IWNEST PUBLISHER

Journal of Industrial Engineering Research

(ISSN: 2077-4559)

Journal home page: http://www.iwnest.com/AACE/

Modeling and Optimization the Conductivity of Wastewater Discharged into the Bouregreg River (Rabat, Morocco) in Function of Ions: Chlorides, Sulphates, Nitrates and Bicarbonates

NabihZerki, KarimaAchelhi, RahmaBchitou and Ahmed Bouhaouss

Nanostructures Laboratory, Process Engineering and Environment, Department of Chemistry, Faculty of Sciences, University Mohammed V-Agdal, Rabat, Morocco.

ARTICLE INFO

Article history:
Received 22 February 2015
Accepted 20 March 2015

Keywords:
Conductivity; waste water; anions; modeling; optimization.

ABSTRACT

Discharges of domestic and industrial wastewater in the two banks of the Bouregreg River without any treatment, usually has a large number of health and environmental risks, among these water pollution by dangerous chemicals. The Objective of this study is to follow the variation of the conductivity of wastewater discharged into the Bouregreg river depending on the anions concentration of chlorides (Cl^-), sulfates (SO_4^{2-}), bicarbonates (HCO_3^-) and nitrates (NO_3^-) to determine the ions that have an effect on this physicochemical parameter for modeling and optimization this parameter according anions analyzed in wastewater discharged into the Bouregreg river with help of the experimental designs method and isoresponses curves.

ToCite ThisArticle: NabihZerki, KarimaAchelhi, RahmaBchitou and Ahmed Bouhaouss., Modeling and Optimization the Conductivity of Wastewater Discharged into the Bouregreg River (Rabat, Morocco) in Function of Ions: Chlorides, Sulphates, Nitrates and Bicarbonates. **J. Ind. Eng. Res.,** *1(3), 35-40, 2015*

INTRODUCTION

Population growth accompanied by rapid urbanization causes many disturbances to the natural environment [1] in particular pollution of the Bouregreg River [2,3] from several sources, such as domestic and industrial discharges, lixiviation from landfills and the garbage treatment plant [4]. Indeed, the composition of the wastewater is extremely variable according to their origin [5,6,7]. They may contain many substances, in solid or dissolved form, and many microorganisms. According to their physical, chemical, biological and health characterizations they represent, these substances can be classified into four groups: microorganisms, suspended solids, inorganic or organic trace elements and nutrients [8].In this study we follow the variation of the concentration of some anions: Cl^-, SO_4^{2-}, NO_3^- and HCO_3^- on the conductivity of wastewater discharged into the Bouregreg River for modeling and optimization this parameter in the wastewater discharged into the river by a statistical treatment of analytical findings obtained.

MATERIALS AND METHODS

Sites and samples:

Bouregreg River is one of Morocco's major rivers crossing the Rabatcity and Salecity, and opening out onto the Atlantic Ocean.

Samples collected were performed during 2011 at several sites of discharges of wastewater in the downstream region of the river.

Chemical Analysis:

To study the effect of four anions (Cl^-, SO_4^{2-}, NO_3^- and HCO_3^-) in wastewater, we used a raw wastewater charged on several sites in the region downstream of the river.Wastewater samples were collected using plastic bottles, previously rinsed with distilled water. They were then stored at 4 °C during transport to the laboratory and were analyzed within 24 hours.

Corresponding Author: NabihZerki,Nanostructures Laboratory, Process Engineering and Environment, Department of Chemistry, Faculty of Sciences, University Mohammed V-Agdal, Rabat, Morocco.

