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Treatment of heavy metals by nanofiltration present in the lake Reghaïa

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Abstract

The wetland of the lake Reghaïa closes significant potentialities and historical, cultural, scientific, economic, biological values. The establishment of the industrial park and the urban development of Reghaïa and Rouïba constitute one of the sources of contamination. The volume of waste water zone is estimated at more than 20,000 m^3/day. In order to improve quality of water we introduced into our study the nanofiltration like a means of treatment to control the ionic concentration divalent and trivalent (sulphates, chlorides, sodium and many metal ions made up organic to give a better watery life. The membrane used is Nanomax50 of surface 0.37 m^2 and pore size approximately equal at 1 nm. The load of the surface of the membrane overall is negative. The permeability of the membrane is of 10^{-6} m/s bars.

Keywords: Nanofiltration; Heavy metals; Area water; Effluents

1. Zone Environmental description for the lake of Reghaïa

1.1. Generality

The site (Fig. 1) extends on more than 3 km length and approximately 720 m broad. It is located at 30 km in the east of Algiers. The wetland of the lake Reghaïa closes again significant potentialities and historical, cultural, scientific values. The establishment and the urban development of Reghaïa and Rouïba, around the industrial park constitute one of the sources of contamination of water and the grounds by heavy metals. A significant share of the localities of the area not being connected to the stations of purification pours the water used directly in the lake of Reghaïa.

1.1.1. Industrial activities

Creates in 1960, the industrial park of Reghaïa extends on a surface from 900 ha and contains more than 180 industrial plants, of which half

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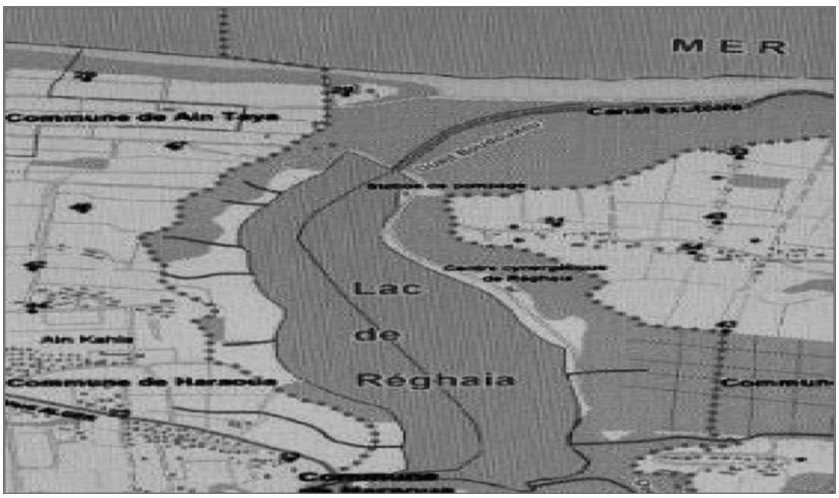

Fig. 1. Geographical situation of the Reghaïa Lake.

meadows is polluting. The majority of the effluents are not treated as a preliminary.

1.1.2. Agricultural activities

The area of Reghaïa is a zone with agricultural vocation where one meets primarily truck farming and the citrus fruit cultivation which occupy a significant surface.

1.2. Nature and origin of pollution in the lake Reghaïa

The analysis of the information collected on the site or from the engineering departments, enabled us to note that the rejections which pollute water have various origins (industrial activities, domestic and municipal rejections, agricultural activities). This pollution by the various rejections contributes in a considerable way in the contamination of the rivers is in its majority is in metal matter of which some are very toxic. These rejections are also very charged with MES (585 mg/L). The volume of waste water of the whole of the zone is estimated at more than 20,000 m^3/day. The principal metals rejected by a few production facilities of the Rouïba zone — Reghaïa (Table1).

1.3. Quality water of the Reghaïa Lake

The chromatographic analysis reveals an organic pollution due to the existence of the organic micropolluants such as phenols and hydrocarbons (Fig. 2).

The quality of water of the lake Reghaïa compared to heavy metals was based on the analysis campaign carried out on water at the entry, the exit and in the medium of the lake (Table 2).

