**Biological hydrogen production by *Rhodopseudomonas palustris*: comparison of a packed bed and fluidised bed photobioreactor systems.**

Brandon Ross1, Robert Pott1 \*

*1 Department of Process Engineering, Stellenbosch University, South Africa*

\*Corresponding author: rpott@sun.ac.za

**Highlights**

* *R. palustris* used in the photobioreactor systems is immobilised in a transparent PVA cryogel
* A packed bed bioreactor and a fluidised bed bioreactor will be compared based on specific hydrogen production
* It is expected that the fluidised bed will outperform the packed bed.

**1. Introduction**

Biological hydrogen production is a promising replacement for the current modes of hydrogen production seen in industry today. However, key issues with the process still need to be solved before such processes can be scaled up to industrial levels. The use of photosynthetic bacteria such as *Rhodopseudomonas palustris* to produce hydrogen has shown to have a low environmental impact but the required energy input is greater than the energy derived from the hydrogen produced. Therefore, to increase the efficiency of the biohydrogen production process the ratio of energy consumed to energy produced must be improved.

The scalability of processes using photosynthetic bacteria to produce biohydrogen relies on the optimisation of the process parameters, of which the immobilisation of the photosynthetic bacteria in a poly vinyl-alcohol (PVA) based hydrogel by entrapment has been identified as covering several of these key areas. These areas include but are not limited to: i) protection from physio‑chemical challenges, ii) cryptic growth, iii) higher biomass concentration than in planktonic systems, iv) reduced number of cell divisions resulting in metabolic energy being focused on product formation [2].

The immobilisation of such bacteria then raises the question, what bioreactor configuration suites photosynthetic biohydrogen production when using immobilised bacteria. Not many configurations have been proposed, let alone investigated, for the use of immobilised photosynthetic bacteria due to most immobilisation matrices being opaque. Thus, two reactor systems were designed to investigate the hydrogen production performance, namely a packed bed photobioreactor (PBPBR) and a fluidised bed photobioreactor (FBPBR).

**2. Methods**

*R. palustris* was immobilised in transparent PVA cryogel where the PVA solution was 10% (w/v) PVA dissolved in a 50% (v/v) glycerol-water solution. The PBPBR and FBPBR were designed to allow the synthetic waste stream to pass through the bed of immobilsed bacteria with a 100% recycle stream to operate as a batch system with all hydrogen produced collected off the headspace of the photobioreactors. The Hydrogen production by immobilised *R. palustris* was compared to planktonic cultures in the same photobioreactor system.



**Figure 1.** PBPBR and FBPBR experimental setup

**3. Results and discussion**

It is anticipated that the fluidised bed photobioreactor will outperform the packed bed photobioreactor with respect to the specific hydrogen production (specific in terms of both biomass loading and volume of the reactor). This is due to the motion of the fluidised bed increasing the amount of light that each PVA cryogel bead that contains the immobilised bacteria receives. Full results will be available from the 30th of May 2019.

**4. Conclusions**

We present a proven design for photobioreactors that can be used in conjunction with transparent immobilised *R. palustris*. Preliminary studies with planktonic media in the photobioreactors proved the viability of the system with regards to production and collection of biohydrogen. Further conclusions with regards to the hydrogen production in the PBPBR and the FBPBR will be drawn once all results have been obtained.

**References [Calibri 10]**

[1] A. Adessi and R. De Philippis, ‘Photobioreactor design and illumination systems for H2 production with anoxygenic photosynthetic bacteria: A review’, *International Journal of Hydrogen Energy. Elsevier Ltd*, 39(7), pp. 3127–3141. doi: 10.1016/j.ijhydene.2013.12.084. 2014.

[2] G. A. Dervakos and C. Webb, ‘On the merits of viable-cell immobilisation’, *Biotechnology Advances*, vol. 9, no. 4, pp. 559–612, Jan. 1991.