International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 6, pp: 689-962 www.ijaem.net ISSN: 2395-5252

Performance Evaluation of Industrial Wastewater Stabilization Ponds in Brazil

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Date of Submission: 15-09-2020 Date of Acceptance: 29-09-2020

ABSTRACT: The objective of this paper is to analyse the removal of organic matter through the performance of stabilization ponds of the vegetable oil extraction industry. For that specifically, it features and verifies the operation of two stabilization ponds built-in series, one of them an anaerobic type and the other a facultative aerated type. The research is characterized as a case study that uses laboratory analysis to evaluate the collected material and discussion of results. It appears that the residual water from the stabilization ponds analysed in this specific case, presents an effective performance, pointing to superior results than the limit already specified in Brazilian Standards.

KEYWORDS: Stabilization ponds; industrial effluent; treatment plants.

I. INTRODUCTION

[1].The industrialization of oilseeds is currently one of the most important processes in the agribusiness system. Such importance is due to the demand for its products and its by-products in the bioenergy, cosmetics, and raw material industries like food processing for human and animal consumption.

[2].Crude vegetable oils are extracted using solvent hexane. In this type of extraction, the oil is depleted of the oleaginous material through the commercial solvent hexane distilled from petroleum.

The equipment that performs this operation is the continuous extractor that leaves the oleaginous material impregnated with the solvent.

After the extraction of oil contained in the soybean, the mixture of oil and hexane solvent is called miscella, from which the solvent is recovered by evaporation in a closed circuit, leaving the crude oil, still slightly contaminated with solvent. The wastewater generated by the process ofcrude oil extraction of soybeans has a high concentration of organic matter in terms ofchemical oxygendemand (COD), biochemical oxygen demand (BOD), and fat, oils, and greases (FOG), which can cause significant impact if released in its raw form, into the environment.

The equipment necessary to reduce the concentration of organic materials (FOG) and oxygen demands (COD and BOQ) in such wastewater, that fits legalstandards foremissions to the environment has been adopted as a treatment plant consisting of a sedimentation box, ponds anaerobic and aerated facultative pond.The limits established in the Brazilian environmental standards will be presented in this paper, later on.

The flowchart for the extraction of soybean vegetable oil by hexane solvent used by this industrial plant is shown in Figure 1.1. It is visible that from the preparation sector to the final process where the wastewater is discharged, there is a complex trajectory composed of many stages.

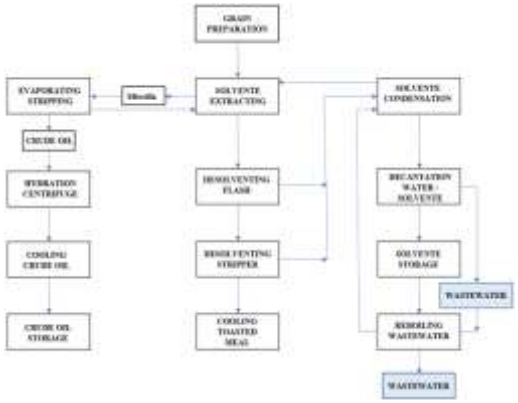

Fig 1.1 - Extraction of soybean vegetable oil by a hexane solvent

Prevention and reduction of pollution caused by wastewater can be achieved by direct means of recycling and reusing it or by using different treatments.

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[3].The biological treatment or biotreatment of wastewater and solid waste employs the joint action of different species of microorganisms in reactors that, operated under certain conditions, result in the stabilization of organic matter. This treatment system must meet some important aspects such as the reduction of organic matter (reduction of biochemical oxygen demand (BOD) and supply of effluents in conditions that do not affect the balance of the final receiving system and meet the relevant environmental legislation.

The operation followed by the monitoring of biological wastewater treatment systems must be guided by specific federal and state legislation.

[4].The São Paulo State Act No. 8,468 / 1976, updated by Act 54,487 / 2009 [5], establishes the emission standards for effluents from different activities. Article 18 of this Act establishes quantitative limits for the discharge of liquid effluents directly into water collections.

The main limits fixed by Act no. 54,487 / 2009establishes the standard indicators for the emission of effluents and are presented in Table 1. Among the main indicators are temperature, the pH that indicates the level of acidity, neutrality or alkalinity of a solution, the amount of sediment, the presence of oils and greases, and the five days biochemical oxygen demand (BOD).

