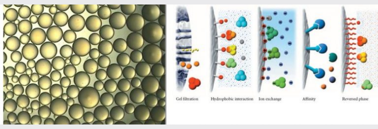
November 12, 2020 BLOG



How to Transition to an Industrial Chromatography System from a Lab Experience or Process (Computer) Model

Ion exchange chromatography is a proven technology that has been applied in most industries, including chemical, biobased, biotechnology, and water treatment. In this blog, we present aspects that are essential to be considered in the design & engineering route to Large Industrial Scale.

Background
Ion exchange chromatography is an industrially proven technology which substantially contributes to the portfolio of separation and purification technologies on which industries can rely. Similar to membrane processes, chromatography is an easily scalable process (if properly characterized taking the critical parameters into account). Where membrane processes offer a variety in terms of hydrophobicity, selectivity, and ionic retention, chromatography resins offer a broad pallet of ionic/non-ionic affinity, hydrophobic/hydrophilicity, particle size ranges, matrices (polymer and possible crosslinking, zeolite and silica based), pore size distribution, density, etc. (Figure 1).

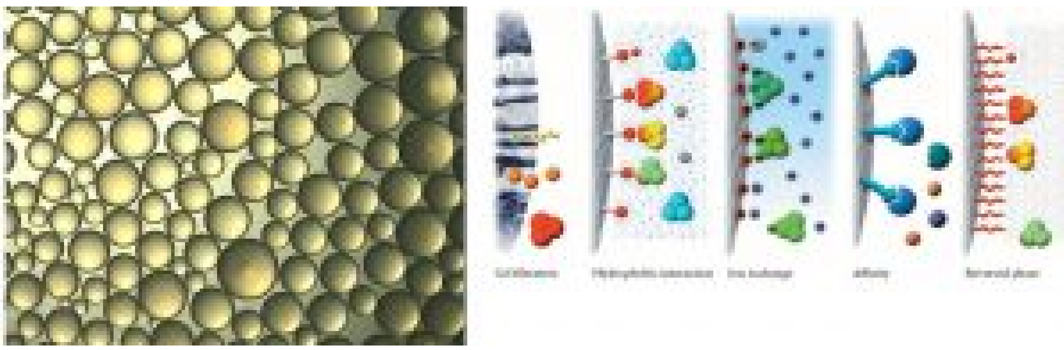


Figure 1. Typical appearance of a resin (polymer matrix, left image) and affinity mechanism's (right image)

Product and Process Definition
The starting point to an industrial chromatography system, is a well-defined and techno economically feasible separation process concept. Theoretical modelling and simulations give a good early assessment, based on the feed stream properties and the desired product quality attributes. The true proof of concept is in lab scale experiments that allow

for confirmation of the process and generating of samples to analyze the product properties.

Conceptual Engineering Phase
Based on a solid concept of the adsorption process, the engineering may start. In this phase it is vital to make inventories and include in the design package:

- A User Requirement Specification (URS). This is the most vital document, sometimes forgotten by applicants. This document doesn't just address production capacity and input/output conditions, but also addresses space related issues (civil engineering aspects), energy, and power requirements
- The minimum and maximum feed capacity. Here the applicant may also include expected growth for the short term
- The materials involved and its interaction, e.g. related to corrosion features, temperature, or hazardous reactions related to piping, instruments, and tanks, as well as to feed liquor and buffer media
- A Process Flow Diagram (PFD) and a (simplified) Piping & Instrumentation Diagram (P&ID)
- Equipment/instrument/valve lists
- The position in the (downstream) process, and the connections outside the boundaries of the adsorption process equipment
- A preliminary floor plan
- Simple Mass Balance for all process streams

Basic Engineering Phase
The next phase includes a more detailed specification of the conceptual engineering documents:

- More thorough User Requirements Specification (URS)
- Defined scope and battery limits
- Detailed P&ID
- Detailed Mass Balance, related to the detailed PFD, and List of Utilities
- Energy balance
- Detailed material lists and related equipment/instrument/valve data sheets (ready for procurement)
- Bill of Material
- Hazardous Operation Assessment on the design package. This may have impact on certain design details and therefore the outcome should be implemented in the engineering package as well as a risk assessment related to process and product quality
- Detailed lay-out and floor plan
- Functional Specification of the process equipment, and for process control system(s). Here the connections with other plant processes will be documented, data processing is also part of the functional automation specification
- Design Qualification
- Last but not least: a project planning and a detailed project budget

Detailed Engineering and Engineering, Procurement and Construction (EPC)
With the basic engineering package from the previous phase, the detailed engineering and procurement may proceed. In this phase much attention will be given to:

- Detail piping specification and lay-out plan
- Equipment lay-out
- Procurement and purchase conditions, delivery times
- Site conditions
- Contracting site construction and installation
- Construction, and assembly plan
- Installation works, e.g. electrical and control panels, and the connections with the field equipment
- Commissioning, training, and start-up

XPure Systems
XPure has successfully developed design packages for various chromatography systems, for example:

- Recovery and purification of human milk oligosaccharide from clarified inactivated E-coli based fermentation broth
- Recovery of API from a recycled (crystallization/filtration) mother liquor
- Design and build of a multi-purpose Expanded Bed SMB (16 columns) bench system for sustainable materials process development
- Design and build of a plant protein isolation 6 column SMB
- Design and build of a large scale rotating multi-port distributor valve system for sugar refinery

XPure partners with researchers and manufacturers to tackle separation challenges in the food ingredient, biotech, and chemical industries. Our focus on automated technology and scalable, modular, and continuous ion exchange chromatography systems — combined with end-to-end process consulting — help to ensure productivity is maximized, costs are minimized, and processes are sustainable.

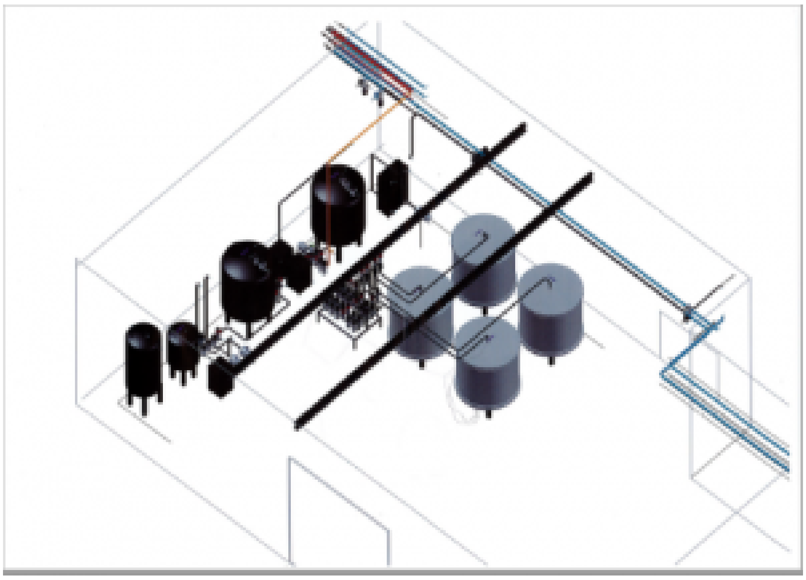


Figure 2. demonstrates a 3-dimensional scan of a 4-column chromatography plant with storage tanks, pumps, and interconnecting piping.