RESEARCHING HYDRODYNAMIC FLOW STRUCTURES OF EXTRACTION DEVICE IN THE INDUSTRY

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ABSTRACT

Correspondingly, the coordinated water increases the electron density and steric hindrance of the center metal ions and thus inhibits the subsequent extraction. Therefore, a means of reducing solvation (adding lactic acid) was developed, and this approach exhibited good performance. The separation factor was improved by a factor of 192. These results open a new avenue for high-performance selective extraction of Co, which features a green recovery process and is suitable for future use in industrial production. Hydrodynamically confined flow device technology is a young research area with high practical application potential in surface processing, assay development, and in various areas of single cell research. Several variants have been developed, and most recently, theoretical and conceptual studies, as well as fully developed automated systems, were presented. In this article we review concepts, fabrication strategies, and application areas of hydrodynamically confined flow devices.

Key words: *technological process, flow diagnostics, flow separation, dynamic characteristics, theoretical and conceptual studies.*

INTRODUCTION

Liquid-liquid extractions in the laboratory usually make use of a separatory funnel, where two immiscible phases are combined to separate a solute from one phase into the other, according to the relative solubility in each of the phases. Typically, this will be to extract organic compounds out of an aqueous phase and into an organic phase, but may also include extracting water-soluble impurities from an organic phase into an aqueous phase. Solid-liquid extractions at laboratory scales can use Soxhlet extractors. A solid sample containing the desired compound along with impurities is placed in the thimble. An extracting solvent is chosen in which the impurities are insoluble and the desired compound has at least limited solubility. The

solvent is refluxed and condensed solvent falls into the thimble and dissolves the desired compound which then passes back through the filter into the flask. After extraction is complete the solvent can be removed and the desired product collected.

MATERIALS AND METHODS

An extraction, much like a liquid-liquid extraction, works by exploiting differences in a compound's solubility in two liquids, which are also known as solvents. Depending on the solubility of the compound, it will either stay or be transferred into another solvent. In a liquid-solid extraction, a substance can be transferred from a solid material by being washed with a solvent in which the substance is highly soluble.

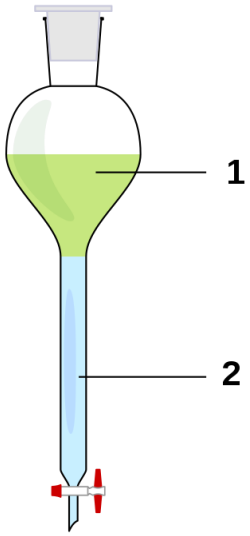

Figure 1. Schematic of a separatory funnel showing two immiscible liquids, where 1 is any phase less dense than 2. Phase 1 is typically an organic solvent and 2 an aqueous phase.

Innovative flow diagnostics techniques are used to extract critical flow phenomena such as the state of the boundary layer (laminar, transitional, or turbulent), leading-edge stagnation point, flow separation and reattachment, and vortex pattern and their dynamic characteristics from surface hot-film signatures obtained with multielement, micron-thin surface hot-film sensors operated by a bank of constant voltage anemometers. Unsteady hydrodynamic loads and moments are then obtained as a function of the instantaneous locations of the critical surface signatures.

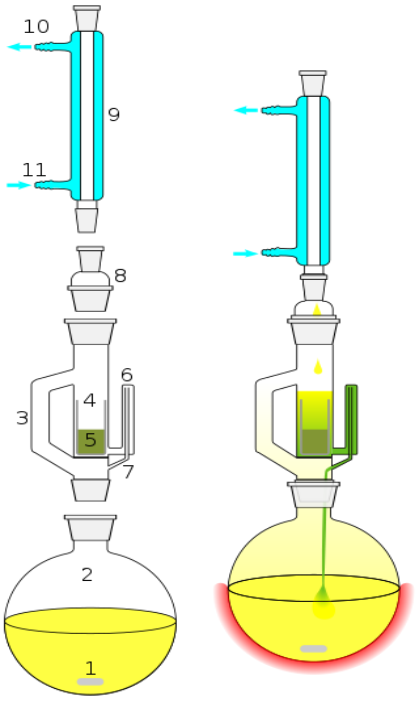

Figure 2. Laboratory apparatus

It was originally designed for the extraction of a lipid from a solid material. Typically, Soxhlet extraction is used when the desired compound has a limited solubility in a solvent, and the impurity is insoluble in that solvent. It allows for unmonitored and unmanaged operation while efficiently recycling a small amount of solvent to dissolve a larger amount of material. In the chemistry lab, it is most common to use liquid-liquid extraction, a process that occurs in a separatory funnel (Figure 4.2). A solution containing dissolved components is placed in the funnel and an immiscible solvent is added, resulting in two layers that are shaken together. It is most common for one layer to be aqueous and the other an organic solvent. Components are "extracted" when they move from one layer to the other. The unwanted acetone has to be removed. You decide to use water as an extraction agent. Your employee can add the water, mix it well and decant the two phases afterwards. After yesterday's accident you are fascinated by extraction and order your employee to prepare the same mixture as yesterday. However, this time you will use a 3-stage cross flow extractor. For every stage you will add approximately one third of the water that you added in the previous one stage process. A high specific surface allows to increase the mass transfer, thus improving the extraction efficiency.

