MICROAEROBIC PROCESSES FOR H2S REMOVAL AND PROCESS ROBUSTNESS ENHANCEMENT

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Anaerobic digestion (AD) of organic wastes is able to transform a large part of the organic content into biogas, 60-70 (v/v)% of methane, which can be energetically recovered, thereby destroying most of the pathogens present in the sludge and limiting possible odour problems associated with residual putrescent matter. As a result, AD is a technology widely employed for the treatment of sewage sludge, municipal and agricultural solid wastes and industrial wastewaters with high organic load. However, the large diversity of microorganisms implied in the transformation of complex compounds to more simple compounds that can be converted to methane requires an equilibrium between the intermediate products so that environmental conditions allow microorganisms to consume the organic matter properly. Intrinsic variations in organic loads of the waste may result in intermediates accumulation and process failure. Furthermore, when sulphur compounds are available for microorganisms, hydrogen sulphide is produced to a different extent with several associated problems. Hydrogen sulphide is corrosive and considerably impairs installations lifetime, is toxic to live beings, causes inhibition in microorganisms and holds a strong bad odour.

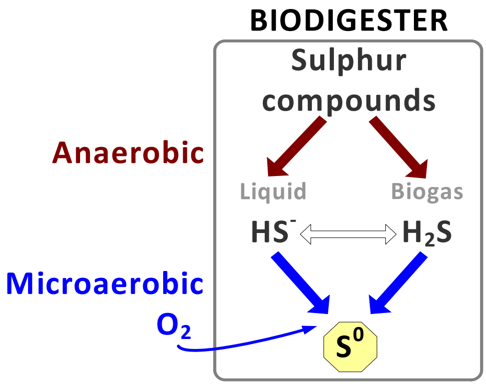

Figure 1. Microaerobic H_2S oxidation

Recent research has shown that controlled oxygen supply to AD can modify some of the transformations produced in the anaerobic environment while methanogenesis is not affected. This fact opens a wide research field to modify undesirable situation and preserve methanogenesis and organic matter removal. For example, limited oxygen supply to the bioreactor, thus creating microaerobic conditions, can provide a better environment to deal both with hydrogen sulphide production and intermediate accumulation.

Figure 2. Pilot plant for sludge digestion and microaerobic removal of H_2S.

Hydrogen sulphide treatment

The limited introduction of oxygen (or air) to the biodigester can lead to the biological removal of hydrogen sulphide, both from the biogas and the liquid under appropriate conditions (Fig.1). Sulphur-oxidizing microorganisms (such as *Thiobacillus* sp.) have shown to outcompete oxygen utilization to aerobic degradation of organic matter, leading to oxygen consumption to produce elemental sulphur; then, removing hydrogen sulphide while methanogenesis proceeds normally. The development of this technology is a great promise to improve the economic balance of biogas production and utilization due that high expenses on additional equipment to treat hydrogen sulphide are necessary nowadays to protect the engines for biogas employment. Microaerobic removal of hydrogen sulphide is being researched in the treatment of sewage sludge (pilot-plant scale, Fig.2) and in the treatment of the organic fraction of municipal solid wastes.

Organic overloads recovery

When treating a real waste from an industrial proccess, variations on the organic load of feed to the biodigester might lead to intermediates accumulation, particularly volatile fatty acids (VFA) due to substrate inhibition, pH drop and process failure. Limited oxygen supply to the biodigester during this situation can consume VFA aerobically, thereby protecting from the pH drop and subsequent process failure, consuming accumulated VFA and proportioning a faster recovery to stationary conditions.

Relevant publications

Díaz I., Lopes A.C., Pérez S.I., Fdz.-Polanco M., 2010. Performance evaluation of oxygen, air and nitrate for the microaerobic removal of hydrogen sulphide in biogas from sludge digestion. Bioresource Technology (accepted for publication.

Fdz.-Polanco M., Díaz I., Pérez S.I., Lopes A.C., Fdz.-Polanco F., 2009. Hydrogen sulphide removal in the anaerobic digestion of sludge by microaerobic processes: pilot plant experience. Water Science and Technology, 60 (12), 3045-3050.

Fdz.-Polanco M., Pérez S.I., Díaz I., García, L., Torío R., Acevedo A.F., 2009. Eliminación de H_2S en digestión anaerobia por procesos microaerofílicos: experiencia en planta piloto. Tecnología del Agua, 304, 58-64.

Cirne, D.G., van der Zee, F.P., Fdz-Polanco, M., Fdz-Polanco, F., 2008. Control of sulphide during anaerobic treatment of S-containing wastewaters by adding limited amounts of oxygen or nitrate. Reviews in Environmental Science and Biotechnology, 7, (2) 93-105.

van der Zee, F.P., Villaverde, S., García, P.A., Fdz.-Polanco, F., 2007. Sulphide removal by moderate oxygenation of anaerobic sludge environments. Bioresource Technology, 98, 518-524.