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Effect of Non-Regulated pH on the Dynamics of Dark Fermentative Biohydrogen Production with Suspended and Immobilized Cell Culture

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Abstract : Biohydrogen has been identified as a promising alternative to the use of non-renewable fossil reserves, owing to its sustainability and non-polluting nature. pH is considered as a key parameter in fermentative biohydrogen production processes, due to its effect on the hydrogenase activity, metabolic activity as well as substrate hydrolysis. The present study assesses the influence of regulating pH on dark fermentative biohydrogen production. Four experimental hydrogen production schemes were evaluated. Two were implemented using suspended cells under regulated pH growth conditions (Sus_R) and suspended and non-regulated pH (Sus_N). The two others regimes consisted of alginate immobilized cells under pH regulated growth conditions (Imm_R) and immobilized and non-pH regulated conditions (Imm_N). All experiments were carried out at 37.5°C with glucose as sole source of carbon. Sus_R showed a lag time of 5 hours and a peak hydrogen fraction of 36% and a glucose degradation of 37%, compared to Sus_N which showed a peak hydrogen fraction of 44% and complete glucose degradation. Both suspended culture systems showed a higher peak biohydrogen fraction compared to the immobilized cell system. Imm_R experiments showed a lag phase of 8 hours, a peak biohydrogen fraction of 35%, while Imm_N showed a lag phase of 5 hours, a peak biohydrogen fraction of 22%. 100% glucose degradation was observed in both pH regulated and non-regulated processes. This study showed that biohydrogen production in batch mode with suspended cells in a non-regulated pH environment results in a partial degradation of substrate, with lower yield. This scheme has been the culture mode of choice for most reported studies in biohydrogen research. The relatively lower slope in pH trend of the non-regulated pH experiment with immobilized cells (Imm_N) compared to Sus_N revealed that that immobilized systems have a better buffering capacity compared to suspended systems, which allows for the extended production of biohydrogen even under non-regulated pH conditions. However, alginate immobilized cultures in flask systems showed some drawbacks associated to high rate of gas production that leads to increased buoyancy of the immobilization beads. This ultimately impedes the release of gas out of the flask.

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