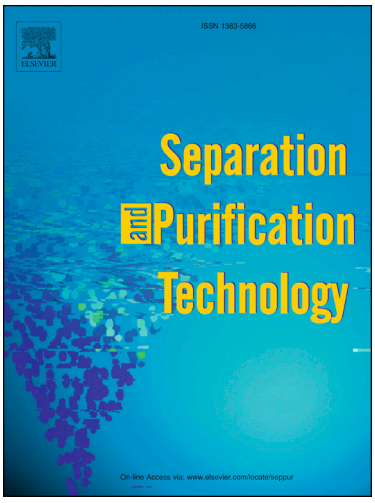

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Microwave enhanced advanced oxidation treatment of sewage sludge from the membrane-enhanced biological phosphorus removal process

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Abstract
This study investigated the effectiveness of bench and pilot-scale microwave enhanced advanced oxidation process (MW-AOP) for treatment of sewage sludge in neutral, acidic (pH 4) and alkaline (pH 9) conditions. The MW-AOP treatments were very effective: total suspended solids reduction and chemical oxygen demand solubilization were better in the sets at pH 9 than at pH 4. Alkaline conditions would be more favorable for the subsequent anaerobic digestion for biogas production. Release of orthophosphate, particle size distribution, dewatering properties and settling of the sets at pH 4 were better than at pH 9. The supernatants obtained from the sets at pH 4 had a high orthophosphate concentration and a low total suspended solids content, which were more suitable for struvite (a fertilizer) recovery process. Energy consumption was lower for the pH adjusted treatment sets compared to those of MW only and MW-AOP at neutral conditions; energy for the pH adjusted sets varied between 0.32 and 0.41 kWh/L of sludge treated. The results indicated that the MW-AOP could reduce the volume of sludge for disposal, and produce a high quality treated effluent suitable for further resource and energy recovery. Depending on the needs of each wastewater treatment plant's treatment priority, the experimental conditions applied in the process can be adjusted accordingly.

Keywords: microwave, sludge, solids disintegration, nutrient release.

Introduction

Thermal hydrolysis using conventional heating process has been used for destroying cell walls, and degrading intracellular and extracellular substrates of waste activated sludge (WAS) (Sakai et al., 1997; Neyens et al., 2002; Menedez et al., 2002; Neyens and Baeyens, 2003; Neyens et al., 2003a, b; Appels et al., 2010; Abelleiraa et al., 2012). A combination of thermal heating and chemicals, such as ozone, hydrogen peroxide, acids or alkali resulted in higher rate of degradation than the individual thermal or chemical treatment processes (Neyens et al., 2003b); it was effective in reducing amounts of sludge solids, improving dewaterability of sludge, and releasing nutrients and metals (phosphorus, nitrogen, calcium and magnesium).

Both microwave treatment (MW) and microwave enhanced advanced oxidation process (MW-AOP) were also very effective in treating sewage sludge (Liao et al., 2005; Wojciechowska, 2005; Hong et al., 2004; Eskicioglu et al., 2007; Hsieh et al., 2007; Carrere et al., 2010; Wong et al., 2007; Qiao et al., 2008; Dogan and Sanin, 2009; Chi et al., 2010; Chang et al., 2011; Tyagi