REDUCTION OF WATER AND WATER-RELATED ENERGY CONSUMPTION BY IN-SITU MEDIA AND BUFFER PREPARATION ON DEMAND IN CONTINUOUS INTEGRATED BIOMANUFACTURING

Alois Jungbauer, University of Natural Resources and Life Sciences Vienna (BOKU), , Austria
alois.jungbauer@boku.ac.at
Daniel Komuczki, University of Natural Resources and Life Sciences Vienna (BOKU), , Austria
Tommaso De Santis, Austrian Centre of Industrial biotechnology (acib)
Peter Satzer, University of Natural Resources and Life Sciences Vienna (BOKU) , Austria

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A strong incentive for continuous integrated biomanufacturing is the improved economics compared to traditional batch wise biomanufacturing. The floor space and the size of unit operations are substantially smaller than in batch. This size reduction allows consequent implementation of single use technology, because single use equipment is not available at large scale biomanufacturing, e.g. reactor volumes above 2000 L or columns bigger than 100 L. However, a point often overlooked is that this transformation only “shrinks” the unit operations itself, while the necessary auxiliaries such as hold tanks, surge vessels and demand of process materials are unchanged or even drastically increased. Hence, the supply chain is facing an increase in demand of process materials and the necessity of handling significantly larger volumes. Media and buffer are always prepared in excess to mitigate the risk of failure for a campaign by running out of it. On a company level, but even more on a global level, this is an enormous waste of resources. We have previously shown that the water consumption is the major contribution to energy demand and CO_2 emissions in a bioprocess. This link is described by the so-called metric WARIEN (WAter Related Impact of ENergy), which is also related to the metric PMI (Process Mass Intensity). The reduction and optimization of water consumption bears the highest potential to improve the environmental footprint of biomanufacturing, by reduction of energy consumption and CO_2 emission. Here we show a single use device to continuously reconstitute chemically defined media on-demand and buffers directly from solids resulting in the same quality as by conventional batchwise preparation (Figure 1). The long-term operation over a duration of 12 hours demonstrated that such on-demand medium product is robust and precise. This technology with on-demand reconstitution directly from solids will make the repeated preparation of cell culture media and buffers and intermediate hold tanks obsolete which contributes significantly to the reduction of needed floor space. We present an economic and environmental analysis how the on-demand production improves economic and environmental footprint. This is exemplified by manufacturing of antibodies enzymes, hormones and growth factors. Preliminary economic analysis based on Biosolve and SuperPro models that were already built from data coming from the industry the amount of expenses that would be saved yearly on a global scale only by saving medium and buffer is almost 2.8 billion $ if we assume that 20% extra buffer is prepared for each of the bioprocess considered. This number is probably an overestimate but it's just to demonstrate the potential and impact of this technology. The savings by reduction the floorspace are not take into consideration by this economic evaluation. The single use technology and process intensification towards integrated continuous biomanufacturing is a perfect marriage get improved sustainability of biomanufacturing.

Figure 1 – (A) 3D printed single use device for feeding of dry powdered medium or buffer with its (B) top-, (C) front-, (D) and side view.