Feasibility of phosphorus and nitrogen recovery from biogas digester effluent

P.W.A. Perera [1], ***Z. Han*** [2], ***Y. Chen*** [2] ***and W.Wu*** [2]

[1] Department of Animal Science, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya

[2] College of Environmental and Resource Sciences, Zhejiang University, 268, Kaixuan Road, Hangzhou, 310029, P R China

Abstract

The anaerobic digestion of swine waste is a widely used practice to reduce the pollutant load and to abate the odour problems, while producing biogas for many farm operations. The resultant liquor is rich in phosphate and ammonium as well. These compounds are the principal pollutants associated with surface water pollution. The reduction of phosphate and ammonium to the acceptable limits is a prerequisite for the disposal of effluent. As both these elements are highly sought material in agriculture, recovery of those not only prevents the pollution, but also reduces the excessive use of natural resources. The potential of nitrogen and phosphorus recovery from swine waste biogas digester effluent through pH and NH_4^+: Mg^{2+}: PO_4^{3-} molar ratio amendment was studied. Precipitation experiments with swine waste biogas digester effluent were conducted at pH 7.5, 8.0, 8.5 and 9.0 together with NH_4^+: Mg^{2+}: PO_4^{3-} molar ratios 1: 0.2: 0.08, 1: 1: 1, and 1: 1.5: 1.5. Chemical and X-ray diffraction (XRD) analysis were done to determine the composition of the precipitate. Scanning Electron Microscopy (SEM) was done to determine the crystal structure of the precipitated product. The highest removal and recovery of NH_4^+ and PO_4^{3-} were achieved at pH 9.0 in each experiment. The elevation of pH to 9.0 alone could decrease the initial PO_4^{3-} concentration from 42 mg L^{-1} to 4.7 mg L^{-1} and 89.2% PO_4^{3-} recovery was achieved. The pH-molar ratio combination 9.0-1: 1.5: 1.5 reported 76.5% NH_4^+ and 68.5% PO_4^{3-} recovery. The molar ratio of 1: 1: 1 together with pH elevation to 9.0 resulted over 70% and 97% of the initial NH_4^+ and PO_4^{3-} removal respectively and it was determined to be the optimum combination for both NH_4^+ and PO_4^{3-} removal. It is found that nitrogen and phosphorus could be recovered from biogas digester effluent. The XRD patterns and the SEM images proved that the precipitated product is struvite.

Keywords: Swine waste, Biogas, Phosphate recovery, Ammonium nitrogen recovery, Struvite