

# Liquid-Liquid Extraction Technology

Engineering-Equipment-Turnkey Systems

*Packed Columns*

*Agitated Packed Columns*

*Agitated Tray Columns*



# Liquid-Liquid Extraction Technology

## Introduction :

Liquid-liquid-extraction is a separation technology that is based on the distribution of one or more components between two immiscible or almost immiscible liquids and is one of the most important separation/purification techniques widely used in process industries. Extraction finds its most suitable applications when the material to be separated is non-volatile or heat sensitive and when it is not possible to separate by distillation or evaporation.

Fenix specializes in the design and manufacturing of liquid-liquid extraction equipment engineered to fulfill the increasingly challenging purification requirements of chemical, pharmaceutical, petrochemical, biotech and flavor & fragrance industries by using in-house internals such as Fenix structured packings, random packings and sieve trays.

Our procedure for extraction system design consists of three steps : (a) Study properties of the material to be separated, (b) Find suitable solvent/s for extraction from our knowledge bank and equilibrium data, (c) Proceed with design calculations and related drawings to complete the report.

In addition to the extractor, an extremely important aspect of any extraction application is the design of the system to recover and recycle the solvent. In most cases, these additional steps are accomplished by means of distillation, and when necessary, are also studied during the pilot tests. We often supply the extraction and distillation components as a complete modular system.

Fenix also provides replacements parts, repair services and troubleshooting assistance for all types of extraction columns and process related support.

## Advantages of Liquid-Liquid-Extraction:

- Very large capacities are possible with a minimum energy consumption
- Selectivity when other standard separation methods (such as rectification) fail or require expensive equipment or energy cost.
- Heat sensitive products are processed at ambient or moderate temperatures

## Typical fields of Application:

- Purification of organic chemicals in general
- Purification of vitamins
- Recovery of Active Pharma Ingredients from reaction mixtures
- Recovery/removal of phenol, dimethylformamide from waste
- Recovery of olefins from paraffins
- Removal of CO<sub>2</sub>, H<sub>2</sub>S from LPG
- Separation between isomeric compounds
- Separation of aromatics from aliphatics
- Recovery of aroma- & flavour-chemicals from dilute solutions



