



Zaiput Flow Technologies

Liquid-Liquid/Liquid-Gas Separators

Providing in-line liquid-liquid separation for batch/flow chemistry

Technical Data

Short Description

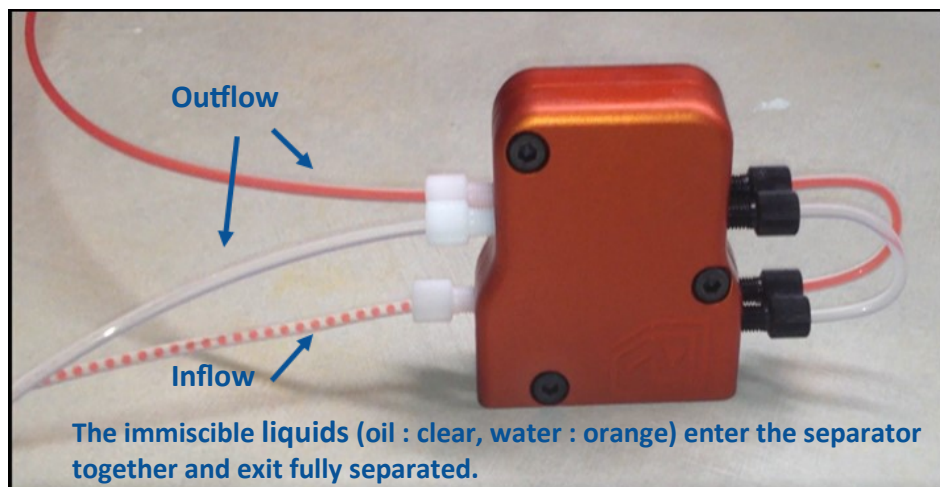
Zaiput Flow Technologies' patented liquid-liquid/liquid-gas separators *enable liquid extraction in flow chemistry-based processes and provide a solution for challenging batch-based liquid extraction steps* (i.e., slow settling time/separation of emulsions, elimination of the need to run batches at half capacity to provide space for subsequent extraction steps).

Zaiput's devices utilize membrane technology to exploit surface tension as a separation driving force. Zaiput's devices contain an innovative mechanical on-board pressure control system to provide plug-and-play functionality. The modularity allows for use in a variety of conditions and scalability ensures seamless process scale up from bench to production.

Zaiput's separators are rated for high pressure use, allowing in-line separation in pressurized flow systems. Finally, Zaiput's devices have broad chemical compatibility, easy maintenance and come at an affordable price.

Features

- ◆ Continuous operation
- ◆ Separation of emulsions
- ◆ Ability to separate liquids with same density
- ◆ Plug-and-play functionality
- ◆ Easy and direct scale-up
- ◆ Minimal internal volume
- ◆ Excellent chemical compatibility
- ◆ Allow operation under pressure
- ◆ Easy usage and maintenance
- ◆ No electrical power required



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Principle

Liquid-Liquid/Liquid-Gas Separators

Principle



- Zaiput Flow Technologies' patented separator provides continuous separation of an immiscible phase (liquid-liquid or liquid-gas) by leveraging differences in wetting properties of the liquids onto a porous membrane.
- When a stream composed of two phases (for example: an aqueous liquid and an organic liquid or a gas and a liquid) enters the separator, one phase will have an affinity for the membrane and fill the pores (this is referred to as the “wetting” phase). The other phase will be repelled and will not fill the pores (this is referred to as the “non-wetting” phase).
- Once the membrane pores are filled with the wetting phase, a pressure differential is applied between the two sides of the membrane. This pressure differential is finely adjusted by Zaiput’s patented internal pressure controller to apply just enough pressure to “push” through the wetting phase without forcing the non-wetting phase through the pores (see figure below). The separator is designed to maintain a constant pressure differential across the designated flow rates even when conditions are fluctuating. As a result, the separator can be used as a “plug-and-play” modular unit.
- A key aspect of the technology is that it exploits differences in wettability and surface forces to accomplish the separation; as a result, the device can separate liquids with the same density and emulsions with continuous operation.