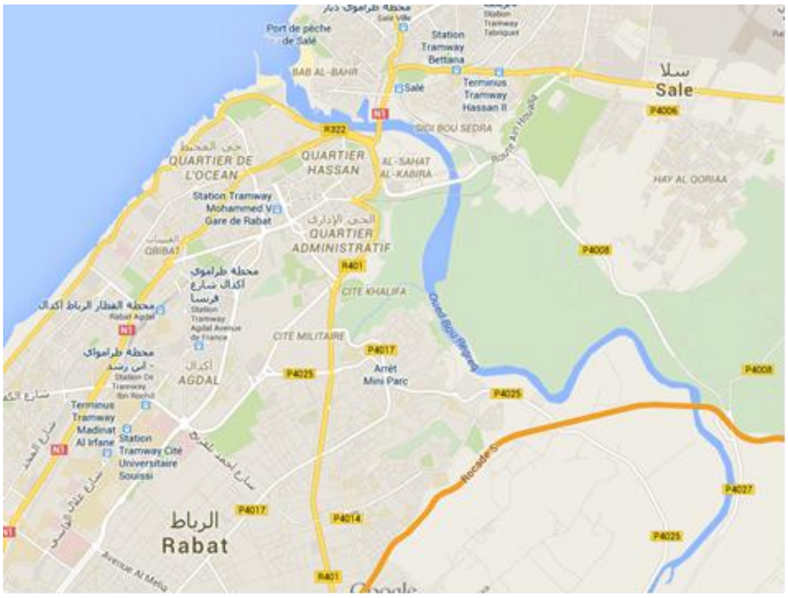

Fig. 1: Location of the Bouregreg River.

For measure the conductivity, the electrode is immersed in the solution and we read the value. The measurement result is shown in µS/cm. the conductivity is measured by the unit CONSORT C831, has a temperature of 19.5 °C.

Statistical Analysis:

To determine the influence of certain chemicals on the variation the value of the conductivity of the wastewater discharged into the Bouregreg river, were determined isoresponses curves of the conductivity as a function of the anions studied using the JMP statistical discovery software [10].

RESULTS AND DISCUSSION

Effect of anions on the waste water conductivity:

The measured results of the wastewater conductivity as a function of the studied anions are given in table 1.

Table 1: Results for the various elements in the waste water conductivity.

sample	conductivity (µS/cm)	$[Cl^-]$ (mg/L)	$[SO_4^{2-}]$ (mg/L)	$[HCO_3^-]$ (mg/L)	$[NO_3^-]$ (mg/L)
wastewater	948	88.75	94.06	384.43	0.61

Modeling the waste waterconductivity:

The raw wastewater used for modeling and optimization of the conductivity was measured with levels of chlorides, sulphates, nitrates and bicarbonates are given in table 1, after it has proceeded to application of a plan experience to know the effect of these elements on the conductivity.

To find out the effect of the four anions on wastewater conductivity, we proceeded to the application of a composite plan for this, we have added four anions (Cl^-, SO_4^{2-}, NO_3^- and HCO_3^-) prepared synthetically from NaCl, $MgSO_4$, $NaNO_3$ and $NaHCO_3$ in 100 mL of the raw sample then we measured the response that the wastewater conductivity according to the protocol composite plan [11,12].

Experimental results:

At a temperature of 19.6 °C, we have measured thewastewater conductivity of the prepared solutions, the pH is around 8.3, and the results found are shown in Table 2, which shows the matrix of experiments:

Interpretation of results:

Using the 31 experiments, we established the mathematical expression connecting the experimental response to the coded variables. The results of calculations of model coefficients of wastewater conductivity are reported in Table 3.

The mathematical model of the conductivity as a function of the four studied anions (Cl^-, SO_4^{2-}, NO_3^- and HCO_3^-) in wastewater conductivity is written as:

$$\mathbf{Y_3\ (cond) = 3828{,}5714 + 2048{,}25.X_1 - 1443{,}75.X_2 - 893{,}75.X_3 + 13582{,}083.X_4 + 3490{,}6696.X_1^2 + 2962{,}625.X_{12} + 3490{,}6696.X_2^2 + 2942{,}625.X_{31} - 2934{,}375.X_{32} + 3493{,}1696.X_3^2 + 2990{,}125.X_{41} - 3259{,}375.X_{42} - 3396{,}875.X_{43} + 3491{,}9196.X4^2.}$$

Table 2: Experimental conditions and measured responses to wastewaterconductivity.

