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Fermentative biohydrogen production II: Net energy gain from organic wastes

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ABSTRACT

Several reports have demonstrated the feasibility of hydrogen production by dark fermentation (DF). However, most reports had resorted to mesophilic or thermophilic conditions to increase hydrogen yield, overlooking the energy input to the process and hence, loss of net energy gain. For net positive energy gain, energy input to the process should be minimized and additional energy should be harvested from the aqueous end products of DF. Our previous study presented an approach to assess the potential for net energy gain from the hydrogen produced by DF, and from the end products of DF via anaerobic digestion (AD) or microbial fuel cells (MFC). In this study, that approach is extended to identify the most promising process configuration and operating conditions to maximize net energy gain possible from liquid and particulate organic wastes. Based on this analysis, DF followed by MFC appears to result in higher net energy gains.

1. Introduction

Hydrogen has been proposed as an efficient and cleaner fuel that has the potential to augment or replace fossil fuels. However, hydrogen as a fuel is not freely available and has to be generated from hydrogen-rich sources. Over 95% of world's hydrogen demand is now being derived from fossil fuels [1], with a net negative energy gain negating some of the advantages of hydrogen. For hydrogen to be considered a sustainable alternative fuel to replace the fossil fuels, it has to be generated from cheap and readily available feedstocks that are renewable, via processes that can yield as high net energy gain as possible [2].

Biological processes have the potential to generate hydrogen – *biohydrogen*, from renewable and/or recyclable feedstocks. Over the past decade, feasibility of biohydrogen production from organic waste streams has been demonstrated. Use of organic waste streams for producing biohydrogen as a fuel could be a sustainable approach, because energy production and waste stabilization could be accomplished simultaneously. Among the bioprocesses for hydrogen production, *dark fermentation (DF)*, a modified form of the anaerobic process has been suggested as one with the greatest potential, due to its higher rate and its unique ability to utilize particulate organic wastes as feedstock.

Even though DF has the highest rate among the feasible bioprocesses, its hydrogen yield is low due to formation of a mix of volatile fatty acids and alcohols as end products. Lee et al. [3] had conducted a thermodynamic evaluation of the dark fermentation process and concluded that insufficient

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