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ETUDE PHYSICO-CHIMIQUES DES TERRILS DE CHARBON DE LA VILLE DE KENADSA POUR LEUR UTILISATION DANS TRAITEMENT DES EAUX USÉES

PHYSIC-CHEMICAL STUDY OF THE COAL HEAPS OF THE CITY OF KENADSA FOR THEIR USE IN THE TREATMENT OF WASTEWATER

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Résumé - La ville de Kenadsa qui se trouve dans une région saharienne aride, connaît des problèmes de pollution des eaux superficielles et souterraines dont les causes principales sont: le déversement des eaux usées dans la nature sans épuration et l'absence de systèmes d'épuration et de dépollution des eaux usées. Dans ce contexte notre étude se propose à la valorisation de quelque matériaux locaux à savoir les terrils du charbon qui font tellement partie du paysage de notre région qu'on finit presque par ne plus les voir. Ces majestueuses montagnes sont parfaitement intégrées aux paysages de Kenadsa et Béchar Djédid et témoignent d'une exploitation active des mines de charbon qu'a connue cette région. L'objectif de ce travail est de maîtriser la technique de filtration et de suivre l'évolution des paramètres physico-chimiques pour évaluer l'apport de la filtration sur différents lits filtrants pour la production d'eau à usage humain et/ou d'irrigation. La valorisation du filtre à sable des dunes du Grand Erg occidentale combiné à un géo matériaux disponible dans la région du Sud Ouest Algérien tel que le terril de Kenadsa a été choisie comme un procédé de filtration des eaux usées urbain de Oued Béchar dans notre travail.

Mots - clés : Eau Usée, Terril, Filtration, Débit, Analyse Physico-chimiques, Colmatage

Abstract- The city of Kenadsa, which is located in an arid Saharan region, is experiencing pollution problems, the main causes of which are: the discharge of wastewater into nature without purification and the absence of wastewater treatment systems. In this context our study proposes to the valuation of some local materials, namely the coal heaps are so much part of the landscape of our region that we almost end up not seeing them anymore. These majestic mountains are perfectly integrated into the landscapes of Kenadsa and Bechar Djedid and bear witness to the active exploitation that this region has known. The objective of this work is to master the filtration technique and to follow the evolution of the physicochemical parameters to evaluate the contribution of filtration on different filter beds for the production of water for human use and / or irrigation.

Keywords: Waste water, coal heap, filtration, flow rate, physic-chemical analysis, clogging.

1-Introduction

The South West region contains very large coal deposits, the discovery of the first deposits dates back to the 1900s, but since the discovery of oil and gas in all the southern regions in the 1950s, investment and mining of coal experienced a sharp slowdown from the beginning of the 1960s, which quickly led to the closure of the last mines in operation. Algeria today considers coal mines as energy reserves for years after oil. The Kenadsa region (located 19 km from the town of Bechar) has been an important coal mining center for more than 50 years (Yann,1991).

Coal dumps: coal mining has led to an accumulation of coal shale deposited. After the sorting operations carried out outside to separate the coal and the shales, the latter were deposited to form heaps. At the start of operations, sorting was first carried out manually, then by means of semi-automatic washhouses allowing separation by flotation and a significant reduction in the rate of residual coal in the shales. The heaps also contain, deposited, materials from the construction of shafts and communication galleries of the mines themselves(Yann,1991) .

Figure 1. The Kenadsa slag heap

Coal shales are therefore made up of these deposits, washhouse shale's (for the most recent ones) and very small quantities of coal (especially since the slag heap is old). The heaps are very large in size and often have (Kendouci,2012) :

• or essentially a conical shape (discharge by means of a skip);

• either flat and of great length, then called riders (supports of operating railways).

All the coal mines are now closed. The surface on which the slag heaps are located extends from Béchar Djedid (peripheral district of the city of Béchar) to the city of Kenadza, the cradle of the coal mines, i.e. over a length of 25 km with a strip of width that can reach the 20km.

The recovery of the materials contained in the slag heaps becomes an emergency since these slag heaps disfigure the landscape and block the extension of the neighboring agglomerations without taking into account the fallout from the point of view of the health of the population during periods of sandstorms.

Figure 2. The slag heap next to the Kenadsa coal mining plant.

After the definitive closure of the exploitation of the coal mines, during the year 1975, for economic reasons (high costs, profitability, technology, ...), successive development programs always included a budget intended for the industrialization of the region, and the encouragement of agriculture to meet the needs of the region, and to alleviate the unemployment crisis which affected an increasingly large population after the closure of the mines.

