PH Analysis of an Wastewater Treatment Plants (WWTP) in a Paper Recycling Industry

Haroldo Sávio Albuquerque Soares
haroldosaviosoares@gmail.com
FAMETRO University Center – Brazil

Fabiana Rocha Pinto
fabiana.floresta@gmail.com
Engineering Coordination at FAMETRO University Center – Brazil

David Barbosa de Alencar
david002870@hotmail.com
Galileo Institute of Technology and Education of the Amazon – ITEGAM

Manoel Henrique Reis Nascimento
hreys@bol.com.br
Galileo Institute of Technology and Education of the Amazon – ITEGAM

Abstract

The paper industry in its production process consumes a large amount of water, and the flow of effluent is very variable, being related to the manufacturing process used in production capacity. Effluents are formed by complex mixtures of chemical compounds. The wide composition variability among the effluents from the most diverse origins, added to the market entry of numerous chemical substances every year, which will become part of the effluents, makes the complete characterization of its composition very difficult. To characterize the effluent, some parameters are analyzed, which may be physical, chemical or bacteriological. The pH, which is directly related to the coagulation efficiency, as it influences the chemistry of the coagulants, their reactions in the aqueous environment, the predominant hydrolysed species and the variation in surface charge of colloids present in the effluent, where in the aqueous system it is typically measured by use of a pH meter. Therefore, the objective of this study was to perform an effluent treatment plant (ETE) analysis of a paper recycling industry, the inlet and outlet flow values of the WWTP, using the pH parameter, comparing the dry periods, flood and transition from August 2018 to July 2019. Initially, a survey of technical documents related to the effluent treatment process and the verification of the standard norms, in use in the Industry WWTP was carried out. The collections were performed bimonthly, observed at times that did not interfere in the results and identified according to CONAMA Resolution, nº 430/2011. The pH values obtained at the WWTP revealed an improvement in the quality of the effluent treated in accordance with current legislation. However, although the effluent was adequate for the release pattern, the high toxicity found in the inlet and outlet pH of the WWTP, evidences the need to define new treatment and / or control strategies to comply with the legislation regarding this parameter.

Keywords: Wastewater Treatment Plants; Paper industry.

1. Introduction

From the economic point of view, the relevance of industries for the different production processes is unquestionable, however they are often sourcing responsible for major pollution, including water, caused by environmental contamination, generated by improper disposal of waste, where they do not have a system. efficient and applicable management.

The paper industry in its production process consumes a large amount of water, and the flow of effluent is very variable, being related to the manufacturing process used in production capacity. Considering the characteristics of the pulp and paper industries, with regard to water consumption, the generation of liquid effluents and the current crisis in water resources, highlights the need for efficient treatment of their wastewater and simple release into receiving bodies.

According to [1], water pollution occurs when its nature is altered or its legitimate uses are impaired due to the addition of substances or forms of energy. This pollution can cause various effects on water bodies, such as oxygen consumption problems, waterborne diseases, different odors, among many others.

Among the different forms of dumping, one of the most serious is industrial wastewater that contains a considerable amount and variety of chemicals that affect public health and the environment if released to untreated water bodies [2].

Effluents are formed by complex mixtures of chemical compounds. The large composition variability among the effluents from the most diverse origins, added to the entry into the market of numerous chemical substances every year, which will become part of the effluents, makes the complete characterization of its composition very difficult [3].

Proper wastewater treatment requires strict control of the system used, in addition to understanding the influence of toxic compounds on the purification process and how efficient the toxic load removal system is, which is often measured by COD reduction (Chemical Oxygen Demand), BOD5 (Biological Oxygen Demand), toxicity, or other compound whose removal is indispensable for final disposal [4].

To characterize the effluent, some parameters are analyzed, which may be physical, chemical or bacteriological. One example is turbidity, due to the presence of suspended matter in water, which decreases its transparency. Turbidity is a parameter used to identify the interference that light suffers when passing through the liquid [5].

