Application of Nanofiltration for the Removal of Homogeneous Catalysts from Aqueous Systems

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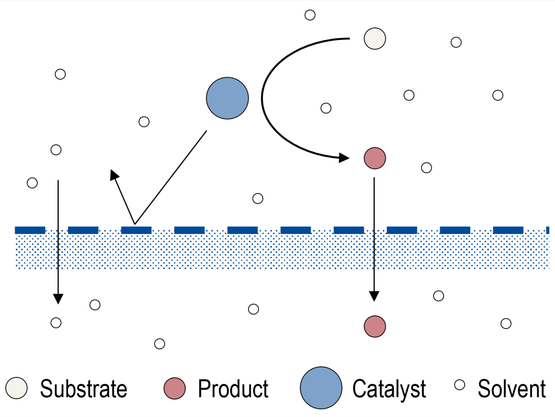
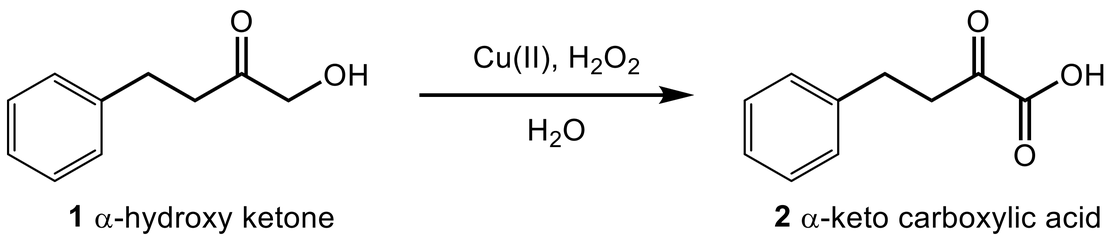
The separation of homogeneous catalysts from reaction mixtures has been a pressing problem ever since. Due to its adjustable selectivity and energy efficiency, nanofiltration is a promising method for removing catalysts from reaction mixture in order to facilitate their reuse. Until now, such systems have mainly been explored in the field of solvent-resistant nanofiltration, while aqueous systems are far less common. In this work, the use of nanofiltration for the separation of inorganic oxidation catalysts from aqueous solution was investigated.



