Effects of Microwave, MW/H_2O_2 and Heat/H_2O_2 Pre-treatments on the Anaerobic Biodegradability of the Wastewater Sludges

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Anaerobic digestion has been used to stabilize wastewater sludges by providing a reduction in organic content and mass of input sludge while producing energy in form of biogas. Efficiency of digestion and biogas/methane production can be enhanced by pretreating the sludge prior to anaerobic digestion. This study investigates the effects of microwave (MW), combined microwave-hydrogen peroxide (MW/H_2O_2) and combined heat-hydrogen peroxide (heat/H_2O_2) pre-treatments on the biochemical methane production potential of wastewater sludges and compare these pre-treatment methods for the anaerobic digestion efficiency in terms of organic removal rates.

The microwave pretreatment was applied to sludge samples by irradiating them at 160 ^{0}C for 15 minutes in a MW oven (Berghoff MWS+3 Speedwave Microwave System). The combined MW and H_2O_2 pretreatment was applied to sludge samples by mixing them with 1 g H_2O_2/g TS and microwaving them at 160^{o}C for 15 minutes. In the combined heat and H_2O_2 pretreatment, 1 g H_2O_2/g TS was added to sludge samples at 75 ^{o}C for 90 minutes. The pretreated sludge samples and the inoculum were mixed in 120 mL reactors with an inoculum to substrate ratio (I:S) of 1:1 (w/w on VS basis). The reactors were sealed, and flushed with nitrogen gas for 2 minutes to remove traces of oxygen and create an anaerobic environment. The sludge samples were anaerobically digested at 37°C for 40 days. Total gas productions were measured daily and gas compositions were analyzed weekly during the digestion period of the batch reactors. Initial and final characteristics of the reactor contents were analyzed according to Standard Methods.

The pre-treatments applied to sludge samples prior to anaerobic digestion speeded up the hydrolysis step and improved the biodegradability of the organics by increasing their solubility. Application of MW, combined MW/H_2O_2 and heat/H_2O_2 pre-treatments increased the methane yields by 65.5%, 40% and 20%, providing 626 mL CH_4/g VS, 529 mL CH_4/g VS and 453mL CH_4/g VS methane yields, respectively. The COD removal rates obtained in MW/H_2O_2, MW and heat/H_2O_2 pretreated reactors were 54.8%, 48.7% and 46.9%, respectively.