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Influence of iron on sulfide inhibition in dark biohydrogen fermentation

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HIGHLIGHTS

- ▶ Sulfide inhibition on dark biohydrogen fermentation has been studied.
- ▶ Low sulfide concentration (25 mg/L) significantly enhanced the hydrogen production.
- ▶ High sulfide concentrations (500 mg/L) completely inhibited hydrogen production.
- ▶ Addition of ferrous iron entirely eliminated the inhibitory effect of sulfide.

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ABSTRACT

Sulfide impact on biohydrogen production using dark fermentation of glucose at 37 °C was investigated. Dissolved sulfide (S^{2-}) at a low concentration (25 mg/L) increased biohydrogen production by 54% relative to the control (without iron addition). Whereas on initial dissolved S^{2-} concentration of 500 mg/L significantly inhibited the biohydrogen production with total cumulative biohydrogen decreasing by 90% compared to the control (without iron addition). At sulfide concentrations of 500 mg S^{2-}/L, addition of Fe^{2+} at 3–4 times the theoretical requirement to precipitate 100% of the dissolved S^{2-} entirely eliminated the inhibitory effect of sulfide.

1. Introduction

To mitigate the worldwide increasing energy demand, scientists are focusing on the production of energy from various renewable sources. Hydrogen is a promising alternative clean fuel for the future that has very high energy content (142 kJ/g) (Sinha and Pandey, 2011). Hydrogen can be produced through various processes such as steam reforming of natural gas, water electrolysis, and biologically through dark fermentation, photofermentation, and photolysis. Due to the increased interest in utilization of renewable sources such as waste and wastewater for bio-energy production, biological conversion of waste to biohydrogen has received a considerable attention in recent years (Sinha and Pandey, 2011; Wang and Wan, 2009). Biological hydrogen production through dark fermentation is significantly influenced by various environmental and operating factors such as inoculum, substrate, pH, temperature, availability of macronutrients (N, P, S), and micronutrients (K, Mg, Ca, Fe, Mn, Co, Cu, Mo, Zn) (Mara and Horan, 2003). If the aforementioned operating conditions, micronutrients, and macronutrients are not maintained within a certain range, they may inhibit the activity of hydrogen producing microorganisms. Thus, the impacts of the aforementioned parameters have been extensively studied to optimize biohydrogen production as well as to explore the inhibition levels (Wang and Wan, 2009; Sinha and Pandey, 2011).

Sulfate (SO_4^{2-}) is a common form of sulfur in many wastes used as feedstock for anaerobic digestion (AD) such as pulp and paper industry and food processing industry wastes (Lens et al., 1998). During AD, sulfate can be reduced to sulfide (S^{2-}) by sulfate reducing bacteria (SRB). Additionally, sulfide can be produced through the anaerobic degradation of sulfur containing compounds such as proteins. Sulfide has been identified to be toxic or inhibitory to the fermentative microorganisms (Hwang et al., 2011; Dezham et al., 1988). Sulfide can also reduce the bioavailability of essential macronutrients (trace metals) through the formation of insoluble

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