The station of purification is operational since 1997, receives and treats on average 15,000 m^3 of water per day coming from the industrial park and of the rejections of the cities bordering. The only processes in progress in the station of treatment consist of a cleaning, desanding and de-oiling. The process of treatment before rejection is a priori definitely insufficient to be able to have clean water before rejection in the lake. We note that the Lake is slightly basic (pH = 7.56) and an excessive mineralisation exceeding (1.8 mS/cm). The analysis by atomic absorption of sampling shows abundance raised compared to nickel

Table 1
Principal metals rejected by the industry of the zone Rouïba Reghaïa

Units	Elements	Rejected quantities (mg/L)	References	Normes (mg/L)
SNVI.CVI	Pb	1.12		1
	Fe	12.25		5
	Zn	19.12	CNTC	5
	Ni	<0.063		5
	Cd	<0.03		0.2
ALTUMET	Fe	0.38	ADE	5
BATIMETAL	Fe	–	DEWA	5
	Zn	–		5
SNIC (lame)	Fe	–	"	5
	Cr	–		3
TAMEG/ROUIBA	Cr	36.70	TAMEG 2005	3

and cadmium following their use on the level of the industrial park (Table 3).

2. The membranes

Membrane technology became a true challenge for the processes of separations [1–7], concentration and regulation of the concentrations of the liquid solutions. The nanofiltration is a membrane process which could find a place in the water treatment of surface while eliminating, or to control the concentration of certain ionic species in order to maintain a balance ionic in the receiving medium in order to preserve the life in the lake. This technique of separation with indeed already made this evidence in elimination of many compounds present in water (ions trivalent and divalent, organic sulphates, chlorides, sodium).

3. Sample treatment by nanofiltration

3.1. Description of the installation

The installation of nanofiltration thus realized (Fig. 3) makes up of a stainless cell. The effluent

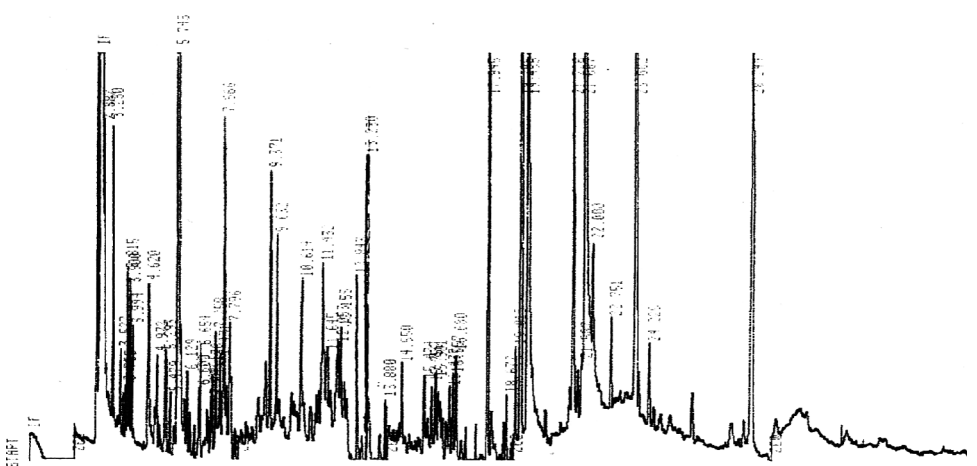

Fig. 2. Chromatographic spectre of sample Reghaïa Lake.

Table 2
Quality of water Reghaïa Lake

Parameters	Unit	Up Lake	Medium Lake	Down Lake
T	°C	11.5	13	12.5
Conductivity	mS/cm	1.66	1.60	1.46
O_2 dissous	mg/L	3	1.5	2.5
pH		7.27	7.50	7.47
Turbidity	NUT	100	8	10
Residus Secs	mg/L	947	1096	1026
MES	"	12	3	11
DCO	"	54	60	64
DBO_5	"	7.6	4.6	5.8
COT	"	14.87	16.01	19.7
Ca	"	125.48	138.79	126.90
Mg	"	27.48	30.57	29.27
Na	"	145.01	169.58	160.67
K	"	10.99	13.63	13
Cl	"	240	282	240
SO_4	"	200	200	206
CO_3	"	0	0	0
HCO_3	"	278	339	337
NO_3	"	17.71	3.72	4.90
NO_2	"	1.56	0.46	0.49
MO	"	13.2	10.8	8
PO_4	"	0.77	3.37	3.14
NH_4	"	7.24	7.60	6.64
SiO_3	"	7.56	8.06	7.87
Fluor	"	0.29	0.26	0.027
Fe	"	1.43	0.44	0.52
Mn	"	0.34	0.27	0.24
Cu	"	<0	<0	<0
Zn	"	0.72	0.17	0.15
Cd	"	<0	0.01	0.02
Cr	"	0.01	0.03	<0

