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An ozone assisted process for treatment of EDC's in biological sludge

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HIGHLIGHTS

- Ozone pulsing of waste sludge on 4 successive days reduced aerobic digestion from 30 to 4 days.
- MLSS reduction was over 80% in the same period.
- The 1.1 mg O_3/L pulse was adequate to affect over 99% removal of EDCs in sludge.
- Prolonged ozonation on the 4th day did not improve on EDCs removal.
- Most EDCs were brought down to undetectable concentration in sludge after ozonation.

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ABSTRACT

A novel aerobic sludge digestion process to stabilize and decrease the amount of excess sludge produced during biological treatment and removal of EDCs sorbed onto sludge during this process is discussed here. Waste activated sludge samples from two different wastewater treatment plants were ozonated for different periods in Erlenmeyer flasks once a day on each of four consecutive days. Flasks were continuously aerated between ozone applications by shaking on an orbital shaker. The residual EDC concentrations in sludge samples were analyzed at the end of digestion periods. An MLVSS reduction of up to 95% was achieved with an ozone dose of only 1.05 g O_3/kg MLSS in this process on the fourth day. During this process destruction of some selected endocrine disrupting compounds, namely diltiazem, carbamazepine, butyl benzyl phthalate, acetaminophen and two natural hormones, estrone and progesterone, which tend to accumulates in sludge, are studied. Over 99% removal of these contaminants were achieved at the end of the fourth day. The analyses were conducted by using LC (ESI) MS/MS after solid phase extraction (SPE). By this process it became possible to save on contact time as well as achieving a bio-solids digestion far exceeding the standard aerobic process and concomitant removal of micropollutants at the expense of minimum ozone dose. The developed process is deemed superior over side-stream ozonation of activated sludge, in that it does not cause reduction in active biomass in the aeration tank.

1. Introduction

Activated sludge is currently the most widely used biological treatment process that relies on a dense microbial population which is being mixed with wastewater under aerobic conditions [1]. However, excess biological sludge produced during the process is a rapidly emerging problem for the utilities as sludge management has become an important environmental and legal issue due to the stringent regulations now imposed worldwide. This requires sludge minimization technologies to be even more efficient and effective [2]. Amongst the methods available, ozonation of sludge is becoming popular owing to its successful full-scale applications and high sludge volume reduction capability [3,4]. In earlier studies, ozone has been applied, continuously or intermittently, to the recycle stream of activated sludge. Alas, direct application into the reaction tank would lower active biomass amount and cause high inert materials build up in the aeration tank, which in turn result in reduced removal rates, lower oxygen transfer efficiency and larger plant foot print [5]. Hence, it was deemed more feasible by the present authors to apply ozone in a segregated digester than applying to a side stream. This constitutes the main theme of the present study where decrement of Endocrine Disrupting Compounds, EDCs, sorbed onto the sludge, is expected to occur simultaneously during ozone aided aerobic digestion.

Due to hydrophobic nature of most emerging contaminants, which tend to accumulate in sludge, both highly biodegradable or non biodegradable EDCs are removed from effluents just by

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