**Improving CO2 Bioconversion Processes: Effect of Carbonic Anhydrase and a Fixed Bed Trickle Down System on gas solubilization**

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**Highlights**

* Use of carbonic anhydrase (CA) to enhance CO2 solubilization.
* Different concentrations of CA tested.
* Use of a fixed bed trickle down system to enhance CO2 solubilization.
* Comparing the two different strategies and their combination.

**1. Introduction**

In recent times, CO2 has started to be used as a building block to produce a wide range of chemicals and products *via* biological processes. This has drastically changed the point of view, from seeing it just as a pollutant, to consider it as an economic substrate. This idea totally fits in the idea of circular economy, reducing greenhouse gases (GHG) emissions and converting CO2 into a high value product.

However, one of the major bottlenecks in the conversion of CO2 into desired molecules *via* industrial biotechnology is the low yield of the target compounds. Among the different factors responsible for this low productivity, issues regarding gas availability should be addressed, like gas-liquid mass transfer and CO2 solubility.

This study assesses two different strategies and their combination, a fixed bed trickle down system (TBR) [1] and a robust enzyme carbonic anhydrases (CA) [2], [3]. The improvement of gas-liquid mass transfer and CO2 solubility enhance further 3-hydroxypropionic acid (3-HP) production using the *Cupravidus necator*.

**2. Methods**

Temperature and pH are two physical conditions that must be defined to promote the solubility of CO2 and enhance the performance of the selected microorganism or enzyme. In this case, the experiments are performed at 30ºC (optimal temperature for *Cupravidus necator*) and at pH 8 (being the bicarbonate the main chemical species at liquid phase). The solution has a buffer of K+-PO43- and each experiment takes place in 3 hours.

Figure 1 shows the two main strategies for CO2 solubilisation. On one hand, CO2 is introduced in a 1 L stirred vessel filled with the buffer solution with and without CA. On the other hand, a TBR filled with Raschig rings (6x6mm) is first optimized in terms of liquid flow and gas flow ratio (in countercurrent) and then the optimized concentration of CA is introduced in the system.

Samples are withdrawn regularly during each experiment to study the kinetics of CO2 absorption.



**Figure 1.** Experimental set-up for solubilization in vessel (left) and in TBR (right).

**3. Results and discussion**

Table 1 shows the preliminary results of CO2 absorption in different conditions.

**Table 1.** Preliminary results on CO2 absorption.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Water** | **Buffer** | **Buffer + CA** | **TBR** |
| **CO2 absorbed (%)** | 6,49 | 16,34 | 17,91 | 39,67 |

As it can be seen, the use of the buffer increases significantly the amount of CO2 absorbed as the pH is maintained at 8. The use of CA has a slightly positive effect, but further experiments using higher concentration of CA are needed. Furthermore, the TBR presents the better result in terms of CO2 adsorption and the use of CA in this system is expected to increase this value even more.

**4. Conclusions**

The use of CA and TBR has proven to be effective strategies to enhance CO2 solubility. This will allow the conversion of CO2 into desired molecules *via* industrial biotechnology to have a higher yield of the target compounds such as 3-HP (as is the case of the project in which this study is framed) and other chemicals and products *via* biological processes.

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