The total weight of the heap materials taken into account constitutes more than approximately 456 million tones. Raw material reserves in case of exploitation are quite profitable (Kendouci,2012).

2- Materials and methods

2.1- Experimental pilot

Figure 3 presents the experimental device used to carry out the filtration tests. The pilot consists of a glass column 5 cm in diameter and 100 cm in height and cylindrical in shape. The effective height of the filter bed and 60cm, 30 cm is used for filtered water which is kept constant along the experiment, in order to keep the same hydraulic head on the filter bed. Technically it was practically impossible for us to create sampling points along the height of the filter, for this the monitoring of the evolution of the physicochemical parameters of the water was made at the outlet of the column.

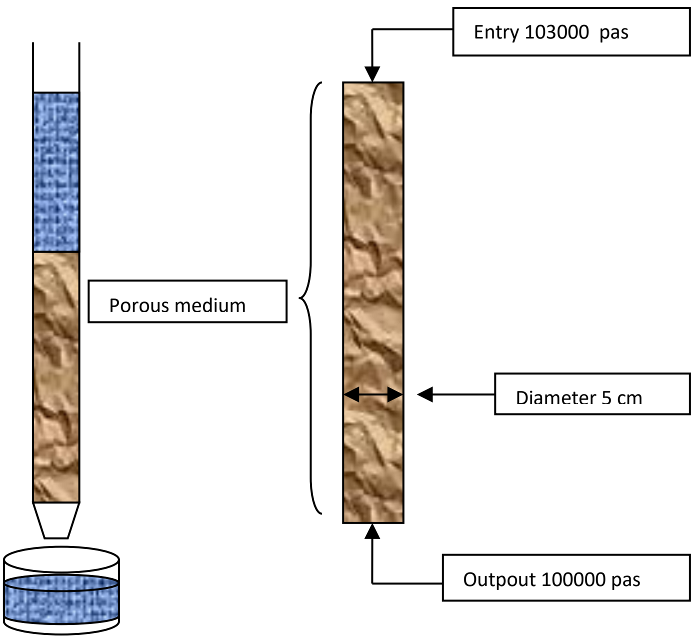

Figure 3. Schematic illustrating the experimental device

2.2-Materials

In the region of South West Algeria there are materials with large quantities such as the sand of the great Western Erg and the geo materials available in the region of Kénadsa, these two local materials have been chosen for a possible valuation.

2.3-Methods

The physical parameters measured are: pH, salinity, TDS and conductivity.

The chemical parameters determined are: the sulphate, chloride, nitrate, nitrite, ammonium, COD, BOD sodium and potassium content according to standard analysis techniques. The assay methods [4] used are as follows:

• pH, salinity, TDS and conductivity, potentiometric method (Consort 861)

• Kjeldahl nitrogen after mineralization AFNOR T 90-110 standard [5]

• Spectrophotometry was used for sulphate determination;

• Colorimetry for determining the content of; Nitrates and Nitrates (Rodier, 2005).

3-Characteristics of the filter beds used

Due to the advantages and expected potential of sand filters, we have tried to improve the performance of this filter by adding mine coal, made by the homogeneous mixture of a geo-material available in the study area. it is the slag heap of Kenadsa and the sand of Béni Abbés (dune sand of the great Western Erg). This method was chosen as a process for filtering urban wastewater from Oued in this study region (Béchar wadi); The experience lasts 14 days.

The two filter beds have a composition containing a large amount of sand (to increase the flow) and a small amount of heap (to minimize the oily quantity and promote possible adsorption), the first is MST95/5 (95% sand and 5% slag heap) and the second is MST90/10 (90% sand and 10% slag heap)

3.1-Physical characteristics

The particle size curves of the filter beds (figure 2) were established by passages over sieve columns (standard method NF ISO 565). From the particle size data, the moduli of fineness (MF) as well as the coefficient of uniformity (CU) are easily accessible. Represented in table 1

Table 1. Physical characteristics of filter beds

Parameter	S100	T100	MST90/10	MST95/5
Fineness modulus(MF)	2.16	4.52	2.05	2.16
Effective diameter d10 mm	0.17	0.16	0.16	0.17
Uniformity Coefficient (CU)	1.76	2.95	2.33	1.76
Specific area of material cm-1(As)	36.69	19.4	30.38	35.22
Permeability (m/s) 10-4	7,26	/	4.27	7,26
Density abs kg/m3	2.63	1.90	2.22	2.64
Porosity	42.01	38.81	41.00	42.00

The type of filter bed studied belongs to the fine sand category, this is well confirmed by its low porosity 42% and 41%; can also be quantified by the effective diameter d10 estimated from the particle size analysis which is around 0.17mm and 0.16mm, the fineness modulus (MF) 2.16 and 2.16 l; as well as their very low sand permeability coefficient which is of the order of 7.26 10^{-4} ms^{-1}

3.2-Chemical composition

The chemical analysis carried out on the overall fraction of the (raw) sand and the slag heap has provided us with qualitative and quantitative information on the chemical composition of the sample.

