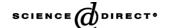


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Review

Recovery and separation of organic acids by membrane-based solvent extraction and pertraction An overview with a case study on recovery of MPCA

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Abstract

Various possibilities of the application of membrane-based solvent extraction (MBSE) and pertraction in recovery and separation of organic acids, and in biotransformations are discussed. A short overview of the subject literature is presented. Factors, which have to be considered in the development of MBSE application, will be discussed. Hybrid processes employing MBSE will be covered as well. Mass-transfer characteristics of hollow fiber contactors for MBSE of organic acids are presented. The kinetics of formation and decomposition of the permeant–extractant complex may influence greatly the mass-transfer rate and should be taken into account in modelling. A case study on recovery of 5-methyl-2-pyrazinecarboxylic acid (MPCA) by simultaneous MBSE and membrane-based solvent stripping shows potential of this process. Optimised process parameters for MPCA are suggested on bases of simulations. Outlook for future applications of HF contactors in extraction separations is discussed and potential for progress is envisaged, especially for higher value acids and integrated or hybrid reaction-separation systems.

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Keywords: Recovery; Separation; Organic acids; 5-Methyl-2-pyrazinecarboxylic acid; Solvents; Liquid membranes; Membrane-based solvent extraction; Membrane-based solvent stripping; Pertraction; Hollow fiber contactors; Simulation

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Nomenclature

\boldsymbol{A}	surface area (m ²)
$A_{ m w}$	arithmetic mean value of the inner and outer
	geometric surface areas of fibers (m ²)
c	molar concentration of the solute (undissoci-
	ated acid or acid in the complex) (mol m^{-3})
D	distribution coefficient (–)
k	individual mass-transfer coefficient (m s ⁻¹)
$K_{\rm e}$	overall mass-transfer coefficient in the extrac-
	$tor (m s^{-1})$
$K_{\rm s}$	overall mass-transfer coefficient in the stripper
	$(m s^{-1})$
'n	$molar flux (mol s^{-1})$
$N_{\rm cs}$	number of contactors in series (-)
$N_{\rm ct}$	total number of contactors (both in parallel and
	series) (–)
$r_{\rm e}$	rate constant of the extraction reaction, Eq. (3)
	$(m s^{-1})$
r_{S}	rate constant of the stripping reaction, Eq. (4)
	$(m s^{-1})$
R	overall mass-transfer resistance (s m^{-1})
Re	Reynolds number (–)
и	linear velocity of the flow $(m s^{-1})$
\dot{V}	volumetric flowrate (m ³ s ⁻¹)
$Y_{\rm MA/OA}$	ratio of mineral acid to organic acid flux (-)
Z	concentration factor of the solute in the con-
	centrate (output from the stripper) defined by
	relation $Z = c_{R,n+1}/c_{F1}$ (-)
β_{n+1}	concentration ratio $\beta_{n+1} = c_{S,n+1}/c_{S,n+1}^*$ (ap-
	proach to an equilibrium on the raffinate end
	of the contactor in MBSE, $c_{S,n+1}^* = D_F c_{F,n+1}$)
	(–)
ε	porosity of the wall (–)
$\eta_{ m e}$	yield of the solute in extraction (–)
$\eta_{ m conv}$	conversion of the reagent in the stripping solu-
	tion (–)

Subscripts 0 initial value 1 feed or stripping solution inlet end of a HF contactor or a series of contactors 2 raffinate or stripping solution outlet end of a HF contactor or a series of contactors b boundary layer in the bulk phase e extractor (MBSE) F feed phase, feed boundary layer inner surface of the fiber wall i number of the contactor segments n outside surface of the fiber wall o R stripping solution; stripping interface stripper (MBSS) S S solvent phase, boundary layer in the solvent w fiber wall Abbreviations 6-APA 6-aminopenicillanic acid sodium di(2-ethylhexyl)sulfosuccinate (an-AOT ionic surfactant) BLM bulk liquid membrane CF HF cross-flow hollow fiber contactor D2EHPA di(2-ethylhexyl)phosphoric acid DLC double Lewis cell with layered BLM DNNSA dinonylnaphtalenesulfonic acid EC equilibrium cell for contacting two liquids **ELM** emulsion liquid membrane **EXT** solvent extraction **FSC** flat sheet contactor HF hollow fiber MBSE membrane-based solvent extraction membrane-based solvent stripping MBSS MHS multimembrane hybrid system (LM between two ion-exchange membranes) MIBK methylisobutylketone

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