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Environmental Context of the Wastewater Treatment Plant (WWTP) of Batna (Algeria)

Hannachi Abdelhakim* and Gharzouli Rachid

University Ferhat Abbas of Setif 1, El Bez, Setif, Algeria

Abstract

An investigative study was reported on the wastewater treatment plant (WWTP) in Batna city which is located in the Algerian east, in order to highlight the problem of industrials wastewaters pollution and their impact on WWTP function. The average value of "COD / BOD" was reported as high (3.5) compared to the contract value (2.5) which characterize the biodegradable rejection. In addition the concentrations of industrial discharge were higher than the Algerian's standards. Our analyses showed that the daily index measurement Mohlman is 200 mg/ml (≥ 150) which confirm the disruption of the biological process; this is why they must be treated before being discharged. Many solutions should be made to lutter against this problem: Applying the rules, additional treatments and rehabilitation of the WWTP in a more conventional extended aeration process for better elimination of pollution. Finally, for a better understanding of the industrial pollution problem, an obligated characterization of wastewater must be made for each industry to improve the discharge quality.

Keywords: Batna; COD/BOD report; Industrial discharge; Quality; WWTP

Introduction

The increase in wastewater quantities generated by industries in the world presents risks to health and the environment [1]. The countries are trying to find safe ways environmentally to treat and eliminate this wastewater [1]. The large volume of industrial wastewater discharged daily in the wadis, continue to be a real problem of pollution through the territory of the region of Batna.

Liquid industrial wastes from factories, and wash stations, have a negative impact on the quality of wastewater. It is the fact that agricultural irrigation to polluted wastewater is carried out in some parts of the region of Batna with potential impacts on public health. Designed for only 200,000 inhabitants, the wastewater treatment plant of Batna is unable to process the discharge of a considerable volume from homes and other structures rapidly growing large city now but actually more than 299 230 inhabitants in 2012 [2].

The purpose of this work is an investigation at the WWTP of the city of Batna (east of Algeria) to show the problem of industrial wastewater pollution and its impact on the operation of a WWTP purification, since it is necessary to consider the wastewater treatment plant, not as a machine purifying industrial pollution but a satisfactory solution to minimize their impact on the environment.

Description of Wastewater Treatment Plant in the City of Batna

The project of the wastewater treatment plant of the city of Batna (east of Algeria) was started in 2005, which will cost 980 million DZD (about 9 million Euros). It is managed by the National Sanitation Office (NSO) [2], which used to treat 20,000 m^3 per day, or discharging the population rubbishes for 200000 numbers of people.

The wastewater treatment plant for the city of Batna was in service following to the classic procedures of the activated sludge: (normal –medium or average process). In this process, the power of the flow is major sources which cause the erosion of the biofilm as improving the oxygenation operation. The floating water being faster in the said process which requires another circulation before the clarification step. The sludge are lesser oxidized and must be recovered after secondary sedimentation [3].

According to the process mentioned before a field of contact type stabilization, including an average mass loading after a conventional aeration in order to obtain the required elimination of the biological oxygen demand (BOD) (Table 1).

The wastewaters of the sanitation system of the city of Batna, before reaches the wastewater treatment plant crossing firstly el –wadi (this is a loan word from Arabic which means a stagnated water) called: El Gourzi in a culvert of: 1 × 1 m, and suspended above el- wadi, however, if there is an over load of the wastewaters, automatically going to be poured in el- wadi (Figure 1).

Monthly operating reports from January to October were observed. Table 2 lists the average flow and COD / BOD reports (report indicative of biodegradability; COD: chemical oxygen demand) on the entry side, and the effectiveness of treatment. Concerning the power flow during its entering to the WWTP, we notice a regular increase to more than 20 000 m^3 per day in September and October. However the WWTP has been designed for a daily average flow of 19,875 m^3 per day and a maximum flow power in dry weather of 27,210 m^3 / day.

However the average monthly rates of more than 20000 m^3 / day were regularly observed, with some monthly average of more than 22000 m^3/day. The average monthly beginnings were lower because of the dropping in dry weather.

