DEVELOPMENT OF A BENCH SCALE SYSTEM FOR ANAEROBIC ACIDOGENIC DIGESTION OF WASTEWATER FROM ISOLATED SOY PROTEIN

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***Abstract*— Wastewater from isolated soy protein (ISP) production is characterized by high organic load. A complex primary wastewater treatment system has been studied: an anaerobic acidogenic reactor, a tubular reactor and a sedimentation tank. Anaerobic digestion is a very complex process; the control of temperature, pH, alkalinity, TSS/VSS and COD is fundamental. The objective was to develop and compare the efficiency of a bench scale anaerobic acidogenic reactor, followed by the precipitation, coagulation and sedimentation steps, with an existing industrial ISP wastewater treatment system. The results obtained with bench system (reaction time of 6 h, 48 °C) were very close to the industrial ones: pH reduction of 4.5 to 3.7 (indicating the protein hydrolysis), high VFA accumulation (1,300 and 2,650 mg.L^{-1} minimum and maximum concentration), no methane production and increase in TSS/VSS. This study gives an insight of the industrial primary wastewater treatment system and can be useful in future researches.**

***Keywords*— Acidogenisis, anaerobic digestion, isolated soy protein, wastewater treatment.**

I. INTRODUCTION

Indispensable nowadays, a wastewater treatment system is able to reduce, drastically, the damages caused by industrial wastewaters. In some cases, the efficiency of this kind of treatment is so great that the wastewater, previously discharged, can be used as a water source in the industrial processes.

A conventional system treating a high organic load wastewater generally involves a primary and a secondary treatment system. In the primary system, a portion of the suspended solids and organic load is removed from the wastewater by, basically, physical and chemical operations. The wastewater from the primary system still contains considerable organic loads and a relatively high chemical oxygen demand (COD). As a consequence, this system cannot be used as the sole treatment method, except in particular situations. The main function of this system is to serve as a precursor to the secondary treatment system (Tchobanoglous *et al.*, 1991).

The wastewater from ISP production is characterized by very high organic load, composed mainly of soluble proteins and carbohydrates, and has COD values greater than 16,000 mg·L^{-1} with high nitrogen concentrations. Consequently, a very efficient wastewater treatment system is required to comply with the specific regulatory limits imposed by legislation.

Conventional biological treatment processes, such as aerobic and anaerobic digestions, have been used for a long time to treat this kind of effluent; these systems, however, demand significant physical space, due to the great volumes of the unit operations involved. Moreover, the effectiveness of these processes has become limited over the last two decades (Mohamammadi and Esmaeelifar, 2004).

The researches challenge is, therefore, to find more effective clean methods to remove the organic matter from the wastewater or, at least, to decrease the wastewater pollutant material concentration in order to post-treat it, successfully, with conventional systems.

The bench scale systems are fundamental to understand and to get important data about the behavior of different wastewater treatment systems. Within this context, the objective of this work is to develop a bench scale primary treatment system, firstly, to treat the wastewater from an ISP industry and to observe each stage behavior and, second, to compare this bench scale system to the industrial one. The industrial system comprises a primary anaerobic acidogenic reactor (AAR), a tubular reactor and a primary sedimentation tank and this comparison will permit the study of different pre-treatment methods to optimize the industrial treatment system.

A great variety of studies simulating some unit operations of industrial wastewater treatment systems can be found in the literature: Bayard *et al.* (2008) developed laboratory-scale bioreactors (designed to simulate the anaerobic condition of sanitary landfill, with incubation time of 400 days to achieve the biodegradation) to study the behavior of untreated and pre-treated residues; Biswas *et al.* (2006) used a 10 dm³ anaerobic batch digester (equipped with a mechanical agitator) under controlled environment (pH 6.8, temperature = 40 °C) to study the biogas generation kinetics using municipal waste as feed stock; Borja *et al.* (2005) studied the effect of hydraulic retention time (HRT, 10 to 50 days) on the anaerobic acidogenic fermentation of two-phase olive pomace at laboratory-scale and mesophilic temperature (35 °C); Calli *et al.* (2005) studied the behavior of UASB reactors inoculated with different seed sludge, operated for 450 days under high ammonia concentrations, to investigate inhibition effects; Demirer and Chen (2005) investigated possible exploitation of the advantages of two-phase anaerobic digestion for unscreened dairy manure with hydraulic retention time of