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Fermentation of primary sludge at multimillion liters scale and volatile fatty acid production for biological nutrient removal

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ABSTRACT

Biological nutrient removal is a multimillion liters scale biotechnological process operated across the world. Volatile fatty acids (VFAs) produced by fermentation of primary sludge are important part of the modern day biological nutrient removal processes. Anoxic heterotrophic denitrification can be promoted by using these VFAs as external electron donors. Similarly, polyhydroxyalkanoates (PHAs) synthesis can be enhanced by introducing VFAs as external carbon source. Later in the aerobic phase of biological phosphorus removal process, these PHAs are utilized by phosphate accumulating organisms (PAO) for intracellular phosphorus accumulation and removal. This article critically reviews two years' (2014 & 2015) weekly collected data of a full scale (1.745 million liters) fermenter being used for VFAs production by fermentation of primary sludge. Average VFAs production was around 440.7 ± 208.5 mg /L, out of which 44.21 ± 4.02% were acetic acid and 41.15 ± 5.66% were propionic acid. It has been concluded that there is a liner correlation (R2=0.93) between acetic and propionic acid concentration in the fermenter supernatant and a static fermenter is more suitable for propionic acid rich VFAs production. Oxidation of propionic acid has been proposed as the dominant mechanism of acetic acid production. Co-digestion of primary sludge with crude glycerol, hydrolysis of nonliving fraction of the primary sludge, combined hydrogen and VFAs production and pH, DO and hydrogen partial pressure based metabolic shifts are identified as potential strategies for improved VFAs production.

Keywords: Acetic acid; crude glycerol; denitrification; hydrogen production; phosphorus removal; primary sludge; propionic acid; volatile fatty acid