Process performance

The wastewater reaches the wastewater treatment plant of the city of

***Corresponding author:** Hannachi Abdelhakim, University Ferhat Abbas of Setif 1, El Bez, Setif, Algeria, Tel: 00213553189324; E-mail: HAKHANNACHI@yahoo.fr

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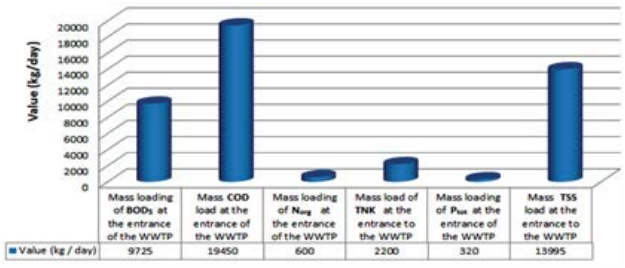
Parameters	Unit	Parameters Value		
		Urban	Industrial	Total
Equivalent habitat	EH	140000	60000	200000
Specific water consumption	l/hab./Day	100	-	-
Rejection rate	-	0.80	-	-
Average flow rejected	m^3/day	11200	8675	19875
Daily peak flow in dry weather	m^3/day	16800	10410	27410
Hourly peak flow in dry weather	m^3/h	1050	600	1650
Hourly peak flow in rainy weather	m^3/h	1575	600	2175

Table 1: Hydraulic loads treated by WWTP of Batna.



Note: N_{org}: Organic Nitrogen; TKN: The Kjeldahl nitrogen includes organic nitrogen (N) and ammonium nitrogen (NH4 +) in the water; P_{tot}: Total Phosphorus

Figure 1: Pollutant's loads.

	Mean monthly flow m^3/day ratio	BOD output		COD output		SM output	
		mg/l	yield	mg/l	yield	mg/l	yield
Month							
January	16216	24	91.0%	109	87.0%	43	87.0%
February	14439	19	91.0%	108	87.0%	46	87.0%
March	17816	15	92.5%	106	85.4%	42	81.6%
April	18970	15	93.6%	103	86.5%	37	82.5%
May	18653	15	94.0%	118	85.7%	46	91.0%
June	19445	12	94.3%	116	86.0%	40	84.0%
July	18508	13	95.0%	105	88.0%	34	89.0%
August	19954	14	95.0%	101	89.0%	28	89.0%
September	20527	18	93.6%	99	88.0%	31	87.0%
October	20186	13	95.0%	100	89.0%	29	88.0%

Table 2: Data from monthly operating reports (January to October).

Batna with the following average characteristics: 211 mg/l of BOD_5, 759 mg/l of COD, 334 mg/l of TSS, 3.59 the COD/BOD report, pH of 7.5 and a temperature of 14°C (Figure 2). Corresponding to the following average costs: 3.12 tons/day of BOD, 11.3 tons/day of COD, 5 tons/day of TSS.

Nature of wastewater from the city of Batna

It should be noted that the monthly values of the indicative biodegradability COD/BOD report is high, compared to the contract value of 2.5 which features a biodegradable urban rejection (Figure 3). It is very significant that the discharge of the city of Batna is characterized by a predominance of non-domestic substances, including industrial oils and hydrocarbons (Table 3).

The industrial zone management company of Batna (EGZIB) faces

Figure 2: Wastewater average characteristics.

a lot of troubles to issue the work. The Table 3 shows, the discharges of several units located in the industrial zone. These ones are directly discharging without prior treatment in the sewerage network (sanitation system), which evacuates directly in the wadi called: El Gourzi, although such phase never being mentioned as a clause in the management contract.

The treatment efficiency

The average concentrations in the output are: 19 mg/l of BOD_5, 108 mg/l of COD, 46 mg/l of TSS. The treatment efficiency is on average 91% removal of BOD_5, 87% removal of COD and 87.6% removal of TSS (Figure 4). Dissolved oxygen is supplied to the biological basin average of 1.77 mg/l.

The field of sludge is extracted and treated about 4506 m^3 of thickened sludge. The pretreatment zone is extracted about 12 m^3 of sand and 6 m^3 for refusing screening (Solids) (Figure 5).

Pollution Sources

The sanitation system in the city of Batna drains urban discharges of almost all parts of the city to wadi El Gouzi and the discharge of the industrial area. The rain water evacuation is also in the wadi El Gouzi thus drains all flow to the basin called: El Maadher through wadi El Maadher. It is signaled that many homes discharge their wastewater directly into el_ wadi El Gouzi [4].

Industrial discharges

In addition to domestic pollution, there is industrial pollution as the majority of production units in the industrial area of the city of Batna are discharging in wadi El Gouzi (Figure 6). Even, many illegal, jewelry shops are discharging directly without treatment in the wadi El Gouzi. The diagnose must be causes of these direct discharges (The characteristics of the water discharged by industrial units are presented in the enclosed table herewith (Table 4).