Table 3
Analyze sample by the atomic absorption before treatment

Element	Concentration (mg/L)
Cr	0.297
Ni	0.904
Cd	0.289
Pb	0.208
Zn	0.015
Cu	0.001

is introduced into the feed tank, cooled by a cryo-thermostat, thus circulating in the installation using a positive-displacement pump. Filtration is carried out under the effect of a difference in pressure creates on both sides membrane and which is controlled by two governors automatically-controlled placed before and after the cell. Permeate and retentate are recycled in the feed tank.

The membrane used is of organic nature (Nanomax50), spiral composite polyamide and

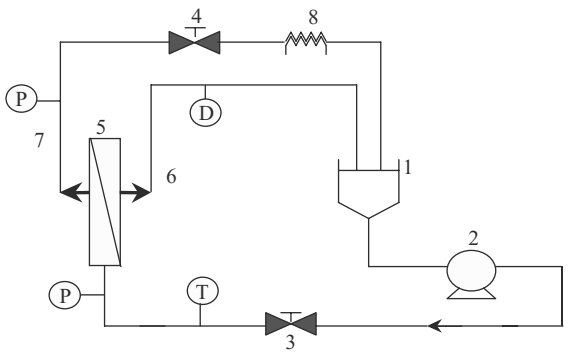

Fig. 3. Pilot description: (1) feed tank; (2) volumetric valve; (3) and (4) regulator pressure valves; (5) membrane; (6) permeate flow; (7) retentate flow; (8) temperature control; (D) debimeter; (P) pressure control; (T) thermomètre.

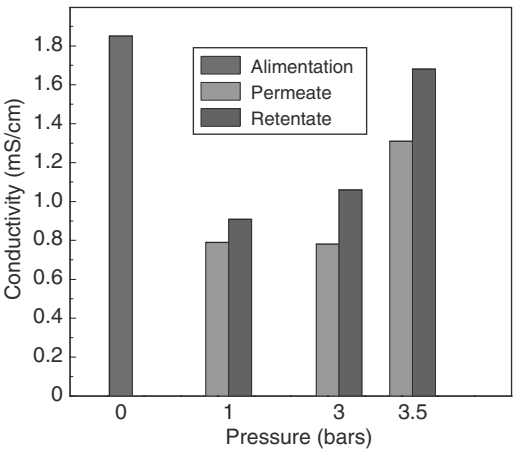

Fig. 4. Evolution of conductivity according to the pressure.

polysulfone. Area membrane is 0.37 m^2 and with pore size is approximately 1 nm.

3.2. Procedure

Initially, and to check the performances of the membrane we determined the water permeability membrane ($Lp = 10^{-6}$ m/s bars) then we carried out taking away for each value of pressure on the solutions of retentate and permeate for the analyses of various parameters has to know, conductivity, the pH, Turbidity, MES, DCO, DBO, as well as measurements of permeate and retentate flows.

3.3. Study of the influence of the parameters external on the nanofiltration of the effluent

We studied the influence of the pressure and the pH on the permeation of the membrane.

3.3.1. Influence pH

Basic medium: Initially we took the sample in basic medium thus at its origin of pH (Figs. 4 and 5), and one carried out the process by pressure evolution for 1 at 3.5 bars with measurement of different physicochemical parameter (Table 4).

In the second time, the nanofiltration was applied to an acid medium (Figs. 6 and 7). We prepare a sample similar to that of the preceding sample and we adjust the pH at 2.5, and with the same preceding procedure we followed the treatment. The various characteristics of the sample before and after treatment are gathered in the Table 5.

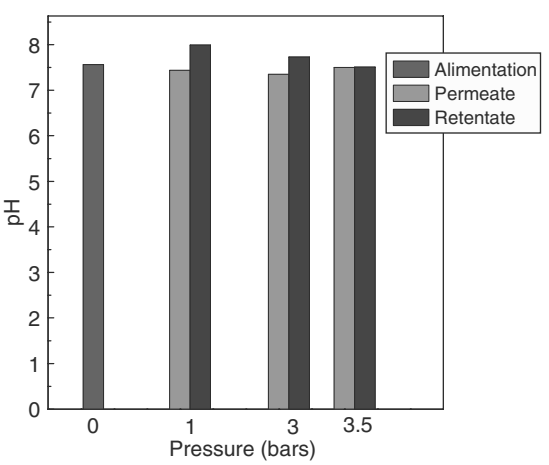

Fig. 5 . Evolution of pH according to the pressure.

