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IMPLEMENTATION OF ALTERNATING LANGMUIR AND ANTI-LANGMUIR ZONES IN CHROMATOGRAPHY COLUMNS

KEYWORDS

- Preparative chromatography
- HPLC
- Concentration overloading
- Dispersion minimization
- Plug flow reactor

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STATE OF THE ART

The most versatile and powerful technique for the separation of key compounds in the pharmaceutical industry is liquid chromatography. A limitation of this technique is that high efficiencies can be obtained only for low sample concentrations. For high concentrations leading to overloading, an undesired concentration shock arises, which will either broaden the component zone downstream (Langmuir or L-behavior) or upstream (anti-Langmuir or AL behavior). In chromatography, analytes need to be in selective interaction with a stationary phase. When there is insufficient surface on this stationary phase, the analytes migrate downstream the channel in the mobile phase until a free interaction site is found. Because the migration distance is longer under overloading conditions, considerable dilution occurs compared to a non-overloading situation, resulting in a non-symmetrical peak either at the right (Langmuir) or the left (Anti-Langmuir) of the (space-based) peak (Fig. 1).
This sample band gets wider and wider until the concentration has dropped to a value at which sufficient interaction surface is available.

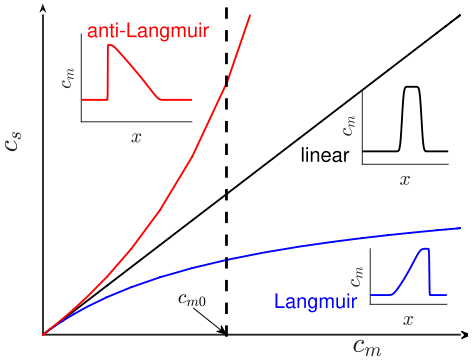

Fig. 1: Characteristic sample band profiles for different stationary phase concentration (cs)-mobile phase concentration (cm) equilibrium values

THE INVENTION

The core of the invention is to alternate Langmuir and Anti-Langmuir zones along the column (Fig. 2) so that the steeper concentration front is periodically moving up- and downstream the center of the peak (in an accordion fashion), thereby limiting overloading dispersion.

Fig. 2: implementation of L-AL zones in the column

Two different types of stationary phases with respectively L and AL adsorption properties have to be incorporated in the column alternatively in space to achieve this effect. Simulations have indicated that an increase in performance by a factor of 2 can be obtained (see Fig. 3 for a representative result).
Such a decreasing in dispersion allows to generate much higher concentrations and purity of the separated streams.

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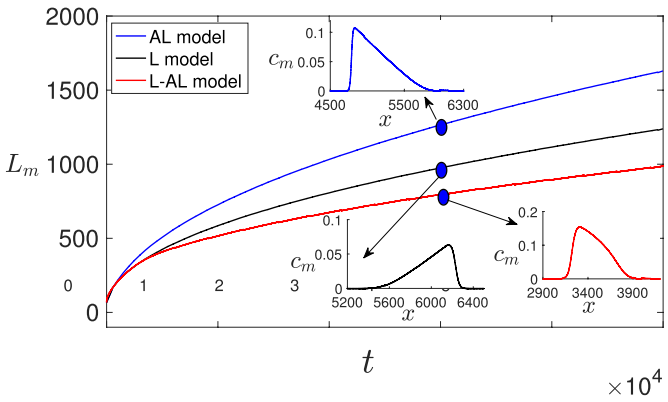

Fig. 3: Reduction in band width (Lm) for the alternating L-AL approach.

POTENTIAL APPLICATIONS

- Pharmaceutical industry
- Biotechnology
- Food-water-environmental control

KEY ADVANTAGES OF THE TECHNOLOGY

- Separation and purification with higher final concentration
- Higher throughput for preparative separation

THE TEAM

Prof. Wim De Malsche, µFlow group, Department of Chemical Engineering, VUB : combining our know-how on chemical engineering and precision and micro-machining technology, our group is ideally positioned to develop novel devices and processes in the area of microfluidics and microreactor technology.

Prof. Anne De Wit, Non-linear Physical Chemistry unit, ULB : our group is devoted to the theoretical study of spatio-temporal dynamics of physico-chemical systems resulting from reactions coupled to transport processes (diffusion, convection) or phase transitions.

RELEVANT PUBLICATION

> Decreased peak tailing during transport of solutes in porous media with alternate adsorption properties, Rana, C., De Malsche, W., De Wit, A. (2019), Chemical Engineering Science, 203, 415-424.

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