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WASTEWATER CHARACTERIZATION OF IPEN´S FACILITIES – A PRELIMINARY STUDY

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ABSTRACT

As part of IPEN´s Environmental Monitoring Program, wastewater sample collection and analysis was implemented on a daily basis. CQMA- Centro de Química e Meio Ambiente was responsible for the determination of total, fixed and volatile solids, pH, metals (as Al, Sb, Ba, Cd, Pb, Co, Cu, Cr, Hg, Mo, Ni, Ag, Na, Zn, Ca, Mg, Be, Sn, Li, K, Sr, Ti and V), semimetals (As, B, Se and Si) and anions (such as chloride, nitrate, sulfate and fluoride). The results were compared to the legal values established by the Sao Paulo State regulation 8,468/76, which defines the maximum permitted values for most of the studied substances in wastewater, aiming its releasing in public wastewater treatment system. The evaluation of this parameters concentration on Ipen's effluent implies that 50% of the wastewater corresponds to organic matter due to the sanitary load and inorganic macro elements, mainly as sodium, potassium, calcium. The only parameter not found in accordance with Brazilian legislation was pH in four out of the one hundred and seven samples collected throughout 2009 (2.8% of the samples analyzed). This preliminary study showed the effluents generated at Ipen´s facility is characterized by the presence of organic matter and macro elements, commonly found in sanitary wastewater and it is in compliance with Sao Paulo regulations.

1. INTRODUCTION

Ipen total area covers 478,000 m^2, including two nuclear reactors, one radiopharmacy installation that produces radioisotopes for treatment and diagnosis, several laboratories and manufacture buildings, that supports production and research. All those activities include the use of many hazardous and controlled substances. The proper manipulation, treatment and disposal consist in a safety, health and environmental concern. Due those activities an environmental monitoring plan was started on October 2007. At that time an effluent collection and monitoring station was installed at North Entrance of Ipen.

This work will discuss the conformity of the effluent results with the applicable law. In that case, the Sao Paulo State decree 8468/76 [1], especially the article 19A that establishes physical and chemical conditions (see Table 1) that approves effluent launching on public sewer system. For those compounds analyzed on Ipen´s monitoring plan and not contemplated on Decree 8486, it was used the legal standards for launching on natural courses of water, established by CONAMA´s resolution 357, article 34 [2], complemented by CONAMA resolution 397 [3].

Table 1 : Maximum value permitted for effluent launching on public sewer system, according to article 19A Sao Paulo State Decree 8468/76 [1].

Parameter	São Paulo State Decree 8468/76 art. 19-A
pH	≥6 and ≤10
Temperature	<40°C
Settable material	≤ 20 mL/L
N-Hexane Extractable Material	≤ 150 mg/L
Light organic solvents(1)	Absent
Total Arsenic *	≤ 1.5 mg/L
Total Cadmium *	≤ 1.5 mg/L
Total Lead *	≤ 1.5 mg/L
Total Copper *	≤ 1.5 mg/L
Hexavalent Chromium(1)	≤ 1.5 mg/L
Total Mercury *	≤ 1.5 mg/L
Total Silver *	≤ 1.5 mg/L
Total Selenium *	≤1.5 mg/L
Total Chromium *	≤ 5.0 mg/L
Total Zinc *	≤ 5.0 mg/L
Total Tin *	≤ 4.0 mg/L
Total Nickel *	≤ 2.0 mg/L
Total Metal Content (Sum of all assigned metals*)	≤ 5.0 mg/L
Total Cyanide (1)	≤ 0.2 mg/L
Total Phenols	≤ 5.0 mg/L
Soluble Iron	≤ 15 mg/L
Fluoride	≤ 10.0 mg/L
Sulfide (1)	≤ 1.0 mg/L
Sulfate	≤ 1000 mg/L

(1) Not monitored.

2. METHODS

2.1. Sample collection, treatment and analysis:

The sewer collector that services Ipen is connected by a tubular network that starts at Rua do Matao and goes up to Barueri Public Sewer Treatment Station (ETE-Barueri), from SABESP. At Ipen's Effluent Monitoring station, located at Travessa R, close to Ipen's North entrance it is performed all effluent sample collection.

