

Simulated Moving Bed (SMB) Process For Potential Application Of Xylitol Purification In Industrial Processes

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SUMMARY

A new generation of biorefinery aims to produce sustainable chemicals and materials from biomass. The IMPRESS project evaluates different approaches for such production among them the conversion of xylose to xylitol and its purification for application in food industries. The continuous SMB process shall be applied for the purification of xylitol from fermentation mash and is currently established.

INTRODUCTION

The 2nd generation of biorefinery processes uses lignocellulosic biomass such as straw or wood as source which is not competing with human nutrition. KNAUER takes part in the IMPRESS (Integration of efficient downstream ProcessEs for Sugars and Sugar alcohols) project which will demonstrate and validate a new hybrid biorefinery process for the first time. The aim is to find ways to produce sustainable chemicals and materials. One process of this project is the production and purification of xylitol from fermentation process where SMB should be applied for the xylitol purification.



RESULTS

Analysis of fermentation mash from xylose to xylitol conversion by yeast revealed a xylitol concentration of 70 mg/ml and led to indication of arabinol, glycerol and arabinose in the sample (Fig. 1).

A mock-up solution of glycerol, arabinol and xylitol with similar proportions to the fermentation sample was used for the first SMB experiments. The “cut” for the SMB separation was laid out between arabinol and xylitol (Fig. 2). Volume overload studies showed a linear absorption behaviour of the sugars.

A classical 2:2:2:2 column set-up with 4 zones was used for the SMB experiments using semi-preparative columns (Tab. 1, Fig. 3).

The two outlet streams raffinate and extract were analysed after the process reached a steady state. It was shown that the xylitol was collected in the extract and arabinol and glycerol in the raffinate (Fig. 4).

Tab. 1 SMB parameter

Parameter	Value
Column length (mm)	l = 250
Column diam. (mm)	ID = 20
Particle size (µm)	dp = 35-70
Number of columns	n = 8
Zone configuration	2:2:2:2
Mobile phase	H ₂ O _{dd}
Temperature	50°C

