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Reduction of the pollutants concentration in the effluents of the fish canning industry using air nanobubbles, Callao

[Reducción de la concentración de contaminantes en los efluentes de la industria de conservas de pescado utilizando nanoburbujas de aire, Callao]

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Resumen

La presente investigación se realizó con el propósito de evaluar la reducción de los contaminantes de los efluentes provenientes de la industria de conservas de pescado utilizando nanoburbujas de aire. El estudio se realizó a escala de laboratorio utilizando un equipo generador de nanoburbujas de aire. Los resultados obtenidos fueron reducción en 89,5 % de sólidos suspendidos totales (de 6180 mg/L a 645 mg/L), 76,5% de DBO5 (de 7350 mgO2/L a 1730 mgO2/L), 73,6% de DQO (de 10356 mgO2/L a 2735 mgO_2/L) y 79.4% de aceites y grasas (de 96,3 mg/L a 33,2 mg/L). Se concluyó que el tratamiento mediante nanoburbujas de aire logra reducir significativamente la concentración de los contaminantes presentes en los efluentes de la industria de conservas de pescado.

Palabras clave: Nanoburbujas, efluentes, conservas de pescado, reducción

Abstract

The present investigation was carried out with the purpose of evaluating the reduction of pollutants in the effluents tested from the fish canning industry using air nanobubbles. The study was carried out on a laboratory scale using air nanobubble generator equipment. The results were reduced by 89.5% of total suspended solids (from 6180 mg/L to 645 mg/L), 76.5% of BOD5 (from 7350 mgO_2/L to 1730 mgO_2/L), 73.6% of COD (from 10356 mgO_2/L to 2735 mgO_2/L) and 79.4% of oils and fats (from 96.3 mg/L to 33.2 mg/L). It was concluded that the treatment using air nanobubbles can significantly reduce the concentration of the pollutants present in the effluents of the fish canning industry.

Keywords: Nanobubbles, effluents, canned fish, reduction

1. Introduction

The direct consumption fishing industry has been driving the economy in the Port of Callao by notably increasing its production levels (PRODUCE, 2016; PRODUCE, 2017). On the other hand, despite the environmental effort that the productive fishing industrial sector has been developing, environmental implications persist, polluting the beaches and seas of the Peruvian coast in general; due to the direct discharge of its effluents without prior treatment to the home sewerage network, and worse still, discharging its wastewater directly into the sea, not complying, in most cases, with the environmental quality standards (ECA) or with the maximum permissible limits

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(LMP) stipulated in current environmental legislation (MVCS, 2009). These direct and illegal discharges cause the deterioration of the quality of the receiving waters, being the case of the seas and rivers the most vulnerable due to the damage, in some cases irreversible, of the marine and river ecosystems, generating a negative impact on the economy. regional and local.

This research focuses on the environmental problems generated by the effluents generated by the canned fish industries, which in most cases do not have pollutant removal systems prior to dumping, mainly due to the high costs of operation generated by conventional treatment systems such as activated sludge or dissolved air flotation. This is where nanotechnology appears as an alternative of sustainable solution through the use of nanobubbles that has shown high efficiency in the removal of pollutants from wastewater in various industrial processes.

Here are some investigations in this regard: flocculants and coagulants removed fats from 80.13% to 91.57% and in SST from 69.97% to 83.67% (Cipiran, 2012). Polyaluminium Chloride (PAC) and Sodium Oleate (NaOl) achieved an increase in the efficiency of wastewater clarification by 40% compared to the typical coagulation process. In addition, a removal of more than 95% of the turbidity and total solids was evidenced (Tsai et al., 2007). García et al (2016) chitosan extracted from the shell of lobsters Panulirusargus achieved a removal of total suspended solids (SST) of 89.5% and chemical oxygen demand (COD) of 30.4%, while with the chitosan acetate a removal was achieved SST and COD of 84% and 23.9% respectively.
Micro-nanobubbles can be applied in environmental issues; and other areas; where a problem is sought to be solved, the fields of application of these tiny bubbles are detailed below. (Valverde, 2016; Abate and Valverde, 2017; Valenzuela and Valverde, 2018).

2. Materials and Methods

The sample was collected after the unit sterilization process (autoclave) of a factory that produces canned fish in the Callao district, taking approximately 8 liters to determine the initial values of contaminants and 24 liters for the laboratory experience. The treatment of the sample was carried out using an air nanobubble generator system patented by Dr. Jhonny Valverde Flores, taking treatment intervals of 30 minutes for a total time of 120 minutes. Samples were taken at the end of each time interval (30, 60, 90 and 120 minutes of treatment) and sent to be analyzed in a laboratory accredited by the National Quality Institute (INACAL), in order to determine the final parameters. of pollutants and carry out their reduction calculations.