### ↘ Chemicals

Water Treatment  
High BP Organics

### ↘ Pharmaceuticals

Antibiotics  
Vitamins  
Fermentation Products

### ↘ Foods

Lactic Acid  
Flavors/Fragrances

### ↘ Polymers

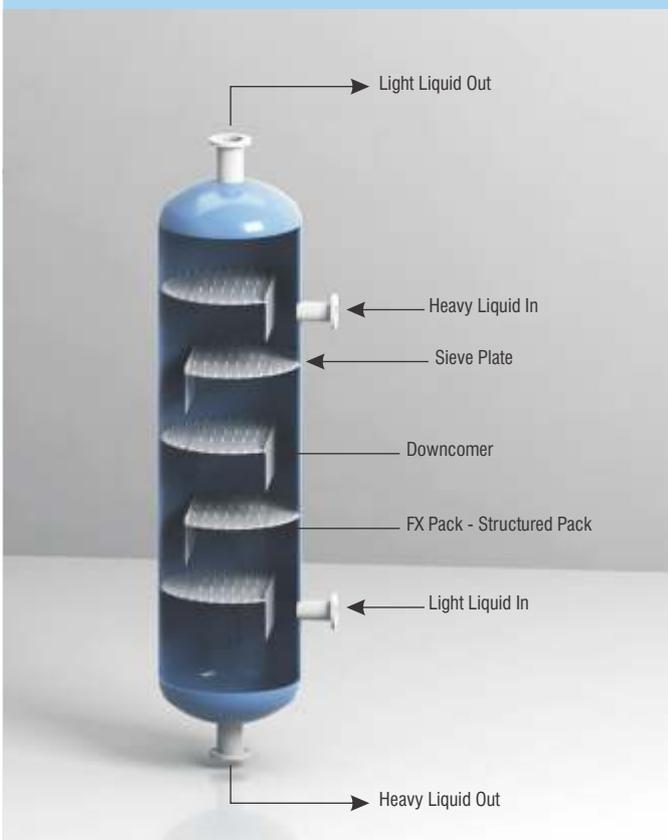
Caprolactam  
Adiponitrile

### ↘ Refining

Lube Oils  
Aromatics

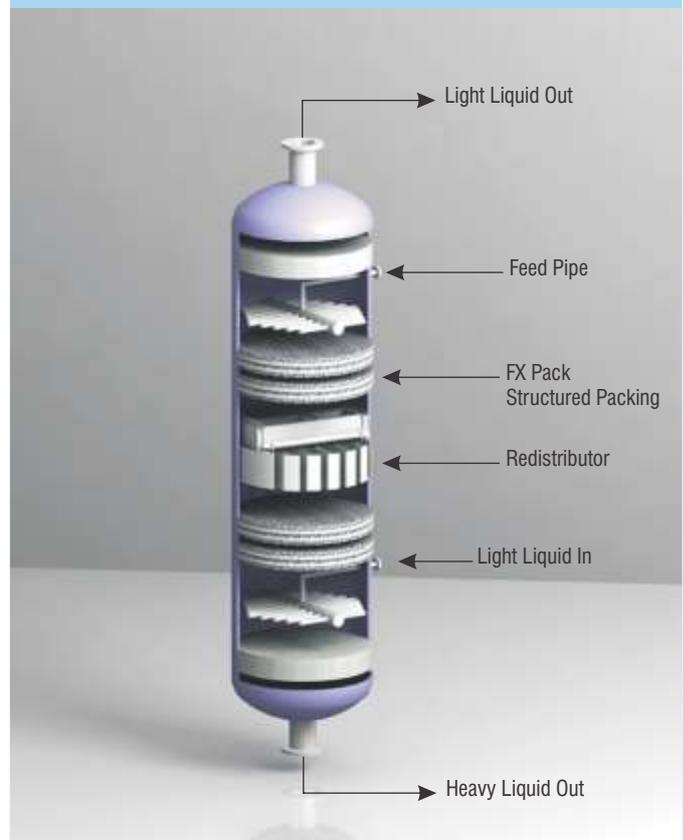
# Agitated Extraction Columns

## WITH TRAYS



Tray columns are multi-staged, counter-current contactors where the axial mixing of the continuous phase is confined to the region between trays, and dispersion occurs at each tray resulting into effective mass transfer. Tray columns are very effective, especially for systems of low-interfacial tension, with respect to their liquid handling capacity and extraction efficiency.

## WITH PACKING



The packed tower is arranged such that the light phase is dispersed. The tower is a cylindrical shell filled with packing which is rested on support plates. The heavy liquid is fed from the top and light liquid is fed from the bottom. A large portion of the void space in the packing is filled with the continuous phase which flows downward.

### Function

As no other type, the agitated extraction column is universally suitable for practical all kind of extracting applications. Limiting condition is a minimal density difference of  $0.05 \text{ kg/m}^3$  between both phases and a not to strong tendency to form a stable emulsion, in order to allow a smooth agitation.

### Advantage

- Adaptation of the compartment and agitator geometry to the specific product and the operational process conditions
- The optimal droplet size can be adjusted by variation of the agitator speed.
- Insensitive to solids
- Alternatively heavy or light phase dispersed

The mechanically simple construction together with the extremely small agitator speed gives:

- Minimal apparatus costs
- Minimal maintenance costs
- Minimal energy consumption

# Packed Bed Columns

## FUNCTION

Contacting columns are practical for most liquid-liquid extraction systems. The packings, trays, or sprays increase the surface area in which the two liquid phases can intermingle. This also allows for a longer flow path that the solution can travel through. In the selection of a packing, it is necessary to select a material that is wetted by the continuous phase. Lastly, the flow in a column should always be counter-current.

Use in cases of difficult physical properties:

- low density difference:  $<50 \text{ kg/m}^3$
- low interfacial tension:  $<1 \text{ mN/m}$
- tendency to form emulsions

High specific throughput:

- small column diameters
- revamping of existing columns to increase capacity

Reliable scale-up

- various packing grades for different efficiency and capacity requirements
- no movable parts in unpulsed columns

## ADVANTAGE

- Efficient
- No moving parts
- Choice of various packing types
- Low operating costs



# Pilot Plant Services for LLE Testing

Most LLE projects involve a pilot test to provide the basis for commercial plant design. Unlike distillation, which can often be designed by simulations alone, liquid-liquid extraction usually has many unknown factors such as stage efficiency, rates of diffusion, emulsion formation and capacity data. Small trace impurities can have a significant impact on all of the above. For this reason, only actual plant solutions are best used for these tests.

Before pilot testing begins bench scale tests are performed to generate the liquid-liquid equilibrium data. Besides supplying the equilibrium data, these tests can reveal information on emulsions or entrainment that help guide extractor selection.

