PRODIAS
Processing Diluted Aqueous Systems

SPIRE PROJECT

Bipolar electrodialysis for purification of fermentation-based products

P. Schmidt[1], H. Voß[1], D. Janowitz[2], M. Wessling[2], [1]: BASF SE, Ludwigshafen, [2]: AVT.CVT, RWTH Aachen, Aachen

Motivation

- Raw-material and energy efficiency in downstream processing (DSP) of fermentation-based products
- **Objective**: Evaluating bipolar electrodialysis (ED) as one promising technology in hybrid processes
- Exemplary system: γ-amino butyric acid

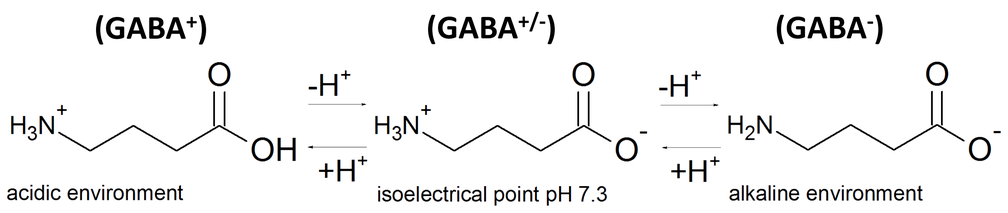

Fig. 1: Charge of GABA as function of pH value.

Bipolar electrodialysis in DSP

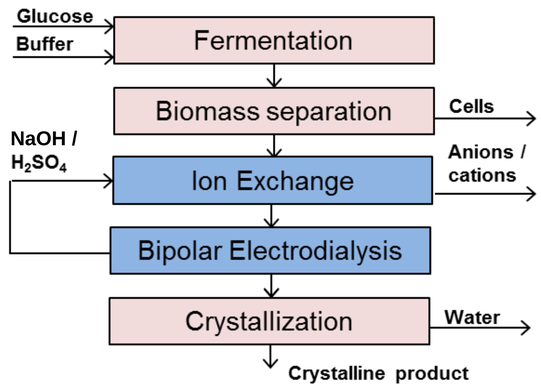

Fig. 2: Flowsheet integrating bipolar ED and Ion Exchange.

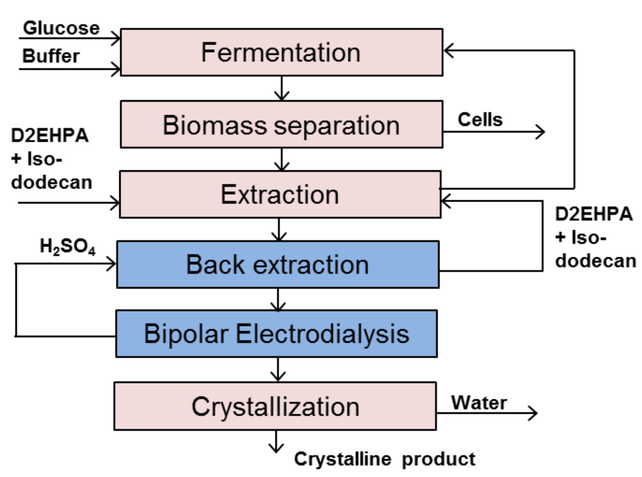

Fig. 3: Flowsheet integrating bipolar ED and extraction.

Experimental setups

- Two-loop batch arrangement on 5 litre scale
- Inline measurement of membrane resistances using platinum wires (**BPM**, **CEM**, **AEM**)
- Two functions of bipolar ED
  - (1) **Desalination** of ionic GABA by removing ions through anion exchange membranes (**AEM**) or cation exchange membranes (**CEM**)
  - (2) **Caustic** / **acid** **generation** using bipolar membranes (**BPM**) depending on configuration **[Fig. 4 / Fig. 5]**

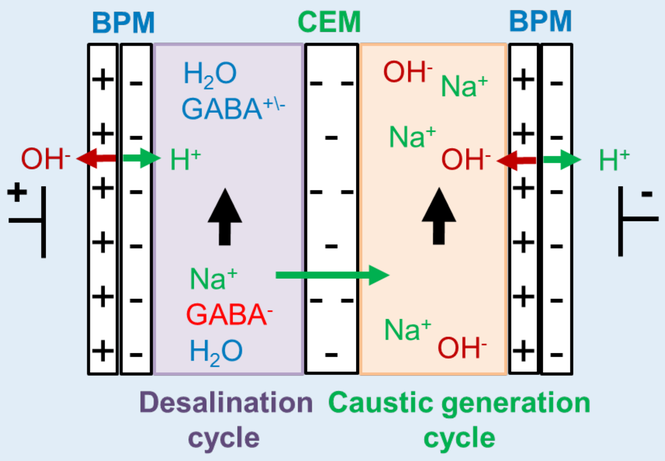

Fig. 4: Configuration 1 consisting of BPM and CEM ("caustic stack").