Figure 1. Fat flotation in the upper part of the outlet container

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3. Results and discussions

Results before and after nanobubble treatment of the effluents from the fish canning industry.

After having carried out the treatment of the effluent sample from the fish canning industry using air nanobubbles in the established time intervals, the sample was transferred to the laboratory to determine the initial and final values of the contaminants.

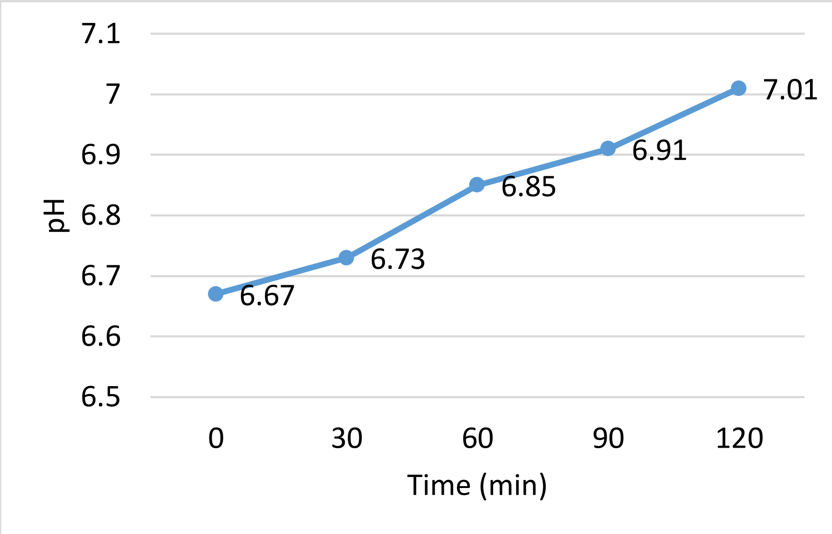

Figure 2. Variation of pH over time

Figure 2 shows the behavior of the pH during the entire treatment time, showing that this parameter did not suffer significant variations. From an initial pH value of 6.67 it only increased to 7.01 at the end of the treatment. The final pH value is within the range allowed by the D.S. 021-2009 - Housing - Maximum Admissible Values, which is from 6 to 9.

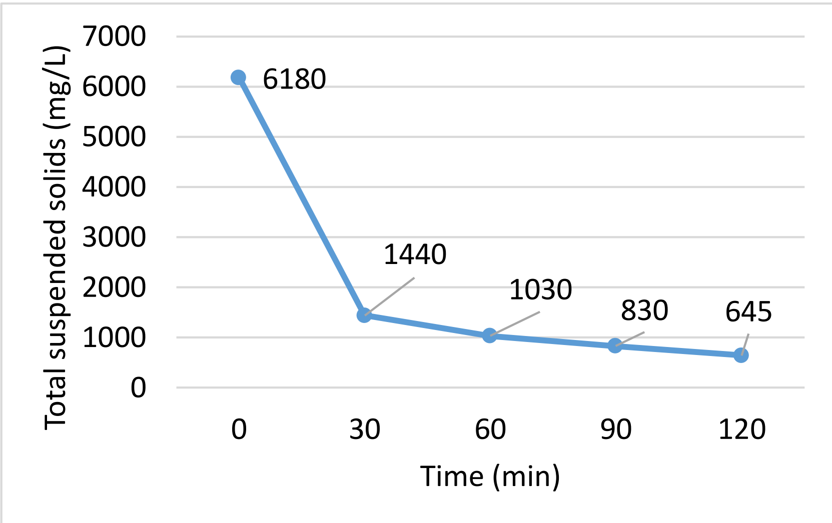

Figure 3. Variation of Total Suspended Solids through the treatment time.

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Figure 3 shows a large reduction in baseline SST values in just half an hour (76.7%). After all the treatment (120 min) a total reduction of 89.5% of total suspended solids was achieved. From an initial TSS value of 6180 mg / L it could be decreased to 645 mg / L, which shows a very significant reduction. The final value of Total Suspended Solids (645 mg/L) exceeds the Maximum Admissible Values (500 mg/L); however, this figure could have been lower if they had continued with the treatment.

