we figured that the column (gravel, sand and coal) has a better ability at removing pollutants in comparison to the Algerian standards for sewage drainage and the world organization for Health OMS. In contemplation of studying the capacity of column on adsorbing the H_2SO_4 solution through titrating the solution extracted from the column with hydroxide sodium NaOH.

3.2.Calibration results

Table V: calibration results

Ti s	V_{H2S} ml	V_{NaC} ml	C_{ec} mol,	$C_{eq/}$	$R=(C_0-C_{eq})/C_0x1$
1	10	0.0!	0.00(	0.0	99.5
2	10	0.0!	0.00(	0.0	99.5
5	10	0.1	0.00	0.(	99
8	10	0.2!	0.00!	0.0	97.5
1(	10	0.4	0.00	0.(	96
1:	10	0.6	0.00	0.(	94
1(	10	0.8	0.00	0.(	92
1!	10	1	0.0!	0.	90
2!	10	1.2	0.01	0.:	88
2!	10	1.4	0.01	0.:	86
2(	10	1.4	0.01	0.:	86
3(	10	1.4	0.01	0.:	86

Based on the table results *(indicated in the table above)*, we have drawn the following two curves

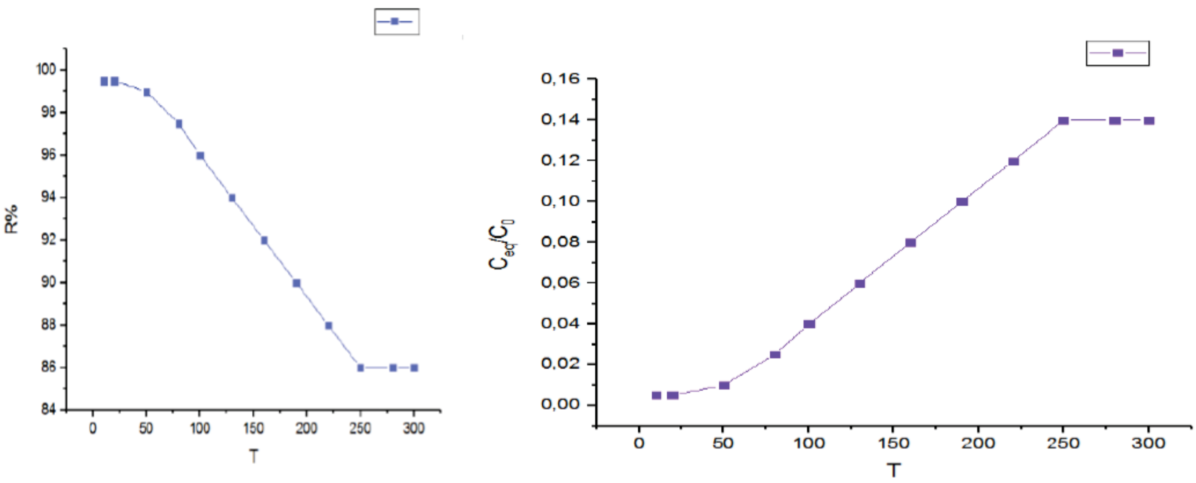

Figure 2: study the capacity of column to adsorb H_2SO_4 solution.

The nature of the adsorbent materials impact the process of adsorption, in which these materials (gravel, sand and coal) have proven their efficiency in removing pollutants dissolved in water. That could be traced back to their porosity. As gravel has the ability to detach large-sized solids materials from water, while the sand has competence on absorbing pollutants and small solid materials in water since it contains silicates. Regarding activated carbon (charcoal), it has the capacity to absorb (odor, color, remove bacteria, toxic gases and vapors). But in terms of time according to the yield curve, we noticed that within an hour the yield was large 99.5% and gradually decreases to stabilization at 86%, whereas we marked an increase in the concentration H_2SO_4 in the extracted solution, this is due to the saturation of the adsorbent surface with solution.

4.Conclusion

The sewage treatment process aims to remove pollutants resulting from the increase in population growth, industrial and agricultural activity. In the light of the increased need for hydro resources treating wast-water became essential, in order to reduce problem of the environmental pollution and diseases spread. Through removing the organic and inorganic materials suspended and dissolved in water. And also by eliminating of pathogenic organisms (bacteria).

Through this work,we studied the capacity of a column consisting of gravel, sand and coal on treating and absorbing pollutant sewage for a chosen city, that is based on observing the international pollution standards (MES, DBO_5, DCO, PO4-3). In addition to some physical and chemical factors such (temperature, pH, electrical conductivity, dissolved oxygen… etc.). therefore the results obtained confirmed the efficacy of this method in sewage treatment via the special adsorption ratio DCO, DBO5, phosphate and MES that are estimated respectively as DCO 94.53%, DBO_5 = 93.08%, MES = 99.49% and phosphate 98.21%. pursuing the adsorption capacity of column , firstly by changing the mass of its components (sand, gravel and coal), secondly by changing its size.

References

[1] Hacini.Z., Kafi.N., Habib.I and Bousseba.W. "Treatment of touggourt waste water by bildet omar clay"; Scholars International Journal of Biochemistry ISSN 2616-8650 (2019).

[2] Tchobanoglous.G., Burton,F.L., and Stensel. H.D." Wastewater Engineering" (Treatment Disposal Reuse) / Metcalf & Eddy, Inc (4th ed.). McGraw-Hill Book Company. ISBN 0-07-041878-0 (2003).

[3] Yang.D., Renzun.Z. "Advanced Oxidation Processes (AOPs) in Wastewater Treatment". *Current Pollution Reports*. 1 (3): 167–176 (2015).

[4]Sperling, M.. "Wastewater Characteristics, Treatment and Disposal". *Water Intelligence Online*. **6**: 9781780402086 (2015).