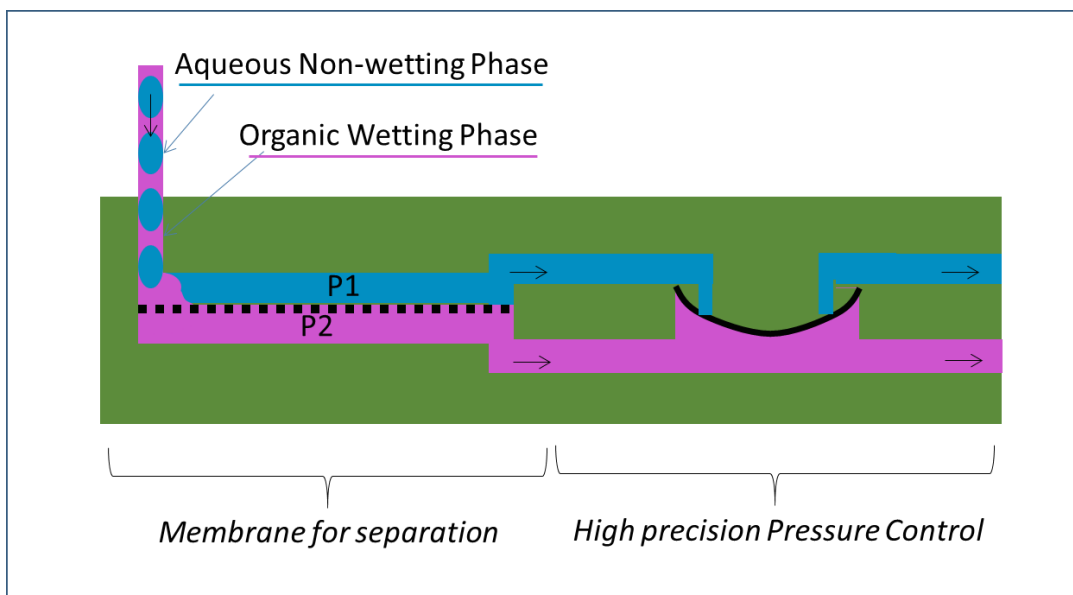


Fig 1—Schematic of the separator

The wetting phase (pink) passes through the membrane //(dotted line) while the non-wetting phase (blue) is retained.



Specifications

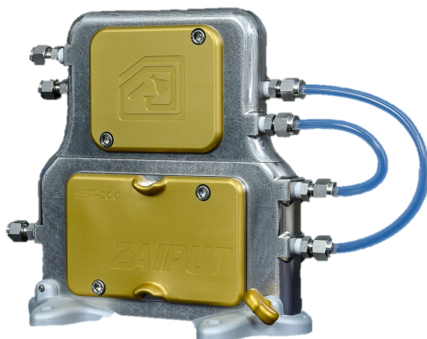
Liquid-Liquid/Liquid-Gas Separators

Laboratory Scale



Part Number	SEP—10
Width	◆ 77 mm (3.03 inches)
Depth	◆ 29 mm (1.14 inches)
Height	
Maximum Pressure	2 MPa (300 psi)
Factory Installed Membrane	Hydrophobic PTFE 0.5- micron pore size
Ports	¼ - 28 flat bottom
Wetted Parts	Perfluorinated polymers (ETFE, PFA, FEP, PTFE)
Total Flow Rate	0-10 ml/min

Pilot Scale



Part number	SEP—200 (Hastelloy/Stainless Steel)
Width	◆ 206 mm (8.11 inches)
Depth	◆ 26 mm (1.02 inches)
Height	◆ 196 mm (7.71 inches)
Maximum Pressure	2 MPa (300 psi)
Factory Installed Membrane	Hydrophobic PTFE 0.5-micron pore size
Ports	Swagelok for ¼" OD
Wetted Parts	Hastelloy C 276 or SS 316 L and FFKM, PTFE, PFA
Total Flow Rate	20-200 ml/min