N exp.	X_1	X_2	X_3	X_4	Y (responses)
1	-	-	-	-	1066
2	+	-	-	-	49400
3	-	+	-	-	5310
4	+	+	-	-	51600
5	-	-	+	-	3480
6	+	-	+	-	50100
7	-	+	+	-	7470
8	+	+	+	-	52800
9	-	-	-	+	1394
10	+	-	-	+	49600
11	-	+	-	+	5480
12	+	+	-	+	51700
13	-	-	+	+	3510
14	+	-	+	+	50500
15	-	+	+	+	7520
16	+	+	+	+	53000
17	-2	0	0	0	3790
18	+2	0	0	0	3870
19	0	-2	0	0	3820
20	0	+2	0	0	3840
21	0	0	-2	0	3780
22	0	0	+2	0	3900
23	0	0	0	-2	3830
24	0	0	0	+2	3840
25	0	0	0	0	3830
26	0	0	0	0	3830
27	0	0	0	0	3830
28	0	0	0	0	3820
29	0	0	0	0	3830
30	0	0	0	0	3830
31	0	0	0	0	3830

Table 3: Model Coefficient for the Y values and the standard error of wastewater conductivity.

Coefficients	Estimated Coefficient	standard error	t exp	Confidence level
a_0	3828,5714	6903,199	0,55	0,5868
a_1	2048,25	3728,153	0,55	0,5903
a_2	-1443,75	3728,153	-0,39	0,7037
a_3	-893,75	3728,153	-0,24	0,8136
a_4	13582,083	3728,153	3,64	0,0022
a_{11}	3490,6696	3415,456	1,02	0,3220
a_{12}	2962,625	4566,037	0,65	0,5256
a_{22}	3490,6696	3415,456	1,02	0,3220
a_{31}	2942,625	4566,037	0,64	0,5284
a_{32}	-2934,375	4566,037	-0,64	0,5296
a_{33}	3493,1696	3415,456	1,02	0,3216
a_{41}	2990,125	4566,037	0,65	0,5219
a_{42}	-3259,375	4566,037	-0,71	0,4856
a_{43}	-3396,875	4566,037	-0,74	0,4677
a_{44}	3491,9196	3415,456	1,02	0,3218

A significance level of 50٪ (confidence level 50٪) only the coefficients a_1, a_2, a_3, a_{12}, a_{13}, a_{23} and a_{41}can be considered significant. The estimated wastewater conductivitymodel can be written as:

$$\mathbf{\hat{Y}_3 = 3828{,}6 + 2048{,}3X_1 - 1443{,}8\ X_2 - 893{,}8X_3 + 2962{,}6X_{12} + 2942{,}6X_{31} - 2934{,}4X_{32} + 2990{,}1X_{41}}$$

(±0.55) (±0.55) (±0.39) (±0.24) (±0.65) (±0.64) (±0.64) (±0.65)

X1: the chlorides content;
X2: the sulfates content;
X3:the bicarbonatescontent;
X12: the interaction between chlorides and sulfates;
X31: the interaction between chlorides and bicarbonates;
X32: Interaction between sulfates and bicarbonates;
X41: the interaction between the chlorides and nitrates;

The analysis of this model has led us to exclude the non-significant parameters ([NO_3^-]) and to highlight interactions between chlorides and sulfates, chlorides and bicarbonates, sulfates and bicarbonates, chlorides and nitrates.This last interaction will not be treated because the effect of nitrate is negligible.

Journal of Industrial Engineering Research, 1(3) May 2015, Pages: 35-40

Optimization of wastewater conductivity:

The mathematical model above is found for plotting the response surfaces which are shown in Fig. 2, 3 and 4 which respectively represent the isoresponses conductivity curves in the plans: ([chlorides] (X1)* [sulfates] (X2)), ([chlorides] (X1)* [bicarbonates] (X3)) and ([sulphates] (X2)* [bicarbonates] (X3)) that is to say, the most influential factors.

Optimization of [Cl^-] and [SO_4^{2-}]:

The isoresponses curves of the conductivity represented in Fig.2 show that the optimum of chloridescontent lessto 753 mg/L and a sulphates content less to 403.5 mg/L.

Optimization of the [Cl^-] and the [HCO_3^-]:

The isoresponses curves of the conductivity represented in Fig. 3 show that the optimum of chlorides content is less to 754 mg/L and carbonates content is less to 185 mg/L.