Another parameter to be analyzed is Oxygen Demand, which according to [5], are linked to organic compounds, chemicals that contain carbon, hydrogen, oxygen, nitrogen, sulfur and / or phosphorus, which may be present in the effluent and biologically and chemically oxidized, demanding oxygen.

Biochemical Oxygen Demand (BOD) is the measure of oxygen required for bacteria to destroy organic matter, indicating the amount of oxygen needed for microorganisms to oxidize organic compounds. It can also be used to size equipment, measure process efficiency and ultimately assist as an indicator within the process of environmental standards [6].

As the COD is recognized as an indicator of effluent treatment, it can be used to evaluate the pollution load in relation to the amount of oxygen required for its total oxidation in CO_2 and H_2O. Therefore, the lower the BOD and COD values, the lower the organic load and effluent pollution capacity [5].

[7] points out that the analysis of COD values in effluents is one of the most expressive analyzes to determine its degree of pollution. Performed COD analyzes, the value obtained indicates an estimate of the oxygen consumption that an effluent discharged directly into a water body would require. If the amount of organic matter present in this effluent could be mineralized, the higher value of this parameter indicates a higher effluent pollution content [8].

Another parameter is achieved by turbidity, measured by the property of light transmission through water, related to the colloidal and suspended residual material, which is based on the comparison of the scattered light intensity in the sample with the amount of water dispersed in a solution. under the same conditions and correlated with the suspended solids concentration [9].

Another important indicator is hydrogen potential, better known as pH, which is determined at various stages of water treatment as it can affect numerous processes. An acidic pH (below 7) indicates that water or effluent is corrosive and can damage pipes; a basic pH (above 7) indicates that they are foul, which can also damage appliances [5].

The pH is directly related to the coagulation efficiency, as it influences the chemistry of these coagulants, their reactions in the aqueous environment, the predominant hydrolyzed species and the variation in the surface charge of colloids present in the effluent, where in the aqueous system is typically measured by the use of a pH meter [10].

Large industries, whose production process requires high water consumption, are potential generators of large volumes of liquid effluents, such as pulp and paper industries, which demand water at all production stages and can generate life-effluent effluents. water and the environment. Thus, it becomes the sixth largest environmental polluter, given all its contribution of environmental losses, in the most different areas [11].

Therefore, the objective of this study was to perform an analysis at a Wastewater Treatment Plant (WWTP) of a paper recycling industry, evaluating the inlet and outlet flow values of the WWTP, using the pH parameter, comparing the periods. from drought, flood and transition from August 2018 to July 2019.

2. Materials and Method

Initially, a survey of technical documents related to the effluent treatment process and the verification of the standard norms in use in the ETE of a paper recycling industry was carried out.

The collections were performed bimonthly, observed at times that did not interfere in the results and identified according to CONAMA Resolution [12], during the established period (Table 1).

Table 1 - Collection Period by Season

Period	Season
August to October - 2018	Dry Season
November to January - 2019	Transition Station
February to April - 2019	Rainy season
May to July - 2019	Transition Station

Source: Own authorship (2019).

Samples were collected from 1000 ml polyethylene bottles and taken directly to the laboratory. Since this condition is given in less than an hour, there is no need for refrigeration according to NBR [13].
The samples of the collected effluents were sent to the industry service laboratory, Analytical Center, registered with the Amazonas Environmental Protection Institute (IPAAM), for the analysis of the Ph, by the Electrometric Method (4500-H + B) SMEWW. [14]
The variation of the pH during the seasons was verified, being identified which ones generate the largest amount of effluent, describing the reasons for the increase of the effluent flow.

