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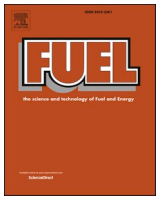

Green hydrogen derived from municipal wastewater via bioconversion by attached microalgae onto various sizes of polyurethane foam cubes

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ABSTRACT

In order to mitigate the environmental impacts of fossil fuel consumption and gear up for its depletions over the years, it is essential to explore the transition towards the renewable energy sources. Microalgae are characterized as the primary producers in an ecosystem which can adapt easily and have high growth rate. Indeed, microalgae can produce various biofuels, inclusive of green hydrogen which is touted as the most clean and sustainable option for fossil fuel replacement. Immobilization of microalgae onto polyurethane foam had been employed in the current study to increase the hydrogen yield, while offering an easy harvesting process for potential reusability, and preventing cells' wash out from cultivation system. Polyurethane foam cubes of four different sizes, namely, 0.5, 0.75, 1 and 2 cm (cubes' edge lengths), were initially used to immobilize microalgae for 7 days. They were then introduced into municipal wastewater medium to provide alimentation for attached microalgae in performing dark fermentation. The results revealed that the 1 cm cubes' size could consistently produce high hydrogen volumes of 20 – 21 mL with the COD and ammoniacal nitrogen removal efficiencies being achieved at 70% and 57%, respectively. The smaller sizes than 1 cm cubes failed to sustain its hydrogen yields due to the excessive losses of attached microalgae stemming from the abrasion process when the cubes were fluidizing in the culture medium. The bigger cubes than 1 cm had produced lesser hydrogen due to the limited surface area available to populate attached microalgae. And also due to the diffusion limitation of essential nutrients from culture medium into the cubes to support the metabolic activities of attached microalgae within the cubes. The hydrogen production from 1 cm cubes was also well fitted into the first order kinetics, attaining the$R^2 = 0.9998$ and rate constant of $0.1247 \pm 0.0005\,h^{-1}$. Lastly, a statistical model was derived to predict the overall hydrogen yield from attached microalgae onto 1 cm polyurethane foam cubes. This was carried out based on the amount of

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