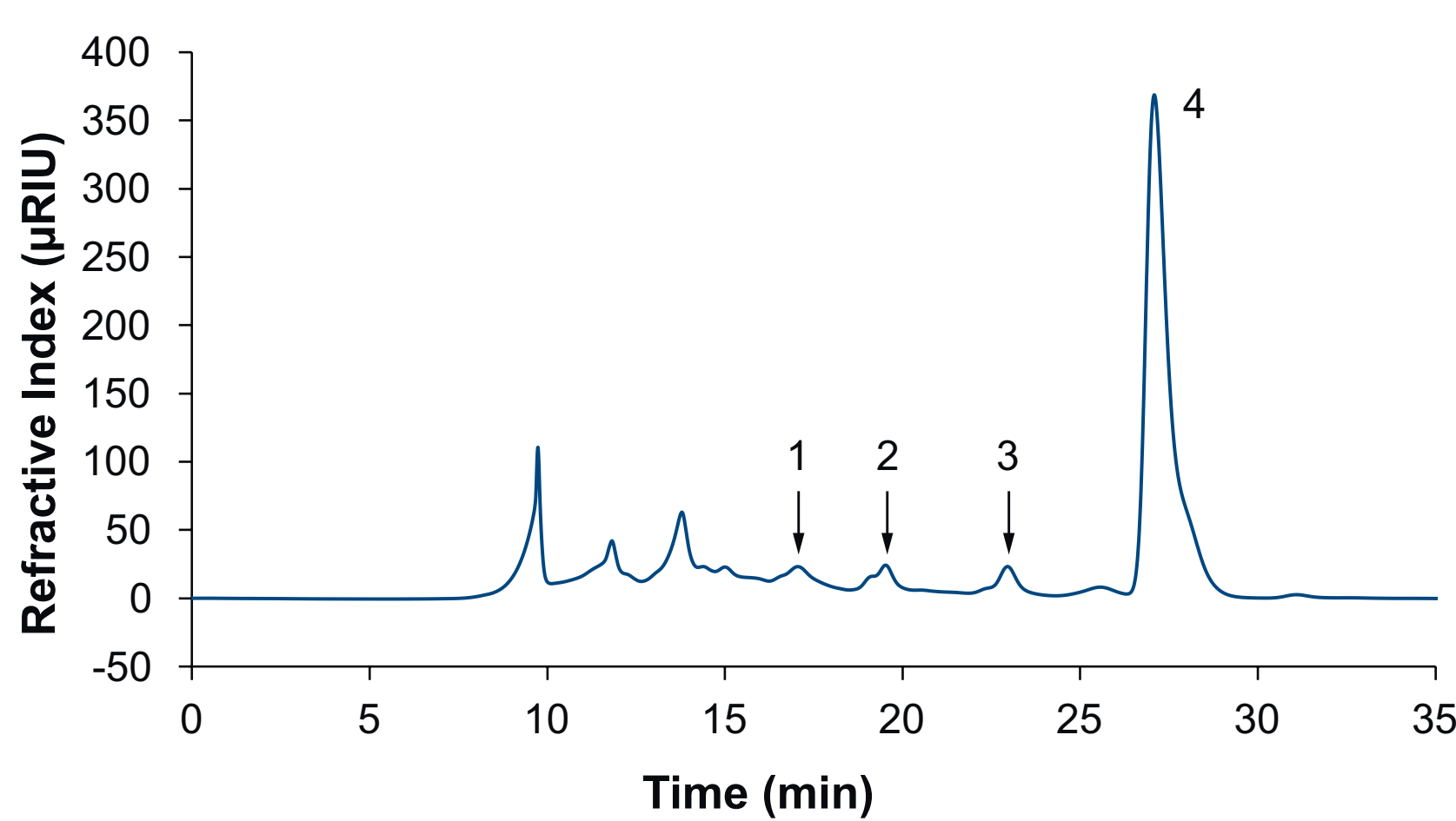


Fig. 1 Analytical chromatogram of fermentation sample (filtered, deionized, active carbon treatment); 1 - arabinose, 2 - glycerol, 3 - arabinol, 4 - xylitol; Eurokat Ca 300x8 mm, 10 µm, 0.5 ml/min, 75°C, 20 µl injection

