

Purification of bio-slurry waste using an electrolytic biomass solar cell with Co-generation of Bio-hydrogen Gas

Abstract

Bio-slurry disposal in areas lacking farmyards, where they can be used as organic manure is a challenge. On contrary, there is a dire need for greener processes to increase clean potable water and bio-fuels. This study purposed to electrolyze bio slurry for its purification while producing bio-hydrogen gas. An electrolytic biomass solar cell (EBSC) of capacity 4,000ml and current density 3.458amps/cm² was used. Carbon and steel wool were used as the anode and cathode respectively. The levels of physico-chemicals and bacteria inhibition in the bio-slurry were monitored over a 24-day retention period. Solid matters in the bio-slurry were effectively reduced by 32.15% while turbidity decreased from 18.92 to 6.85 NTU. The pH value decreased from 8.5 to 6.5 with the electrolysis process. Removal of *E. coli* bacteria was significantly higher than that of *S. aureus* ($P > 0.05$). There were observable changes in the functional groups of the raw and electrolyzed samples, corresponding to the changes in compounds and pH decline. Bio-hydrogen gas production was largely affected by the temperature and decreased over the retention period.

Keywords: Bio-slurry, clean water, bio-hydrogen, electrolysis.

Research questions:

1. What is the potential use of the accumulated waste bio-slurry?
2. Are there any sources of renewable bio-hydrogen?
3. Is there an efficient way to dispose of bio-slurry that cannot be treated?

Methods used: Physico-chemical analysis for %TSS

$\frac{A-B \times 1000}{Volume (ml)}$ and %TDS = TS% - TSS%, pH the functional group analysis using FT-IR Shimadzu 119, analysis of microbial activity for both gram-positive (*S.aureus*) and gram-negative (*E.Coli*) bacteria, antimicrobial sensitivity tests. Statistical analysis: 95% level of confidence was used for all the statistical analyses done. MS Excel (version 2016) and Origin Lab (version 6.5) statistical softwares were used.

Results; *Physico-chemical levels of the bio-slurry:* All the parameters analyzed decreased continually with the electrolysis process. The TS values at the onset of the experiment (32.0%) were quite high but within the range of a closed water system (20 to 500mg/L). *Production of bio-hydrogen and other anodic gases:* The amount of bio-hydrogen gas produced cumulatively during the retention period was significantly higher than the mixture of anodic gases produced (presumably biogas). This is supported by the theoretical molar volumes of hydrogen gas produced in comparison to oxygen gas during electrolysis of water (two folds higher).

Conclusion: The turbidity levels were reduced from 18.92 to 6.85NTU within the electrolysis process. The pH of the bio-slurry reduced from 8.5 to 6.5. The pathogenic microbes were also effectively removed with *E. coli* inhibition being more than that of *S. aureus* ($P > 0.05$). There was a change of IR spectra of the raw and electrolyzed bio-slurry samples where the organic acids peaks intensified as other functional groups were quenched with the electrolysis process. The highest biohydrogen gas volume recorded was 450.0ml. Gas production was largely influenced by the temperature conditions and decreased over time due to electrode poisoning.