SULZER

CASE STUDY

Up to 40% less capex in phosphoric acid purification with OptimEXT™

Purification of phosphoric acid

Phosphoric acid is a valuable chemical in the fertilizer, nutrition, and electronic industries. Approximately 90% of the global production of phosphoric acid is derived from the wet process. Although the wet process is significantly more cost-effective than the alternative thermal process, the phosphoric acid produced by the wet process contains a high level of impurities (e.g. 0.1 to 1.0 wt.% Fe). These impurities must be completely removed to meet industrial standards, typically through a liquid-liquid extraction process (e.g. 1 to 15 ppm Fe). This extraction process includes an extraction step, followed by a scrubbing step, and finally a stripping (release) step, as shown in Figure 1.

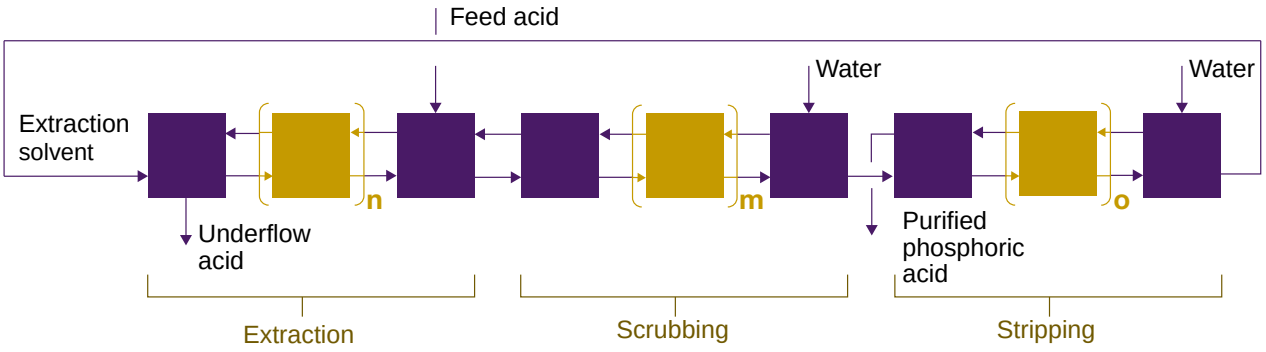

Figure 1: Schematic Block Flow Diagram of purification of phosphoric acid showing the different extraction steps “extraction”, “scrubbing”, and “stripping”

The extraction process involves a significant number of theoretical extraction stages, which were initially carried out in a series of mixer-settlers, with each mixer-settler representing a single theoretical stage. Consequently, the initial capital investment for the extraction process was substantial and required a considerable spatial footprint. To enhance the economic feasibility of the process, extraction columns are used for each individual step, thereby consolidating the required equipment into three primary extraction units. This approach significantly reduces both the capital investments and the extraction plant footprint. Despite these improvements, Sulzer engineers sought to further optimize the process.

OptimEXT™— Process optimization by integrating multiple extraction steps in one column

OptimEXT™ Kühni™ extraction columns are known for their exceptional flexibility thanks to their customizable column internals. This flexibility allows Sulzer process engineers to design extraction columns capable of handling a wide range of large volume flow ratios in a single unit. Consequently, it becomes feasible to integrate an extraction and a washing step within one single column.

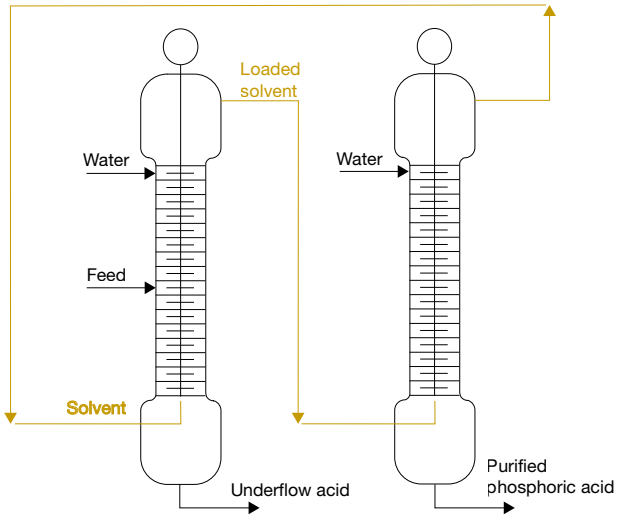

Figure 2: Schematic overview of the OptimEXT™ two-column system in the phosphoric acid purification process

In the context of purification of phosphoric acid, this means that the number of extraction columns can be reduced from three to two (Figure 2), without compromising the performance of the extraction process. The two-column system has been demonstrated to achieve stringent specifications required for food-grade Purified Phosphoric Acid (PPA), while exceeding a PPA recovery yield of 70%.

