INVESTIGATING THE EFFECTS OF INITIAL COD, VSS AND PH TO IMPROVE DARK FERMENTATIVE HYDROGEN PRODUCTION FROM SUCROSE AND MOLASSES

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Renewable energy production technologies are the world's most probable solution to its ever increasing energy demand. Organic waste can be a very important source for energy production if it is properly managed. Bio-hydrogen production systems are being exhaustively investigated for clean energy production possibilities. Because of its high energy content and possibility of the resources to be utilized for energy production, hydrogen systems are of great interest. In order to increase bio-hydrogen production, a number of approaches are being investigated, like modification of the operational conditions, pre-treatment of the waste, application of two-phase systems or the use of genetically modified organisms.

The objective of this study was to investigate the optimum operational conditions, such as initial chemical oxygen demand (COD), volatile suspended solids concentration and pH, leading to the largest amount of hydrogen gas production via dark fermentation in batch reactors. To this purpose, two sets of batch reactors were operated with different substrates, namely sucrose and sugar beet molasses. Molasses, sugar industry by-product, is a renewable source which can be converted to hydrogen by dark fermentation due to its high organic content (>80% sucrose). An experimental design approach, i.e. Response Surface Methodology, was used to decide on the parameter values to be tested and to evaluate the results of the experiments. The results of the dark fermentation batch sets revealed that;

For batch studies using sucrose as subsrate;

- Maximum hydrogen yield of 2.3 mol H_2/mol $sucrose_{added}$ was achieved at an initial pH of 7 and initial COD concentration of 10 g/L.
- Hydrogen production yield decreased as the initial COD increased from 10 to 50 g/L, while it increased as the initial pH value increased from 4 to 7.
- The studied initial ratio of substrate to volatile suspended solids (VSS) (S/X_o) values of 4, 12 and 20 g COD/g VSS had no effect on hydrogen production yield.
- Maximum hydrogen productivity (10.7 mL $H_2/(L_{reactor}.hr)$ was achieved at initial COD concentration of 26.6 g/L, S/X_o of 11.8 and pH of 6.7. Productivity increased with the increase in the initial pH value from 4 to 7.
- Initial COD concentration was not as radically influential on hydrogen production rate as was the pH.

For batch studies using molasses as substrate;

- The change in hydrogen yield and productivity could not be explained with the studied ranges of three variables (i.e. initial pH, COD and VSS values).
- Initial COD was the only variable that affected the hydrogen yield and productivity. Maximum of both was achieved at 10 g/L as 2.88 mmol H_2/g $sucrose_{added}$ and 8.26 mL $H_2/(L_{reactor}.hr)$.
- Initial VSS concentration in the reactors had no effect on yield or productivity for the values studied (2.50, 5.0 and 7.5 g/L).
- The decrease in the H_2 and CO_2 percentages of the headspace gas and suction observed in the reactors were attributed to homoacetogenic activity. Molasses, for containing potential intrinsic microorganism, might be more suitable to support and trigger the homoacetogenesis than sucrose.