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A Holistic Approach for the Treatment of Agro-Industrial Wastewater and Food Waste by Combining Anaerobic-Aerobic Sequential System and Photocatalysis

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Abstract

Co-treatment of agroindustrial wastewater via anaerobic digestion is an effective process for the exploitation of high organic content materials. On the other hand, there is a potential risk of emerging pollutants and pathogenic bacteria that may be present in the digestate. Heterogeneous photocatalysis has been noted as a very efficient technology for removing organic pollutants and much research has been applied to the use of the semiconductor TiO_2 due to its high efficiency and low cost. The main purpose of this work was to study the treatment of agroindustrial wastewater presenting a holistic approach. In order to achieve this, a three-stage process was applied, consisting of anaerobic digestion, aerobic treatment and photocatalysis. For anaerobic digestion a CSTR was used, which was followed by a SBR that was operated under aerobic and anoxic conditions on a 24hr cycle with 5 days HRT. The effluent of SBR was treated with TiO_2 P25 photocatalyst in the final stage in which the effect of several parameters that affect the photocatalytic rates were evaluated, such as UV irradiation, addition of H_2O_2 and concentration of TiO_2. The feed mixture that was used in the process, was consisted of liquid pig manure (LPM), cheese whey (CW) and dried kitchen waste (DKW). Three different scenarios were examined depending on the operational conditions (HRT, temperature) of the anaerobic digester and the concentration of the DKW. The digester was continuously fed with an influent composed (v/v) of 75% LPM and 25% of CW in which two different concentrations of DKW were added (10g/L and 30g/L) for each case study. Several parameters were monitored through each process. The average removal in the AD process for the 1st scenario (30 days HRT, 35 ^{0}C, 10 g/L DKW) of total COD was 60.7%, 72.5% for the 2nd (40 days HRT, 40 ^{0}C, 10 g/L DKW) and 85.6% for the 3rd (40 days HRT, 40 ^{0}C, 30 g/L DKW). In order to evaluate the SBR performance, total COD and nitrogen removal were monitored for the 3 case studies, which resulted to 57.3 %, 28.8%, 19.4% (COD) and 38.0%, 29.2%, 22,1% (TN) respectively. The photocatalytic treatment of the SBR effluent was monitored by UV-Vis analysis before and after 3 hr irradiation, at two wavelengths, 270 nm corresponding to the aromatic groups and 465 nm for the

visible-light absorbing chromophore groups. When TiO_2 P25 was employed, high reduction rates were observed for the three effluents after 3 hr of irradiation, i.e. 18.3%, 23.9%, 17.0% for the aromatic and 31.2%, 37.9%, 17.5% for the chromophore groups respectively. Moreover, the addition of 25mM H_2O_2 as an oxidizing agent in the reaction medium had a beneficial effect on the removal of both aromatic and chromophore groups (37.9%, 46.0%, 37.6% aromatic and 73.3%, 75.5%, 39.9% chromophore).

Keywords: Agroindustrial wastewaters, catalysis, anaerobic digestion, TiO2, treatment, toxicity

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