XPURE
innovative continuous chromatography

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#Pilot Study: Lactic Acid

Platform molecules form the basis for several formulations in chemical, food, and pharmaceutical industries (Figure 1). Lactic acid (LA), a 3 carbon carboxylic acid, is one such platform molecule. LA has a broad application field ranging from the food industry to polymer production. Complying with the traditional philosophy of demand vs scale vs cost, a cumulative annual growth rate > 20% for LA drives the need for cost-effective and efficient production processes to meet the demand.

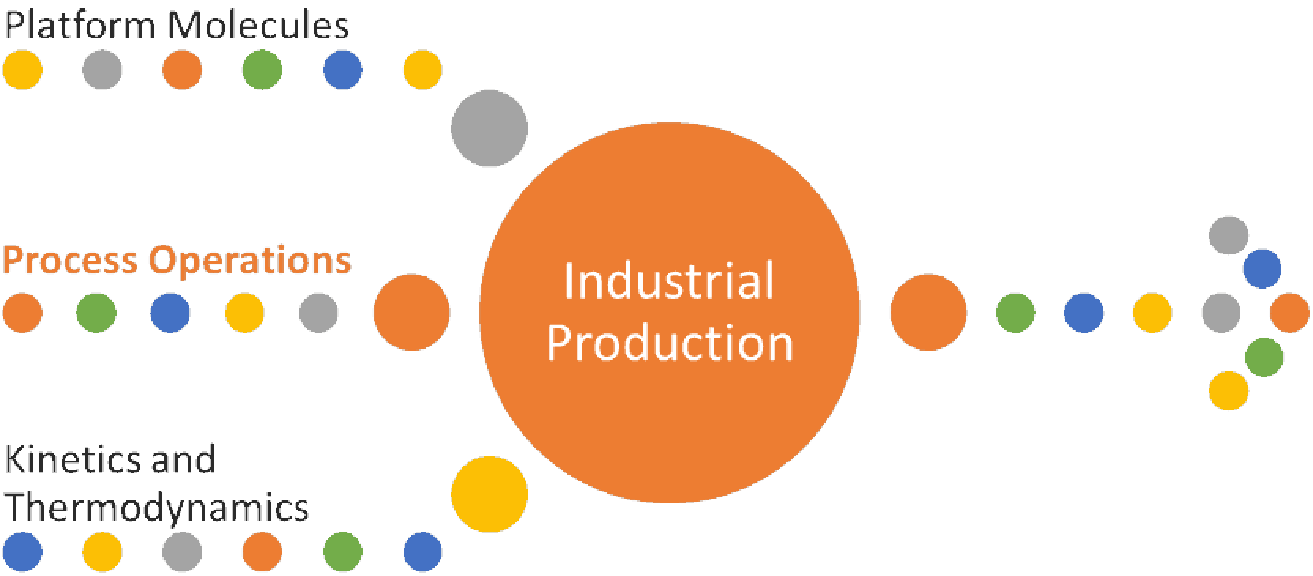

Figure 1. Fundamental aspects involved in industrial production of products (Orange: Involves XPure technologies)

LA is produced by both chemical synthesis and fermentation, where fermentation has been the preferred choice due to enantio-selectivity and environmental sustainability factors. However, fermentation-based processes require highly efficient downstream processing (DSP) for removal of impurities and to enable the claimed environmental benefits; if DSP is energy-intensive, then sustainability can become questionable. Further, DSP also contributes to > 50% of the overall cost of goods (COGs) which can define the business model (Figure 2). In this application note, we will discuss how the use of simulated moving bed (SMB) mode of ion exchange adsorption (IEX) steps can influence the overall COGs.