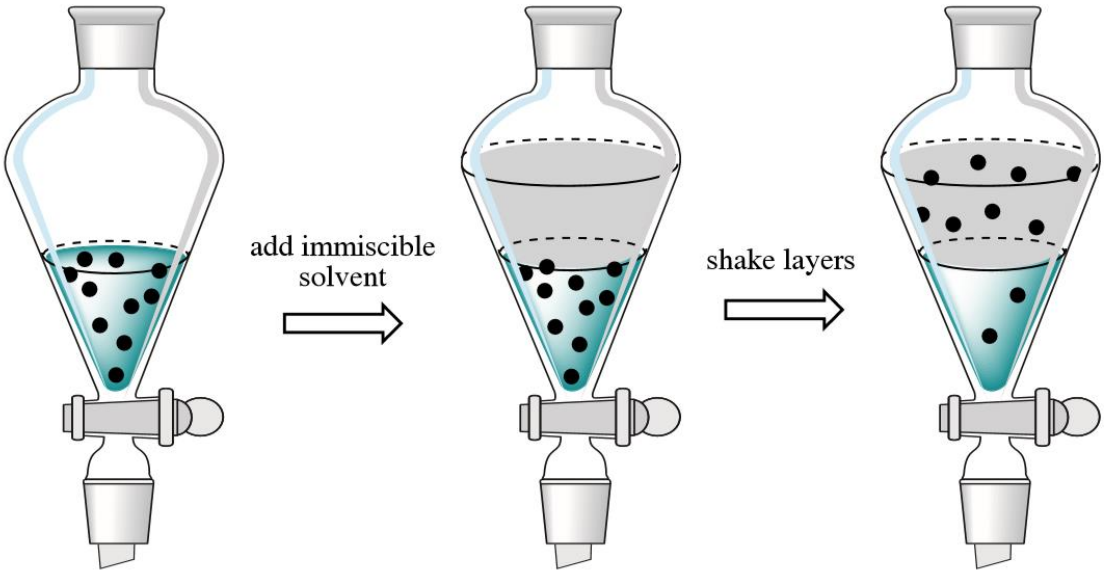

Figure 3. Schematic of extraction.

Compounds move from one liquid to another depending on their relative solubility in each liquid**.** A quick guide to solubility is the "like dissolves like" principle, meaning that nonpolar compounds should be readily extracted into nonpolar solvents (and vice versa). The compounds responsible for the taste and color of tea must be polar if they are readily extracted into hot water. When allowed to equilibrate between two liquids in a separatory funnel, the majority of a compound often ends up in the layer that it is more soluble. Extraction is a process in which one or more components are separated selectively from a liquid or solid mixture, the feed (Phase 1), by means of a liquid immiscible solvent (Phase 2). The transfer of the components from the feed to the solvent is controlled by the solubility behavior of each component in the corresponding phase. Two phases result from the extraction step: one enriched (EXTRACT Phase) and the other depleted (RAFFINATE Phase) in the components to be separated, respectively. Afterwards in order to regenerate the solvent, another separation step (e.g. distillation) is finally required.

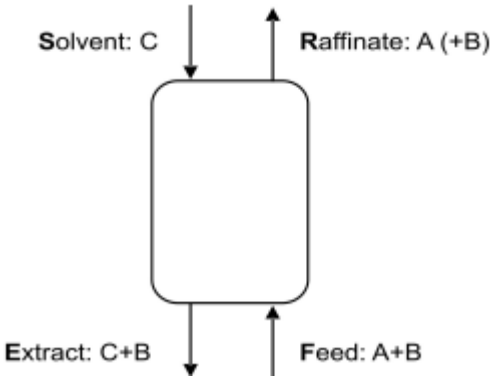

Figure 4. A typical extraction steps.

Compared to distillation, extraction processes have the disadvantage that a new component is added to the system. This leads to additional impurities as complete immiscibility does only exist in theory. Furthermore, a subsequent separation process is required to regenerate the solvent. As production engineer, you are responsible for a pharmaceutical plant, were toluene is used as a solvent. Acetone is added to receive a final mixture of 5% mol acetone. The common method is to generate small droplets of one phase that are dispersed in the other, continuous phase, as in the stirred column used in this laboratory. Interactions between droplets and droplets and with the continuous phase result in complex fluid dynamic problems that are usually treated using empiric equations. The simplest form of an extractor apparatus has only one stage and the process is performed in two steps. In the first step, the feed is mixed with the solvent to create a high surface area allowing to achieve high mass transfer rates.

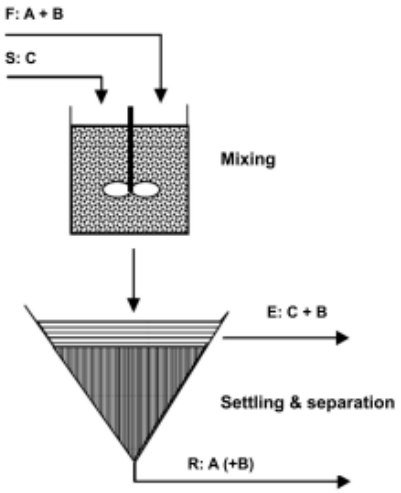

Figure 5. The one-stage extractor

However, in order to obtain the required separation several steps of mixing and phase separation are mostly needed. Therefore, in practical applications multi-stage extractors are usually used. As for many separation processes, a co-, a cross-, or a counter-flow concept can be applied [5]. Liquid-liquid extraction is most widely used and will be considered within this laboratory. It is applied e.g. to remove heavy metals or acids from waste water or for the production of aromatic compounds from mixtures of hydrocarbons. Another application is gas-liquid extraction which is also called absorption.

CONCLUSION

Some of the important aspects for designing multi-stage extractors are discussed in the following sections. To allow an optimal extraction process, it is crucial to

ensure a good mixing between the solvent and the feed, to have enough contact time between the two phases and to give enough settling time to separate the two phases

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