54d Performance of a Pilot Scale Digester and Comparison with Laboratory Scale Units

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Anaerobic digestion of biomass helps in reducing pollution and produces methane, a source of biomass energy. Also, utilizing anaerobic digesters enables farmers to control odor, capture methane for energy, and generate either liquid or semisolid soil conditioners as a by-product. Anaerobic digesters of various designs are used for this purpose, including covered lagoons, plug flow, up-flow sludge blanket reactor, and configurations mixed by mechanical agitation, gas recirculation, and slurry recirculation. Mixing in anaerobic digesters provides a uniform environment, one of the keys to good digestion. In spite of the crucial role of mixing in the operation of larger digesters, contradictory findings are reported in the literature about the necessity of mixing and the mixing intensity required to enhance the digester performance. Some researchers find mixing to be detrimental whereas others find mixing to beneficial for digester performance. No effect of mixing on the digester performance is also widely reported in the literature. There are many reasons for the controversies and uncertainties about the mixing effect on anaerobic digesters. One of them is that mixing is not adequately quantified and characterized in these systems. Another important reason is that most of these digester performance studies are performed in small laboratory scale reactors and/or using low solids concentration. These approaches do not contribute greatly in understanding the mechanisms by which mixing influences anaerobic digestion performance and do not provide criteria for full scale digester design or strategies of operation. Laboratory scale reactors are valuable in estimating kinetic parameters; whereas, experimentation on a large scale digester is necessary to elucidate the operational problems and difficulties, such as the effects of improper mixing, clogging of feed and outlet ports, solids accumulation, foaming and so on. Considering the above facts, it was decided to study the effect of mixing on digester performance in a pilot scale unit. A 97 liters stainless steel pilot scale digester was used for this study and 3.78 liters laboratory scale units were used for comparison studies. Mixing was achieved by recirculation of biogas at rate of 9.07 L/min with a sparger and draft tube. The digester was operated using cow manure, which was processed to maintain the volatile solids content of 6.6 gm/L. Hydraulic retention time of 16 days was maintained. The digester operation was started with biogas recirculation then it was switched to unmixed mode of operation. The gas production data, methane production and methane content data showed that the mixed reactor performs better than the unmixed reactor. Mixed digester also performed well in terms of reduction of total volatile solids and total volatile fatty acids. No effect of mixing was observed on performance of small scale digester units. It was concluded from the results that the large scale operation of digester units is necessary to investigate the effect of mixing and to obtain meaningful data that can be used for design and scale up of anaerobic digesters.