3. Results and Discussion

Industrial and domestic effluents should be treated by mixing with water from aquatic environments that are seriously contaminated with heavy metals and organic matter, reducing or extinguishing many types of aquatic life and also generating an environment conducive to other non-aquatic species. desirable. In addition to rivers and lakes, groundwater has been contaminated through seepage, septic tanks, sinks or industrial wastewater reservoirs [15].
In Brazil, the discharge of industrial effluents is regulated at the federal level by Resolution [12]. This Resolution, dated May 13, 2011 in its wording provides on conditions, parameters, standards and guidelines for the management of effluent discharge into receiving water bodies.
Eco-toxicity tests allow the assessment of environmental contamination by various polluting sources, such as: agricultural, industrial and domestic effluents, sediments, medicines and chemicals in general, as well as to evaluate the resultant of their synergistic and antagonistic effects [16].
Strategies for reducing effluent toxicity primarily involve knowledge of the production processes, associating the raw materials and inputs used, as well as the effluent treatment process [17].
Toxicity testing has been employed to monitor industrial effluents in order to minimize environmental impact, evaluate the efficiency of treatment plants and comply with legal requirements. The analyzes carried out in an effluent as required by the environmental agency are insufficient to relate to toxicity and sometimes the limits set for effluent release patterns present toxicity to at least one of the trophic levels analyzed. Based on this information, strategies and targets for reducing effluent toxicity on solution characteristics can be defined [17].
The characteristics of a solution depend largely on the solute contained in it. There are substances that do not react with the medium and do not interfere with its balance, while acids and bases, when dissolved, ionize or dissociate and alter the amount of H^+ and OH^- of the medium, making it acid or alkaline [18].
The pH values obtained in the paper industry's TEE were represented in the table and graph, showing larger oscillations in the dry-rain season with Input 8.14 and Output 7.21; and smaller oscillations during the Dry-Rain season with Input 5.21 and Output 5.18, proving that they are in accordance with Resolution [12] which determines a pH range between 5.0 and 9.0 (Table 2). .

Table 2 - Industrial ETE Stations Period

Industrial (WWTP)		
Station	pH Input	pH Output
Rain	6,1	6,52
Dry Rain	8,14	7,21
Rain Dry	5,21	5,18
Rain	6,82	6,85
Average	6,568	6,440
Standard deviation	1,238	0,886
95% CI	1,213	0,868

Source: Own authorship (2019).

The pH or hydrogenic potential is a parameter that indicates the acidity, neutrality or alkalinity of an aqueous solution, determined by the concentration of hydronium ions. The values vary on a scale from 0 to 14, being acidic - pH below 7, basic - pH above 7 and neutral - pH 7, which can be measured using the pH meter [18].

The pH condition of the effluents results from the contamination caused by the various industrial manufacturing processes. The contact of water with substances such as caustic soda, caustic potash, lime, among others, releases a highly harmful alkaline final effluent to water sources, requiring a corrective solution to reduce pH to tolerable levels. Inorganic, sulfuric and hydrochloric acids are generally used for industrial effluents. The damage caused by these aggressive acids and the high risks arising from their use and problems during transport can seriously compromise the environment [19].

Often the pH measurements obtained using equipment without proper calibration and control may be indicating values allowing the discharge of effluent at pH within the established environmental standard; However, in reality, non-compliance may be occurring due to lack of knowledge of the uncertainty of these values. And uncertainty can only be established when the traceability of measurements is known [20].

PH is the measure of the acid balance of a solution, defined as the negative logarithm of hydrogen ion concentration. The pH values are related to natural factors, such as rock dissolution, atmospheric gas absorption, organic matter oxidation and photosynthesis, and to anthropogenic factors due to the disposal of domestic and industrial sewage, due to the oxidation of organic matter and acid washing. tanks respectively [1].

The data show the average pH range for 6.56 at Input and 6.44 at Output with standard deviation of 1.23 and 0.88 respectively (Figure 1).

