Anaerobic prefermentation and primary sedimentation of wastewater in a sequencing batch reactor

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Abstract

This research was carried out with the aim of evaluating the solubilisation and acidification capacity of fermenting organisms in suspension in a sequencing batch reactor (SBR), which had a volume of 1 800 ℓ. Using 8 h cycles with 340 min of anaerobic reaction time, the wastewater fed to the SBR presented an average of total and dissolved COD of 315 and 230 mg/ℓ. The experiment was divided into three phases: In Phase 1 the organic load was decreased from 1.46 to 0.27 kgCOD/kgTSS·d, as total COD, during a period of 154 d. If the acidification is defined as the fraction of organic substrate that is transformed to volatile fatty acids (VFA) then the highest acidification percentage (80%) of the dissolved COD (COD_D) was obtained for the organic load runs of between 0.62 and 0.72 kgCOD/kgTSS·d. Within this range of organic load the 2nd and 3rd experimental phases were achieved at the same time after 130 d while the pH and temperature were the control parameters: pH from 5.5 to 7.5 and temperature from 22 to 31ºC. Finally, the higher production level of the dissolved COD during the fermentative reaction period was 35 mg/ℓ. The acidification of the dissolved influent COD was increased from 50 to 60% by decreasing the pH from 7.0 to 5.5 and this percentage was doubled from 33 to 66% when the temperature was increased from 22 to 31ºC. All of the dissolved effluent COD was in the form of VFA, when an organic load of 0.62 kgCOD/kgTSS·d was used or when the temperature was increased up to 31ºC. The VFA production rate that was achieved after 80 min diminished by half when the solids retention time (SRT) was decreased from 8 to 2 d or when the temperature was lowered from 31 to 24ºC.

Keywords: prefermentation, hydrolysis, volatile fatty acids, wastewater

Introduction

If the prefermentation phase of biological pathways in anaerobic degradation (hydrolysis or liquefaction and acidogenesis) is used, a greater proportion of the readily biodegradable COD (RBCOD) can be obtained to be fed directly to the downstream biological treatment process (Rössle and Pretorius, 2001). Goncalves et al., 1994, Wentzel and Ekama, 1997 and Münch et al., 1999 report on the subject of the basic principles of prefermentation in wastewaters:

- Micro-organisms responsible for enzymatic reactions are found in the sewage solids
- In order to increase the RBCOD they carry out extracellular hydrolysis of organic particulate or complex matter, the hydrolysis rates often being the limiting factor
- A portion of the RBCOD is used to synthesise cellular structure (growth), another fraction to produce VFA with the implicit production of CO_2. The remainder is used for the only possible loss of total COD through H/CO_2 production.

The RBCOD which is not transformed into VFA leaves the SBR as COD_D and is discharged from the system in the effluent. Ligero et al. (2001a) relate the advantages of the anaerobic prefermenter fed with wastewater: When the prefermenter is designed as an activated primary tank (APT) (Barnard, 1984) or as a hydrolytic upflow sludge bed reactor (HUSB) (Ligero et al., 2001a) the system can achieve the function of a primary settler. The sludge in the prefermenter is stabilised, partially, at the same time as the SRT proportioned for the prefermenter is increased. The fermentative bacteria increase the biodegradability of the remaining COD by producing RBCOD while the COD particulate is diminished. A higher fraction of RBCOD favours the subsequent biological elimination of nutrients (N, P).

The present study was undertaken with the aim to determine the fermentative capacity of the biomass retained in an SBR reactor when fed with municipal wastewater and operated under various organic loads.

Materials and methods

Analytical methods

Parameters determined in the influent and effluent were total COD (COD_T) and dissolved COD (COD_D), total suspended solids (TSS), temperature, pH, nitrogen as ammonium (NH_4-N), nitrate (NO_3-N) and total Kjeldahl nitrogen (TKN-N), phosphorus as orthophosphate (PO_4-P) and volatile fatty acids (VFA). COD_D and VFA were determined during fermentation cycles. *Standard Methods* (1989) was employed to determine all the parameters, except for VFA determination. The VFA were determined by means of gas chromatography (HP-5890 Serie II) using an AT-1000 column (Alltech, 10 m x 0.53 mm ID, 1.2 µm); samples were filtered through 0.45 µm. The VFA concentrations were expressed as COD (VFA_{COD}).

Wastewater characteristics

The sewage was collected in the influent of the wastewater treatment plant of the National University of Mexico. By adding maltodextrine and corn gluten hydrolysed protein to the wastewater, the total and dissolved COD was increased from 120 and 80 mg/ℓ to 315 and 230 mg/ℓ, respectively. The average of the

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