# EFFECT OF ADDING AN ANAEROBIC LAGOON TO A TWO-LAGOON SYSTEM FOR WASTEWATER TREATMENT OF AN INDUSTRIAL PLANT

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## ABSTRACT

The efficiency of a three-lagoon system for the treatment of organic waste from a plant involved in fly sterilization was evaluated during 23 months period. The addition of a third anaerobic lagoon ($9^{th}$ month) to the initial system of two aerobic lagoons remarkably decreased the biochemical demand of oxygen ($BOD_5$) to levels stipulated by Mexican law. It was observed that the improvement in water quality of the effluent of the system was a consequence of a better treatment process. The biochemical demand of oxygen ($BOD_5$) was reduced by 97% which met the legal requirements. The constant maintenance and improvement in the treatment system reported a decrease in effluent values down to 4.9 mg $BOD_5$/ml. The nitrogen, measured as Total Kjeldahl Nitrogen (TKN), was bellow the standard (<40 mg/l as TN). However, erratic behaviors were observed for phosphorus (P-$PO_4$) and a stabilization of the parameter in accordance with the standards was achieved in the last year of the study. Although the percentage of reduction of $BOD_5$ was above 90%, there was a lack of data for other parameters to monitor the efficiency of the system in an integral perspective.

## INTRODUCTION

### AREA OF STUDY

The Mexican-American Commission for Eradication of the Worm (*Cochliomyia hominivorax*) that affects livestock, has a massive fly sterilization project in Chiapas, the southernmost state of Mexico. This industrial plant, located close to Tuxtla Gutiérrez,

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discharges its effluent in the man-made reservoir of Chicoasén, formed by a large hydroelectric dam. The plant is a prototype for programs of biological control through insect sterilization resulting in eradication without the use of insecticides (Guillén-Trujillo et al., 2001). This program has been very successful in exterminating fly infestation. The current production in the plant is around 143 million sterile insects per week, of which 3 million are dispersed in the surrounding area for security reasons; the rest are sent to Costa Rica, Panama and Jamaica. (CMAEGBG, 1999).

## WASTEWATER TREATMENT SYSTEM

The objective is to treat the biological materials that are generated in the process of production of sterilized insects. In order to achieve Mexican water quality requirements (NOM-001-ECOL-1996), the plant initially had a treatment process that consisted of two aerobic lagoons. An anaerobic lagoon was later added at the front end of the system . The organic waste generated in the production process is basically the diet that the insect consumes during its larva stage. The composition, in dry weight, consists mainly of: blood (6%), eggs (4%), milk (4%), gel (2%), and water (84%) (CMAEGBG, 1999).

## METHODS

The laboratory methods used for $BOD_5$, Total Kjeldahl Nitrogen (TKN) and Total Phosphates ($P\text{-}PO_4$) were those specified by Mexican law. According to NOM-001-ECOL-1996, the maximum concentrations allowed for discharge in reservoirs of public use, are 75, 40 and 20 mg/l for $BOD_5$, Total Nitrogen and Total Phosphorus, respectively (CNA, 1999).

## RESULTS AND DISCUSSION

During the first 8 months of the study, the treatment system initially consisted of two aerobic lagoons. In the 9th month of the study, a third lagoon was added at the front end of the system. This lagoon, 4.5 m deep with a hydraulic retention time (HRT) of 8 days, was kept under anaerobic conditions and used as a sedimentary tank. Seventeen air diffuser units were updated in the second lagoon (2.5 m depth with a HRT of 32 days). The last aerobic lagoon (2 m depth and a HRT of 11 days) continued working as a polishing system.

Figure 1 illustrates the biochemical oxygen demand ($BOD_5$) required by law and the results of the analyses done during the 23 months of study. This parameter was not within the legal limits during the first 9 months. However, since the 10th month, when the anaerobic lagoon was added and the air diffusers were updated, a remarkable reduction in $BOD_5$ was observed. The level of reduction of the $BOD_5$ (Figure 2) was around 97%, complying with federal law.

