

Anaerobic treatment of seafood processing waste waters in an industrial anaerobic pilot plant

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Abstract

Fish and shellfish canning industries produce waste waters whose characteristics depend upon the raw material processed which, in turn, varies throughout the year. Some production lines operate simultaneously, although it is possible to segregate or combine streams in order to optimise the treatment process. The main streams, produced in the cooking of mussel or tuna and in the manufacture of fish-meal, were treated individually or in combination at an industrial pilot plant, with an anaerobic central activity digester (CAD) of 15 m³ for two years. The most noticeable characteristics of wastes are their high organic load (COD 20 to 90 g/l) and the salinity (up to 14 g/l of Cl⁻). Another problem is the high ammonia content, up to 4.5 g/l, produced after the degradation of proteins. A strategy for adapting sludges to the salinity and to the ammonia content was followed and specific methanogenic activities of 0.7 kg COD/kg VSS-d were achieved, with chloride, sodium and ammonia concentrations of up to 15.5, 9.7 and 3.5 g/l, respectively. COD reductions, applied OLR and HRT ranged between 70 and 90%, 5 to 6 kg COD/m³-d and 4.5 to 5 d, respectively. During the entire experimental period, nutrients addition was not necessary and pH remained neutral due to the high buffering capacity of the process (3 to 4 g CaCO₃/l). Sudden changes in the influent composition did not affect the stability of the process, except when high suspended solids mixtures were treated. The biomass content in the digester varied around 11 g VSS/l and the mean specific methane production was 301 l/kg COD removed (15°C, 1 arm), with a biogas content of 60 to 65%. Hydrogen sulphide in biogas ranged from 1 to 4%. The mean anaerobic biodegradability was calculated for the main influents treated, being 84.9% for tuna-cooking effluents, 92.7% for mussel-cooking effluents, 79.4% for mixtures of tuna and mussel effluents and 71.4% for the tuna/mussel/Fish-meal mixtures.

Notation

CAD	-	central activity digester
COD	-	chemical oxygen demand (mg/l)
OLR	-	organic loading rate (g COD/l.d)
TSS	-	total suspended solids (g)
VSS	-	volatile suspended solids (g)
IA	-	intermediate alkalinity
TA	-	total alkalinity
VFA	-	volatile fatty acids
HRT	-	hydraulic residence time

Introduction

Seafood processing is a very important industrial activity in those regions of long fishing tradition such as Galicia (NW Spain), where the largest number of these factories are found in Spain. They are mainly located on two broad estuaries where environmental problems have been detected because of the large volume of discharged waste waters. In previous work (Soto et al., 1990), waste waters produced in different factories were characterised. There are five major production lines that correspond to the main products processed in Galicia (Omil et al., 1994): tuna, mussel, sardine, octopus and fish-meal. In each of these lines different waste waters are produced. The characteristics of the final effluent largely depend upon the relative contribution of each of them, which is variable depending on the season.

High salinity (chloride, sodium, sulphate and other inorganic ions present in sea water), characteristic of these waste waters, may

cause toxicity problems in biological treatment systems and the high protein content of these effluents can generate high levels of ammonia, which is a compound with significant toxic effects (Soto et al., 1991). Perhaps because of this, anaerobic treatment of these effluents has only been considered very recently (Carozzi, 1988; Méndez et al., 1992; Prasertsan et al., 1994; Veiga et al., 1994a; b). Anaerobic treatment of some particular streams, generated during different production lines, was considered in previous work carried out at laboratory-scale by Soto et al. (1995) and Guerrero et al. (1993), and at pilot-scale by Veiga et al. (1992).

Another peculiar characteristics of these factories is the frequent change of products to be processed (Soto et al., 1990) with concomitant changes in waste-water characteristics and stand-by periods, which bring about periodic restart phases of the waste-water treatment plant (Balslev-Olesen et al., 1990).

The objective of this paper was to study the anaerobic treatment of three main waste-water types: tuna-cooking effluent, mussel cooking effluent and fish-meal plant effluent, in an industrial pilot plant. Although these three effluents account only for 3% of the total flow, their organic load represents more than 40% of the discharged effluent. The study was carried out in the factory and the response of the process to common events, such as sudden change of raw material used, stand-by periods, etc., was also considered.

Experimental

Anaerobic pilot plant

The flow-sheet of the industrial pilot plant used in this work is illustrated in Fig. 1. It comprises a 7 m³ predigester (where waste waters were collected and prepared), a 15 m³ anaerobic digester; and a 3 m³ clarifier.

The CAD (Fig. 1), is conceptually close to the anaerobic contact system, with its central cone working as an internal settler,

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