The Mitigation of Environmental Impacts of High Polluted Effluents from Tuna Canning Industry through Eco-Efficiency Strategies

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Abstract
Food industry use high volume of water and energy to carry out their processes. Specifically, the fish canning industry generates effluents with high organic and saline loads, which complicates their suitable treatment before discharging to water bodies. The LIFE VERTALIM project has demonstrated the efficiency of a holistic solution (including technical, legislative, social, and environmental aspects) for the controlled integration of food industry wastewater from small and medium enterprises (SMEs) in the urban sanitation system. The implementation of low-cost innovative solutions, through the clean and eco-efficient production and wastewater pretreatment for fish canneries, has led to on average a reduction of 30% of the wastewater discharges to the environment and a reduction of food losses of up to 0.1%. Moreover, there has been a reduction of between 40% and 90% related to high organic load. These results allow the canneries to dispose their pretreated effluents to the urban sanitation system, avoiding the high costs of an industrial wastewater treatment plant (WWTP). During the project, a physical-chemical quality control has been achieved in the river waters as well as in the marine water surrounding the urban WWTP. In fact, a remarkable improvement of the river water quality has been measured.
Keywords: Industrial wastewater management, eco-efficient food production, fish canning industry, real-time control system

1. Introduction

The Water Framework Directive (WFD) and other directives related to water have helped to strengthen the protection of the waters of the European Union (EU). However, due to decades of previous degradation and persistent ineffective management, there is still a long way to go before the quality of all EU waters is sufficiently good (Waughray, 2011). Among other aspects, the industrial sectors cause important environmental impact mainly by the high-water consumption, the generation of wastewater and the production of waste. In this context, the fish canning sector produces effluents with high organic load, organic matter, oils and fats, and salt content (10- 50 times higher than the urban wastewater), generating a serious problem by the discharge to the corresponding wastewater treatment plant (WWTP) (Gutierrez *et al*, 2019). These loads can cause problems of inhibition in the biological treatment of the WWTP considering the canneries agglomeration and their seasonal production.

Despite the efforts of the competent basin agency to avoid it, the companies continued to pour their effluents into the river, at the beginning of the project. Moreover, urban WWTP managers have no obligation to treat industrial waters, and companies refused to install sewage treatment plants to treat wastewater with guarantees to discharge to water bodies. Under this framework, the LIFE VERTALIM project (http://www.azti.es/vertalim) is intended to demonstrate an midway approach in which companies reduce the pollution through eco-efficiency actions and the installation of sewage treatment plants for compliance the networks limits. Additionally, the implementation of a GSM telecontrol (global system for mobile communication) in the sanitation network for the control of industrial discharges.

2. Material and Methods

2.1. Description of the demonstration scenario

This project is being carried out in the Artibai basin, its estuary, and the adjacent coastal waters (Basque country, Northern Spain). There is a strong presence of small companies of the fish canning sector that are widely dispersed and high seasonal activity.

2.2. Eco-Efficiency for wastewater pollution prevention

Eco-efficiency is the concept of doing more with less, applied at factory level; in other words, it promotes creating goods and services while preserving natural resources and reducing waste and pollution during manufacturing (Despeisse *et al*. 2016).

2.3. *Analytical characterization*

The analytical characterization of wastewater and surface water were made according to the standard methods for the examination of water and wastewaters (APHA, 2012) and the methods in seawater analysis (Grasshoff *et al*, 1983).

2.4. Virtual simulation platform of Sanitation system

The optimization of organic and saline loads into the WWTP had been developed and validated in a Real Time Control (RTC): 1) The simulation platform for modelling the Sanitation Network through a comercial software MIKE Urban (www.mikebydhi.com) and 2) the modelling of the urban WWTP by WEST (www.mikebydhi.com) under the mathematical modeling methodology Plant-Wide Modelling (PWM) (Lizarralde *et al*, 2015).

3. Results

Through the environmental diagnosis of the production and the implementation of low-cost strategies, canneries had managed to not only to reduce water consumption (30%) but also the reduction of pollutants in their effluents, on average, a reduction of between 40% and 90% related to high organic load, depending on the initial situation of the companies and the efforts to implement the improving actions. Also, the wastewater discharges have been reduced by 40% with a decrease of 0.1% food waste. Therefore, companies have got the discharge authorization, and canneries had improved not only environmentally but also economically by reducing consumption and avoiding fines.

The impact of canning discharges on the water bodies environment had been measured periodically with seasonal frequency since autumn 2016 until now. The main and more visible result refer to the removal of pollution in the Artibai river due to the canneries activities.

The environmental impact assessment was made to evaluate and compare the impact with the previous and actual situation. Table 1 shows the environmental impacts caused by the dumping of 1 m^3 of wastewater from the WWTP and the four tuna canning industries of the project.

4. Conclusions

It has been demonstrated the integrated solution for the reduction at the origin and the controlled integration of canneries effluents into the urban sanitation network. The implementation of the eco-efficiency plan had allowed the canneries to install less costly and easier-to-manage iWWTPs as a pretreatment to the discharge into the sewer system, aiming at small businesses to fulfill the current environmental policy. As well as the development and validation of a real-time control system for the optimization of organic and saline loads into the urban WWTP.

All this has led to a better physical-chemical quality in the river area located downstream. The urban WWTP effluent disposal to the surrounding marine waters has not translated into a deterioration of their quality after the integration of industrial wastewaters.

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Table 1. Environmental impact characterization of the discharge of 1 m^3 equivalent to sewerage from the urban WWTP and canneries.

Year		Unit	Canneries	Urban WWTP	Total
2016	Climate change	kg CO_2 eq.	0.00	1.18	1.18
	Fresh water eutrophication	kg P eq.	1.06 × 10−3	4.14 × 10−4	1.48 × 10−3
	Marine eutrophication	kg N eq.	2.38 × 10−2	1.11 × 10−2	3.49 × 10−2
2018	Climate change	kg CO_2 eq.	0.06	0.84	0.90
	Fresh water eutrophication	kg P eq.	1.24 × 10−4	3.7 × 10−4	4.94 × 10−4
	Marine eutrophication	kg N eq.	1.91 × 10−4	7.33 × 10−3	7.52 × 10−3

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