The nitrogen at the effluent of the system was reported as Total Kjeldahl Nitrogen (TKN). There was no available data related to other forms of nitrogen (i.e. nitrates, total nitrogen). Figure 3 shows a comparison between TKN at the effluent of the system and Total Nitrogen required by law. More data is needed to report the efficiency of the system in removing nitrogen.

Phosphorus content in the residual waters was analyzed as total phosphates ($P\text{-}PO_4$). No other forms of phosphorus were measured. Figure 4 compares phosphorus measurements as $P\text{-}PO_4$ versus Total Phosphorus (TP) as set by law. During the thirteen months of the study, the phosphorus content was below legal limits (20 mg/l). However, an increase in phosphorus content was observed in the following months during the study. Additional information is not available to explain these variations.

## CONCLUSION

The addition of an anaerobic lagoon to the initial system of two aerobic lagoons, and the replacement of the air diffusers improved the water quality of the plant's effluent that is discharged into the reservoir. As a consequence, the plant complied with federal law, in regard to the content of organic matter measured as $BOD_5$), some forms of nitrogen and phosphorus. The percentage of reduction of $BOD_5$ was initially around 90%, and improved to 97% because of the new treatment system improvements. Removal efficiency of nitrogen was not calculated because data related to nitrogen was available only in the form of TKN. Phosphorus content (as $P\text{-}PO_4$) showed some variations during the period of study. Additional information is needed to explain these variations. Other parameters (i.e., fecal coliforms) should be monitored to include information related to the removal efficiency of the system as a whole.

## BIBLIOGRAPHY

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# APPENDIX

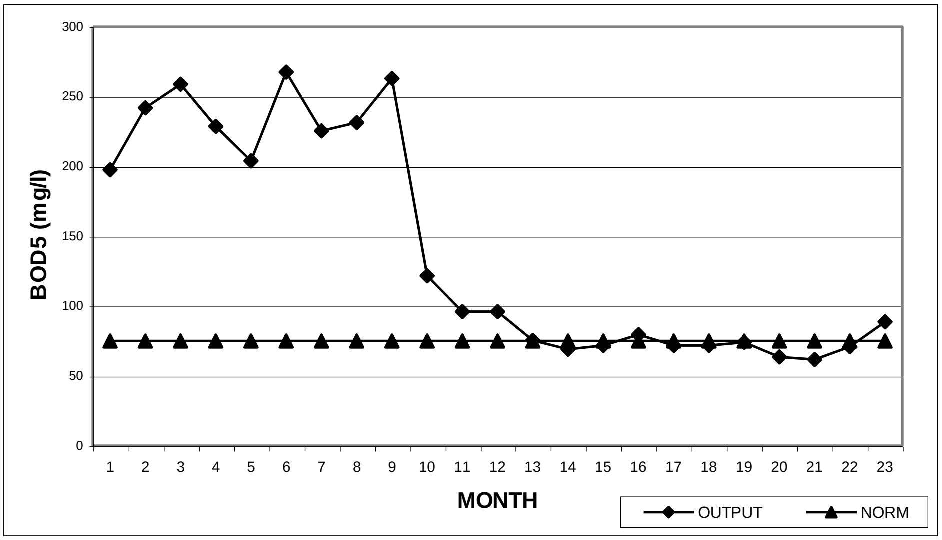


Figure 1. Effluent $BOD_5$ versus $BOD_5$ Required by NOM-001-ECOL-1996.