Act 54,487:2009 - Emission limits for liquid effluents	
pH	5.0 - 9.0
Temperature	Less than 40ºC
Sedimentable materials	Until 1,0 ml/l in 1.0 hour of Imhoff Settling Cone test
Oils and greases (FOG)	No oil and greases and maximum concentration of 100 mg / l of substances soluble in hexane
Biochemical oxygen demand BOD - 5 days	Maximum of 60 mg / l at 20ºC

Table 1 –Emission limits forliquid effluents

The stabilization pondsare kind of large tanks that have little depth and whose purpose is to treat raw wastewater, using for that purpose, only natural processes. [6]. Theseponds are bioreactors, with relatively shallow, lentic water, built to store specific wastewater, such as domestic and industrial wastewater, and should result in the stabilization of organic matter through biological processes. Biological treatment can take place under anaerobic, facultative or aerobic conditions, according to the availability of dissolved oxygen in the water.The predominant biological activity, the affluent organic load, the physical characteristics of each unit designed to treat raw wastewater or pre-treated effluents, by natural and artificial processes. [7]. The stabilization ponds are systems in which the effluents are treated biologically by natural processes involving mainly algae and bacteria and are considered one of the main techniques currently used for effluent treatment, due to their lower costs and simple operations, The stabilization of organic matter is processed at slow rates, which creates the need for an extended period of hydraulic retention, generally around 20 days.

The objective of anaerobic pond is the removal of biochemical oxygen demand (BOD) and suspended solids. In Brazil, due to high ambient temperatures, BOD removal reaches 50% to 70% of wastewater, and the removal of suspended solids reaches around 70% [8].

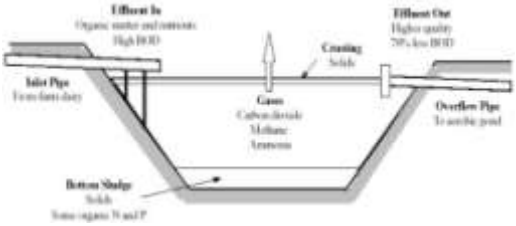

Fig 1.2 –Anaerobic pond

The anaerobic pond built before the facultativepond reduces the organic load of the raw wastewater effluent. This installation in this position aims to reduce the area required in the facultative pond.[9]. Facultativepond represents in their stratigraphic profile an anaerobic layer (close to the bottom) and another aerobic layer (close to the surface). As a result of this stratification, the constant organic load in the effluents is removed through these two biochemical processes - aerobic and anaerobic degradation.

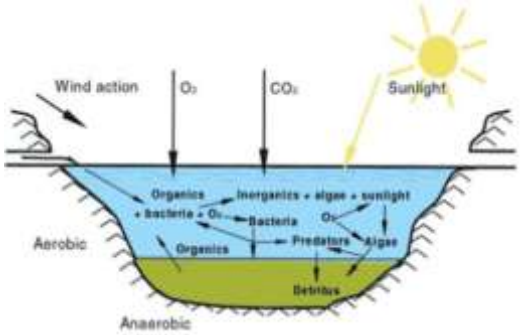

Fig 1.3 – Facultative pond

The main biological reactions that occur in facultative ponds include the decomposition of organic matter by facultative bacteria, nitrification of nitrogenous organic matter by bacteria;

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production of oxygen in the upper layer through photosynthesis of microalgae, and reduction of organic matter (part of the suspended BOD that is deposited down) by anaerobic bacteria at the bottom of the pond. There is a balance between the oxygen consumed by bacteriaresponsible for the degradation of organic matter and the oxygen produced by algae [10].

II. OBJECTIVE

The main objective of this paperevaluates the performance of the liquid effluent treatment station of an industrial plant for the extraction of crude soybean oil, built with a conventional oil separator, anaerobic pond, and facultativepond, located inland of the Sao Paulo State / Brazil.

Fig. 2.1 – Liquid effluent treatmentinstalation

III. METHODOLOGY

To achieve the proposed objective, a bibliographic search was performed based on published materials, scientific articles published in electronic media, and specific books. The analysis laboratory of the University of Ribeirão Preto - UNAERP, collected the liquid effluents from the extraction of vegetable oil, before and after the treatment.

The wastewater used to research this paper comes from an industrial plant for the extraction of crude soy oil, located inland the State of São Paulo, in the Alta PaulistaRegion.This industrial plantprocesses 1,800 tons of soybeans daily, producing 315 tons of crude oil and 1,440 tons of bran.

The wastewater from the production process is treated in a system that consists of sedimentation of suspended solids, removal of fat, oils, and greases, and stabilization ponds, the first being the anaerobic pond and the second isa facultative pond.

The flowchart for the liquid effluent treatment station of an industrial plant for the extraction of crude soybean oil is shown in Figure 3.1.