The norms of the discharge in Algeria

Referring to the maximum settings of discharging into natural outlets are set to be referring to Table 5 (Decree n° 06-141 corresponding to 19 April 2006 regulating discharges of liquid and industrial effluents), we can conclude that besides temperature and pH, the concentrations of wastewater from the industries listed exceed the standards. Therefore, they should be pre-treated before being discharged.

Current Situation in Batna

The polluted and the semi purified Wastewater, are discharged in el- wadi called: El _ Gourzi and goes towards wadi called: El Maâdher

Industrial units	Nature of liquid discharges
ENIPEC	Rejection of 370 m^3/day of industrial wastewater.
COTITEX	Rejection of 470 m^3/day of industrial wastewater.
EMB (cylinder)	Rejection of 60 m^3/day of industrial wastewater containing oils.
GPL	Rejection of industrial wastewater in two pits.
SABA unit (batteries)	Waters loaded acid and lead.
SNTR	Releases waters charged with maintenance oils.
Fuel center	Cooling water discharges.

Table 3: Industrial unit's rejection.

Figure 3: Monthly wastewater COD/BOD report variation.

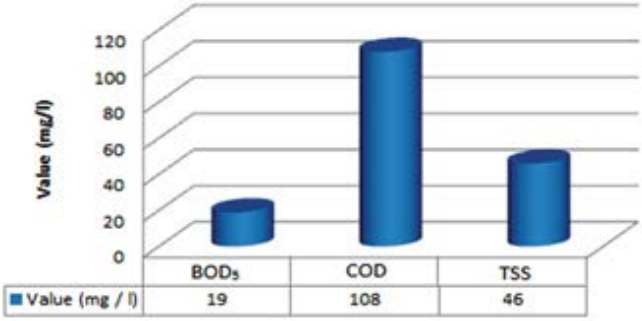


Figure 4: The treatment efficiency of WWTP.

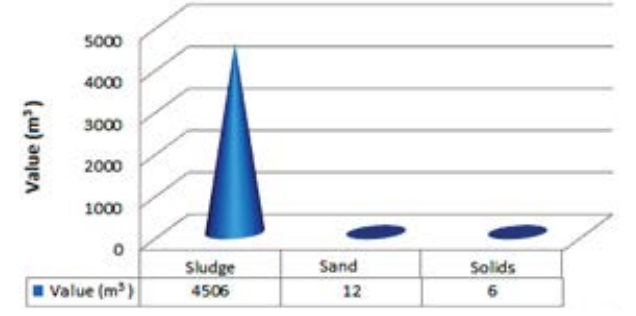


Figure 5: Monthly volume of sludge product by WWTP of Batna.

and taking by the domestic and industrial discharges from cities which contaminate the treated water issued by the wastewater treatment plant of Batna (is a city in Algeria).

Some farmers use the polluted water to irrigate their agricultural lands, the non-compliance of the law from the industrial units which

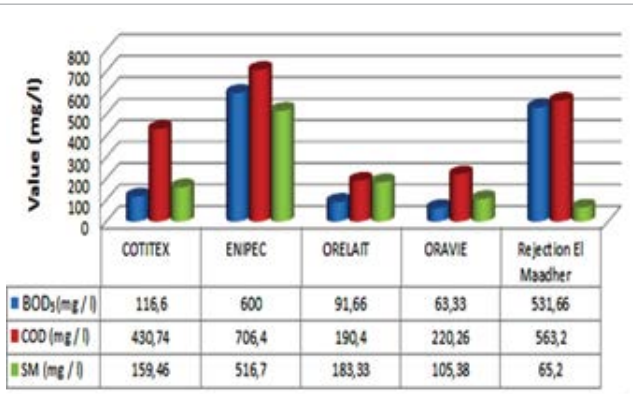


Figure 6: BOD_5, COD and SM characteristics of industrial wastewater.

COTITEX [1]	21	8	13,01	59,73
ENIPEC [2]	20	9	63,9	96,96
ORELAIT [3]	22	9	168,03	33,6
ORAVIE [4]	21	8	/	69,06
Rejection El Maadher [5]	20	7,5	23,06	109,53

Source: The Direction of Environment and Territorial Planning of Batna, 2012) [4].
Note: 1: Complex of Textile; 2: Electrochemical Products Company; 3: milk factory of Batna; 4: Poultry Slaughterhouse; 5: the outlet discharge of the WWTP.

Table 4: Characteristics of industrial wastewater.

they have to be controlled by the environment services in charge. In addition, a considerable number of washing stations spread in the most parts of the cities, they are actually discharging their oil change in the ditches and the canals, instead of being recycled.