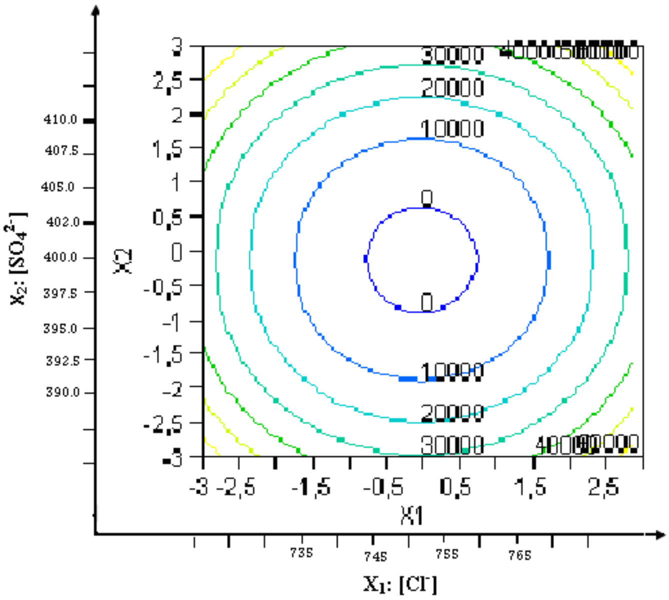

Fig.2: Isoresponses Curves of wastewater conductivity depending on the content of sulfates and chlorides. To: [HCO_3^-] = 175 mg/L, [NO_3^-] = 48 mg/L.

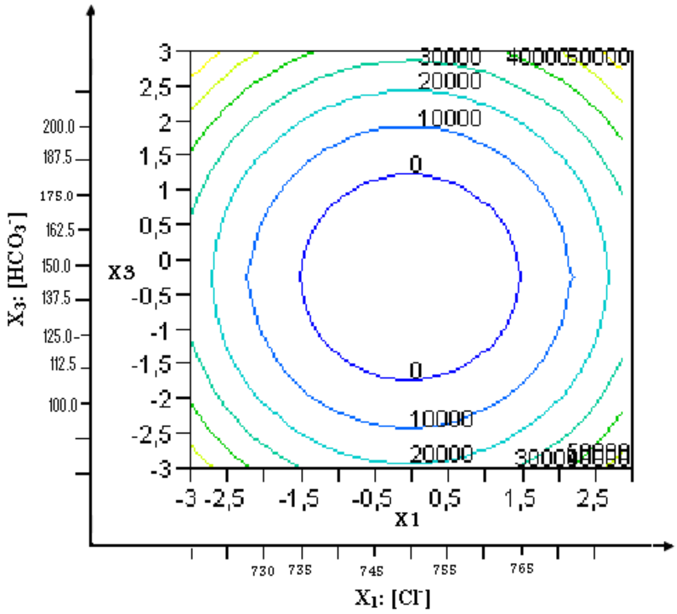

Fig. 3: Isoresponses curves of wastewater conductivity depending on the content of chlorides and bicarbonates. To: [SO_4^{2-}] = 395 mg/L, [NO_3^-] = 46 mg/L.

Journal of Industrial Engineering Research, 1(3) May 2015, Pages: 35-40

Optimization of [SO_4^{2-}] and [HCO_3^-]:

The isoresponses curves of the conductivity represented in Fig.4 show that the optimum of sulphates content less than 151.5 mg/L and content of bicarbonates below to 180 mg/L.