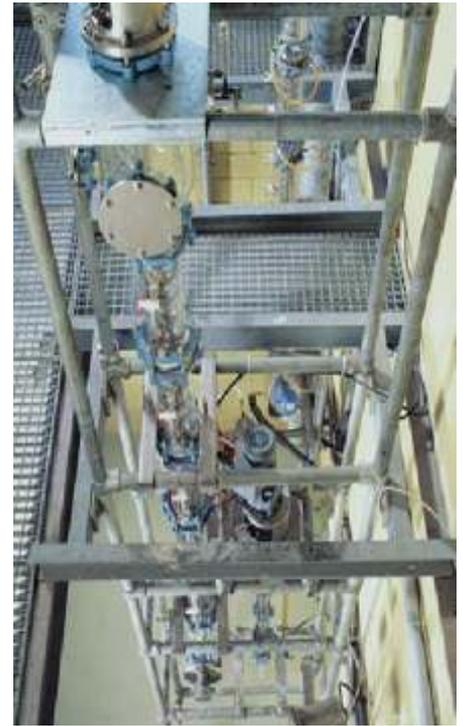
## ADVANTAGE

### Pilot Scale Tests Provide

- Data for scale-up: Stage Efficiency, Throughput, Agitation Speed
- Demonstration of the entire process
- Process optimization
- Basis for performance guarantee

### Bench Scale Tests Provide

- Equilibrium data
- Mixing characteristics
- Settling times
- Extractor type selection for pilot test



## INTERNALS

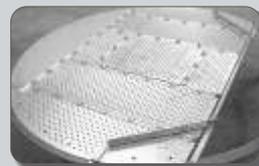
High performance internals designed and manufactured in-house to perfectly suit your extraction requirements



Structured Packing



FX Extract Packing



Double Skin Perforated Baffle



L-L Extraction Distributors



Feed Pipe Distributors



Channel Type Distributors



Feed Pipe Distributor



Wiremesh Mist Eliminator

# Total Solution from Fenix

## Process Technology

Feasibility Study  
Conceptual Design  
Process Simulation  
Testing (Laboratory / Pilot Plant)  
Design Manual  
Process Guarantee

## Control Systems

Instrumentation Diagram  
Control Specifications

## Project Management

Project Engineering  
Equipment Fabrication  
Erection & Commissioning  
Operators Training

## After Sales Service

Troubleshooting  
Spare Parts  
Revamping of Non-Fenix Plants

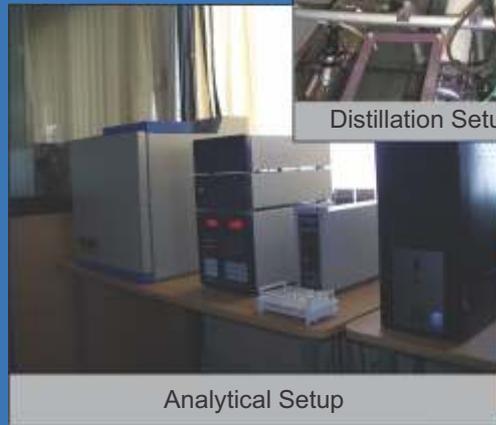
## Fenix Engineering Services

for Distillation, Extraction, Stripping and Absorption

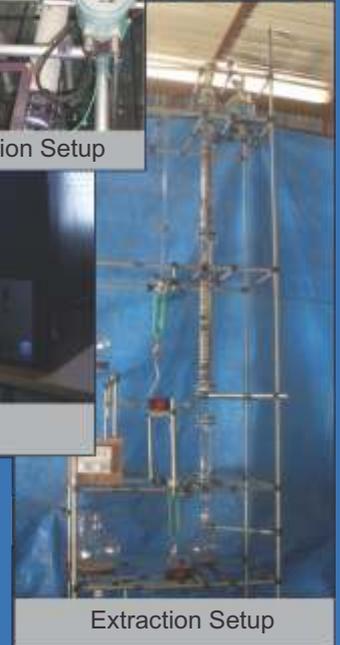
- ◆ Feasibility Study
- ◆ Process Simulation & Process Design
- ◆ Lab & Pilot Plant Facilities
- ◆ Basic Engineering Package BEP
- ◆ Detail Engineering of Key Equipments
- ◆ Startup & Commissioning Assistance
- ◆ Inhouse Analytical & Data Analysis
- ◆ Data Analysis for Plant Operations



Distillation Setup



Analytical Setup



Extraction Setup

[www.fenix.in](http://www.fenix.in)



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