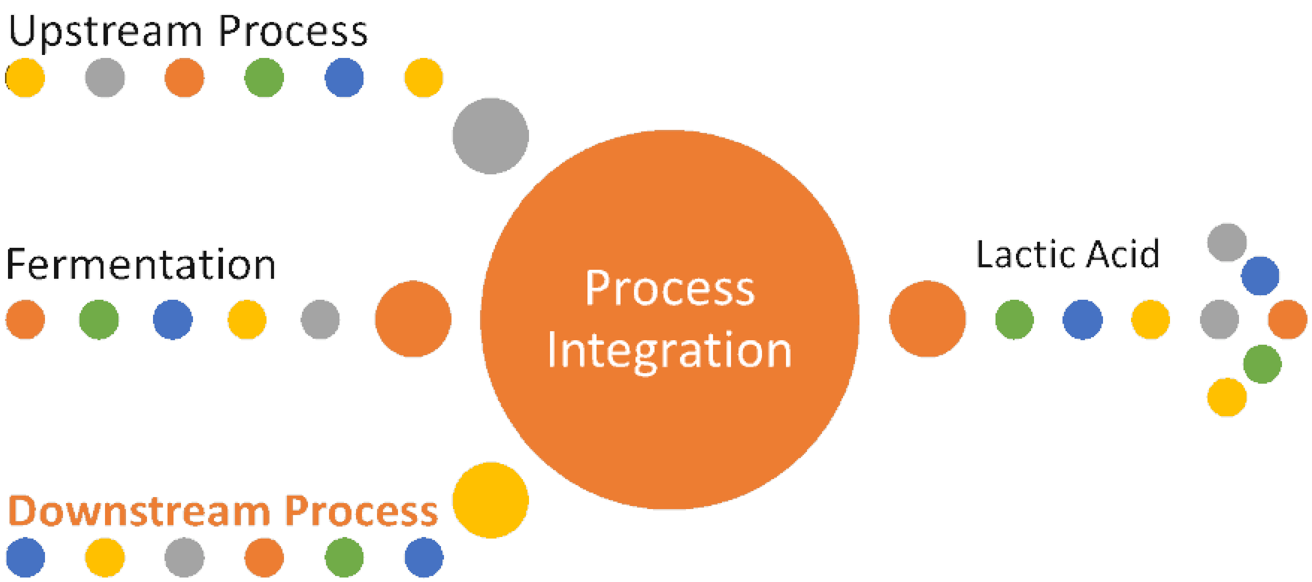

Figure 2. Major sub-processes integrated to produce lactic acid

LA production process involves both cation and anion exchangers to remove positively-charged cationic impurities and to capture LA, respectively. These two steps use industrial resins, which are known for their robustness, high exchange capacity, and long process life. However, operating these resins in batch mode results in partial utilization of the resin capacity and requires larger columns, a large amount of buffers, and waste streams (Figure 3).

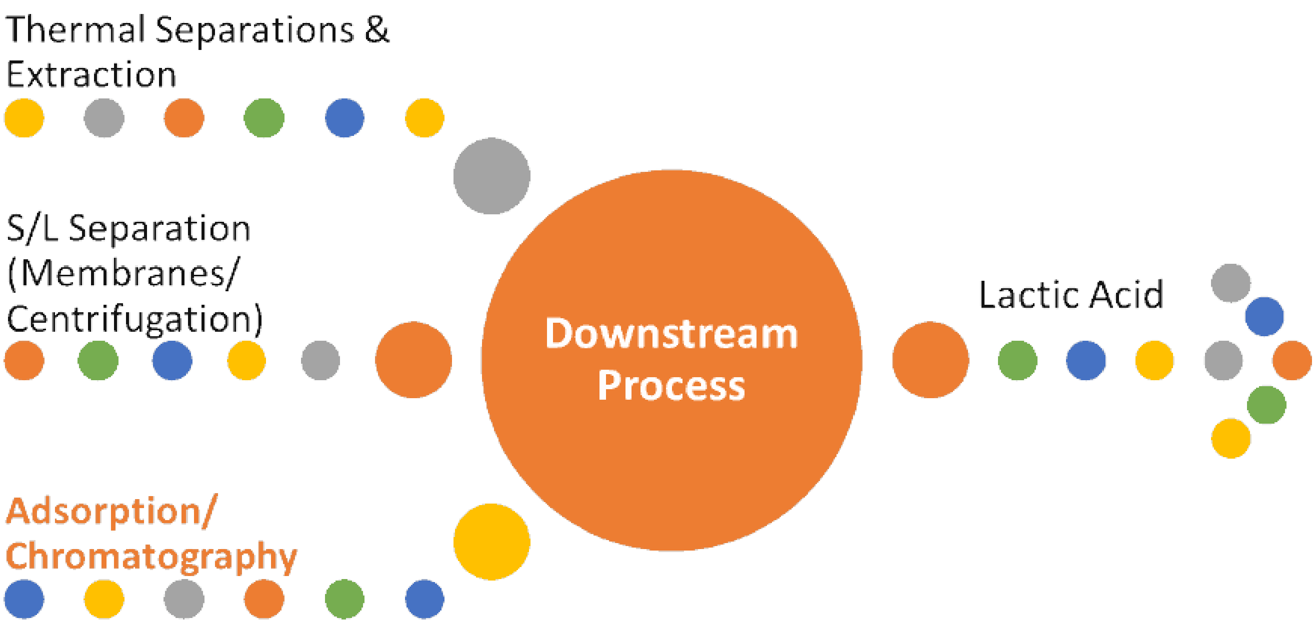

Figure 3. Different separation principles applied in downstream processing of lactic acid

This scenario leads to low productivity, less sustainable process, and increase in process costs. Therefore, the SMB technology can successfully be applied in this scenario, to develop a more sustainable process with reduced costs. This is due to the fact that SMB results in better resin utilization and lower buffer usage, leading to reduced operating costs. Additionally, improved product titers in the case of SMB can reduce the scale of unit operations used post-SMB.

