Electro-membrane filtration

An Alternative Way to Fractionate Industrial Enzymes

Yuan, Linfeng; Korsholm, Lars; Jakobsen, Sune; Woodley, John; Jonsson, Gunnar Eigil

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Electro-membrane filtration: An Alternative Way to Fractionate Industrial Enzymes

Linfeng Yuan[1], Lars Korsholm[2], Sune Jakobsen[2] , John Woodley[1], Gunnar Jonsson[1]
[1]Department of Chemical and Biochemical Engineering, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark
[2]Recovery Development, Novozymes A/S, Smørmosevej 9, 3AM, DK-2880 Bagsværd, Denmark

Introduction

In the application of industrial enzymes separation, pressure driven-membrane filtration is limited to its low selectivity.

Enevoldsen and co-workers [1,2] have shown that by using an electric field during crossflow ultrafiltration (EUF) of industrial enzyme solutions, an improvement in flux of 3-7 fold has been obtained.

EMF combines conventional membrane filtration with electrodialysis. In comparison with pressure-driven membrane filtration an increase in selectivity for the separation of charged components can be expected.

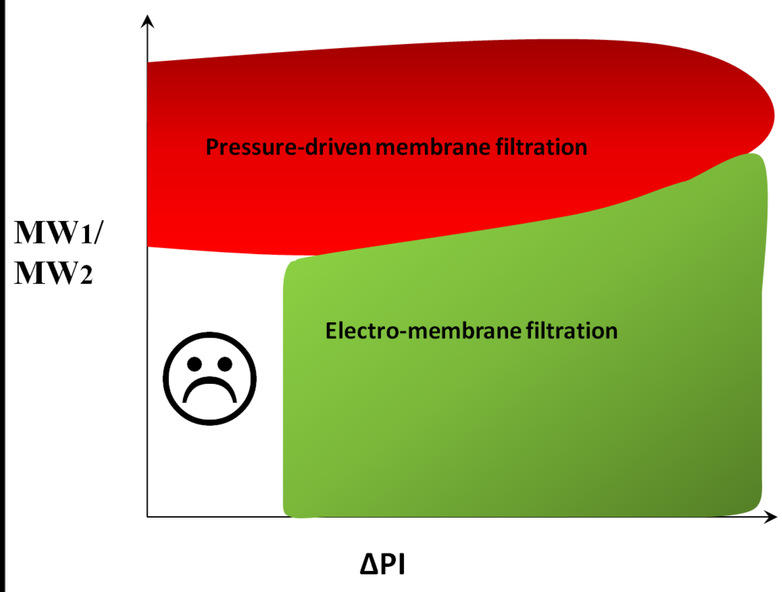

Figure 1 Model of the operation boundary for EMF and pressure-driven membrane filtration

Methodology

• System operated in a batch-wise manner (refer to Fig.2).

• Two industrial enzymes: phospholipase (PLA) with MW 13.3KDa, PI 7.68 and lipase (LP) with MW 29.3KDa,PI 4.7 were used.

• Why PLA and LP were chosen? Pressure-driven membrane filtration is not possible to separate them due to their close MW.

