Implementation of the resource recovery concept in the biotech industry

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The concept of circular economy is attracting significant attention in modern biotech industry. Downstream processing plants are usually focused on the removal of impurities instead of their recovery in the form of value-added products for additional revenues. For example, carboxylic acids, carbohydrates, proteins, lipids, inorganic ions and water itself are amongst various resources that are found in wastewater streams coming from bio-based production processes. Such compounds have a high value at the global market and could potentially be used as raw materials for the manufacturing feed and food additives, cosmetics, medical products, bio-based plastics, bio-fuels (biogas, bioethanol and biodiesel), fertilizers, and even biopharmaceuticals.

A paradigm shift from removal of impurities to their recovery is achieved by implementing a symbiosis of Quality by Design (QbD), Process Systems Engineering (PSE), Lean Production System (LPS), Process Analytical Technology (PAT) and chemistry. The main outcomes of the symbiosis are minimization of costs and non-value added activities already in the early stage of the development together with maximizing quality, efficiency and profit. An illustration of the overall concept could be seen in Figure 1.

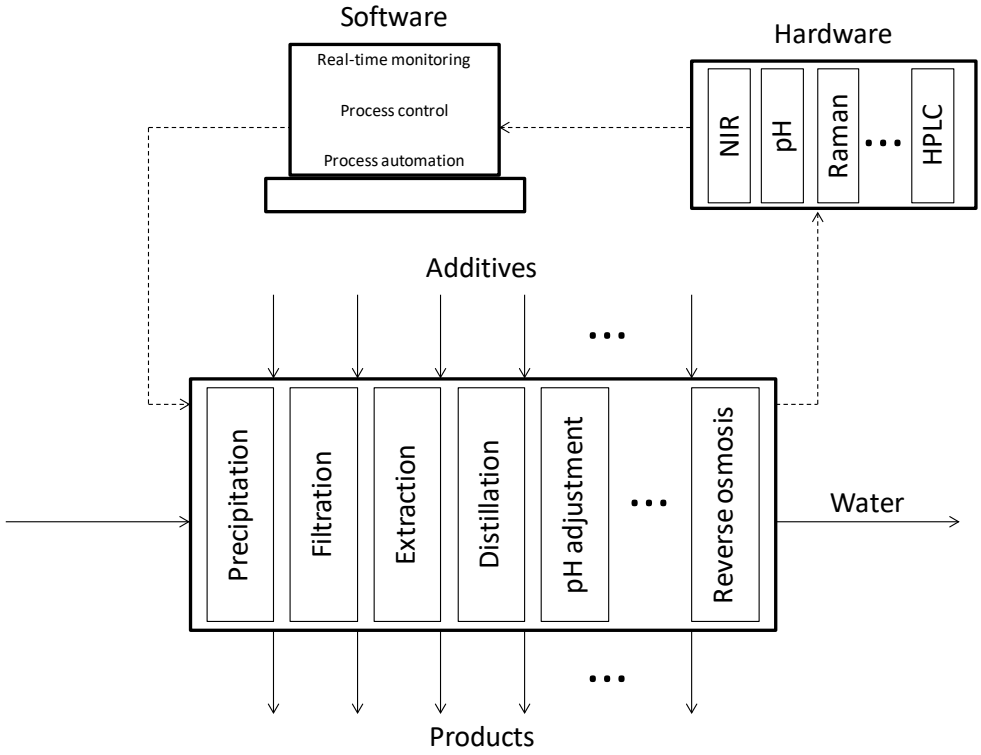

Figure 1 Illustration of the resource recovery concept for the biotech industry

An example processes is purification of fermentation broth in order to achieve potable water quality. Therefore, reverse osmosis (RO) is used to treat a permeate coming from the ultrafiltration step. As a result, the RO permeate could be re-used in fermentation processes or as the process water. The RO concentrate on the other hand consists significant amounts of ions that could be easily converted into

valuable products by implementing precipitation as a unit operation. In such a way fertilizers (struvite, superphosphate) could be produced, as well as products for medical industry (barium-sulphate). The leftover could be send towards production of agrofules, such as commonly applied manufacturing of biogas.