In the traditional scenario of switching from batch to SMB, the IEX costs can be reduced by 30-50%. For example, in a lactic acid purification process, where IEX step can contribute to about 20% of overall DSP COGs, the SMB technology can reduce the DSP COGs by 5-10%. This improvement in process economics can be critical for fermentation-based products like LA, which competes with petrochemical products. See estimated cash flow analysis for LA production process with batch and SMB IEX systems (Figure 4). Here, a 32 kt/a plant capacity is assumed, with an OPEX of about 915 /t, CAPEX of about 21 M , and a sales price of 1500 /t. Shifting from batch to SMB in such a scenario can reduce the breakeven period from 3.25 to 2.75 years, thereby enhancing efficiency, sustainability, and profitability.

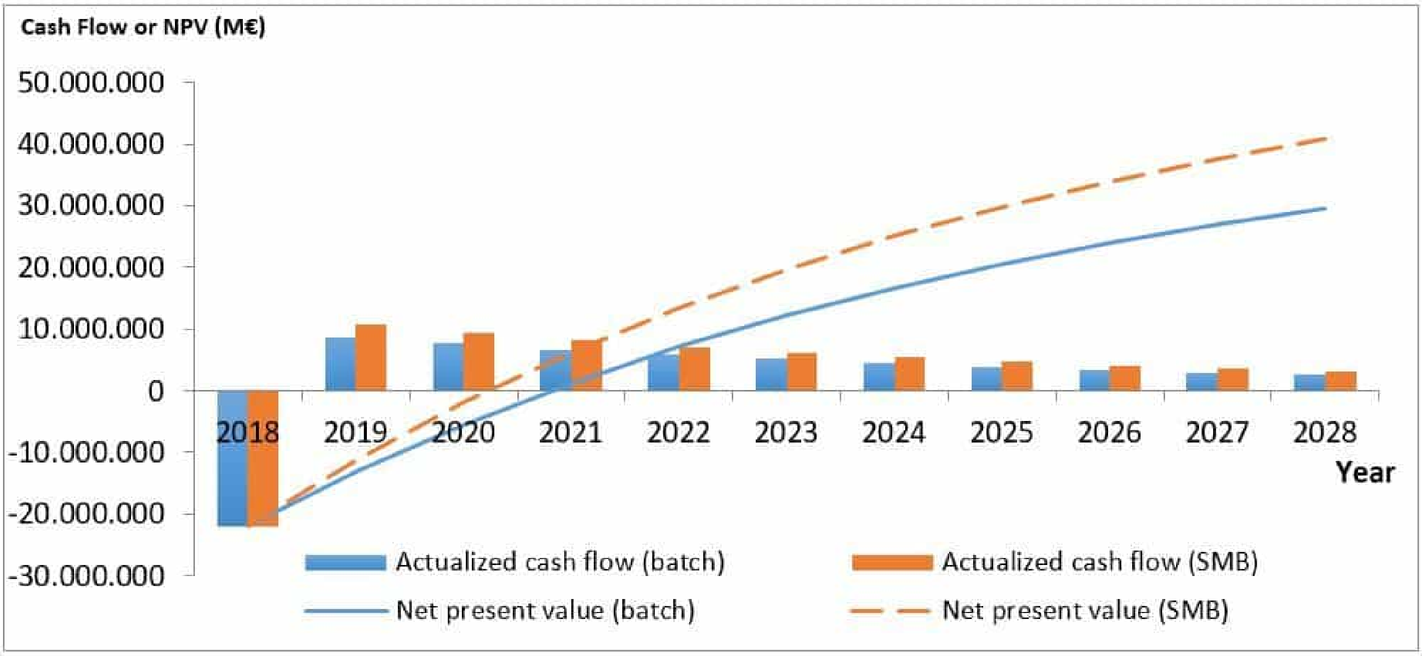

Figure 4. Cash flow analysis with batch and SMB IEX steps for LA purification