

## Basic knowledge

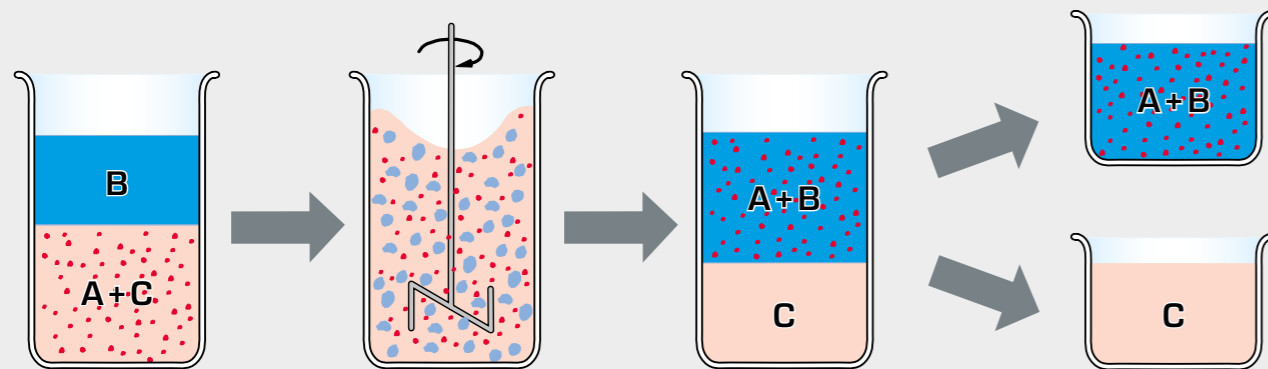
## Liquid-liquid extraction

Liquid-liquid extraction involves using a liquid solvent to remove a liquid component from a liquid mixture. The component dissolves preferably in the solvent. Applications of this process include removal of vitamins from aqueous solutions and aromatic compounds from crude oil fractions.

In the simplest case, three components are involved:

- transition component A
- solvent B
- carrier liquid C

The transition component A is combined with the carrier liquid C as the initial mixture (feed). If the initial mixture and the solvent B are mixed together, the transition component A is transferred into the solvent B. The requirement for this is that the solubility of the transition component A in the solvent B is higher than in the carrier liquid C. In turn, the carrier liquid C should be almost insoluble in the solvent B.



Ideal extraction:

When the initial mixture (A+C) and the solvent (B) are mixed, the transition component (A) is transferred into the solvent. After settling, two phases are obtained: the extract (A+B) and the carrier liquid (C).

The example illustration assumes an ideal situation in which the transition component A is completely taken up by the solvent. In reality, residual transition component always remains in the carrier liquid. In addition, complete insolubility of the carrier liquid in the solvent is assumed. In practice, parts of one substance will always be found in the other.

This means that the actual separation process results in two phases after settling:

- **extract phase** (mainly A and B, with residue of C)
- **raffinate phase** (mainly C, with residue of A and B)

To obtain the purest possible transition component, the extraction is normally followed by a separating stage that takes the form of rectification, in which the solvent is separated from the transition component. The solvent can be recirculated and is then available for the extraction again.

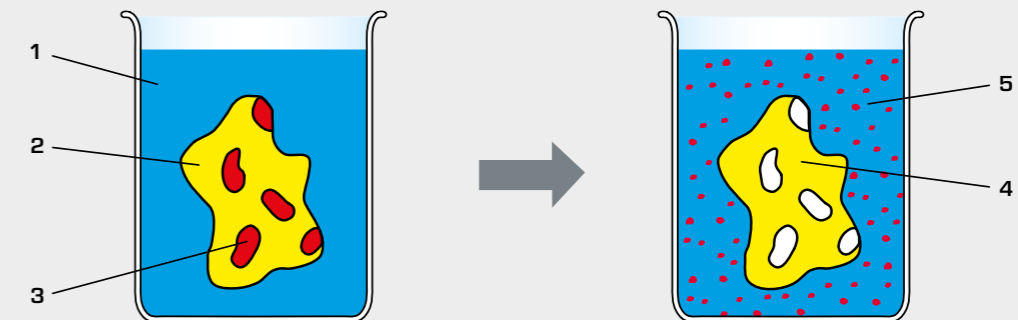
## Basic knowledge

## Solid-liquid extraction

Solid-liquid extraction allows soluble components to be removed from solids using a solvent. Applications of this unit operation include obtaining oil from oil seeds or leaching of metal salts from ores.

An everyday example is the preparation of coffee. Here, water (solvent) is used to remove the coffee flavours (transition component) from the coffee powder (extraction material, consisting of solid carrier phase and transition component). Ideally, this results in drinkable coffee (solvent with dissolved flavours), with the completely depleted coffee grounds (solid carrier phase) remaining in the coffee filter.

In reality, the solid carrier phase will still contain some transition component after completion of the extraction. In addition, some of the solvent will still be adsorptively bonded to the solid carrier phase.



Schematic extraction – before extraction (left) and after extraction (right):

1 solvent, 2 extraction material (solid carrier phase with transition component), 3 transition component, 4 depleted solid carrier phase, 5 solvent with dissolved transition component

To achieve the fastest and most complete solid extraction possible, the solvent must be provided with large exchange surfaces and short diffusion paths. This can be done by pulverising the solid to be extracted. However, an excessively small grain size can cause agglutination and make it more difficult for the solvent to permeate.

In the simplest form of this unit operation, the extraction material and the solvent are mixed well. The solvent and the dissolved transition component are then removed and regenerated.

The extraction material can also take the form of a fixed bed with the solvent flowing through it. In a further form of the application, the extraction material is led through the solvent.

The solvent is normally regenerated using evaporation/distillation. The solvent is evaporated and a concentrated extract solution is left behind as the product. The solvent is condensed and can then be reused.