The Reaction

Selective Oxidation Using Earth-abundant Metals

Prof. Nora Kulak, Isabell Prediger, University of Potsdam

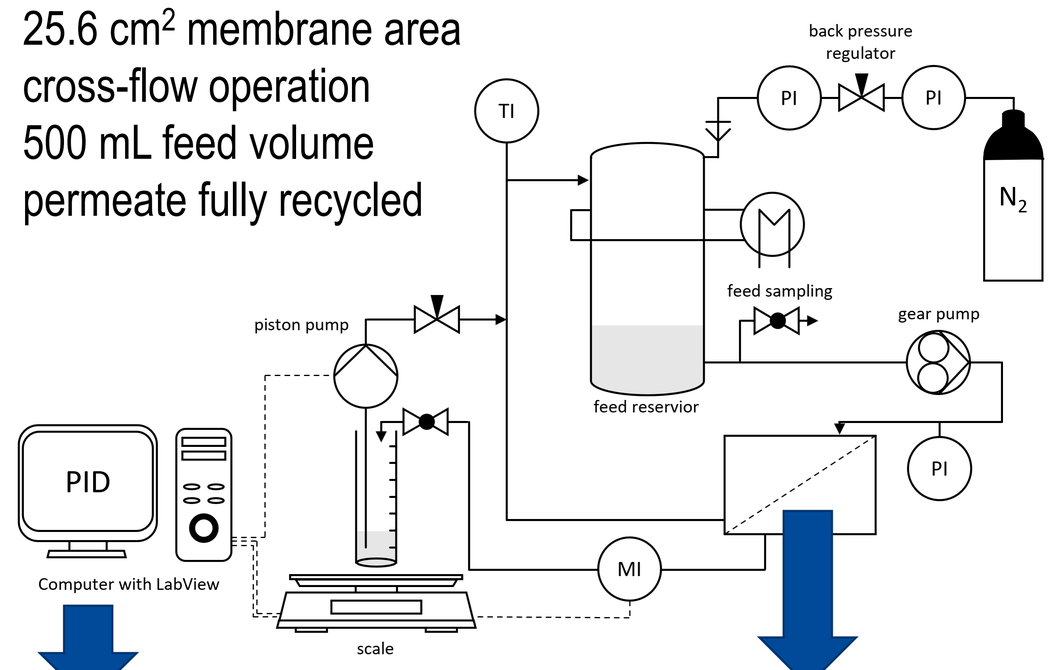


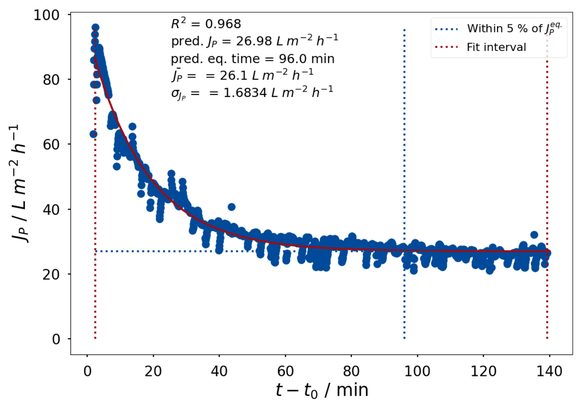
1 α-hydroxy ketone → **2** α-keto carboxylic acid

- fenton reaction with copper(II) as homogeneous catalyst
- batch or semi-batch

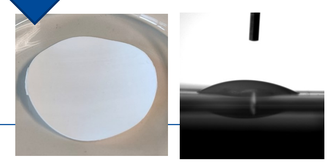
Experimental Setup

- 25.6 cm^2 membrane area
- cross-flow operation
- 500 mL feed volume
- permeate fully recycled





Pure water permeability, TS80, 7 bar, 25 °C, 1.3 m s^{-1} cross-flow velocity.



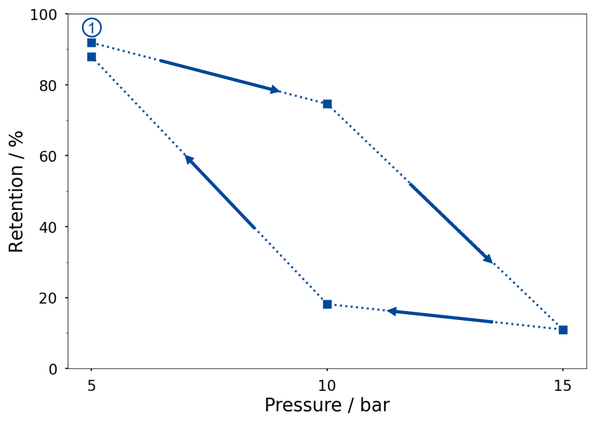
Trisep TS80

manufacturer	MANN+HUMMEL
contact angle (water)[a]	(32.35 ± 3.5)°
R($MgSO_4$)[b]	99.2 %
MWCO[b]	< 300 Da
Material[b]	Polymer (arom.)