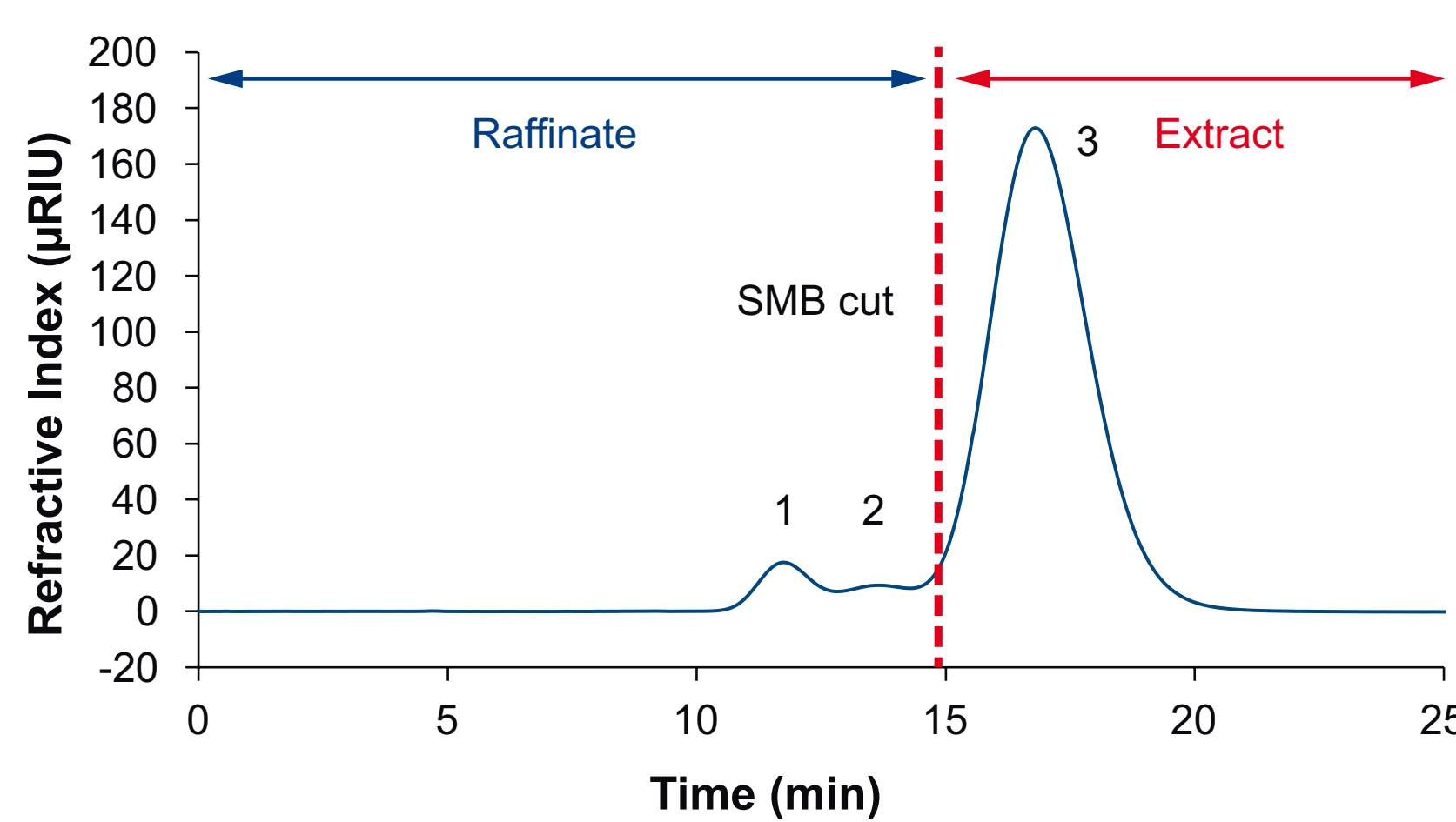


Fig. 2 Chromatogram of mock-up solution on semi-preparative column and indication of SMB fractions; 1 - glycerol (4.5 mg/ml), 2 - arabinol (3 mg/ml), 3 - xylitol (70 mg/ml); Chromalite Ca 250x20 mm, 50 µm, 5 ml/min, 50°C, 200 µl injection

