Mass transfer in liquid-liquid extraction with dispersed aqueous phase -- improved column performance with the right material of construction

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Multistage liquid-liquid extraction processes in the chemical and pharmaceutical industry on industrial scale use extraction columns as common type of equipment. The multi stage and counter current contact of the two liquid phases provides a high mass transfer efficiency, enable a small footprint of the equipment and low liquid inventory, all at the same time. The two liquid phases must be at least partly immiscible, so often an aqueous phase is in contact with an organic phase. One of these phases is dispersed into droplets in the second phase to provide the interfacial area for the mass transfer.

Choosing the dispersed phase

To maintain a dispersion, the column material should not be wetted by the dispersed phase. The standard material of construction for such columns is stainless steel or another metal or metal alloy. Water has a better wetting behavior on metal surfaces than organic solvents, caused by the surface energy of the metal. This is the reason why in many columns the organic phase is dispersed into droplets and the aqueous phase is the continuous phase. If aqueous droplets are dispersed into an organic phase in such a column, the droplets will stick to the metal surface, coalesce and so reduce the interfacial area.

Examples

This paper presents and compares processes where both options for the dispersed phase were tested in a pilot scale column and built in industrial scale. An example of the extraction of an impurity out of an aqueous feed stream by an organic solvent shows that the selection of the dispersed phase has a significant influence on the column efficiency and the achievable raffinate purity.

By optimizing the column design and adapting the material of construction to the dispersed phase the separation is further enhanced. The results show that the overall energy consumption of the process can be significantly reduced while the raffinate purity is improved if materials of construction are adapted to the dispersed phase.