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Title:

In-situ product recovery using membrane-assisted reactive extraction for bio-based 3-hydroxypropionic acid production

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Abstract:

3-hydroxypropionic acid (3-HP) is a platform molecule of industrial interest as a biobased precursor to acrylic acid and polymers. As a carboxylic acid, its accumulation in the bioconversion broth induces a high toxicity towards the producing microorganisms. The production is then limited and the neutralization of the broth is needed to match high concentration with biocompatible pH.

In order to overcome these limitations and to intensify the process through membrane contactor integration, we proposed to couple the bioreactor with a selective separation process. The studied approach is a reactive liquid-liquid extraction assisted by a membrane contactor. It consists in extracting the acid through a reversible complexation reaction using an extractant diluted in an organic solvent. The use of membrane contactor reduces organic phase toxicity towards microorganisms. This integrated process should prevent 3-HP accumulation while performing a primary purification (from cells, proteins, cations, substrates and coproducts).

Tri-*n*-octylamine is used as the extractant, diluted in decanol (selected from a solvent screening for its extraction efficiency and very low solubility in water). A chemical regeneration was used to renew the organic phase and led to a total 3-HP recovery.

Based on experimental and modeling approaches, we propose a setting-up of the 3-HP production integrated with its extraction and the solvent phase regeneration that could allow to reach a stationary state in the production reactor where 3-HP accumulation stays low. A productivity of around 2.5g/L/h (as advised by the DoE and reached by Cargill) would lead to a concentration of less than 5g/L in the broth whose pH can easily be adjusted with a small amount of base.

This study suggests the possibility to control the pH in the bioreactor and get a purified concentrated solution which solves major shortcomings in biotechnological production of organic acids.

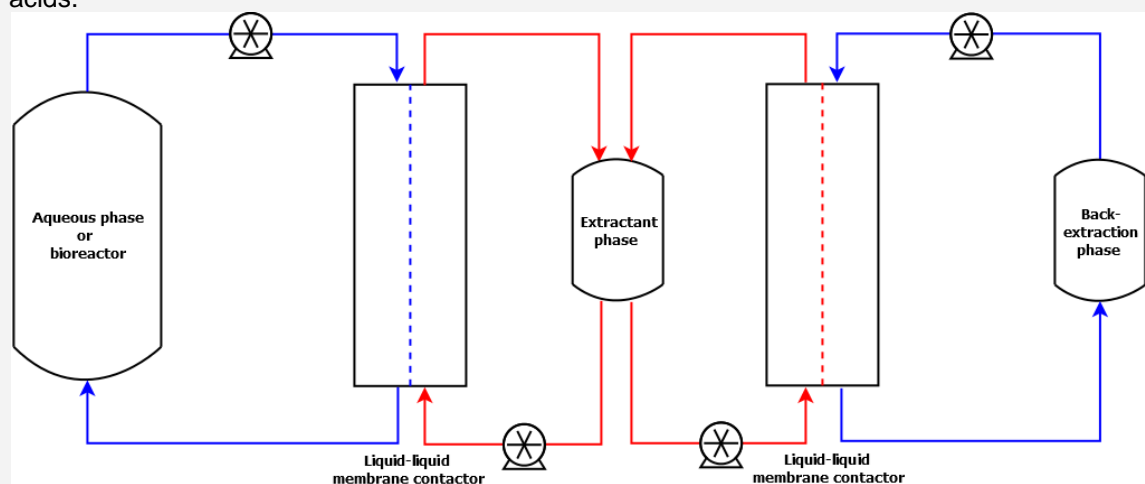


Figure 1: Experimental set-up