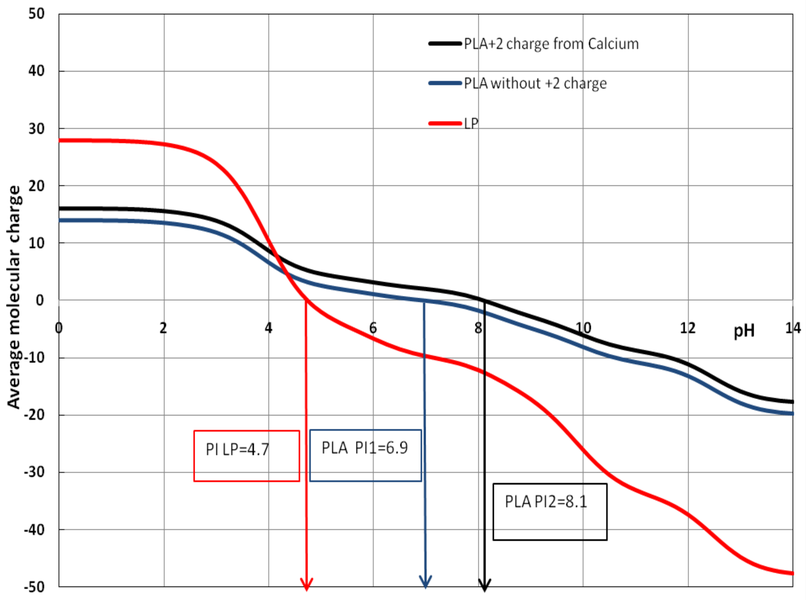

Figure 4 Calculated charge property of PLA and LP as function of solution pH

Operation way and pH selection

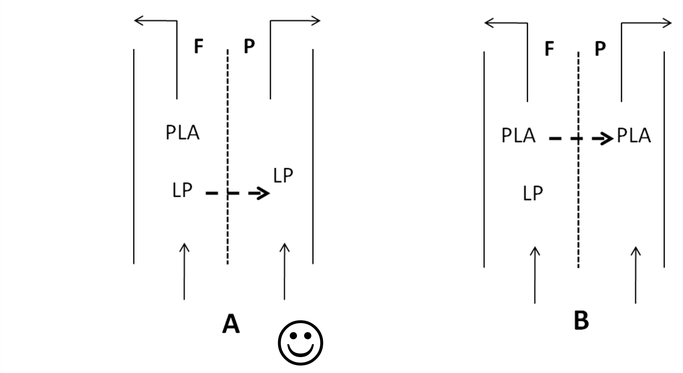

Figure 5 Selection of operating way

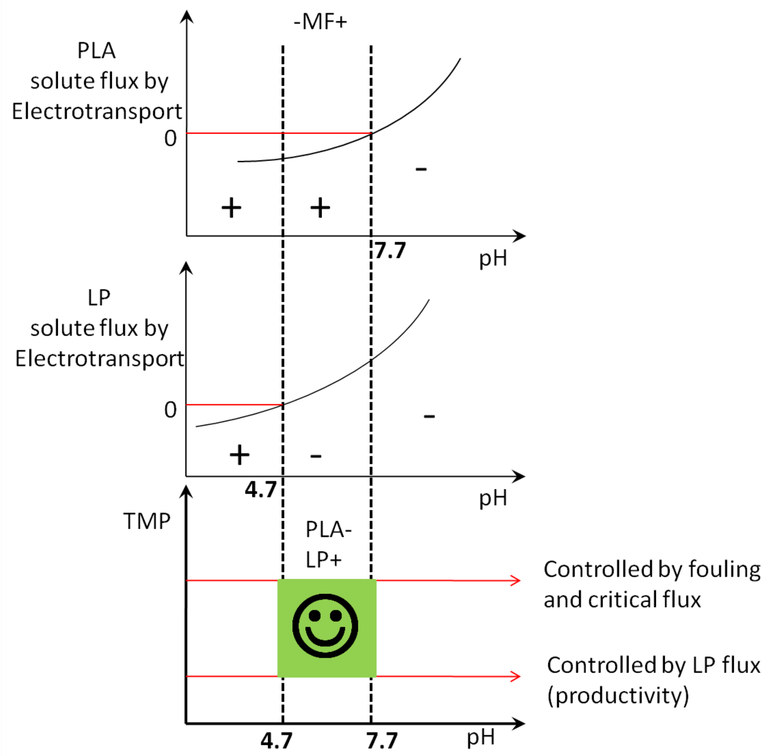

Figure 6 Selection of solution pH

Set-up & Principle

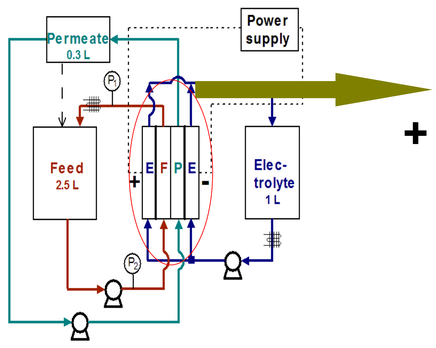

Figure 2 Experimental set-up

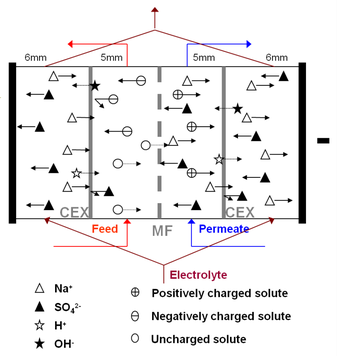

Figure 3 Principle of EMF

$$J_i = J_{i,diff} + J_{i,elec} + J_{i,conv}$$
$$= -D_i \frac{dc}{dx} + Fz_i c_i \mu_i \frac{dE}{dx} + c_i J_v$$

Results

Investigation of operation TMP

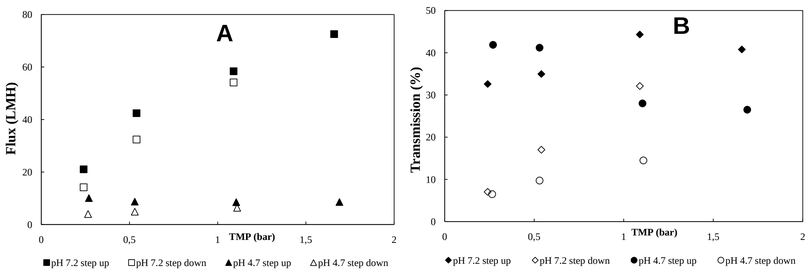

Figure 7 Filtration of 2g/L LP at solution pH 7.2 and 4.7 (**A**) flux as function of TMP (**B**) transmission as function of TMP

Effect of electric field

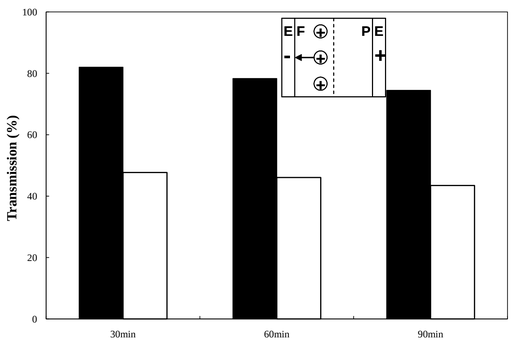

Figure 8 Effect of electric field on the transmission of PLA.Experiments operated with initial 15g/L feed solution, solution pH at 5 and TMP at 0.4 bar(■)MF(□)-MF+

Separation of PLA and LP

Table 1 Selectivity and LP purity improvement in EMF

Experiment	pH	Feed concentration (g/L)	Percentage of LP concentration in feed(%)	Selectivity		Permeate LP purity (%)	
				10min	90min	10min	90min
MF, 0.35bar	5	21.8	23.2	1.01	0.84	23.34	20.32
-MF+,0.35bar,30 V	5	19.1	22.4	2.46	3.49	41.45	50.13

Table 2 Selectivity and LP purity in permeate obtained at different feed concentration

Experiment	pH	Feed concentration (g/L)	Percentage of LP concentration in feed(%)	Selectivity		Permeate LP purity (%)	
				10min	90min	10min	90min
-MF+,0.35bar,30 V	5	19.1	22.4	2.46	3.49	41.45	50.13
-MF+,0.35bar,30 V	5	10.2	21.7	2.88	5.13	44.42	58.74

Conclusion

• By applying the electric field, PLA and LP were separated and the selectivity improved as compared to normal filtration, but the improvement was not impressive. The selectivity was also dependent on the feed concentration.

• Productivity and selectivity were not good, which seemed to be related with the solubility issue of the enzymes dependent on pH and feed conductivity. More work should be done to reduce the fouling and increase the flux

• It seemed that LP was more easier to foul the membrane. Therefore, the other operation way which PLA is going to be removed from permeate should be tried.

Acknowledgments

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References

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[2] A.D. Enevoldsen, E.B. Hansen and G.Jonsson, Electro-ultrafiltration of industrial enzyme solutions, Journal of Membrane science 299(2007) 28-37