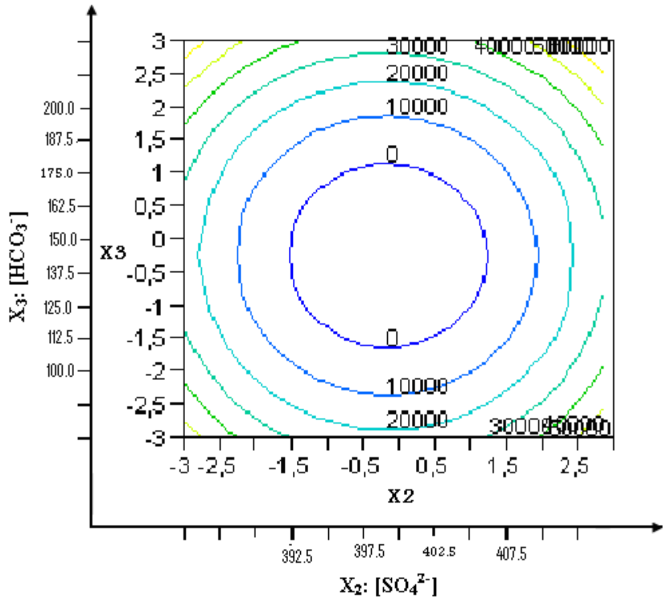

Fig. 4: Isoresponses curves of wastewater conductivity depending on the content of sulfates and bicarbonates. To: [Cl^-] = 760 mg/L, [NO_3^-] = 46 mg/L.

Conclusion:

The experimental research methodology used allowed us characterization, modeling and optimization the conductivity as a function of the four studied anions (chlorides (Cl^-), sulfates (SO_4^{2-}), bicarbonates (HCO_3^-) and nitrates(NO_3^-)) in wastewater discharged into the Bouregreg River.

- Calculate the mathematical model of the wastewater conductivity, written in the following form:

$\hat{Y}3$= 3828,6 + 2048,3X1 -1443,8 X2 -893,8X3 +2962,6X12+2942,6X31-2934,4X32 +2990,1X41.

(±0.55) (±0.55) (±0.39) (±0.24) (±0.65) (±0.64) (±0.64) (±0.65)

With a confidence level of 50%.

- Determination of intervals optimum content of chloride, sulfates and bicarbonates in wastewater discharged into theBouregreg River.

REFERENCES

[1] Mc Kinney, M.L., 2002. Urbaization, biodiversity and conservation.Biosci., 52: 883-890.

[2] Zerki, N., R. Bchitou, A. Bouhaouss, 2011. Characterization of some trace elements in natural waters of the Bouregreg estuary (Rabat, Morocco) by a chemometric study.Phys. Chem. News, 59: 121-126.

[3] Zerki, N., R. Bchitou, A. Bouhaouss, 2012.Modeling and optimization the natural waters conductivity of the Oued Bouregreg (Rabat, Morocco) according to some anions (Cl^-, SO_4^{2-}, HCO_3^- et NO_3^-), First International Colloquium REZAS12, Water resources in the arid and semi-arid regions: challenges and prospects. Case of the African continent, BeniMellal, Morocco.

[4] Technical studies and infrastructure (March 2003), the proposed development of the Bouregreg valley, CID - LPEE - INGEMA – SEGUR.

[5] Fatah, N., J.Bahij, R.Bchitou, A.Bouhaouss, 2007. Waste water purification by lagunage for removal of phosphorus compounds by using the ACP, Phys. Chem. News, 38: 78-83.

[6] Nassali, H., H.Ben Bouih, A.Srhiri,M.Dhahbi, 2005. Influence of the worn water on the lake surface water and surface sediments com position of the lake MerjaFouarate in Morocco, AfriqueScience, 01(1): 145-165.

[7] Zerki, N., R. Bchitou, A. Bouhaouss, 2011.Optimization of analytical data ultrapure water, drinking water and wastewater.1st WorkshopTunisian-Marocco, Treatment and recycling of waste water and biodegradable organic waste, Faculty of Sciences Ain Chock Casablanca.Hassan II University, Morocco.

[8] Belokda, W., 2009.Contribution to management of hospital liquid waste, master engineering of the environment and health, University ChouaibDoukkali El Jadida.

Journal of Industrial Engineering Research, 1(3) May 2015, Pages: 35-40

[9] Zerki, N., R. Bchitou, A. Bouhaouss, 2015.Modeling and Optimization the Conductivity of Natural Waters (Bouregreg River, Morocco) in Terms of Chlorides (Cl^-), Sulfates (SO_4^{2-}), Bicarbonates (HCO_3^-) and Nitrate (NO_3^-), Journal of Industrial Engineering Research, 1(1): 10-14.
[10] JMP Version 3.2 Introduction guide.User's guide and Statistic and Graphics Guide, SAS Institute, USA.1995.
[11] Foucart, T., 1982. Factor analysis microcomputer programming, methods and program. Masson Ed.
[12] Saporta, G., 1978. Theories and methods of statistical,Editions Technip, Paris, pp: 493.