Influence of iron (II) oxide nanoparticle on biohydrogen production in thermophilic mixed fermentation

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Abstract

The effect of initial pH, metal oxide and concentration of nanoparticles (NP) on hydrogen production were investigated in batch assays using glucose-fed anaerobic mixed bacteria in thermophilic condition of 60 degrees C. Two type of metal oxide nanoparticles, iron (II) oxide and nickel oxide, were tested and both metal capable of increasing the hydrogen yield about 34.38% and 5.47% higher than the control test. The experiments on the effect of initial pH were done without adding the nanoparticles to determine the optimum pH for maximum hydrogen production, in which at pH 5.5, the maximum hydrogen yield has reached about 1.78 mol H-2/mol glucose. However, at pH 5.5 and the optimal iron (II) oxide concentration of 50 mg/L, the maximum hydrogen yield has reached to 1.92 mol H-2/mol glucose, and the hydrogen content was 51%. Furthermore, the analysis of metabolites has indicated that the hydrogen production follows the acetic acid pathway. In all experiments with metal oxide nanoparticles, the metal NP was not consumed by the microbes, and the amount of it at the end of the fermentation was similar to the starting amount, which can be concluded that it was acting as an enhancer to the system to improve the hydrogen production. These results suggest that the addition of iron (II) oxide nanoparticles in the system is the vital factor to enhance the hydrogen production. (C) 2017 Hydrogen Energy Publications LLC. Published by Elsevier Ltd. All rights reserved.

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Cited References: 56

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1. **Energetics of overall metabolic reactions of thermophilic and hyperthermophilic Archaea and Bacteria** Times Cited: 392
By: Amend, JP; Shock, EL
FEMS MICROBIOLOGY REVIEWS Volume: 25 Issue: 2 Pages: 175-243 Published: APR 2001

2. **Production of bioengineering and biochemicals from industrial and agricultural wastewater** Times Cited: 1
By: Angenenta, LT; Karima, K; Al-Dahhana, MH; et al.
Trends Biotechnol
[Show additional data]

3. **Improving effect of metal and oxide nanoparticles encapsulated in porous silica on fermentative biohydrogen production by Clostridium butyricum** Times Cited: 41
By: Beckers, Laurent; Hiligsmann, Serge; Lambert, Stephanie D.; et al.
BIORESOURCE TECHNOLOGY Volume: 133 Pages: 109-117 Published: APR 2013

4. **Metabolic flux network and analysis of fermentative hydrogen production** Times Cited: 55
By: Cai, Guiqin; Jin, Bo; Monis, Paul; et al.
BIOTECHNOLOGY ADVANCES Volume: 29 Issue: 4 Pages: 375-387 Published: JUL-AUG 2011

5. **Renewable hydrogen generation by bimetallic zero valent iron nanoparticles** Times Cited: 40
By: Chen, Ku-Fan; Li, Shaolin; Zhang, Wei-xian
CHEMICAL ENGINEERING JOURNAL Volume: 170 Issue: 2-3 Special Issue: SI Pages: 562-567 Published: JUN 1 2011

6. **Advances in biohydrogen production processes: An approach towards commercialization** Times Cited: 135
By: Das, Debabrata
INTERNATIONAL JOURNAL OF HYDROGEN ENERGY Volume: 34 Issue: 17 Pages: 7349-7357 Published: SEP 2009

7. **CFD optimization of continuous stirred-tank (CSTR) reactor for biohydrogen production** Times Cited: 75
By: Ding, Jie; Wang, Xu; Zhou, Xue-Fei; et al.
BIORESOURCE TECHNOLOGY Volume: 101 Issue: 18 Pages: 7005-7013 Published: SEP 2010

8. **Effect of different redox mediators during thermophilic azo dye reduction by anaerobic granular sludge and comparative study between mesophilic (30 degrees C) and thermophilic (55 degrees C) treatments for decolourisation of textile wastewaters** Times Cited: 69
By: dos Santos, AB; Bisschops, IAE; Cervantes, FJ; et al.
CHEMOSPHERE Volume: 55 Issue: 9 Pages: 1149-1157 Published: JUN 2004

9. **A critical literature review on biohydrogen production by pure cultures** Times Cited: 85
By: Elsharnouby, Omneya; Hafez, Hisham; Nakhla, George; et al.
INTERNATIONAL JOURNAL OF HYDROGEN ENERGY Volume: 38 Issue: 12 Pages: 4945-4966 Published: APR 22 2013