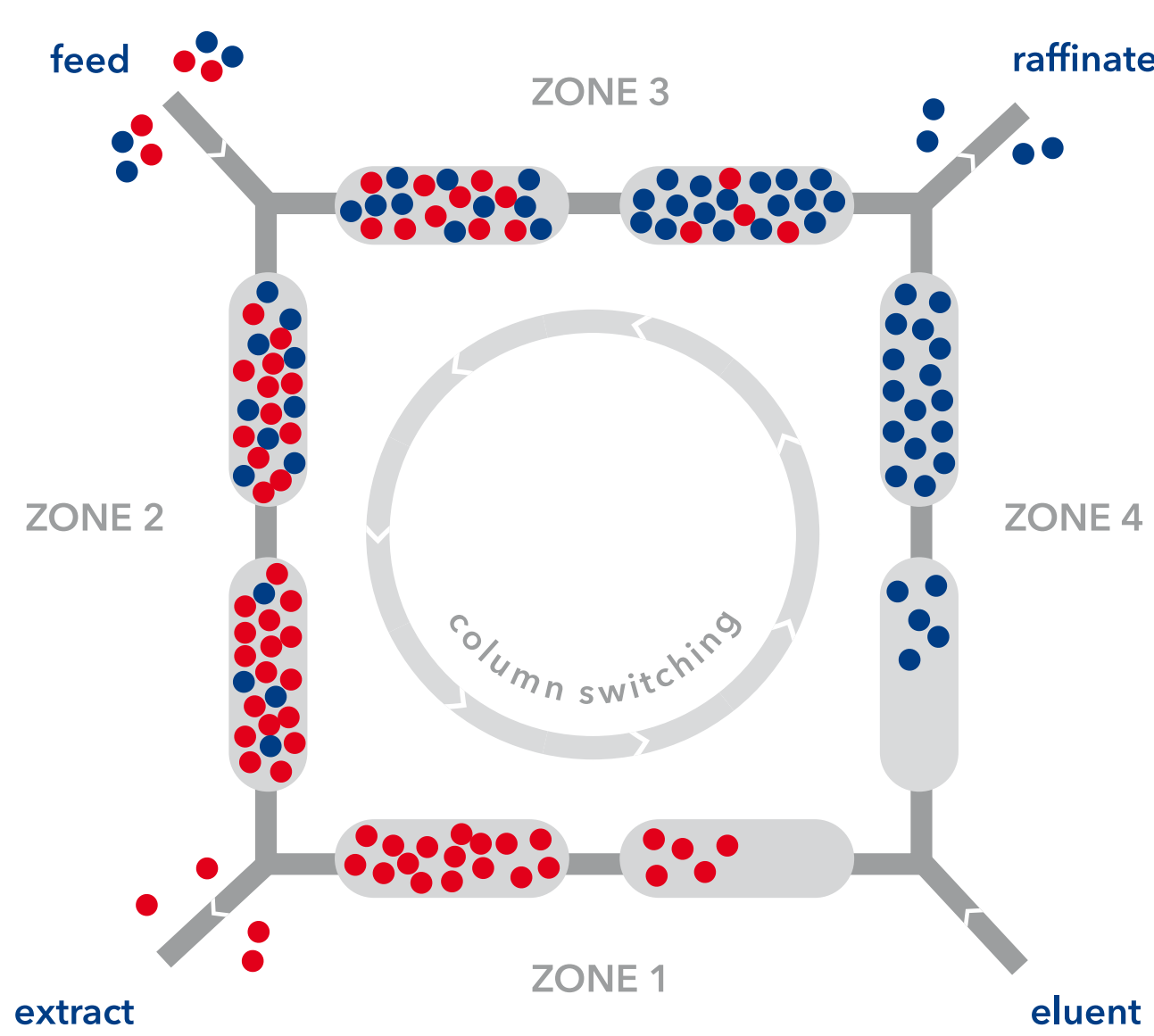


Fig. 3 Scheme of classical 2:2:2:2 column SMB process in 4 zone configuration

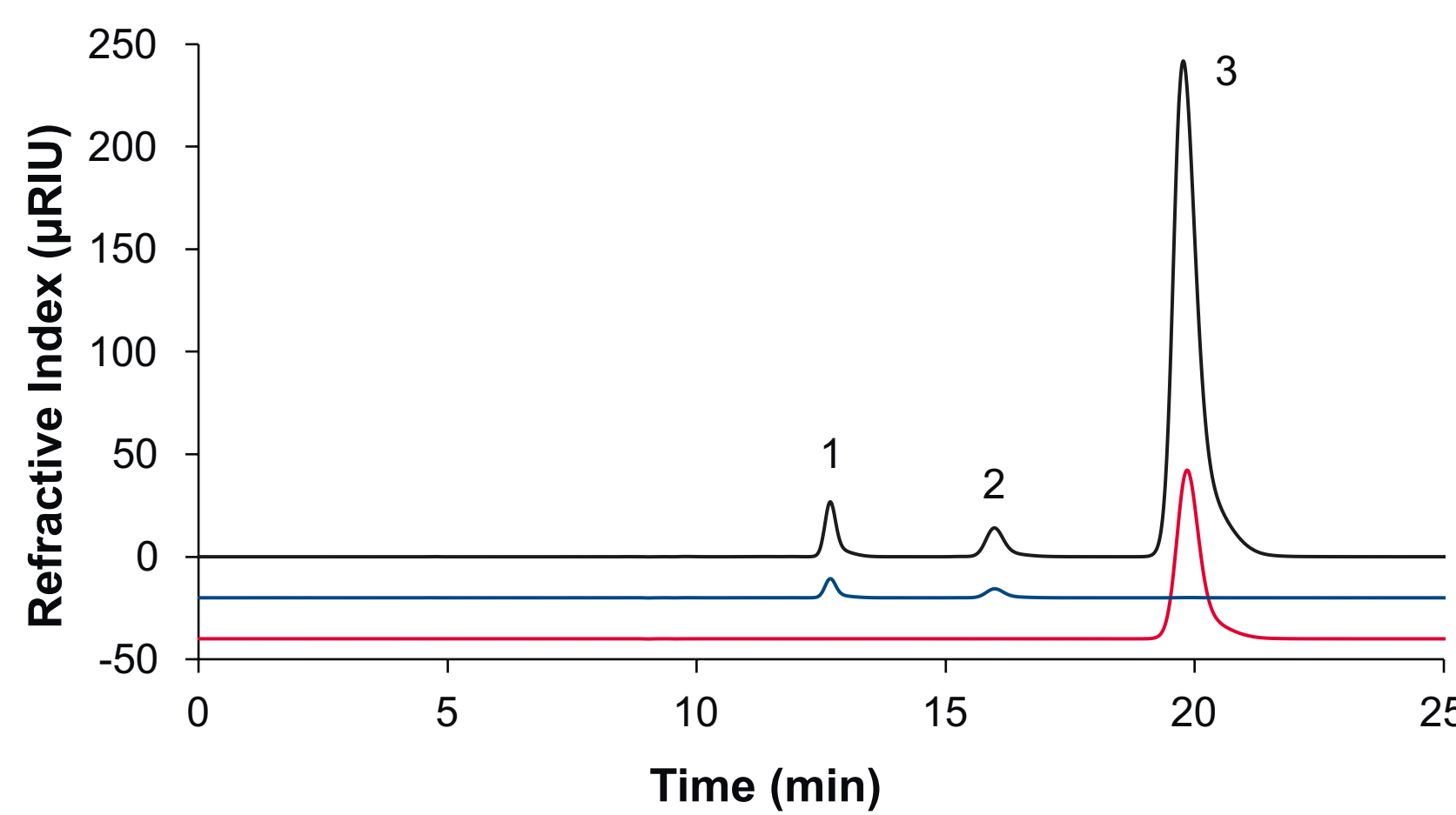


Fig. 4 Analytical chromatograms of feed, raffinate and extract from SMB process; black - feed, blue - raffinate, red - extract; 1 - glycerol, 2 - arabinol, 3 - xylitol; Eurokat Ca 300 x 8 mm, 10 µm, 0.5 ml/min, 75°C, 20 µl injection

CONCLUSION

Analysis of the fermentation mash from xylose to xylitol conversion showed that xylitol is eluting on polymer-based Ca columns as last component. This enables the usage of SMB process for xylitol purification.

First SMB experiments were performed with a mock-up solution with the main sugars to establish starting parameters.

Xylitol was successfully purified by SMB with purity and recovery of > 99%.

