Introduction to DSP – Harvesting

Your Objectives:

At the end of the lesson, you should be able to sequence the steps of harvesting.

Harvesting

Cell _____ is a critical step in connecting upstream monoclonal antibody production with downstream purification. Selecting the _____ cell harvesting technology based on the characteristics of the cell culture process can be challenging. This decision is made early on in process development; a sound understanding of the current process, as well as of the _____ and cons of the various cell harvesting _____ available, is required.

Companies will take decisions as to which harvesting technique best suits their own process, and as to which variables would be preferential for _____.

The selected harvesting method and equipment depends on (1) the type of cells, (2) product being harvested, and (3) properties of the process fluids. Traditional (standard) techniques include **membrane microfiltration, tangential-flow filtration** (TFF, or crossflow filtration), _____, and **depth filtration**, as well as specialized solutions that are to be coupled with either microfiltration or centrifugation with TFF or then with depth filtration.

Centrifugation

Disc-stack centrifugation (e.g. from Alfa Laval Inc. or Westfalia Separator Group Ltd.) has been in use for [ ] harvesting for some time. A disc-stack centrifuge uses [ ], inclined conical discs to separate out whole cells and large cell debris.

Shearing, however, can [ ] cells and thereby increase the number of submicron particles, particles which cannot be removed. Instead, low-shear systems and techniques coupled with second-stage depth filtration is especially useful. The use of depth filtration can [ ] further clarification, removing [ ] solid particulates.

Filtration

The bioprocess industry adopted membrane clarification (purification) methods from other technologies; but it has also [ ] modules specifically designed for biopharmaceutical purposes, including for primary clarification of fermentation and cell-culture systems. When a membrane technique is [ ], the size and fouling potential of the membrane is considered.

Microfiltration is [ ] sensitive to changes in feedstock quality such as cell culture viability, cell density, and medium components. High cell densities and low cell viabilities can result in high **transmembrane pressure** ([ ]) for constant-flux membranes, the extent to which depends on the scale of the feed batch. TMP is relatively lower for typical cross-flow (TFF) microfiltration operations (MF–TFF). The

[ ] of feed solution across the membrane reduces concentration polarization and creates a pressure drop, forcing a size-exclusion condition. Such [ ] are currently available with various pore sizes, typically between 0.1µm and 1µm for primary harvest (e.g. EMD Millipore's ProStak system and PallSep Biotech from Pall Corporation).

Depth filtration retains particles, both larger and smaller [ ] their pore size, throughout their porous media. Particle retention involve both size exclusion and adsorption through hydrophobic and ionic (as well as other) interactions.

[ ] filtration provides some benefits, but is not without its limitations.

Commercially available technologies include filter sheets (Seitz depth filter sheets by Pall Corporation); encapsulated modules (*Supracap* 200, by Pall Inc.); and disposable, scalable formats (e.g. *Millistak+* pod depth filter media by Emanuel Merck, Darmstadt Millipore).

Cell separation using depth filters

Benefits

- Low material and hardware costs
- Ease of use
- Fast process [ ]
- High flexibility from scale-up options (e.g. for multiproduct facilities)
- Filtration with minimal shearing forces so as to offer cell and product protection
- [ ] approved materials
- High-quality of filtrate
- Space-savings equipment

Disadvantages

- Necessity of monitoring differential pressure
- [ ] for conducting economic evaluation at all stages?
- Necessity of the removal and disposal of filters
- Scale-up limitations like budget limits or infrastructural limits

Tangential-flow filtration: Methods for harvesting small-scale [ ] may not work for process scales of between 10,000 and 20,000 litres. As Ian Sellick observed, "Handling requirements for such large [ ] call for employing larger and more continuous types of processing systems, often some form of TFF". TFF is [ ] for fine-sized-based separations since it retains particulates and other molecules too large to pass through its membrane pores, and are transported [ ] the tangential flow.