[a]static contact angle [b]provided by the manufacturer

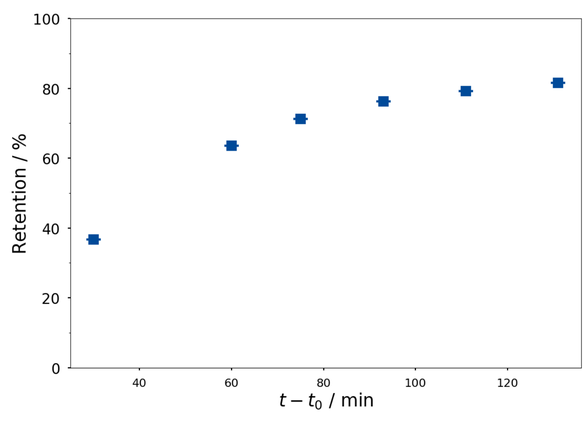
Results

Pressure-dependent $CuSO_4$ Retention



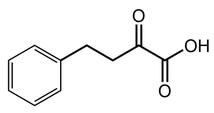
0.005 M CuSO4 in H_2O, TS80, 25 °C, samples were taken after 180 min of filtration, 1.3 m s^{-1} cross-flow velocity (F_V = 55 L h^{-1}). Experiments were conducted with the same membrane sample in the order as indicated by the arrows.

$CuSO_4$ Retention, 7 bar



0.005 M CuSO4 in H_2O, TS80, 25 °C 7 bar, 1.3 m s^{-1} cross-flow velocity (F_V = 55 L h^{-1}).

Retention of **2**, 7 bar



Nr.	J_P (water) L m^{-2} h^{-1}	J_P (feed) L m^{-2} h^{-1}	R %
1	24.61	10.80	26.9
2	26.11	13.47	26.0
3	41.19	18.18	20.0

0.005 M CuSO4 in H_2O, TS80, 25 °C, samples were taken after 200 min of filtration, 1.3 m s^{-1} cross-flow velocity (F_V = 55 L h^{-1}). Experiments were conducted with the same membrane sample in the listed order.

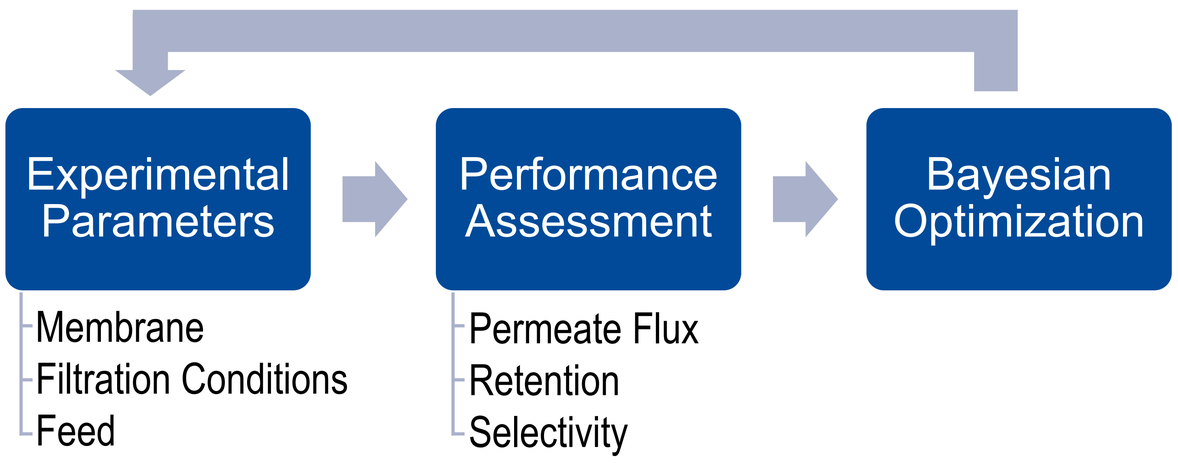
- α($CuSO_4$ / **2**, 7 bar) ≈ 4
- possible improvements:
  - pH adjustments
  - lower catalyst concentration
  - use of different membranes

Summary

- low selectivity between $CuSO_4$ and **2**, need for further optimization
- impact of previous experiments conducted with same membrane sample

Outlook

- systematic optimization of filtration conditions
- rational selection of suitable membranes



References:

[1] M. Micari et al., *J. Mem. Sci.* **2020**, *606*, 118117.

[2] R. Das, D. Chakraborty, *Appl. Organomet. Chem.* **2011**, *25*, 437–442.

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