Production Scale



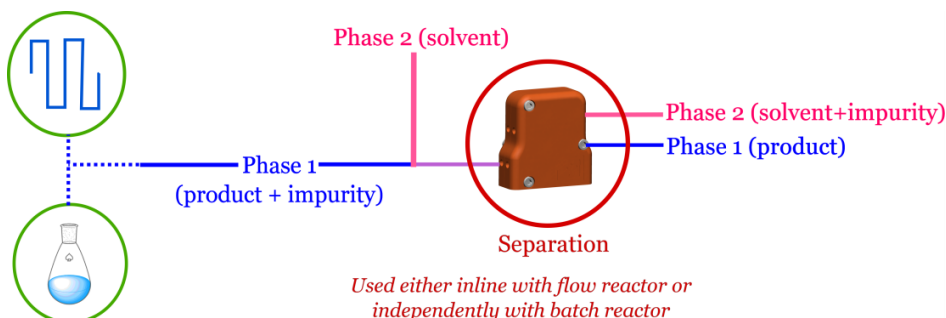
Part number	SEP—3000 (Hastelloy/Stainless Steel)
Width	◆ 460 mm (18.0 inches)
Depth	◆ 150 mm (6.0 inches)
Height	◆ 607 mm (23.9 inches)
Maximum Pressure	2 MPa (300 psi)
Factory Installed Membrane	Hydrophobic PTFE 0.5-micron pore size
Ports	Swagelok 1/2" OD
Wetted Parts	Hastelloy C 276 or SS 316 L and FFKM, PTFE, PFA
Total Flow Rate	200-3000 ml/min



Applications

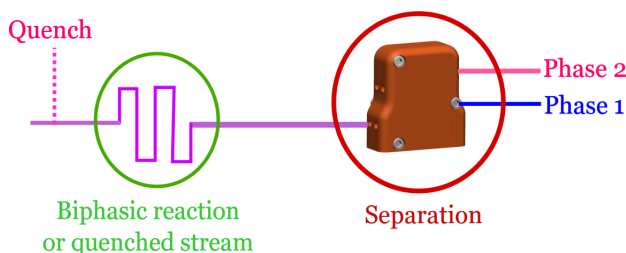
Liquid-Liquid/Liquid-Gas Separators

Liquid—Liquid Extraction / In-Line Workup



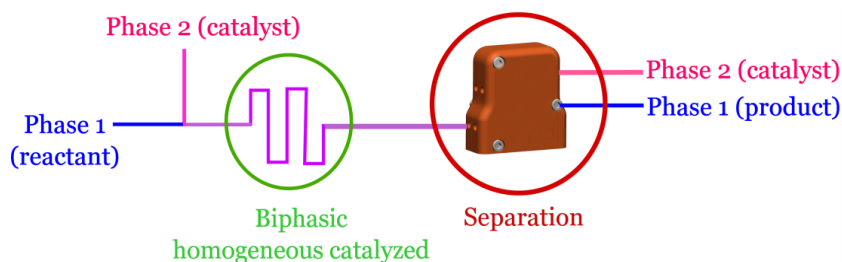
- Liquid-liquid extraction is one of the primary purification methods providing high selectivity and low energy consumption.
- Zaiput's technology provides the ability to perform the extraction in continuous flow with a simple plug-and-play device.
- Zaiput's separator can be used in conjunction with different chemistries, with applications ranging from pharmaceuticals to polymer synthesis.
- Alternatively, it can be a standalone unit operating in any laboratory or industrial process.

Biphasic Reaction or Quenching System



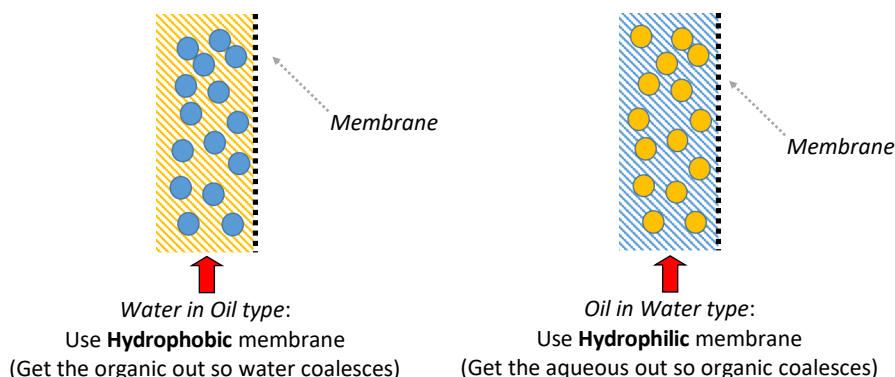
- In liquid-liquid reactions, often the reaction stream needs to be quenched by an immiscible phase.
- Zaiput's liquid-liquid separator can be used downstream or in-line to separate the biphasic reaction.