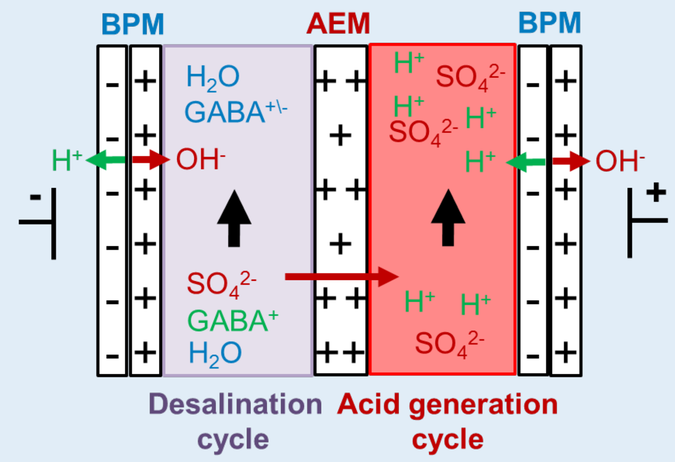

Fig. 5: Configuration 2 consisting of BPM and AEM ("acid stack").

Experimental results

- Spec. energy consumption lower in "caustic stack" config. (0.5-0.8 kWh/kg GABA) **[Fig. 6]**
- Drop in current efficiency observed in reference experiments in "acid stack" over time, most likely due to blockage of the **AEM** by GABA **[Fig. 7]**
- Regeneration of "acid stack" by NaOH **[Fig. 7]**
- Reversible sorption of GABA into BPM observed by analyzing resistance **[Fig. 8]**

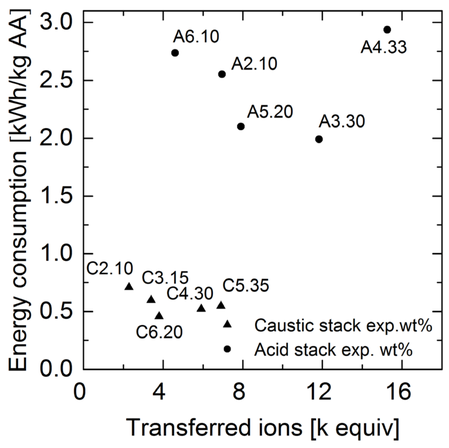

Fig. 6: Spec. energy consumptions in GABA desalination experiments.

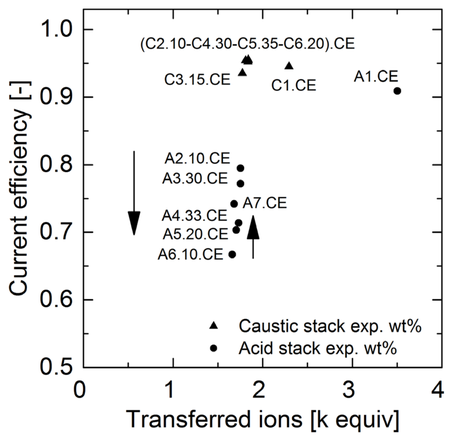

Fig. 7: Current efficiencies in reference experiments (NaOH or H_2SO_4).

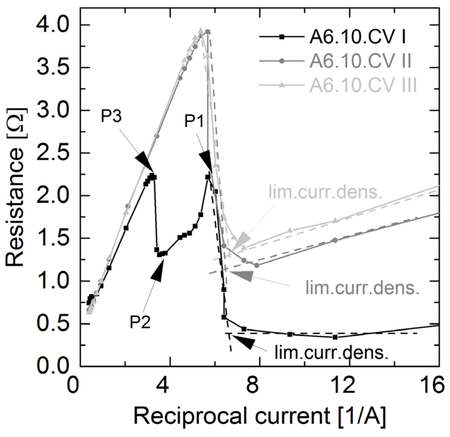

Fig. 8: Current-resist. curves of BPM in subseq. tests (I-III) after GABA run.

Summary and Outlook

- Method for detailed analysis of membrane resistances in stack operation mode using platinum wires developed
- Combination of bipolar ED and IEX using NaOH recirculation most promising

→

- Runs with original fermentation broth (effect of impurities)
- Hybrid system will be run in continuous operation (SMB and bipolar ED) @ BASF in cooperation with Xendo
- Main challenge: Enrichment of impurities in continuous run

PRODIAS CONSORTIUM

BASF We create chemistry · Alfa Laval · GEA · Imperial College London · Cargill · XENDO Solutions for Life Sciences · enviplan · Technische Universität Kaiserslautern · UPM

ABOUT THE PROJECT

- Start date: 1st January 2015
- Duration 48 Months, until 31st December 2018
- Budget: 14 million €
- Project web site: www.spire2030.eu/prodias/

The research project receives funding from the European Community's Framework Programme for Research and Innovation Horizon 2020 (2014-2020) under grant agreement nº. 637077