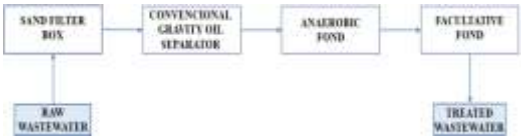

Fig. 3.1 – Liquid effluent treatment flowchart

In this case study, the anaerobic pond has a useful volume of 3,840 m³ and a detention time of 20 days, and the facultativepond has a useful volume of 4,800 m³ and a detention time of 25 days. The average depth of the ponds is 4.50 m.

For the pick-up of the samples, were followed the recommendations of NBR 9898/1987 of the Brazilian Association of Technical Standards (ABNT), which establishes the conditions for the collection and preservation of samples and liquid effluents, both domestic and industrial, as well as water samples. sediments and aquatic organisms.

IV. RESULTS AND DISCUSSION

Table 2 shows the average annual values of the physical-chemical parameters for the characterization of the industrial soybean oil extraction plant (inlet) and the effluent treated in the stabilization pond system (outlet).

Composition of wastewater		
	Inlet	Outlet
pH	7.7	7.1
Sedimentable materials (mg/l)	1.8	< 0.1
Temperature (°C)	42,0	20,0
Fat, oils, and greases (mg/l)	430,0	24,0
BOD (mg/l)	325,0	22,0
COD 9mg/l)	643,0	94,0

Table 2–Composition of wastewater

The fraction of the total solids present in the wastewater is not significant and is of organic origin and can be digested by biological processes. The average removal of solids was almost complete.

The pH values of the pond system effluent remained in the range of 6.9 to 7.3, with an average pH of 7.1, proving that the phases of acidogenesis and methanogenesis are in balance.

The concentration of oils and greases for the effluent from the pond system was 24 mg / l, most of which was removed in the sedimentation and separation box and oil.

The studied pond system showed an average COD removal of 85.3% and an average BOD reduction of 93.2%, above the 70% predicted in the technical literature. This difference may be

associated with the large volume of the facultativepond, which had a detention time of 25 days. (The COD - Chemical Oxygen Demand analyzes were performed due to the request of CETESB - Companhia Ambiental do Estado de São Paulo).

V. CONCLUSION

Based on the results of the laboratory analysis, it was possible to evaluate the performance of the stabilization pond system and it presents an efficient operation since it converted the organic material into effluent treated with a physical-chemical parameter below the quantitative limits regulated by the legislation.

This reduction was presented in terms of COD, below even what has been recorded in the specializedliterature of the matter, which is around 70%, and in the case studied it reached 85.3% and in terms of BOD is 93.2%.

The results denoted that the low cost of implementing the stabilization ponds, as well as the simplicity in the operation process, are profitable indicators that it is a very viable and efficient solution for the treatment of wastewater, both for the COD and the BOD.

REFERENCES

[1]. Moises, M. M., 2011, "Estudo do tratamento de efluentes de um complexo industrial com vistas a melhoria do sistema," Master degreethese. Universidade Estadual de Maringá – Br.

[2]. Cereto, A. C., 2004, "Integração energética da rede de trocadores de calor em extração por solvente para produção de farelo branco de soja," Master degreethese. UFRGS – BR.

[3]. Miwa, A. C. P., 2007, "Avaliação do funcionamento do Sistema de tratamento de esgotos de Cajati, Vale do Ribeira, em diferentes épocas do ano," Master degreethese. USP – BR.

[4]. São Paulo State, 1976, "Classificação dos corpos de água no Estado de São Paulo," Act 8,468. BR.

[5]. São Paulo State, 1976, "Altera e incluem dispositivos e anexos na 997 Law," Act 54,487. BR.

[6]. Silva Filho, P. P., 2007, "Diagnostico operacional de lagoas de estabilização," Master degreethese. UFRGN – BR.

[7]. Silveira, A. G. M., 2011, "Análise de eficiência e confiabilidade em sistemas de baixo custo de tratamento de esgotos do tipo lagoas de estabilização," Master degreethese. UFC – BR.

[8]. Takeuti, M. R. S., 2003, "Avaliação de desempenho de uma estação de tratamento de esgoto por lagoas de estabilização com chicanas," Master degreethese. UNESP – BR.

[9]. Oliveira Neto, G. S. and Santos, H. I., 2007, "Análise de eficiência das lagoas facultativas da estação de tratamento de efluente municipal de Inhumas – Goiás. Source:https://www.yumpu.com/pt/document/read/15807752/1-analise-da-eficiencia-das-lagoas-facultativas-ucg

[10]. Passos, R. G., 2012 "Avaliação de desempenho de lagoas de estabilização por meios de dados monitorados e modelagem fluidodinâmica computacional (CFD)," Master degreethese. UFMG – BR.