Non-catalytic ozonation of palm oil mill effluent (POME)

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Abstract

Ozonation is recognized as an effective treatment to eliminate complex contaminants in wastewater. So far, past studies often applied ozonation for minutes or a few hours. These studies contradict each other in their findings about the ability of ozone to remove inorganics and organics. The present study, for the first time, applied ozone oxidation at doses of 15 and 30 mg/L for a long duration of 144 hours to process high-strength wastewater, palm oil mill effluent. Both doses effectively dissolved non-biodegradable solids, ultimately enhancing toxicity removal. However, the 15 mg/L dose resulted in a slower start-up, instability in treatment, and lower solid degradation than the 30 mg/L dose because it was inadequate to abate influent pollutants. The undesirable results of the 15 mg/L dose demonstrated the need for a higher dosage of ozone to result in a higher rate of conversion of solids into biodegradable and dissolved solids over a shorter period of time. The high ozone dose (30 mg/L) demonstrated better startup, more stable performance, and higher final effluent quality than the low ozone dose (15 mg/L). The high ozone dose continued to deliver high-
performance treatment over the duration of the study compared to the low ozone dose. During ozonation, particulate matter foams were detected on the surface due to aggregation of solids.

**Keywords**: Ozonation (O$_3$); Wastewater treatment; Ozone dosage; Palm oil mill effluent (POME); Ozonation foam.

### 1.0 Introduction

The release of untreated palm oil mill effluent (POME) into rivers jeopardizes the ecosystem, since it contains a high concentration of pollutants [1]. In over 85% of palm oil mills in Malaysia, waste stabilization ponds are used to treat POME due to their affordable capital and operating costs [2]. However, such POME treatment requires a long retention time of about 5.4 months, a large treatment land area of 10,000–50,000 m$^2$, and it is difficult to preserve the treatment efficiency associated with poor decolorization [3].

The ozonation approach has been introduced as an effective treatment for eliminating complex pollutants in water and wastewater [4]. Ozone is a strong oxidant that can eliminate refractory pollutants that various treatments cannot reduce [5]. Technically, ozone interacts with contaminants transforming them into a simpler form. Different studies have reported that ozone is effective for pollutants degradation because of its intense oxidizing activity [6].

Ozone has often been used to enhance pollutant degradability, wastewater and drinking water disinfection, micropollutant removal, and antibiotic removal. For instance, Li et al. (2019) completely degraded N,N-diethyl-meta-toluamide (DEET) by using ozonation [7]. In other studies, ozonation showed a significant degree of microplastic removal compared to filtration systems, such as membrane disc filter and rapid sand filtration [5].

The major factors influencing ozonation process are pH, ozone dosage and temperature, which significantly affect pollutant mineralization. Most importantly, removing chemical oxygen demand (COD) can be improved by increasing the ozone dosage [7]. Other studies did not investigate the