TFF configurations include both cassettes (flat) as well as hollow-fibre formats. In his article, Sellick describes a compact TFF cassette device that uses polyethersulfone (PES) membranes and screens to form [ ] flow paths that prevent product channelling (which occurs when membrane surface area is not fully used and the feed channels to the retentate). He also describes enhanced hollow-fibre [ ] for cell perfusion that will have used a nonbinding polyvinylidene difluoride (PVDF). Disposable, pre-sanitized TFF cassettes provide several benefits over many traditional cassette formats, including cost-savings, lower [ ] of cross contamination, and greater manufacturing flexibility.

Source: https://bioprocessintl.com/downstream-processing/chromatography/a-decade-of-harvesting-methods-331186/

Notabene: "e.g." = one of other examples (zum Beispiel) / "i.e." = namely (sprich, nämlich, das heisst)

Optimisation

[ ] have been made to correlate the characteristics of a cell culture (e.g. viability, density) and the efficiency of a harvest process. In one study of a high cell density culture, the [ ] of the primary recovery depended on cell density and cell viability. High cell densities and low viabilities result in larger numbers of whole cells and solid [ ] such as colloids and cell debris. High **titres*** typically generate from conditions of high cell densities and low viability. Using **turbidity** as a [ ] for product quality, researchers demonstrated a linear correlation between cell culture viability and clarification efficiency [ ] a given centrifugation condition. Their [ ] also showed that higher feed rates lowered clarification because of lower centrifuge residence times and that the correlations for the centrifuge were the same as those [ ] for the subsequent depth filtration step.

The increasing use of single-use technologies in upstream processes may [ ] a shift in harvest strategies. With traditional **fed-batch culture** processes, harvest clarification is usually achieved by centrifugation followed by depth filtration. For processes based entirely on disposables, the disc-stack centrifuge needs to be [ ] by filtration alone".

* **Titre**: (US: titer) = concentration of a solution determined by titration, the minimum volume of a solution needed to reach the end point in a titration; the concentration of an antibody, as determined [ ] finding the highest dilution at which it is still able to cause agglutination of the antigen.

Scale Challenges

The current trend towards a **small-scale** batch process will necessitate primary recovery techniques that can provide quick [ ]. A system of glass-fibre filters, coupled with a retentive membrane to provide "a rapid solution that can be implemented with very little preparation," might be used. Glass-fibre and polyethersulfone [ ] are inherently low in extractables and have been validated for low levels of endotoxin and other contaminants. They are steam sterilizable and are compatible with gamma irradiation, enabling pressure sterilization with [ ] method.

TFF and centrifuge–depth filtration are [ ] methods for harvesting **large-scale** batches. Process transfer, however, sometimes requires alternative, streamlined approaches. A *Genentech* study evaluated various dual-layer, single-stage depth filter media to [ ] an alternative to its traditional two-stage depth filtration train to be used at a separate facility. The work involved [ ] at various turbidities, [ ] in a system that demonstrated increased capacity at all levels without significant plugging of the internal pore structure of the depth filters. Researchers further suggest that "one key to increasing future depth-filter capacity may (…) be to control particulate clustering (…) or modulate flow rate to [ ] or exploit critical shear thresholds within a depth filter."

High-density cell cultures

As [ ] increased during this past decade, so too did the importance of efficient product recovery methods. With monoclonal [ ] titers reaching ~25 g/L and the expectation of even greater values in the future, clarification of high-density cell cultures will present unique challenges to [ ]. Ever-increasing amounts of cell debris will need to be removed quickly [ ] prevent bottlenecks in downstream processes.

Aufgabe Lückentext:

Folgende Wörter bitte in den Lückentext einfüllen.
Jedes Wort kommt einmal vor.
Bitte Gross- und Kleinbuchstaben beachten.

along, antibody, avoid, best, batches, bioreactors, biomanufacturers, by, cell, centrifugation, damage, Depth, developed, diagonal, Efforts, either, FDA, find, for, filters, flow, harvesting, highly, impurities, marker, membranes, modules, Need, provide, pros, quality, replaced, require, resulting, results, risk, shown, smaller, suitable, stacked, technologies, testing, than, them, to, titres, times, TMP, turnarounds, typical, used,