Homogenous Catalyst Recovery



- A biphasic homogeneous-catalyzed reaction refers to catalysis that takes place at the interface between the two immiscible phases.
- At small and large scales, homogeneous catalysis is rarely used because it poses problems with catalyst recovery via phase separation and mixing issues.
- Zaiput's separator offers an easy and flexible way to separate the two phases and recover the catalyst.

Separation of Emulsions and Rag Layers



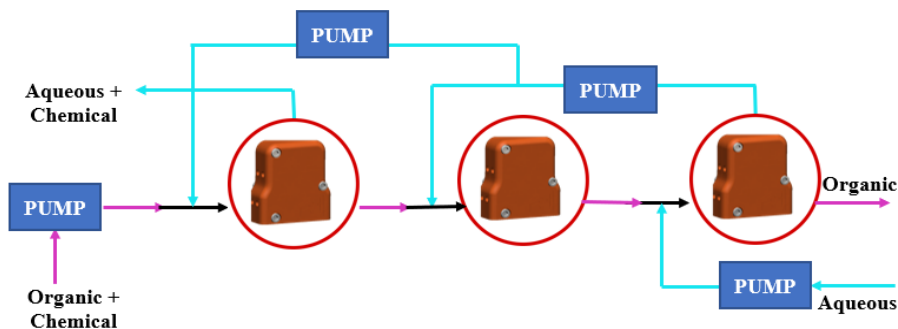
- Emulsions and rag layers typically take long periods of time to gravity separate leading to plant inefficiencies.
- Zaiput's separator allows for easy separation of emulsions by removing the matrix fluid and forcing the emulsion to coalesce.
- Since separation is density independent, even the most challenging emulsions can be separated with ease.



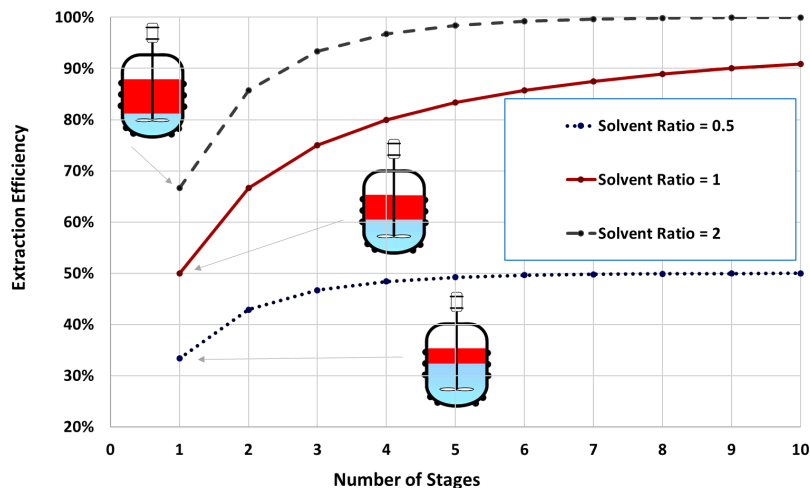
Applications / Publications

Liquid-Liquid/Liquid-Gas Separators

Counter-Current Liquid-Liquid Extraction



Extraction Efficiency: Partition Coefficient = 1



- Multistage extraction is a process where reaction steps are repeated to increase efficiency.
- The scalability of the technology allows seamless processing from the laboratory to the production scale.
- At the laboratory scale we provide an integrated, ready to use platform

- Zaiput Lab scale multistage platform (MS-10) has 5 stages.
- SCALABLE: A process that has been optimized at the laboratory/bench scale can be scaled up using our pilot plant units (SEP-200) or production scale unit (SEP-3000).

