Extraction Technology Group

Liquid-Liquid Extraction Column Design
KARR®, SCHEIBEL® and More – Complete Modular Systems

Koch Modular Process Systems, LLC. (KMPS) Extraction Technology Group specializes in the design and supply of liquid-liquid extraction equipment engineered to fulfill the chemical, pharmaceutical, petrochemical, biotech and flavor & fragrance industries' increasingly challenging purification requirements. Our extractor design expertise includes KARR®, SCHEIBEL®, rotating disc contactor (RDC) columns, pulsed, packed (SMVP) and sieve tray.

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.

KMPS also provides replacements parts, repair services and troubleshooting assistance for all types of extraction columns. A qualified technician or engineer can be provided on-site for both mechanical and process related support.

K M P S

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INTRODUCTION

Chemicals
- Water Treatment
- High BP Organics

Pharmaceuticals
- Antibiotics
- Vitamins
- Fermentation Products

Foods
- Lactic Acid
- Flavors/Fragrances

Polymers
- Caprolactam
- Adiponitrile

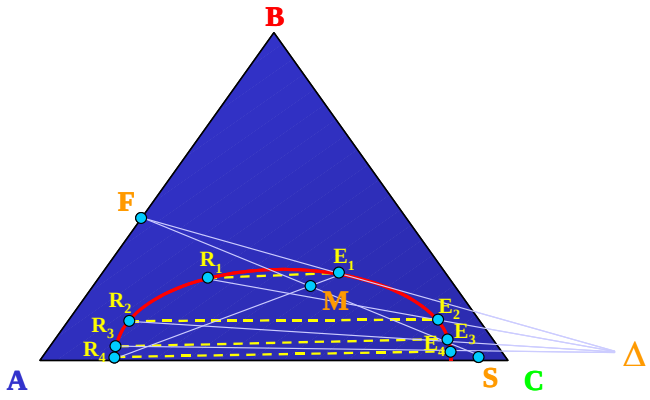
Refining
- Lube Oils
- Aromatics

At KMPS, we don't just sell extraction equipment; we supply solutions to your difficult separation applications. This problem solving effort follows a logical sequence as presented below.

Drawing from our experience, KMPS first determines if liquid-liquid extraction is the appropriate separation technology. If the answer is yes, initial studies are performed to identify possible solvents and operating conditions. This leads to the development of a conceptual process flow sheet.

KMPS next designs laboratory and pilot plant programs to fully evaluate the process and to provide a sound basis for the scale-up to commercial size equipment. Not only are the extraction steps tested, but also the downstream distillation steps for recovery of the solvent and purification of the product. With a broad range of extractor design offerings, ranging from static to agitated columns, combined with 40+ years of liquid-liquid extraction experience, we select the extractor best suited for the particular application.

KMPS then incorporates the extractor into an overall system design, which includes solvent recovery, and further product purification steps. These systems are delivered as modular units with a Process Performance Guarantee.



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INDUSTRIAL APPLICATIONS

While distillation works on the principle of boiling point difference, liquid-liquid extraction works on the principle of chemical structure difference. This makes extraction ideally suited for separation problems such as those listed below by industry.

Chemical
- Washing of acids/bases, polar compounds from organics

Pharmaceuticals
- Recovery of active materials from fermentation broths
- Purification of vitamin products

Effluent Treatment
- Recovery of phenol, DMF, DMAC
- Recovery of acetic acid from dilute solutions

Polymer Processing
- Recovery of caprolactam for nylon manufacture
- Separation of catalyst from reaction products

Petroleum
- Lube oil quality improvement
- Separation of aromatics/aliphatics (BTX)

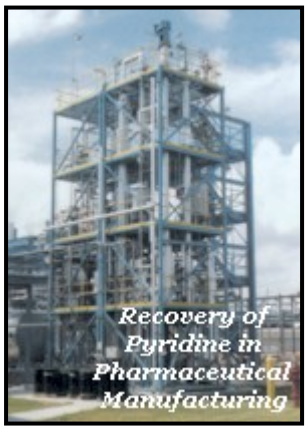
Petrochemicals
- Separation of olefins/parafins
- Separation of structural isomers

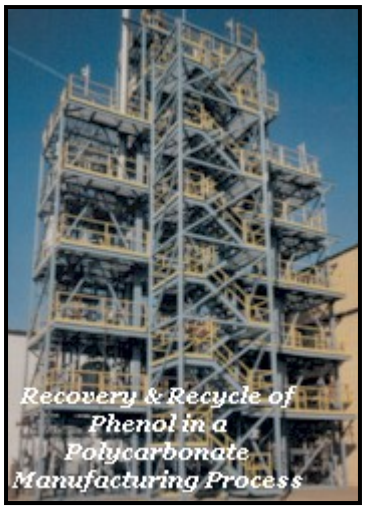
Food Industry
- Decaffeination of coffee and tea
- Separation of essential oils (flavors and fragrances)