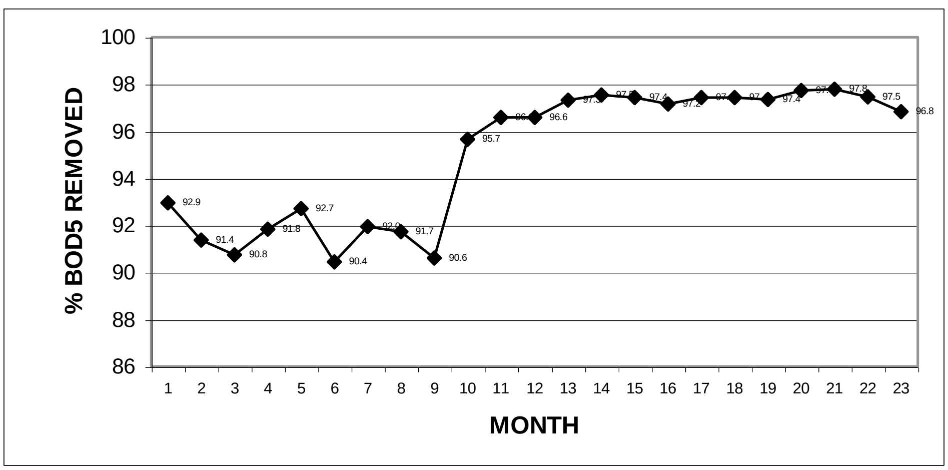


Figure 2. $BOD_5$ Removal Efficiency of the Three-Lagoon System.

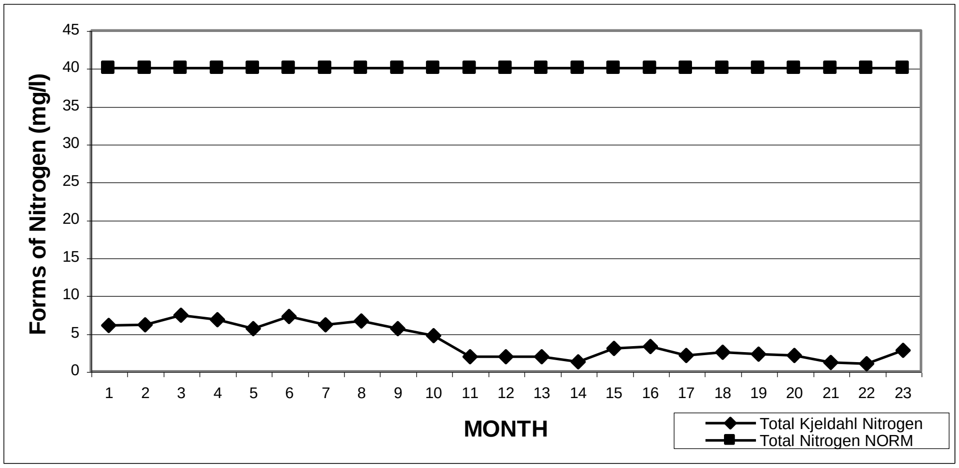

Figure 3. Effluent TKN versus TN Required by NOM-001-ECOL-1996.

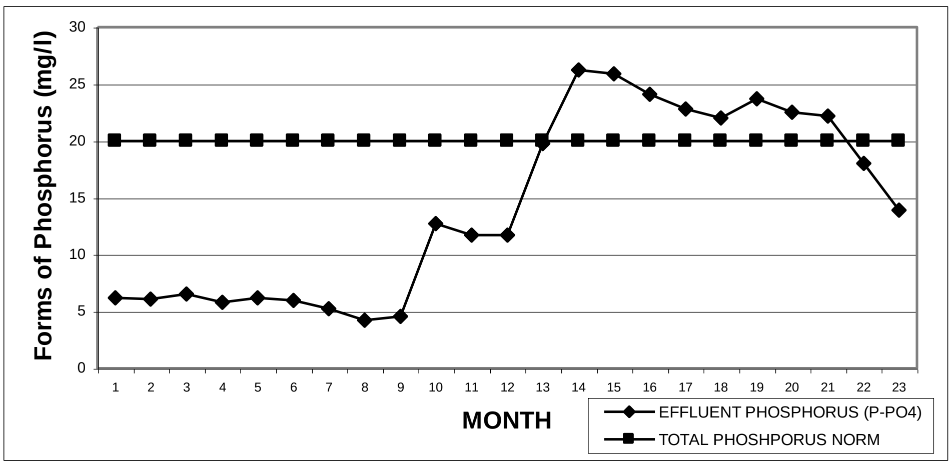

Figure 4. Effluent $P\text{-}PO_4$ versus TP Required by NOM-001-ECOL-1996.