Table 4
Sample treatment by nanofiltration. Basic medium

Parameters	Alimentation	Permeate			Retentate		
Pressure (bars)	0	1	3	3.5	1	3	3.5
pH	7.56	7.44	7.35	7.50	7.99	7.73	7.51
Conductivity (mS/cm)	1.85	0.79	0.78	1.31	0.91	1.06	1.68

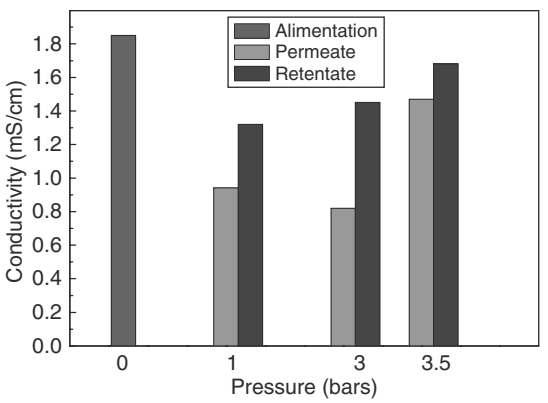

Fig. 6. Evolution of conductivity according to the pressure.

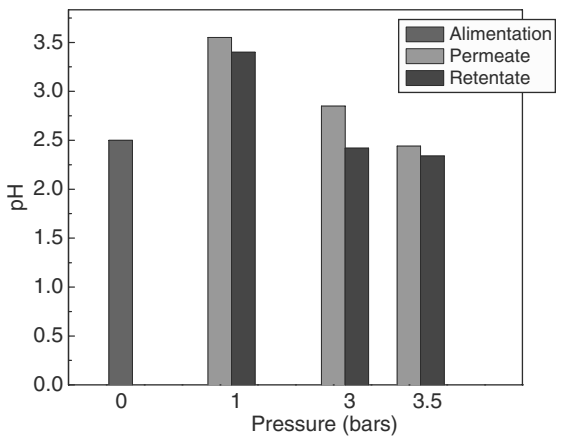

Fig. 7. Evolution of pH according to the pressure.

4. Conclusion

The contamination of water by pollutants of various origins is a current problem. Beyond the economic considerations, the concerns for the environment led the authorities to force industry to take measures in order to decrease the impact of waste on the natural environment. The observation of the results of analyses by the atomic absorption enabled us to characterize and determine the presence of the metal elements traces in our effluent. We noted that filtration carried out in various mediums of acidity (acid medium and basic medium) gives satisfactory results for the ionic retention [48.08% (Figs. 4 and 5) and [41.84% (Figs. 6 and 7)]. The study on the effect of the pressure (Table 6) as allowed us to obtain encouraging results as is for

Table 5
Sample treatment by nanofiltration. Acid medium

Parameters	Alimentation	Permeate			Retentate		
Pressure (bars)	0	1	3	3.5	1	3	3.5
pH	2.50	3.55	2.85	2.44	3.40	2.42	2.34
Conductivity (mS/cm)	1.85	0.94	0.82	1.47	1.32	1.45	1.68

Table 6
Influence pressure on various pollution parameters

Sample	Conductivity (mS/cm)	Permeate flux (10^6 m/s)	DBO (mg/L)	MES (mg/L)	Turbidity (NUT)
Alimentation	1.5	–	42	4	1.545
Permeate 1 bars	1.54	2.04	14	1	0.165
Retentate 1 bars	1.8	–	54	4	–
Permeate 2 bars	1.47	4.83	10	5	–
Retentate 2 bars	1.87	–	75	11	–
Permeate 3 bars	1.48	8.07	6	3	0.115
Retentate 3 bars	1.90	–	110	6	1.715

conductivity, turbidity where we recorded significant abatements [18.94% (conductivity) and 93.74% (turbidity)].

The whole of the results obtained made it possible to highlight the influence of the operating conditions on purification by a membrane of nanofiltration. Into final and taking account of the importance of the results obtained during this work, we hope that this process carries a considerable improvement in the mode of water treatment worn of the purification station of Reghaïa Lake for obtaining a water meeting the rejection standards in the lake [8].

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