LIFE CYCLE ASSESSMENT (LCA) PADA LINGKUP *CRADLE TO GRAVE* SISTEM PENGELOLAAN LIMBAH CAIR DI PT XYZ, JAWA BARAT

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INTISARI

Pesatnya pertumbuhan industri memicu peningkatan jumlah limbah cair yang mengandung bahan kimia dan patogen berbahaya, sehingga menuntut pengelolaan limbah cair yang efektif dan berkelanjutan sesuai peraturan perundang-undangan dan target SDGs. Penelitian ini bertujuan menganalisis inventori data, potensi dampak lingkungan, *hotspot* dampak, serta merekomendasikan arahan pengelolaan pada sistem pengelolaan limbah cair di PT XYZ, Jawa Barat.

Pengumpulan data inventori dilakukan dengan observasi, perhitungan, pengamatan, dan uji laboratorium, kemudian dianalisis dengan metode *Life Cycle Assessment* berbasis standar ISO 14040:2016 dan ISO 14044:2017. Analisis dampak lingkungan dilakukan dengan metode IMPACT 2002+ melalui *software* OpenLCA dan database ecoinvent 3.10 berdasarkan unit fungsi setiap 1 m^3 air hasil olahan dengan batasan sistem *cradle to grave*. Analisis dilakukan melalui 4 tahapan, yaitu *goals and scope, Life Cycle Inventory*, *Life Cycle Impact Assessment*, dan interpretasi.

Hasil analisis menunjukan data inventori yang digunakan berasal dari data primer dan sekunder berupa penggunaan energi, bahan baku, limbah yang diolah, dan produk mencakup emisi. Dampak lingkungan yang dihasilkan meliputi *Aquatic Ecotoxicity* sebesar 2859,82 kg TEG water; *Aquatic eutrophication* sebesar 2,96 x 10^{-3} kg PO_4 P-lim; *Global warming* sebesar 100,53 kg CO_2eq; *Non-renewable energy* sebesar 88,83 MJ primary; dan *Ozone layer depletion* sebesar 4,32 x 10^{-4} kg CFC^{-11}eq. Hasil normalisasi menunjukan dampak *Non-renewable energy, Global warming*, dan *Aquatic Ecotoxicity* menjadi isu penting dengan *hotspot* dari proses *effluent pond*. Skenario perbaikan melalui program *recycle* direkomendasikan karena memiliki sensitivitas sebesar 83% dengan penurunan dampak *Non-renewable energy* sebesar 61,256 MJ primary, *Global warming* 14,042 kg CO_2 eq, dan *Aquatic Ecotoxicity* sebesar 479,641 kg TEG *water*

Kata Kunci : *Cradle to Grave*, Dampak Lingkungan, Limbah Cair, Penilaian Daur Hidup

LIFE CYCLE ASSESSMENT (LCA) WITHIN THE CRADLE TO GRAVE SCOPE OF THE WASTEWATER MANAGEMENT SYSTEM AT PT XYZ, WEST JAVA

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ABSTRACT

The rapid growth of industry has triggered an increase in the volume of wastewater containing hazardous chemicals and pathogens, thereby necessitating effective and sustainable wastewater management in accordance with legal regulations and SDGs targets. This study aims to analyze the data inventory, environmental impact potential, impact hotspots, and provide management recommendations for the wastewater treatment system at PT XYZ, West Java.

Inventory data were collected through observation, calculation, monitoring, and laboratory testing, then analyzed using the Life Cycle Assessment (LCA) method based on ISO 14040:2016 and ISO 14044:2017 standards. Environmental impact analysis was conducted using the IMPACT 2002+ method via OpenLCA software and the ecoinvent 3.10 database, based on the functional unit of 1 m^3 of treated water with a cradle-to-grave system boundary. The analysis was carried out in four stages: goal and scope definition, life cycle inventory, life cycle impact assessment, and interpretation.

The analysis results showed that the inventory data used consisted of both primary and secondary data, including energy consumption, raw materials, treated waste, and product-related emissions. The identified environmental impacts included Aquatic Ecotoxicity at 2859.82 kg TEG water, Aquatic Eutrophication at 2.96×10^{-3} kg PO_4^{3-} P-lim, Global Warming at 100.53 kg CO_2-eq, Non-renewable Energy at 88.83 MJ primary, and Ozone Layer Depletion at 4.32×10^{-4} kg CFC-11-eq. Normalization results indicated that Non-renewable Energy, Global Warming, and Aquatic Ecotoxicity were key environmental issues, with the effluent pond process identified as the primary hotspot. An improvement scenario through a recycling program is recommended, showing a sensitivity of 83% and a reduction in impacts of 61.256 MJ primary for Non-renewable Energy, 14.042 kg CO_2-eq for Global Warming, and 479.641 kg TEG water for Aquatic Ecotoxicity.

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***Keywords**: Cradle to Grave, Environmental Impact, Life Cycle Assessment, wastewater*