HIGH RATE ANAEROBIC DIGESTION OF PIGGERY MANURE WITH POLYURETHANE SPONGES AS SUPPORT MATERIAL

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SUMMARY: The use of polyurethane foam sponges to colonize methanogenic associations for the digestion of piggery manure has been investigated. Fermentors containing polyurethane pads as colonization matrix reached a biogas production rate of ca. 2.0 litres per litre reactor per day (30-33°C, hydraulic retention time 7.5 days) and a biogas yield of 16 litres per litre piggery manure (7-9% TS). Corresponding control fermentors containing no pads reached a gas production rate of 1.3 litres per litre reactor per day and only about 10 litres biogas per litre piggery manure.

INTRODUCTION

The applicability of biogas production from piggery manure depends on the first place upon the possibility of using the biogas directly on site. The second important factor is the rate of production of biogas per unit reactor volume. However, the amount of biogas obtained per unit of manure digested should not be sacrificed because otherwise the energy balance of the total system decreases drastically (Poels et al., 1984).

A higher level of microbial biomass in the methane reactor can be supported on a wide variety of support materials such as glass beads, volcanic rock, wood bark (Salkinoja-Salonen et al., 1982), red drain tile clay, grey potters clay (Van den Berg and Kennedy, 1981; Murray and Van de Berg, 1981) or stainless steel wire mesh (Good et al., 1982). Lynn and Whitmore (1982) investigated the colonization of reticulated polyurethane (PUR) foam as a means of increasing the rate of methane production; Huysman et al. (1983a, 1983b) also reported reticulated polyurethane foam as an excellent colonization matrix. These experiments generally relate to liquids with low suspended solids concentrations. This report deals with the influence of reticulated polyurethane foam in the production of methane from piggery manure (7-9% dry matter, 60-75 g suspended solids per litre).

MATERIALS AND METHODS

Reactors. Two conventional laboratory fermentors with a working digester volume of 1.5 litres were set up. One fermentor served as a control, while the other one was equipped with PUR support matrices. Gas production was measured by water displacement. The digesters were fed twice daily and manually mixed two times a day. The incubation temperature was 30 ± 2°C.

Substrate. Piggery manure from fattening pigs, containing 7-9% dry matter, was used. The levels of particulate organic matter ranged from 60 to 75 g.1 ; total COD was 110-140 g.1 of which ca. 25% was soluble (CODs).
Support material. Reticulated polyurethane (PUR) foam was type T 40 (Recticel, Wetteren, Belgium) with 40 pores per inch, average pore diameter of 0.43 mm, porosity 97%, density 30 kg/m³, specific surface ca. 600 m²/m³ matrix. The PUR foam pads had a size of 2 x 2 x 2 cm. One fermentor received 20 of these pads, a total volume of 160 ml or 10% of the working digester volume.

Analyses. Gas analyses were performed on an Intersmat IGC 120 MB gas chromatograph, with a catharometer detector and a dual column arrangement of Porapak Q (80-100 mesh) and a molecular sieve 5 Å. Volatile fatty acids were analyzed according to Holdeman et al. (1977) on a capillary gas chromatograph, Carlo Erba Fractovap 4160 equipped with a FID detector, on a FFAP column of 25 m, with H₂ as carrier gas. Total fatty acids was estimated by steam distillation according to Deutsche Einheitsverfahren zur Wasseruntersuchung (1972). The total chemical oxygen demand (CODₜ) was measured according to the Standard Methods (1971). COD soluble (CODₘₜ) was determined after centrifugation at 20 000 g for 10 minutes. The total solids (TS) and the suspended solids (SS) after centrifugation at 20 000 g for 10 minutes were analyzed according to Merck (1973).

Microscopy. Microscopic enumeration of the methanogenic bacteria was estimated using a Petroff Haussner counting chamber with epifluorescence illumination on a Polyvar microscope.

RESULTS AND DISCUSSION

Three test periods of 3 months each, with different process parameters, have been analyzed. Steady state conditions were reached about 4 weeks after imposing the process conditions. During the last 6 weeks of each test period, analyses of the various process parameters were performed. Hydraulic retention times of 15, 10 and 7.5 days with corresponding loading rates of 7.8, 13.2 and 14.6 g CODₜ per litre reactor per day, were applied. Figure 1 shows biogas productions, expressed as l biogas per l influent, during steady state conditions for the 3 retention times considered. The methane content of the biogas, analyzed at regular times, varied between 65-70%. At a hydraulic retention time of 15 days, the gas productions of the control reactor and the reactor containing PUR sponges did not differ significantly (Table 1), but on decreasing the hydraulic retention time to 10 days, the biogas yield of the PUR reactor continued at 19 l per l influent, while the gas production of the control reactor decreased to 15 l per l piggery manure. This effect was even more pronounced at a hydraulic retention time of 7.5 days; the control fermentor produced only 10 l biogas per l influent compared to 16 l for the PUR fermentor. The influence of the pads was, when analyzed by a t-test on paired observations, significant at both 10 and 7.5 days retention time. Table 1 also shows that the biogas production rate of the PUR reactor increased at shorter hydraulic retention times. For the control reactor a slight increase from 1.3 to 1.5 l/1.d was obtained when lowering the retention time from 15 to 10 days, but at a hydraulic retention time of 7.5 days the gas production rate dropped to 1.3 l/1.d. The VFA-reductions decreased from 85 to 76 and to 25% respectively for the control fermentor at hydraulic retention times of 15, 10 and 7.5 days. For the PUR fermentor, a reduction from 89% to 70% was noticed when the hydraulic retention time was lowered from 15 to 7.5 days. The reduction of COD, decreased in a similar way (Table 1). Clearly it was not possible to maintain an