Metals Industry
- Copper production
- Recovery of rare earth elements

Inorganic Chemicals
- Purification of phosphoric acid

Nuclear Industry
- Purification of uranium


Recovery of Pyridine in Pharmaceutical Manufacturing


Recovery & Recycle of Phenol in a Polycarbonate Manufacturing Process

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TYPES OF EXTRACTION COLUMNS

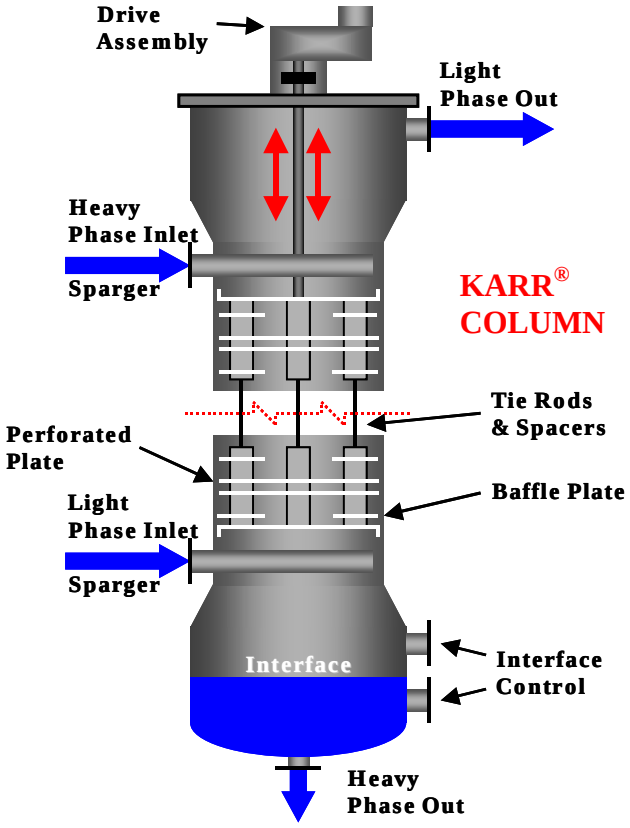
KMPS has a wide range of extractors to choose from, both static and agitated columns. Each extractor is selected and designed according to the specific process application. KMPS also has pilot scale columns for sale and rental.

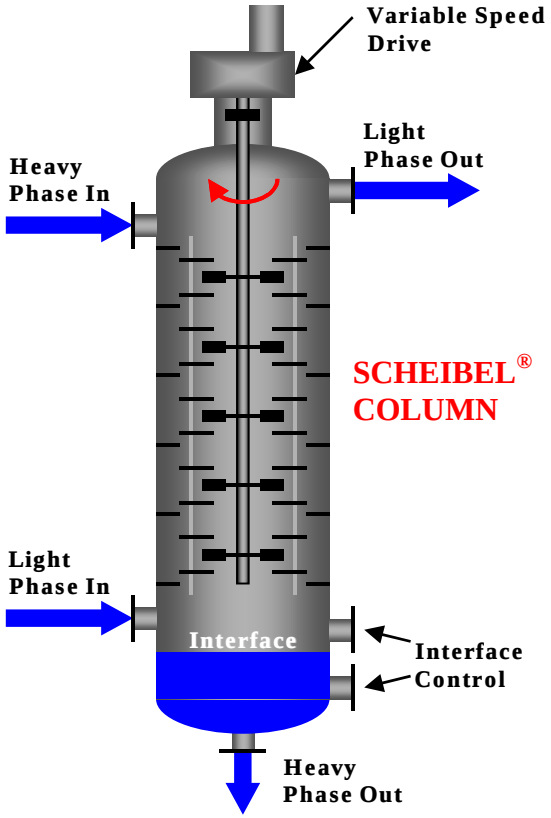
Agitated Columns

- KARR® Column
- SCHEIBEL® Column
- Rotating Disc Contactor (RDC)
- Pulsed Column
- Special Designs

Static Columns

- Sieve Trays
- Random Packing
- Structured (SMVP) Packing





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PROCESS DESIGN

Liquid-liquid extraction is a powerful separation technique that falls right behind distillation in the hierarchy of separation methods (see figure on the right).

REASONS TO USE EXTRACTION

- Separation not feasible by distillation
- Break azeotropes
- Energy requirements of distillation are prohibitive
- A complex distillation sequence is required
- The material is heat sensitive
- The material is non-volatile

The general rule: If a separation can be made economically by distillation, there is no reason to consider extraction. However, in situations where distillation is not feasible for reasons such as a complex process sequence, high investment or operating costs, heat sensitive materials, or low volatility, extraction is often the best technology to use.

Extraction frequently involves additional steps to recover and recycle the solvent. Since most investment and operating costs are associated with the solvent recovery steps, it is very important to consider and study this aspect when designing the entire process.

In a typical extraction process about 3% of the operating cost is in the extractor, with the remaining 97% in solvent recovery. Therefore, it is extremely important to consider the solvent recovery aspects early in the project since they play such an important role in overall process economics.

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PROCESS DEVELOPMENT

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.

Information from Testing

Bench Scale Tests Provide
- Equilibrium data
- Mixing characteristics
- Settling times
- Extractor type selection for pilot test

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

We select the appropriate extractor based on our review of each application. Pilot tests are then run to demonstrate the process performance as well as provide data for scale-up. These pilot tests are performed in the same type of extractor planned for the commercial scale. In some cases, more than one type of extractor will be tested to compare performance.

KMPS Pilot Plant

KMPS has a pilot plant located in Houston, TX dedicated to liquid-liquid extraction testing. Besides extraction we can also test the downstream distillation steps and develop entire process flowsheets.

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