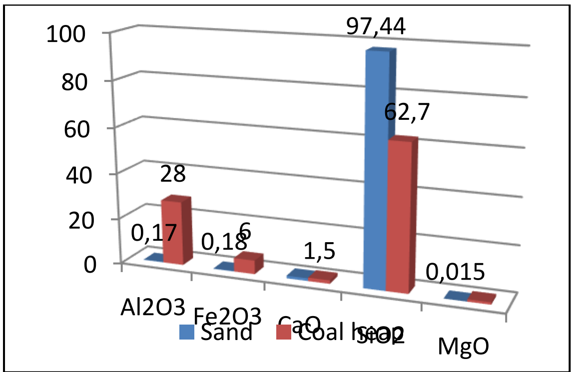

Figure 4. Chemical composition of the Kenadsa sand and slag heap

Quartz is the most represented mineral considered to be the insoluble part in sand and slagheap respectively 97% and 62% (krndouci,2012).

3.3-Hydrodynamic study

Constant head tests impose a constant head difference □h between the two ends of a soil column of thickness L and section S and the quantity of water V (t) which passes through the column is measured at course of time.

To be able to determine this parameter, measurements are carried out for the filter beds, filtration of bi-distilled water filtered on filter paper in order to avoid the phenomenon of clogging, by fixing the hydraulic head (h in cm of water) for the same length L of the granular material, illustrates our procedure (Kendouci,2012).

The figure below shows the variation of the flow rate as a function of time for the two filter beds, these results are obtained experimentally.

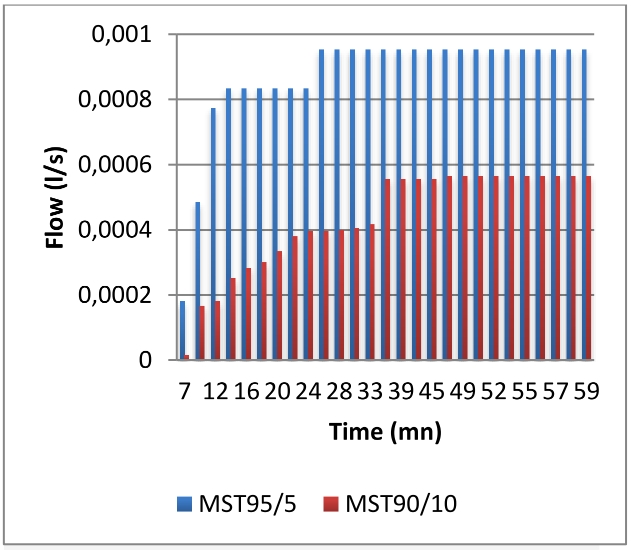

Figure 5: Evolution of flow rate for the two filter beds

The results are obtained for a water height equal to 30cm, according to the hydrodynamic study of the two filter beds we obtained a flow rate for the MST95/5 is 0.95 10^{-6} m3/s and for the filter bed MST90/ 10 the flow is 0.56 10^{-6} m3/s. A permeability was recorded for the MST95/5 which is of the order of 7.26 10^{-4} m/s is justified as noted in Table II.1, on the other hand for the MST90/10 filter the permeability is lower compared to MST95/5 is of the order of 4.27 10^{-4} m/s which implies a lower flow rate.

4-Results and discussion

Contribution of filtration to discharge

Table 2 : Evolution of the parameters measured as a function of time for the MST95/5 filter bed.

T (h)	Conductivity (µs/m)	Salinity (g/l)	PH	DBO (mg/l)	DCO (mg/l)	MES (mg/l)	SO4 (mg/l)	Cl (mg/l)	NH4+ (mg/l)	TNK (mg/l)	NO3 (mg/l)	NO2 (mg/l)
17	2,7	1,35	6,81	10	45	40	1315,6	355	14,78	11,20	1,28	0,9
89	3,82	1,9	6,75	8	55	20	784,81	355	8,87	2,24	1,01	0,9
161	4,72	2,33	6,6	6	5	10	506,35	781	11,82	10,64	1,1	0,3
281	4,02	2,42	6,94	2	5	0	475,14	745,5	1,18	1,68	0,89	0,3

Table 3 : Evolution of the parameters measured as a function of time for the MST90/10 filter bed.

