Comprehensive evaluation of the integrated membrane contactor-microalgae photobioreactor system for simultaneous H_2 purification and CO_2 treatment from biomass fermented gases

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ABSTRACT

Biohydrogen (H_2) has been identified as a potential renewable energy source to substitute energy-based fossil fuel that can be produced from biomass fermentation. However, carbon dioxide (CO_2) is also commonly present in the biogas mixture and must be properly treated as it could contribute to the climate change phenomenon. In this study, an integrated membrane contactor-microalgae photobioreactor system is applied to allow simultaneous H_2/CO_2 treatment from biomass fermented biogases. A comprehensive evaluation of the effectiveness of the integrated system was investigated by screening the essential operating parameters of the system using One Factor at a Time (OFAT) technique followed by optimization Response Surface Methodology (RSM). Serial investigations of the process parameters, the optimum condition was at a pH of 10 with gas and liquid flow rates at the respective levels of 0.1 L/min and 0.5 L/min, while the microalgae concentration was 0.6 g/L. At these optimum conditions, the H_2 purity was found to have increased remarkably, from 69.4% to 83.2%. In a long-term separation performance using the optimized conditions, microalgae solution was found to be capable of sustaining its performance at a longer time with only 2% performance dropped observed within 540 min of the operational time. In conclusion, the use of microalgae in a membrane contactor system could be a promising technique for treating these fermented gases, in a move towards carbon neutrality.

KEYWORDS

H_2 separation; CO_2 absorption; Membrane contactor; Microalgae; Integrated system

ACKNOWLEDGEMENT

The authors would like to acknowledge the financial support of Fundamental Research Grant Scheme (FRGS/1/2018/TK02/UKM/02/2) from the Ministry of Higher Education of Malaysia, Dana Impak Perdana (DIP/2019/012) from Universiti Kebangsaan Malaysia, Dana Modal Insan for the postdoctoral scheme, and all the support from the Department of Chemical and Process Engineering of Universiti Kebangsaan Malaysia.