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Commissioning and Operation of an Enzymatic Reactive Extraction Centrifuge

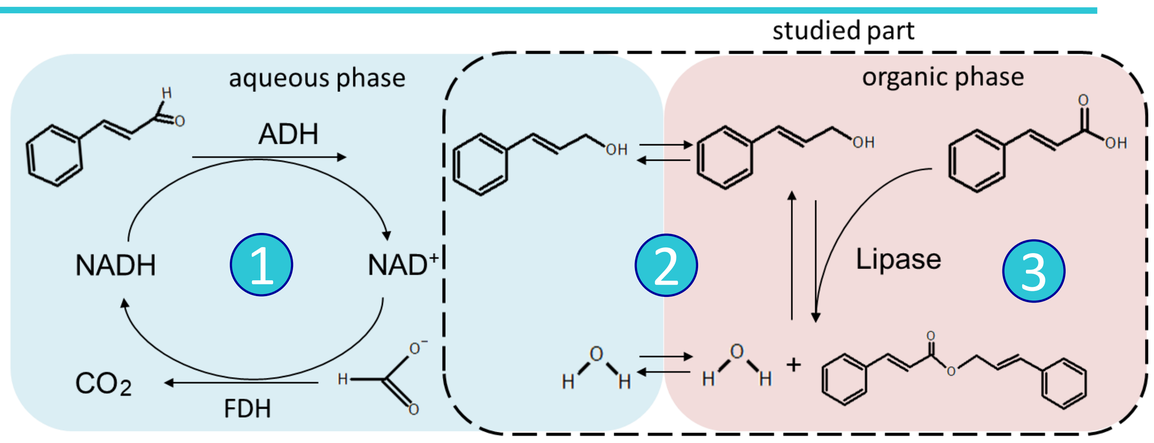
Motivation

- Growth of demand **for natural flavors and fragrances** requires development of new production processes e.g. **multi enzyme cascades**[1]
- To allow industrial application economical efficiency improved by **process integration**

Research goal:

Development of **reactive extractive centrifuge** (REC) from previous setup with extractive centrifuge (EC)[2] in context of a multi-enzyme cascade (shown on the right) with immobilized enzymes

Reaction scheme



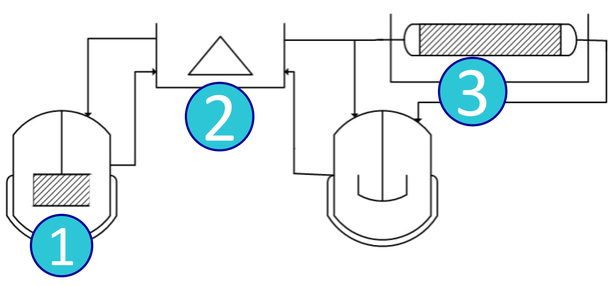
1 Synthesis of intermediate alcohol with parallel co-factor regeneration

2 Mass transfer between aqueous and organic phase

3 Esterification reaction to form the final product: natural cinnamyl cinnamate

Methodology

Previous setup with EC



Process Development

Design

Integration of organic phase reactor into centrifuge
→ Provide space for enzymes

Operation

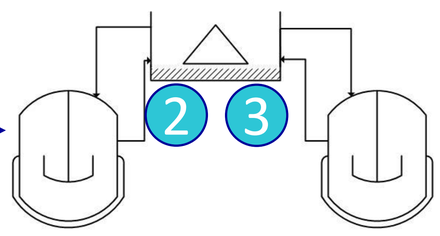
Operational parameters of centrifuge
→ Volume flow
→ Rotational speed

Reaction

Esterification in organic phase in centrifuge

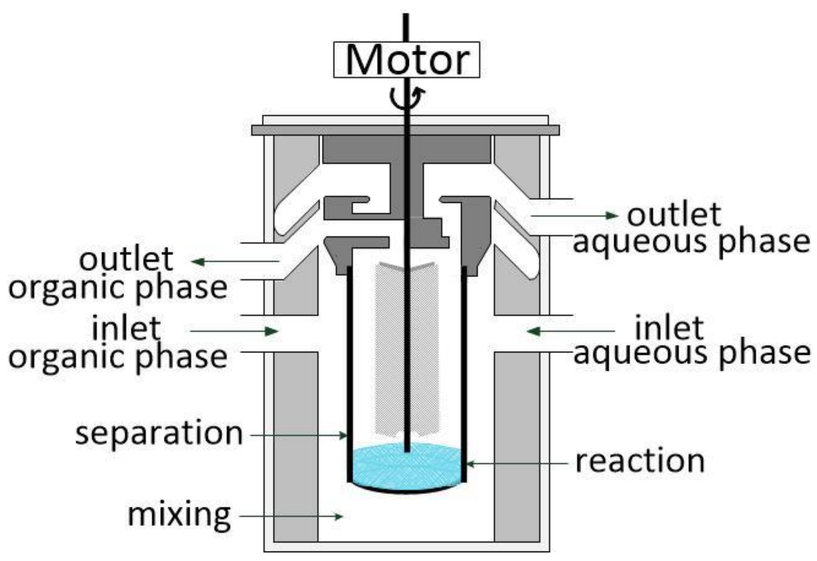
→ Prevent mechanical destruction of particles

