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MODEL BASED DESIGN AND OPERATION OF A MEMBRANE BIOREACTOR FOR LACTIC ACID PRODUCTION

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Due to the increasing lactic acid demand, as primary feed-stock for Polylactic acid production, diverse technologies have been investigated in order to reduce production cost. Thereby polylactic acid production can become economically feasible and substitute its petrochemical based competitors. One main constraint during lactic acid fermentation is product inhibition. Therefore, productivity and yield can be increased by the continuous removal of the biotoxic lactate from the fermentation broth. Membrane bioreactors have shown satisfactory performance in bioseparations, thus they have been increasingly investigated for lactic acid production. Recently, an integrated bioreactor and electrically driven membrane separation process (Reverse Electro-Enhanced Dialysis - REED) has been proposed as a method for *in situ* continuous lactate removal of the fermentation broth (Rype, 2003). During the system operation, lactate is exchanged by hydroxide ions by means of anion exchange membranes combined with periodically varying electrical current to reduce fouling. Such a membrane system allows reducing lactate inhibitory effect and simultaneously assisting the pH control in the bioreactor.

The integrated system is investigated based upon previously developed mathematical models (Boonmee *et al.* 2003, Prado-Rubio *et al.*, 2009; 2010). Due to the dynamic behavior associated with the individual units plus their interaction, the design and operability of the integrated system constitutes a key

issue. The purpose of this contribution is to discuss these challenges and propose a methodology for investigating the integrated system design and operation. The operability of the membrane bioreactor is highlighted through the continuous production of lactic acid. A control structure is designed and its performance evaluated. As a result, the membrane and reactor units interactions are exploited to substantially increase the lactate productivity and substrate utilization compared to a conventional fermentation. At the same time the pH control in the fermenter is facilitated reducing the base consumption. From the preliminary results, it is expected that the implementation of more advanced control structures and controllers can increase even further the process performance.

References

- Boonmee, M.; Leksawasdi, N.; Bridge, W. and Rogers, P. (2003). Batch and Continuous Culture of *Lactococcus lactis* NZ133: Experimental Data and Model Development. *Biochemical Engineering Journal*, 14, 127-135.
- Prado-Rubio, O.A.; Jørgensen, S.B. and Jonsson, G. (2009). Tool for Optimizing the Design and Operation of Reverse Electro-Enhanced Dialysis of Monoprotic Carboxylic Acids. In proceedings: 10th International Symposium on Process Systems Engineering.
- Prado-Rubio, O.A.; Jørgensen, S.B. and Jonsson, G. (2010). Control System Development for Integrated Bioreactor and Membrane Separation Process. In proceedings: 20th European Symposium on Computer-Aided Engineering.
- Rype, J. (2003). Modelling of Electrically Driven Processes. Ph.D. thesis, Technical University of Denmark.