- The power of multistage extraction can be seen in the chart which shows the extraction efficiency of three different systems with a partition coefficient of 1 (50/50 partitioning of solute).
- Solvent ratios of 2:1, 1:1 and 1:2 relative to the feed are portrayed along with their corresponding batch extraction set ups.
- As number of stages increases, extraction efficiency increase, still using the same amount of material that would be used if only one back step was performed.
- Zaiput can assist you in modeling your extraction efficiency for different scenarios

Selected Publications

50+ Publications



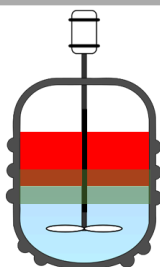
- Jamison, T.F et al, 2017. The assembly and use of continuous flow systems for chemical synthesis. [Nature protocols, 12\(11\), pp.2423-2446.](#)
- Glotz, G et al, 2017 Integration of Bromine and Cyanogen Bromide Generators for the Continuous-Flow Synthesis of Cyclic Guanidines. [Angewandte Chemie, 129\(44\), pp.13974-13977.](#)
- Adamo, A et al. On -demand continuous-flow production of pharmaceuticals in a compact, reconfigurable system. [Science, 352\(6281\), pp.61-67.](#)
- [See a full list on our Web Site](#)



Batch-Based Liquid Extraction

Liquid-Liquid/Liquid-Gas Separators

Key issues of current gravity-based batch processes

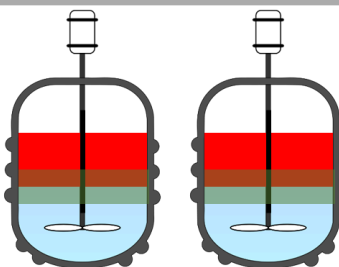


Reactors used at half capacity
"Rag" layer slow to separate

Challenge :

1. When a reaction is followed by an extraction, the batch reactor is used at half capacity.
2. The intermediate layers ("rag layers") determine time/ product losses.

Solution: Zaiput eliminates the need for using reactors at half capacity (see below).

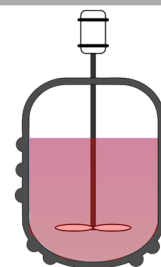


Back/multiple wash cumbersome
(2 washes, twice the time)

Challenge :

Multiple extraction/washes require extensive amount of time as they cannot be done simultaneously.

Solution: With Zaiput, multiple extraction/wash steps can be performed simultaneously (see below).



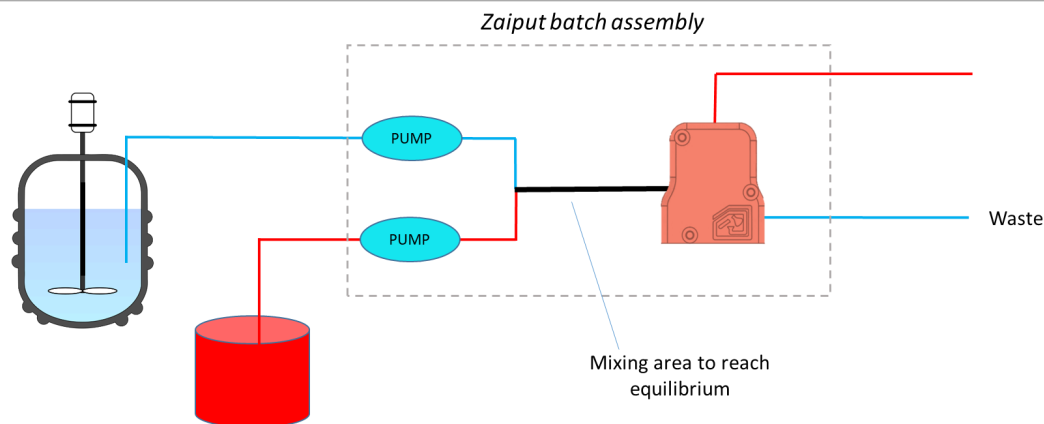
Emulsions

Challenge :

Emulsions take a long time to separate in batch-based processes, resulting in increased cost and process time.