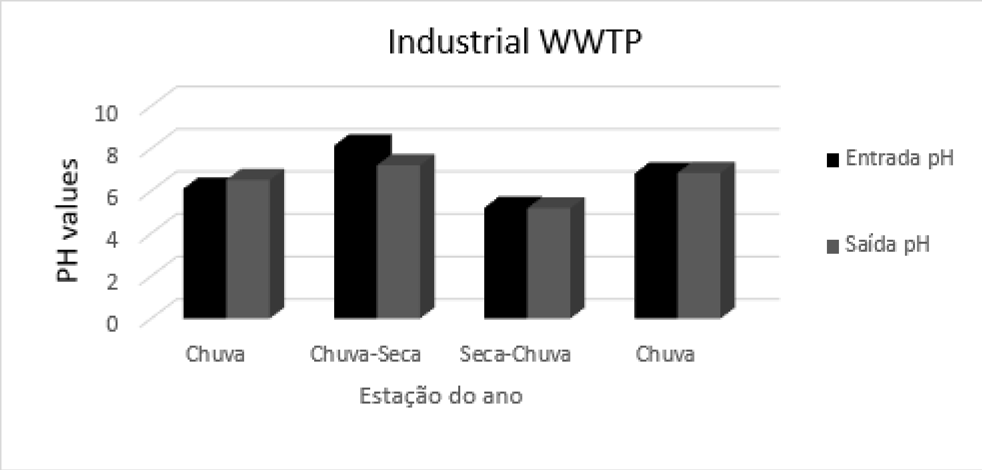

Figure 1. Input and output values in an effluent at different seasons of an industrial WWTP.
Source: Own authorship (2019).

[21] concludes that the pH should remain close to neutrality, and assigns a range of 6.5 to 7.5 as the ideal pH for anaerobic digestion to occur; aiming at higher methane production in the system the pH should be between 6.8 and 7.2.

From the value obtained it can be said, based on {21], that the system was within neutral limits, not making possible problems to the treatment system in this regard. A possible alternative to be indicated for the TEE of the analyzed industry is the feasibility of its exploration for the methane gas formed in the process, due to its pH in the range of higher production of this gas during the dry-rain transition season.

The composition of the effluent and its respective concentrations in the sample is due to several factors, such as: time of collection, rainfall or drought, industrial sewage network clandestinely connected to the collection system and presence of various constituents. Another relevant factor that may change the system is the presence of toxic compounds and the upward flow velocity and inadequate tributary pH, as well as possible mechanical failures may influence the efficiency of the biological treatment process. These requirements directly affect the treatment process and are a fundamental cause of fluctuations in the values of the physicochemical standards of analysis [1].

4. Final Considerations

The analysis of the obtained results reveals an improvement in the treated effluent quality, in compliance with the current legislation regarding the physical and chemical parameters. However, although the effluent was adequate to the release pattern, the high toxicity found in the input and output pH of the wastewater treatment plant evidences the need to define new treatment and / or control strategies to comply with the legislation regarding to this parameter.

It can be observed that the final pH result with the associated uncertainty indicated values confirming that there are control conditions for discharge purposes, when considering the allowable limits of pH 6.0 to 9.0 for the region where the treatment station is located.

Importantly, care should also be taken with the electrodes used for pH measurement. Inadequate maintenance can lead to poor measurement quality. Using meters and electrodes not suitable for use would invalidate all results. Estimating the uncertainty of the measurements thus obtained would be meaningless.

5. References

[1] SPERLING, M.V. **Introdução à qualidade das águas e ao tratamento de esgotos**. 4 ed. Belo Horizonte: UFMG, 2017.

[2] FUNGARO, D.A.; IZIDORO, J.C.; BRUNO, M. **Aplicação de material zeolítico sintetizado de cinzas de carvão como adsorvente de poluentes da água**. Eclética Química. São Paulo, V.34, n.1, p. 45-50, 2009.

[3] MANNARINO, C. F. **Avaliação do tratamento combinado de lixiviado de aterros de resíduos sólidos urbanos e esgoto doméstico utilizando indicadores físico-químicos e biológicos**. 2010. 125 p. Tese – Doutorado, Fiocruz - Fundação Oswaldo Cruz, Rio de Janeiro, 2010.

[4] OLIVEIRA, G.S.S.; ARAÚJO, C.V.M.; FERNANDES, J.G.S. **Microbiologia de sistema de lodos ativados e sua relação com o tratamento de efluentes industriais: uma experiência da Cetrel. Engenharia Sanitária e Ambiental**. V.14, n.2, p.183-192, 2009.