MATERIALS AND METHODS

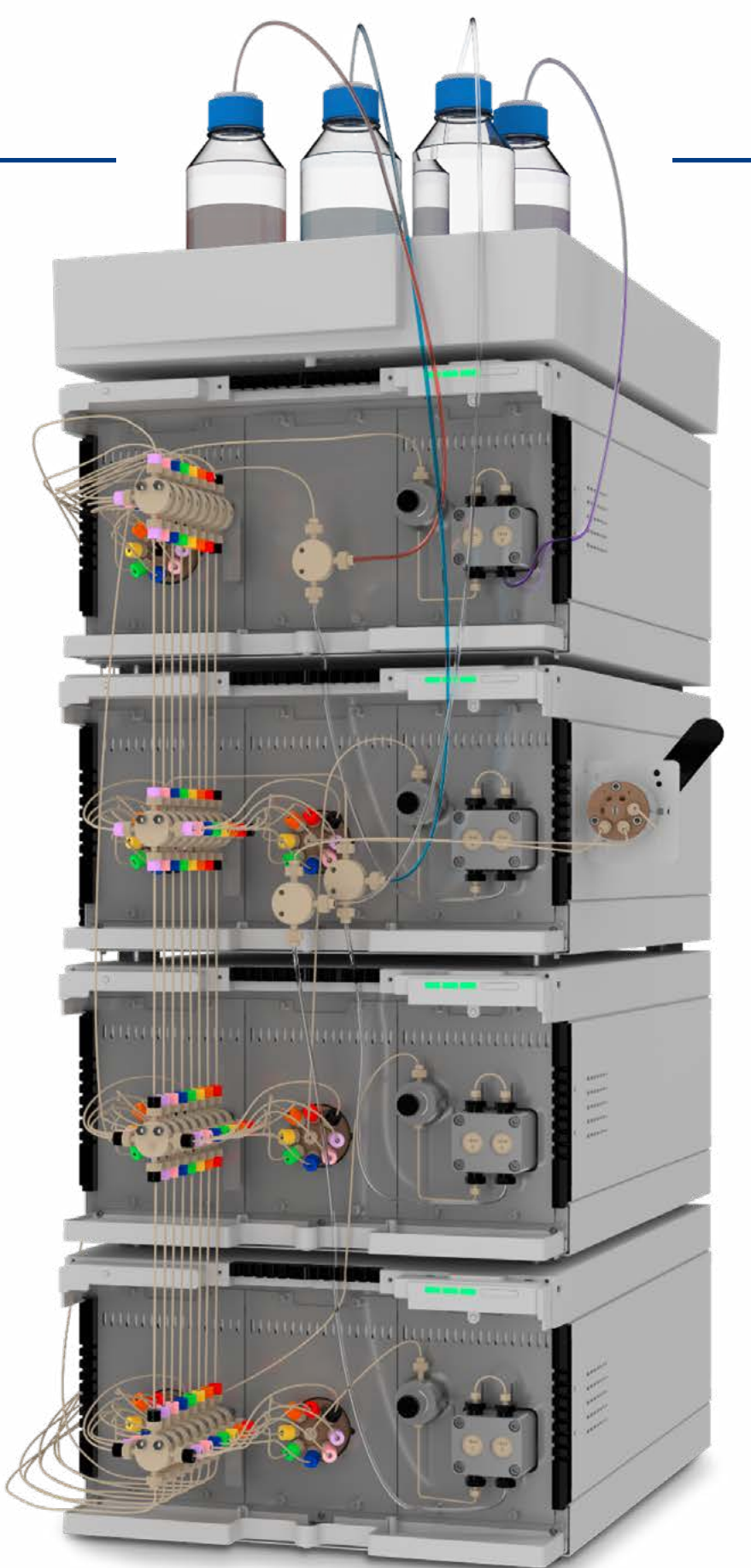
The pretreated fermentation sample was filtered by RC 0.2 µm filter. The analytical method was 0.5 ml/min, 75°C, 20 µl injection, the semi-preparative 5.0 ml/min, 50°C, 200 µl injection both with water as eluent.

Extract und raffinate were analysed by the analytical method after collecting a whole cycle of both fractions.

Tab. 2 System configuration

Instrument	Description
AZURA Lab SMB	Lab SMB sst, 50 ml/min
Columns	8 x Chromalite Ca CGC 50x6, 250x20 mm, 35-75 µm
Software	PurityChrom MCC

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Simulated Moving Bed (SMB) - A powerful tool for continuous purification of xylitol



KNAUER joins industrial sustainability research project