Benefit from process intensification by integrated extraction columns.

The integration of two extraction steps within a single extraction column offers several advantages:

1. **Simplified industrial design and capex savings:**
   The industrial design of the integrated column eliminates the need for two separate settlers, additional level-control systems, and a reduced number of bearings. This simplification is particularly impactful in the case of phosphoric acid production, where large columns (up to 3 meters in diameter) are used, and the corrosive nature of the process necessitates the use of expensive construction materials. Furthermore, peripheral equipment, such as pumps, piping, and flow meters, becomes unnecessary, leading to additional cost savings. On the industrial scale, this design can reduce capital expenditure (capex) for extraction columns by up to **30%**, with an **additional 10% savings** achieved by eliminating auxiliary equipment.

2. **Reduced column volume and inventory:**
   The total volume of an integrated extraction column is approximately 15%–20% smaller compared to the combined volume of two separate columns installed in series. This leads to a lower inventory of materials within the column, minimizing material losses during shutdown phases. In addition, the shorter column volume results in reduced start-up times, which are similarly decreased by 15–20%.

3. **Significant reduction in plant footprint:**
   The adoption of integrated extraction columns, as opposed to traditional mixer-settler configurations, significantly reduces the spatial footprint of the industrial plant. Utilizing the two-column approach, process engineers can further reduce the overall footprint by an additional 30%.

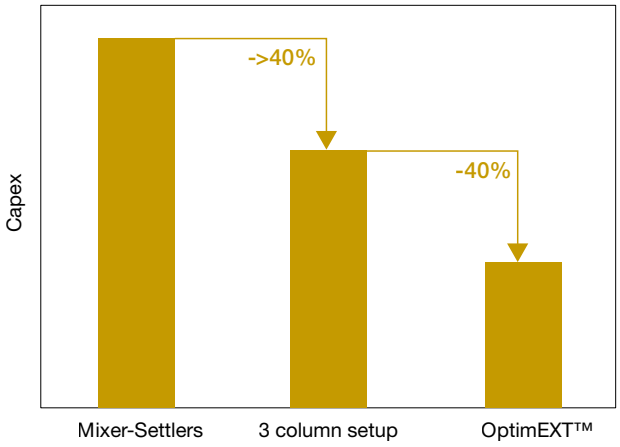

Figure 3. Capital expenditure (Capex) comparison among different process scheme for phosphoric acid purification

Conclusion

Liquid-liquid extraction is a well-established technique to obtain high-purity phosphoric acid from the wet phosphoric acid process. Achieving high yields while simultaneously maintaining stringent purity standards is vital in this process. To fulfill these requirements, the extraction process typically consists of three main steps: an extraction step, a stripping step, and a final release step, with each step comprising multiple extraction stages. The Kühni™ extraction columns enable the execution of several extraction stages within a single apparatus, thereby reducing capital investment costs. Furthermore, the integrated **OptimEXT™ Kühni™** solution enhances process efficiency, resulting in even lower investment costs, minimizing inventory requirements, and a smaller operational footprint.

About OptimEXT™

OptimEXT™ is Sulzer's advanced liquid-liquid extraction and solvent recovery solution, engineered for high-purity performance across various applications. Featuring the high-efficiency Kühni™ agitated column, OptimEXT™ delivers superior separation, high recovery rates, and process flexibility—backed by Sulzer's extensive pilot testing, engineering expertise, and over 700 installed references globally.

Table 1: Reference list of OptimEXT™ extraction columns in the phosphoric acid industry

Country	Extraction column (incl. column diameter in mm)	Year
Morocco	ECR 3000 Kühni™ ECR 3000 Kühni™	2025
USA	ECR 2000 Kühni™ ECR 2200 Kühni™	2004
USA	ECR 2000 Kühni™ ECR 2200 Kühni™	2001
USA	ECR 2700 Kühni™ ECR 2700 Kühni™	1999
Great Britain	ECR 2000 Kühni™	1995
USA	ECR 2600 Kühni™	1989
USA	ECR 2200 Kühni™ ECR 2200 Kühni™	1988
USA	ECR 2000 Kühni™ ECR 2000 Kühni™	1988
Great Britain	ECR 1600 Kühni™	1986
Belgium	ECR 1400 Kühni™	1986
Spain	ECR 1200 Kühni™	1986
Great Britain	ECR 1600 Kühni™	1983
Germany	ECR 1500 Kühni™ ECR 1500 Kühni™	1979
South Africa	ECR 1500 Kühni™ ECR 1500 Kühni™	1978
France	ECR 1600 Kühni™	1977
Yugoslavia	ECR 2100 Kühni™	1977
France	ECR 2100 Kühni™	1975
France	ECR 2100 Kühni™	1975

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