One 20mL grab sample was collected every day for pH and temperature measurements. One composite effluent sample was collected by pumping 1.5L per hour for 8 working hours (from 8 a.m. to 4 p.m.) from Monday to Friday. The composite sample was divided, preserved and stored according the recommended standard procedure [4]. The legal and monitored parameters are listed on Table 1.

2.2. Analytical procedure:

The effluent was analyzed by International Standard approved techniques such as ICP-OES, GF-AAS, and Ion Chromatography. The complete procedure is described elsewhere [5, 6, 7, 8].

3. RESULTS

The effluent results obtained during the year 2009 (from February to December) are presented in Table 2. It is also presented the average concentration above quantitation limit, minimum and maximum values obtained along the year. All results were below legal values established by federal and state regulations [1, 2, 3].

No concentration above quantitation limit was found for trace elements as copper, mercury, chromium, antimony, beryllium, molybdenum, titanium and vanadium. Elements such as nickel, iron, barium, boron, manganese, zinc, and with minor frequency of occurrence, arsenic, cadmium, lead, silver and selenium were found below State Decree 8468/1976 [1]. In order to characterize the effluents chemically, very sensitive analytical techniques were applied, which allowed achieving sample quantitation limits required for drinking water.

Most of the target analytes found in effluent were macro elements such as sodium (from <0.20 to 70.5 mg/L), potassium (from 0.69 to 28.9 mg/L), calcium (from <0.20 to 28.3 mg/L) and silicon (from 4.79 to 7.58 mg/L). The most frequent anions found were sulfate, chloride and nitrate. Among them, only sulfate is regulated by state decree (Table 1). However, sulfate global average obtained for Ipen effluent (21.1mg/L) represents only 2% of the legal value (1000 mg/L). Performing similar comparison considering the monitored parameters (ratio between mean sample levels and legal values), it is observed that Ipen effluent is characterized by the presence of those elements in concentrations between 1 and 5% of the legal values.

Concerning the samples analyzed on a daily basis, from February to September 2009, pH results are presented in Figure 1. It was performed a total of one hundred and seven measurements throughout 2009, and only four results were non-compliant to Article 19A from State Decree 8468/76 [1] which corresponds to 0.9% of total studied samples.

The total, fixed and volatile solids results from 2009 are presented in Figure 2. The sum of fixed and volatile solids provides the total solid value. This analysis allows the estimation of inorganic and organic matter, and also salt content in an effluent sample. Fixed solids include mainly all inorganic salts, stable at high temperature (550^{o} C). Volatile salts correspond to inorganic compounds such as ammonia and carbonate salts, and also organic matter [9]. As seen in Figure 2, total solid content was between 300 and 584 mg/L, fixed solids were between 146 and 320 mg/L and volatile solids varied from 154 to 327 mg/L. By the obtained results, it is possible to conclude that 50% of Ipen´s effluent is composed by organic matter, the other 50% is composed mainly by macro elements such as sodium, potassium, calcium as observed in Table 2. This result usually corresponds to sanitary wastewater, from household activities.

Ipen has an internal policy that segregates all the non-radioactive, hazardous material, such as heavy metals, organic solvents or compounds from nuclear, radiopharmacy production and academic activities, for reduction and later disposal by immobilization and incineration once a year. It is launched in the sewer mostly lavatory, bathroom, restaurant and glassware washing sinks effluents, those effluents have similar composition with sanitary effluents as observed so far. The results presented in this paper confirm that policy has been successfully applied.

Table 2 : Monitored parameters, in Ipen's effluent (from February to December 2009).

Parameter	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
Total Solids	471	300	584
Fixed	224	146	320
Volatile Solids	251	154	347
As *	0.001	<0.001	0.001
Cd *	0.001	<0.0001	0.003
Pb *	0.006	< 0.001	0.023
Cu *	< 0.020	< 0.020	< 0.020
Hg *	< 0.0008	< 0.0008	< 0.0008
Ag *	0.007	< 0.002	0.011
Se *	0.001	< 0.001	0.002
Cr *	< 0.010	< 0.010	< 0.010
Zn *	0.039	0.008	0.200
Sn *	0.087	< 0.060	0.087
Ni *	0.015	< 0.010	0.027
Total metal (Sum of *)	0.050	0.013	0.233
Soluble Fe	0.398	<0.020	3.330
Fluoride	0.645	0.300	1.000
Sulfate	21.11	0.70	114.30
Ba	0.025	<0.010	0.072
B	0.186	<0.020	0.634
Mn	0.030	0.004	0.077
Al	0.026	<0.001	0.214
Sb	<0.001	<0.001	<0.001
Be	<0.002	<0.002	<0.002
Ca	14.41	<0.20	28.30
Chloride	61.36	25.50	98.60
Co	0.017	<0.010	0.025
Sr	0.087	0.065	0.123
Li	0.015	<0.010	0.019
Mg	2.67	<0.20	5.38
Mo	<0.010	<0.010	<0.010
Nitrate	2.02	<0.05	15.00
K	21.26	0.69	28.90
Si	5.59	4.79	7.58
Na	45.46	<0.20	70.50
Ti	<0.040	<0.040	<0.040