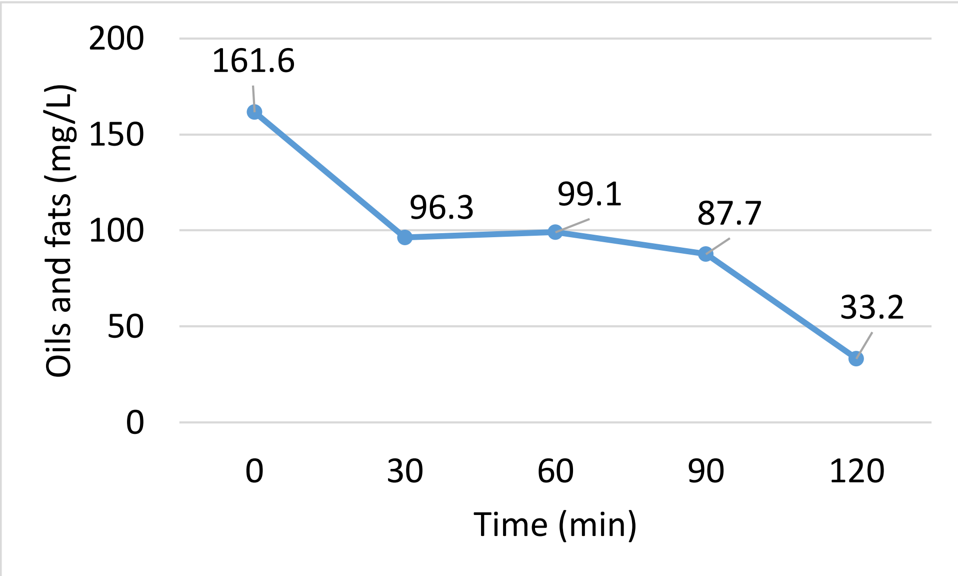

Figure 4. Reduction of Oils and Fats through the treatment time.

Figure 4 shows an anomaly with respect to the oil and fat values of the sample taken 30 minutes after starting the treatment. From an initial value of 161.3 mg/L until the end of the treatment time (2 hours) was possible to reduce this parameter to 33.2 mg/L, registering 79.4% of treatment efficiency. The final value of Oils and Fats of the treated sample is within the Maximum Admissible Values (100 mg/L).

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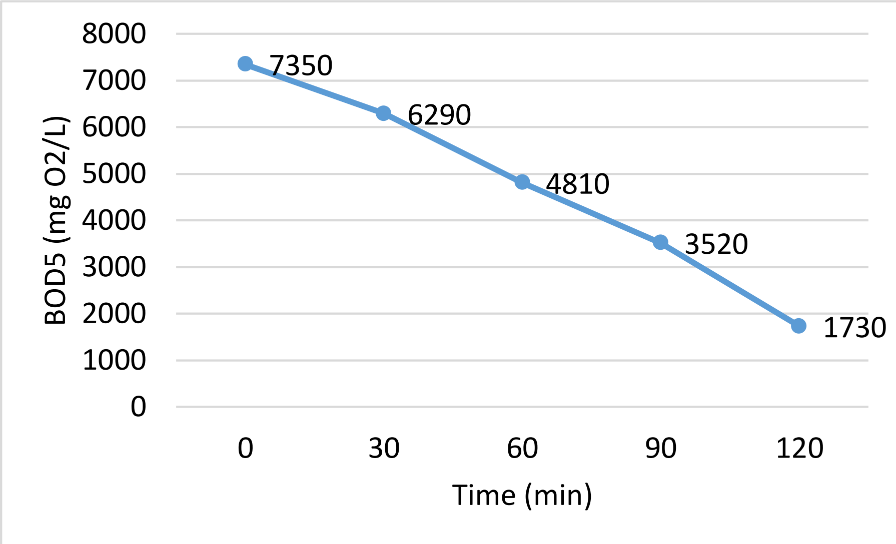

Figure 5. Reduction of the Biochemical Oxygen Demand over the treatment time.