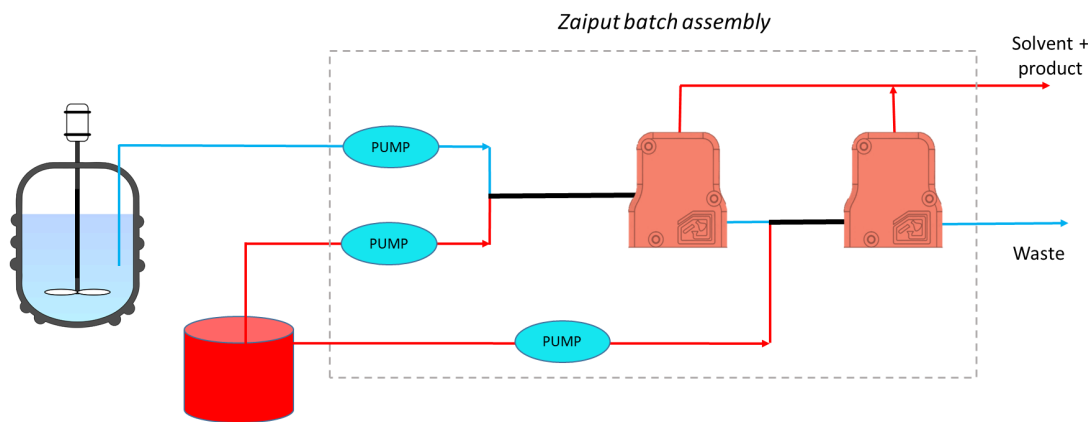
Solution: Zaiput's membrane-based technology readily separates emulsions.

Zaiput eliminates the need for using reactors at half capacity:



- Zaiput's technology can be used to perform an extraction outside of the reactor as liquids are transferred. This eliminates the need of running a reaction at half capacity.

Zaiput allows multiple washes in the same amount of time needed for one:



- Zaiput devices can be cascaded in series to achieve multiple washes/ extractions at the same time: The time needed for one wash is the same as the time needed for many!

Can be arranged in Cross-current or Counter-current

— Mixing area to reach equilibrium



Ordering Information / Contact

Liquid-Liquid/Liquid-Gas Separators

Ordering information

Liquid—Liquid Separator Devices

SEP-10

SEP-200-SS (Stainless steel 316)

SEP-200-HS (Hastelloy C276)

SEP-3000-SS (Stainless steel 316)

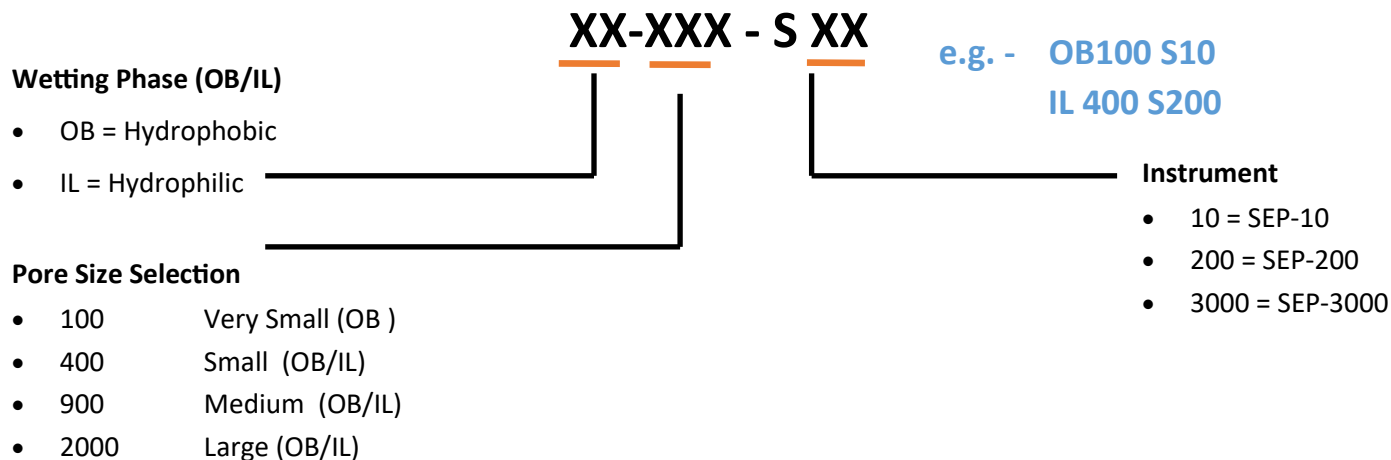
SEP-3000-HS (Hastelloy C276)

Membranes

- A variety of membranes both PTFE Hydrophobic and PTFE Hydrophilic are available in different pore sizes to optimize your separation.
- Membranes are low - cost and easy to maintain.

⇒ Membrane Sampler Package : M-SAMPLER-S10 (available on request for larger devices)

⇒ Specific membrane ordering info:



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