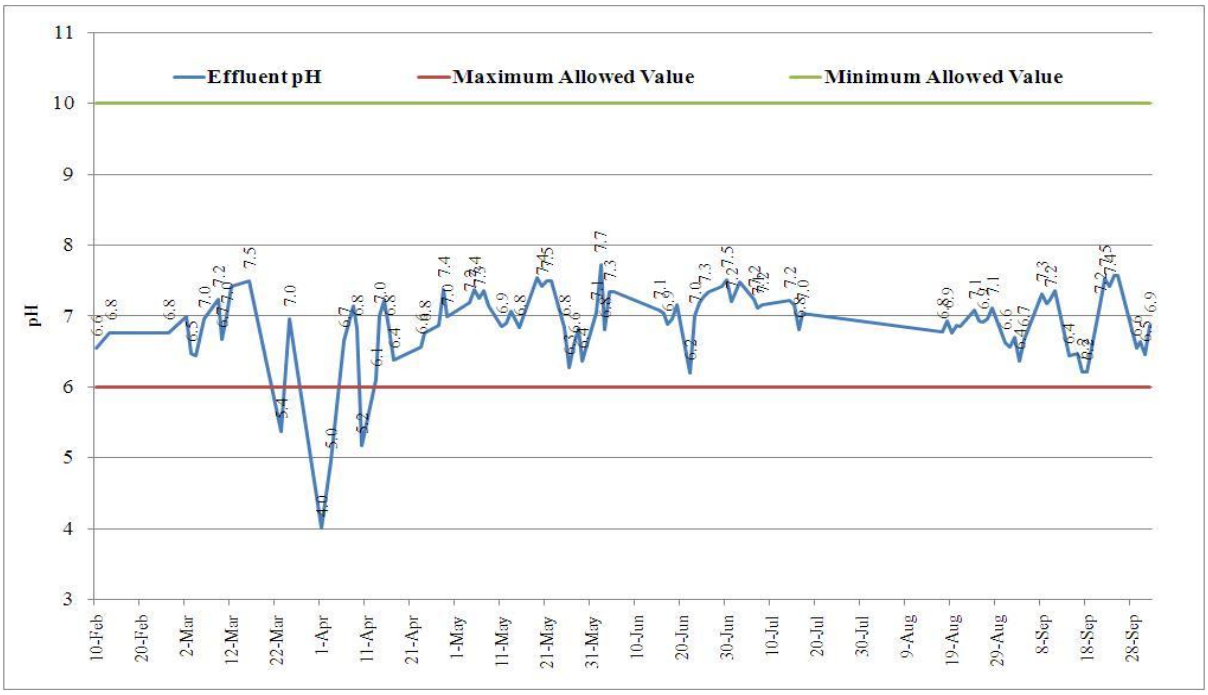

Figure 1: Ipen's effluent pH results, measured from February to September 2009.

Figure 2: Total, fixed and volatile solids present in wastewater samples collected in 2009.

4. CONCLUSION

The implementation of Ipen´s Environmental Monitoring Program made possible to keep a record of some stable chemical compounds released by Ipen´s effluent and to characterize the nature of this effluent. Based on the results herein presented, it was possible to notice that all the monitored parameters on Ipen´s effluent were in accordance with regulatory limits legislated by Sao Paulo State on its decree 8468/76 (articles 19 and 19-A). The single exception was on pH measurements, corresponding to 0.9% from the total of analysis performed. Ipen´s effluent was in average between 1 and 5% from the maximum allowed value for release on public sewer system. Based on those evidences it is possible to conclude that no environmental impact was caused by this effluent release along 2009.

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