[5] GAUTO, M. A.; ROSA, G. R. **Processos e operações unitárias da indústria química**. Rio de Janeiro: Ciência Moderna, 2011.

[6] JORDÃO, E. P.; PESSÔA, C. A. **Tratamento de esgotos domésticos**. 5. ed. Rio de Janeiro: Synergia, 2009.

[7] BRAGA, E. D. A. S. **Avaliação da biodegradabilidade das águas de lavagem provenientes da etapa de purificação do biodiesel produzido com óleo extraído das vísceras de tilápia**. REGA, Porto Alegre (RS), v. 9, n. 2, p.35-45, jul./dez. 2012.

[8] LINS, G. A. **Impactos ambientais em estações de tratamento de esgotos (ETEs)**. 2010. 236 f. Dissertação (Mestrado) – Programa de Pós-Graduação em Engenharia Ambiental, Escola Politécnica e Escola Química, Universidade Federal do Rio de Janeiro. Rio de Janeiro, 2010.

[9] LIBÂNIO, M. **Fundamentos de qualidade e tratamento de água**. 3. ed. Campinas, 494 p. 2010.

[10] ARAÚJO, J. E. **Processos de tratamento terciário para redução da DQO e cor dos efluentes de uma fábrica integrada de celulose Kraft branqueada e papel**. 2013. 68f. Dissertação (Mestrado Profissional em Tecnologia de Celulose e Papel). Universidade Federal de Viçosa, Viçosa, 2013.

[11] KLIDI, N. ***Applicability of eletrochemical methods to paper mil wastewater for reuse***. *Anodic oxidation with BDD and TiRuSnO2 anodes. Journal of Electroanalytical Chemistry*. v. 815. p. 16-23. 2018.

[12] BRASIL. Ministério do Meio Ambiente, Conselho Nacional de Meio Ambiente, CONAMA. **Resolução CONAMA nº 430, de 13 de maio de 2011**.

[13] NBR 9898. **Preservação e técnicas de amostragem de efluentes líquidos e corpos receptores**. Rio de Janeiro, 1987.

[14] APHA. ***Standard Methods For the Examination of Water and Wastewater***. 22 ed. Washington, DC: APHA, 2012.

[15] VALENZUELA, J. **Tratamento de Efluentes Industriais em Indústrias Galvanotécnicas**. 2 ed. São Paulo: Páginas e Letras, 2008.

[16] MAGALHÃES, D. P.; FILHO, A. S. F. A Ecotoxicologia como ferramenta no biomonitoramento de

ecossistemas aquáticos. **Oecologia Brasiliensis**. v.12, n.3, p. 355-381, 2008.

[17] OLIVEIRA, J.M.; AREND, C.O.; GERBER, W.D. **Dossiê técnico: toxicidade em efluentes industriais**. Porto Alegre: Centro Nacional de Tecnologias Limpas, 2011.

[18] PERUZZO, F. M.; CANTO, E. L. **Química: na abordagem do cotidiano: volume 2: físico-química**. 4. ed. São Paulo: Moderna, 2006.

[19] FILHO, E. A. F.; CHUI, Q. S. H. **Qualidade de medições e neutralização de efluentes alcalinos com dióxido de carbono**. Eng. Sani. Ambient. Vol II – nº 2 – abr/jun. 2006.

[20] OLIVEIRA, E. C. **Qualificação da exatidão de um medidor de pH pelas suas fontes de incerteza**. In: METROLOGIA 2003 - METROLOGIA PARA A VIDA, 01 a 05/09/2003, Recife, Pernambuco, promovido pela Sociedade Brasileira de Metrologia (SBM), 2003.

[21] MEYSTRE, J. A. **Partida de um reator UASB, em escala piloto, para tratamento de efluente doméstico: estudo de caso para a região da Serra da Mantiqueira**. 2007. 128f. Dissertação (Mestrado em Ciências da Engenharia da Energia), Universidade Federal de Itajubá, Itajubá, 2007.