Characterization of the Industrial Pollution Impact

Significant emissions of industrial pollutants in the city of Batna are mainly found the out of four industrial units: ORAVIE, ENIPEC, ORLAIT, and COTITEX, due to the nature of the raw materials used in these sectors.

Most of these companies do not have their own wastewater treatment plant but discharging in the WWTP of the city of Batna. The high value of the natural components can explain why because the measurements are carried out in the factories.

Indeed, the daily index measurements Mohlman activated sludge are resulting an average index of 200 mg/ml (≥ 150), which confirms the interruption of biological processes and explains the formation of abundant organic foams in the basin of aeration. The impact of this foam on the purified water is the concentration of Total Suspended Solids (TSS) and COD's both high in the exit of the WWTP.

The problems observed in the upstream sanitation system cannot be controlled because the WWTP does not have a buffer tank. On the quality of wastewater, a COD/BOD rapport is high constantly observed, and indicates the presence of untreated wastewater from industrial sources.

The typical value for an urban effluent is rather between 2 and 2.5. This high ratio may cause several malfunctions: proliferation of foam in aeration basins, disruption of the sludge in the secondary clarifiers.

WWTP represents the last frontier guards for unwanted chemicals contained in wastewater beyond which pollutants may reach easily ecosystems and man [5]. With the growing diversity of chemicals

scattered into the environment, it might be of interest to consider the adequacy between characteristics of the wastewater contaminant load and WWTP characteristics for improvement of pollutant removal [5].

The Solution for Industrial Pollution

The wastewater treatment plant in the city of Batna is currently facing the problem of water units in the industrial area polluted by chemicals. The formal notices sent by direction of Environment and Territorial Planning of Batna to polluting units (COTITEX No. 904 of 19/09/2010, ORELAIT No. 905 of 19/09/2010 and ORAVIE No. 906 of 19 / 09/2010) summed used to treat water before it is discharged into the channel leading to the WWTP had no effect [2].

Algerian standards for industrial effluents

A financing schedule has been set up in Algeria that will help companies to reduce pollution. The most important projects are related to the implementation of wastewater treatment plants. Projects have also been planned, although the projects are currently stopped.

Technical assistance programme from European Union between 2012 and 2015, used to reinforce Algeria's strategic framework for the Water Supply and Sanitation sector, and to improve the efficiency of urban wastewater management and the quality of sewage treatment.

- Law No. 05-12 of 4 August 2005 on water (Official journal of the republic of Algeria No 60. Law N° 05-12 of 04 August 2005 on water).

Art. 119. - Discharge into a public sewerage system or a wastewater treatment plant other than domestic is subject to the prior approval of the authority of water resources. This spill may be subject to an obligation of pretreatment in the case where, in the rough, this wastewater can affect the proper functioning of the public sewerage or wastewater treatment plant.

- Executive Decree No. 09-209 of 11 / 06/2009 laying down the procedures for granting permission to discharge wastewater other than domestic in a public sewerage system or a wastewater treatment plant (Official journal of the republic of Algeria N° 36. Executive Decree No. 09-209 of 11 / 06/2009 laying down the procedures for granting permission to discharge wastewater other than domestic in a public sewerage system or a wastewater treatment plant).

- Law No. 03-10 1 of 19 July 2003 on the protection of the environment in the context of sustainable development (Official journal of the republic of Algeria N° 43. Law N° 03-10 of 19 July 2003 on the protection of the environment in the context of sustainable development).

Art. 10 - The state is monitoring different components of the environment. The state must define the limit values, alert thresholds, and quality objectives, including air, water, soil and. basement, as well as monitoring devices, these recipients and the measures to be observed in special situations.

- Executive Decree No. 06-141 of 19 April 2006 defining the limits of industrial liquid effluent discharge values (Official journal of the republic of Algeria N° 26. Executive order N° 06-141 of 19 April 2006 laying down the limit values for wastewater discharges industrial).

The purpose of this Order, pursuant to the provisions of Article 10 of Law No. 03-10, to define the limits of the discharge of industrials effluents values. It lays down technical requirements for facilities generating such waste and the methods of control, including self, to ensure compliance with emissions limits specified in the Annex to this Order.

Parameters	Units	Maximum Values
Temperature	°C	30
PH	-	5.5-8.5
TSS	Mg/l	30
BOD_5	Mg /l	40
COD	Mg/l	120
Oils Fats	Mg/l	20
Hydrocarbons	Mg/l	20
Detergent	Mg/l	2
Lead	Mg/l	1

Table 5: Discharge standards for industrial effluents in Algeria (Executive Decree n° 06-141 to 19 April 2006).

