

Temperature Phased Anaerobic Digestion at the Intermediate Zone of 45 °C: Performances, Stability and Pathogen Deactivation

(Pencernaan Anaerobik Fasa Suhu di Zon Pertengahan 45 °C: Prestasi, Kestabilan dan Pendeaktifan Patogen)

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ABSTRACT

Temperature phased anaerobic digestion (TPAD) systems with conventional sequences (first stage of 55 °C and second stage of 35 °C) have been widely studied. However, very limited studies were available on TPAD system with the first stage operated at the intermediate zone of 45 °C, mainly due to the notion that limited microbial activity occurs within this zone. The objective of this research was to evaluate the performance, stability and the capability of 45 °C TPAD in producing class A biosolids, in comparison to a conventional TPAD. Four combinations of TPAD systems were studied, 45 °C TPAD 2.5/10 (1st stage solids retention time (SRT) 2.5 days/2nd stage SRT 10 days), 45 °C TPAD 7.5/10, 55 °C TPAD 2.5/10 and 55 °C TPAD 7.5/10. Among all, 45 °C TPAD 7.5/10 was found to have the best performances, attributed to its high volatile solids (VS) destruction (58%), minimal acetate accumulation (127 mg/L), high methane yield (0.58 m³ CH₄/kg VS removed), high COD destruction solid COD (sCOD; 74% and total COD (tCOD) 54%) and minimal free NH₃ content (67.5 mg/L). As for stability, stable pH distribution, high alkalinity content and low VFA to alkalinity ratio, indicated a well-buffered system. Additionally, the system had also able to produce class A biosolids. Therefore, proved that TPAD system operated at the intermediate zone of 45 °C can perform better than the conventional TPAD, hence, highlighting its economic advantage.

Keywords: 45 °C TPAD; 45 °C anaerobic digestion; class A biosolids; TPAD

ABSTRAK

Sistem pencernaan anaerobik fasa suhu (TPAD) dengan urutan konvensional (peringkat pertama 55 °C dan tahap kedua 35 °C) telah dikaji secara meluas. Walau bagaimanapun, terdapat kajian yang sangat terhad pada sistem TPAD dengan tahap pertama yang beroperasi di zon pertengahan 45 °C, disebabkan oleh anggapan bahawa aktiviti mikroorganisma adalah terhad di dalam zon ini. Objektif kajian ini adalah untuk menilai prestasi, kestabilan dan keupayaan TPAD 45 °C dalam menghasilkan biopepejal kelas A, berbanding dengan TPAD konvensional. Empat gabungan sistem TPAD dikaji, 45 °C TPAD 2.5/10 (tahap-1 SRT 2.5 hari/ tahap-2 SRT 10 hari), 45 °C TPAD 7.5/10, 55°C TPAD 2.5/10 dan 55°C TPAD 7.5/10. Antara semua sistem, 45 °C TPAD 7.5/10 didapati mempunyai prestasi terbaik, disebabkan oleh penghapusan VS yang tinggi (58%), pengumpulan asetat minimum (127 mg/L), hasil metana yang tinggi (0.58 m³ CH₄/kg VS dikeluarkan), penghapusan COD yang tinggi (sCOD; 74% dan tCOD 54%) dan kandungan NH₃ yang minimum (67.5 mg/L). Bagi aspek kestabilan, pengedaran pH yang stabil, kandungan alkali yang tinggi dan nisbah VFA kepada kealkalian yang rendah, telah menunjukkan sistem penampunan yang baik. Di samping itu, sistem ini juga mampu menghasilkan biopepejal kelas A. Oleh itu, membuktikan bahawa sistem TPAD yang beroperasi di zon pertengahan 45 °C menunjukkan prestasi lebih baik daripada TPAD konvensional, dengan itu, menunjukkan kelebihan daripada segi ekonomi.

Kata kunci: 45 °C TPAD; 45 °C pencerna anaerobik; biopepejal kelas A; TPAD

INTRODUCTION

A broad array of anaerobic digestion systems has been studied extensively for the treatment of municipal wastewater. Majority of these systems operated at

mesophilic temperatures of 30 to 40 °C. Though effective in reducing the organic content of wastes, the mesophilic systems can achieve only limited destruction of pathogens, hence restricting the final use of the biosolids generated