Temps (h)	Conductivité (µs/m)	Salinité (g/l)	PH	DBO (mg/l)	DCO (mg/l)	MES (mg/l)	SO4 (mg/l)	Cl (mg/l)	NH4+ (mg/l)	TNK (mg/l)	NO3 (mg/l)	NO2 (mg/l)
17	3,35	1,68	6,74	12	35	50	1415,9	355	15,37	13,45	1,28	0,9
89	4,83	2,42	6,61	10	35	25	876,2	816,5	11,82	2,80	1,13	0,3
161	3,82	1,95	6,72	8	5	10	587,4	745,5	14,78	8,96	1,19	0,3
281	4,43	2,2	6,88	4	0	5	532,46	745,5	1,77	2,80	1,19	0,3

The conductivity, salinity and pH for the discharge before filtration are 3930 µs/cm, 1.97 g/l and 8.14 respectively, thus showing fairly high values.

An increase for the values of conductivity and salinity for the two filter beds as a function of the residence time.

The pH value for MST95/5 is 6.94 and 6.88 for MST90/10. The pH of the effluent does not vary much according to figure 4. Indeed, it reaches a maximum of 6.74 and a minimum of 7.94. This shows that it remains slightly basic throughout the process. Since the pH is a parameter influencing both the level of activity, the growth of bacteria and the solubility of compounds, it is important to control it, especially since bacteria are sensitive to its variation.

The BOD, COD and TSS values for the discharge before filtration are 150mg/l, 215mg/l and 156mg/l respectively. According to the results shown in Figure 5: an abatement of 90% is observed for the three parameters (BOD, COD and MES) in the three columns, the residence time factor is very important to achieve the abatement rate.

According to the graph in Figure 5, all the parameters monitored have a strong decrease during the filtration phase as a function of time, apart from the soluble COD. With regard to suspended solids, this effect was expected by the very fact of the function of the filter, and, for COD, this is explained by the physico-chemical reactions. It is then observed that the particulate and colloidal elements will be entrained during settling. At the filtration inlet, the COD will therefore be mostly in soluble form.

The elimination of SS is considerable. From the first stage of filtration, the suspended solids are retained at 76 to 81%. This rate increases to 87 to 94% at the end of the process. These high yields allow the system to produce water of good quality as far as suspended solids are concerned. The water collected at the end of the treatment complies with the standard relating to the discharge of wastewater into the natural environment (50 mg/l).

The sulphate and chloride contents of the rejection before filtration are 795.76 mg/l and 923mlg/l respectively. The sulphates and chlorides present in very high concentrations, these levels can very probably be due is, since the discharges are of an urban nature, to the use of detergents based on sulphites (metastable state) which transforms (oxidation) into sulphate.

The chloride concentration undergoes a decrease from 923 to 745.5 for MST95/5 and MST90/10.

- For the MST95/5 column, the sulphate removal rate is 40%; for the MST90/10 33%.

- For the MST95/5 column, the chloride elimination rate is 20%; for MST90/10 20%

Note that the elimination of chloride is of the same order of magnitude 20%.

5 - CONCLUSION

The results obtained during this study (Physicochemical analysis of discharge and water after filtration) testify in their majority that there is a variation or a change in the contents and the dosage of the parameters studied before and after filtration either with an increase or an abatement

Studies relating to wastewater are complex, because they affect several areas at the same time, such as their treatment, their collection, their recovery, and their impact on the environment, where each of these areas requires a procedure and analyzes that are different from each other. It is thus and for a good control of our work according to the tools and the material which we have, we limited ourselves to the estimation of the polluting load of the urban waste water which turns out to be globally quite loaded in pollutants (Nitrate 7.94 mg/l, Nitrite 0.6 mg/l, Ammonium 26.60 mg/l, NTK 62.18 mg/l) and pose a real threat to the region's environment, especially to groundwater. Western Erg sand filters, combined with the slagheap of the Kenadsa region, have been proposed as a technological alternative for water pretreatment.

The two filter beds give us a remarkable reduction in the levels of contaminant parameters such as NTK, Ammonium, Nitrate, Nitrite, BOD, COD and suspended solids. If we take the nitrite content, we obtain a reduction of 50% for the two filter beds.

The reduction of suspended solids (SS), chemical oxygen demand (COD) and biochemical oxygen demand (BOD) is around 90%, presenting better reduction.

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