Rehabilitation of the wastewater treatment plant

Today, in Algeria, most wastewater treatment plants (WWTP) are of the biological activated sludge type. Generally, the effluents are forwarded to a basin where microorganisms in the form of activated sludge proliferate [6].

From a technical point of view, the essential concept of reliability is "probability of success" or "probability of adequate performance", which is the percentage of time that selected treated effluent quality parameters concentration comply with the requirements [7].

Note that in most of the monthly operating reports, pollution problems are exposed, and work is required, including the collector arriving at the WWTP. The observation of these assessments shows us in this instance, improvements are made to the network to allow the WWTP to improve the effectiveness of treatment.

The WWTP will not improve performance without improvements upstream on the network. Processing performance, however generally good regarding measures BOD, COD and TSS. Right next to, nitrogen and phosphorus cannot be treated properly with the process in place for this WWTP.

These settings are also not measured. They should be monitored regularly in order to quantify the problem and provide better treatment, probably with a rehabilitation of the sector. Rehabilitation of the wastewater treatment plant in a more conventional extended aeration process with nitrification-denitrification would be appropriate.

In WWTPs, chemicals that are recalcitrant to biodegradation processes are expected to be removed mostly by sorption on suspended solids and subsequent sedimentation [8].

Given that, any factor that can decrease the sorption rates of these pollutants will have a negative impact on the removal efficiency of the overall treatment process, since sedimentation occurs from the sorbed phase [8]. The reliability of a WWTP is based on knowledge of the process behaviour. Due to the time variability in both quantity and quality of effluent, the treatment plant should be designed to discharge and effluent, which selected to treat effluent quality parameters should remain below a set discharge threshold [9].

Discussion

To the wastewater treatment plant in the city of Batna, a project pipeline for autonomous domestic wastewater is underway to separate domestic wastewater for the said industrial (this project is already studied and going to be e realized by National Sanitation Office NSO), complementary treatment to adjust the quality of treated wastewater will be necessary. The Aspects concerning the planning,

design, operation and maintenance of wastewater treatment plants are available to be covered in Batna. Batna Water Resources Department has received an allocation of 400 million dinars (3.7 million Euros) in the sector development plan (SDP). This amount is intended for the renovation and expansion of Batna sewerage network and the WWTP [2]. In Algeria, the presence of specific discharge standards for wastewater (Decree n° 06-141 corresponding to 19 April 2006 regulating discharges of liquid and industrial effluents) is a promotional project of treated wastewater and a guideline for environmental protection and the fight against industrial pollution. To better understand the problem of industrial pollution, it would be genius to: characterize the discharge of each industry and analyse the process of each industry for the improvement of the effluent quality [10]. The world's chemical industries face formidable environmental regulatory challenges in treating their wastewater effluents. The use of membrane in final stage of industrial wastewater treatments is increasing [11].

The chemical oxidation techniques to treat wastewater, classical chemical treatment and advanced oxidation processes, is discussed. Several physicochemical options and biological wastewater treatment processes are widely utilised in the successful treatment of industrial wastewaters [11].

Recommendations

To conclude, here are recommendations for environmental protection and the fight against industrial pollution:

- Implementing regulations (Decree n° 06-141 corresponding to 19 April 2006 regulating discharges of liquid and industrial effluents).
- Financial incentives for cleanup projects.
- Communication and awareness.
- Any industrial discharge is subject to taxes.
- Separation of domestic and industrial wastewater.
- The rehabilitation of the wastewater treatment plant.
- The serious inspection of industrial emissions into the water.

Conclusion

The results of the investigation showed high monthly values of the indicative rapport of biodegradability COD / BOD relative to the contract value of 2.5 which features a biodegradable urban rejection. This is very meaningful to say that the discharge of the city of Batna is characterized by a predominance of non-domestic substances.

The daily index measures of Mohlman activated sludge are resulting an average index of 200 mg / ml (≥ 150), which confirms the disruption of biological processes and explains the formation of abundant organic foams in the aeration basin. The impact of this foam on the purified water is the concentration of Total Suspended Solids (TSS) and COD's, both high on the exit of the WWTP.

According to the decree n° 06-141 (the maximum values of discharged wastewaters into natural outlets), besides temperature and pH, the concentrations of water from the industries exceed the standards.

For understanding the problem of industrial pollution, it would be better to characterize the release of each industry and to analyse it for the improvement of quality of effluent. Furthermore, rehabilitation work in the sector is highly recommended to minimize the industrial pollution, especially the control of quality of industrial wastewater discharged, the separation of industrial discharge of the domestic and the rehabilitation of the wastewater treatment plant.

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