REC



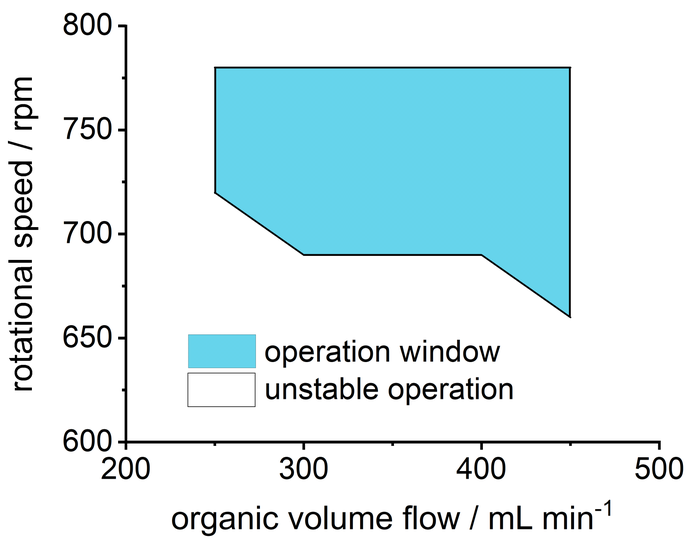
Results

Design



- Reaction zone implemented between separation and mixing
- Mesh used to fix particles in reaction zone

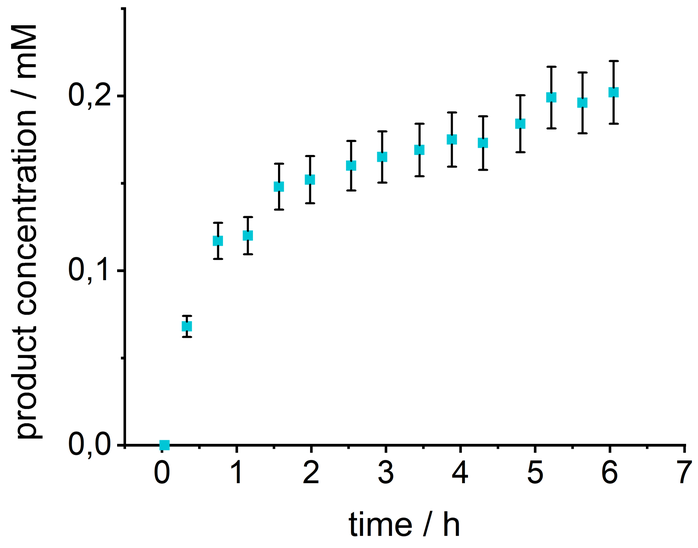
Operation



Operation conditions: V_{orga}=0.6 L, V_{aq}=0.6 L, T=24°C

- Operation condition exemplary shown for an aqueous volume flow of 180 mL*min^{-1}
- Limited by higher pressure drop in centrifuge due to reaction zone

Reaction

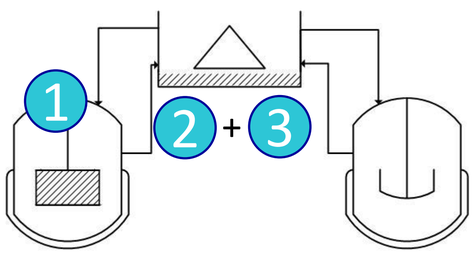


Operation conditions: V_{orga}=0.6 L V_{aq}=0.6 l, T=35°C, $c_{alcohol,0}$= 25 mM, $c_{acid,0}$=50 mM, $m_{Lipase,\ immo}$=7 g

- Continuous increase of product concentration
- Typical shape for equilibrium-based reaction

Conclusion and outlook

- [x] Successful implementation of enzymes in reaction zone of EC to construct a REC
- [x] Determination of operation window
- [x] Proof of concept for REC using an exemplary reaction of a multi-enzyme cascade



- [ ] Operation of REC within the complete cascade

- [ ] Simulation of process in python
- [ ] Case studies and mathematical optimization of space time yield

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References

[1] Engelmann, Johannsen, Waluga, Fieg, Liese, Bubenheim , A multi-enzyme cascade for the production of High-Value Aromatic Compound, Catalysts, MDPI, 2020
[2] Meyer, Johannsen, Liese, Skiborowski, Bubenheim, , Evaluation of process integration, Chemical Engineering and Processing: PI, Elsevier, 2021
[3] Johannsen, Meyer, Liese, Fieg, Bubenheim, Waluga, Multi-Enzyme Cascade Reaction in a Miniplant, AIChE, Wiley, 2021

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