H_2S removal from biogas using novel bioreactor configurations

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Introduction

Biogas produced from anaerobic degradation of organic wastes commonly contains contaminants, such as carbon dioxide (CO_2), hydrogen sulfide (H_2S), ammonia (NH_3) and siloxanes, which should be removed before utilizing the biogas as an alternative energy source. H_2S concentrations in the biogas can range from few ppm in facilities processing renewable resources, such as landfill and off-gas from wastewater treatment plant, to several thousand ppm when treating liquid manure and biological wastes.

Technological challenge

The biological oxidation of the H_2S present in biogas, under aerobic conditions, has been extensively studied in the past decade and applied in full-scale industrial systems. However, oxygen present in the aerobic bioreactors can dilute the methane concentration in biogas and, when present in natural gas streams, can cause various problems, including the degradation of process chemicals and corrosion of pipelines. For safety reasons, it is also necessary to control the ratio of oxygen to methane in order to avoid reaching explosive limits (Petersson and Wellinger 2009; Fernández et al. 2013). Recently, anoxic bioreactors have been introduced for H_2S removal from biogas (Soreanu et al., 2008). A comparison between anoxic and aerobic bioreactors for H_2S removal has indicated that anoxic bioreactors are more practically applicable than the conventional aerobic bioreactors in terms of ease of use and operational costs (Fernández et al. 2013). Among the different bioreactor configurations tested, the biotrickling filter has been widely studied during the last few years (Almenglo et al. 2016; Fernández et al. 2014; Fernández et al. 2013; Soreanu et al. 2008). However, a combination of both suspended and attached growth bioprocesses for eliminating H_2S from biogas streams has not been studied yet. The use of a moving bed biofilm reactor (MBBR), a hybrid bioreactor that combines the operational advantages of the conventional activated sludge and trickling filter processes, was proven to be successful for the treatment of domestic and industrial wastewater (Borkar et al. 2013). The MBBR was originally developed to solve the problems of periodic backwashing and clogging usually occurring in biofilm reactors and has been tested under anoxic, aerobic or anaerobic conditions (Rusten et al. 2006). The main objective of this research was to develop efficient bioreactor configurations for H_2S removal from biogas. For this purpose, two anoxic bioreactor configurations, i.e. a MBBR and fluidized bed reactor (FBR), were studied.

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