Figure 5 shows a clear trend of reduction of the Biochemical Oxygen Demand, managing to decrease its concentration from 7350 mgO2/L to 1730 mgO2/L (76.5% efficiency). The final value of BOD5 after the total treatment time (2 hours) is outside the Maximum Admissible Values (500 mgO2/L); However, the trend that follows the generated curve indicates that the Biochemical Oxygen Demand could have continued to decrease had the treatment continued

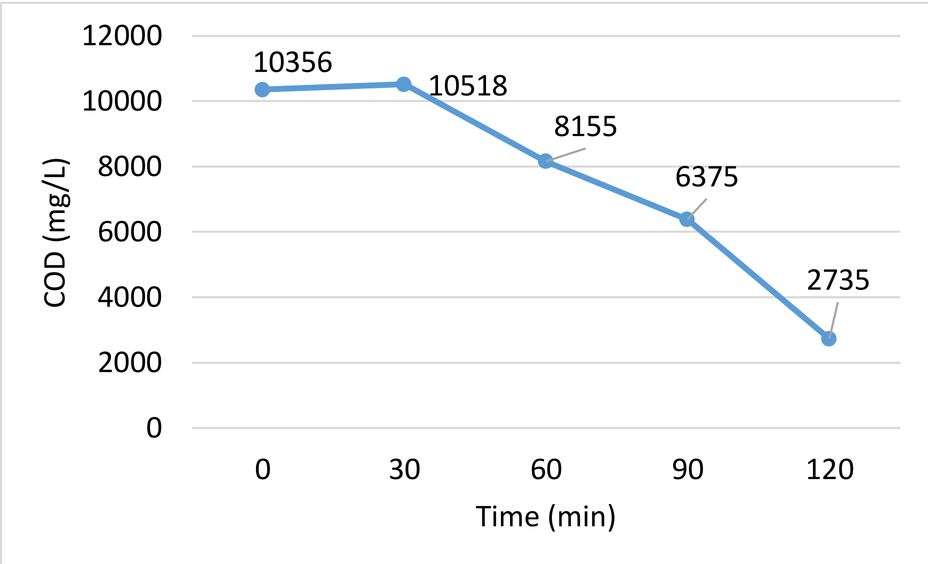

Figure 6. Variation of the Chemical Oxygen Demand over the treatment time.

As can be seen in Figure 6, after a treatment time of 2 hours, the Chemical Oxygen Demand was reduced from 10356 mgO2/L to 2735 mgO2/L, that is, it was reduced by 73.6%. The final COD

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value of 2735 mg/L is outside the Maximum Admissible Values, decreed by the Ministry of Housing (1000 mgO2/L); However, the generated curve predicts that the levels of this parameter can continue to be lowered. Furthermore, in the last half hour of treatment a reduction of 3640 mgO2/L of COD could be observed.

Percentage of pollutant removal by means of air nanobubble treatment.

Total Suspended Solids (TSS)

$$Reduction = \frac{(TSS\ Initial - TSS\ Final)}{TSS\ Initial} x100\%$$

$$Reduction = \frac{(6180\ mg/L - 645\ mg/L)}{6180\ mg/L} x100\%$$

$$Reduction = 89{,}5\ \%$$

Oils and Fats (OandF)

$$Reduction = \frac{(OandF\ Initial - OandF\ Final)}{OandF\ Initial} x100\%$$

$$Reduction = \frac{(161.6\ mg/L - 33{,}2\ mg/L)}{161.6\ \ mg/L} x100\%$$

$$Reduction = 79.4\ \%$$

Biochemical Oxygen Demand (BOD5)

$$Reduction = \frac{(BOD_5\ Initial - BOD_5\ Final)}{BOD_5\ Initial} x100\%$$

$$Reduction = \frac{(7350\ mgO2/L - 1730\ mgO2/L)}{7350\ mg/L} x100\%$$

$$Reduction = 76{,}5\ \%$$

Chemical Oxygen Demand - (COD)

$$Reduction = \frac{(COD\ Initial - COD\ Final)}{COD\ Initial} x100\%$$

$$Reduction = \frac{(10356\ mgO2/L - 2735\ mgO2/L)}{10356\ mg/L} x100\%$$

$$Reduction = 73{,}6$$

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4. Conclusions

- It is concluded that there was a 79.4% decrease in oils and fats, 76.5% in Biochemical Oxygen Demand and 73.6% in Chemical Oxygen Demand from industrial effluent from canned fish, achieved by treatment with air nanobubbles.
- It is concluded that the physical characteristics of the effluents from the fish canning industry achieved a very significant improvement, after treatment by air nanobubbles, removing up to 89.5% of Total Suspended Solids from the contaminated effluent. Likewise, the pH levels fluctuated from 6.68 to 7.01 (almost neutral), which indicates that large effluent flows could be treated without worrying about generating equipment wear due to corrosion.

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