The fast start-up strategy for biocathode acclimation in a hydrogen-producing microbial electrolysis cell

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Microbial electrolysis cell (MEC) provides a new approach for hydrogen generation from renewable biomass. Biocathode MEC, with self-growing capability microbes without relying on noble metal as catalyst, has raised much attention recently for catalyzing hydrogen production for its great economic practicality and acceptable catalytic activity [1-3]. However, the acclimation of biocathode to catalyze hydrogen evolution is a challenging task, which is time-consuming.

In this study, we developed a strategy for fast biocathode cultivation, which was accomplished by extending the exoelectrogenic reaction with H$_2$-full atmosphere firstly to enrich the H$_2$-utilizing bacteria in the bioanode of the MEC. This bioanode was then inversely polarized with applied voltage in a half-cell to enrich the hydrogen-evolving biocathode. To further optimize the performance of the biocathode, the effects of bicarbonate buffer concentrations and cathode potentials on the biocathode for hydrogen production were studied. Results show that the catalytic hydrogen evolution reaction (HER) kinetics of biocathode is enhanced by increasing bicarbonate buffer concentration (0.05-0.5 mol L$^{-1}$) and/or by lowering the cathode potential (-0.9 V to -1.3 V vs. SCE). A hydrogen production rate of 8.44 m$^3$ m$^{-3}$ d$^{-1}$ with a current density of 951.6 A m$^{-2}$ can be obtained under the cathode potential of -1.3 V vs. SCE, 0.4 mol L$^{-1}$ of bicarbonate. The higher bicarbonate buffer concentration increases the electrolyte’s conductivity and protons flux, which improves the performance of hydrogen production catalyzed by the biocathode. Hydrogen production was also assessed in a single-chamber MEC with both of the bioanode and biocathode, and 9.64 A m$^{-2}$ of current density with a hydrogen production rate of 0.51 m$^3$ m$^{-3}$ d$^{-1}$ were achieved at 1.0 V applied voltage. This study provides the information for optimizing the hydrogen production performance of biocathode MEC and widen its possibilities for practical application.

References

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