SPF Technologies

Introduction to Ultra-Thin Channel Filtration (UTF)

Gastón de los Reyes | gaston.de.los.reyes@spftechnologies.com | +1-617-283-5036

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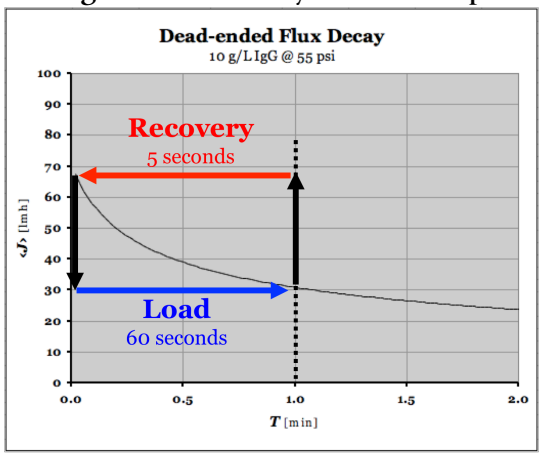
UTF is a new modality for the concentration of biomolecules and buffer exchange by ultrafiltration. It relies on *dead-ended* filtration to deliberately build a concentrated boundary layer on the surface of the membrane – in that sense, it can be thought of as the anti-TFF. Once the boundary layer is built it is removed from the channel by a combination of reverse permeation and displacement with the feed stream. It is, therefore, a repetitive cycling process.

The UTF Concentration Process comprises two steps executed continuously in rapid succession:

1. Loading: the feed stream is loaded into the UTF channels in dead-ended mode, building the boundary layer on the surface of the membrane.
2. Recovery: the boundary layer is removed by a combination of *reverse permeation* and displacement with the feed stream.

These two steps – Loading & Recovery – are repeated every 30~120 seconds, e.g., Loading for 60 seconds and Recovery taking 5 seconds.

Figure 1: Flux Decay and UTF Steps



As expected, the instantaneous flux during the loading step decreases with time. However, once the boundary layer is removed, the flux recovers fully for the next cycle, delivering a high average stable flux for the duration of the process.

Since the permeation flux – the productivity – of an ultrafiltration membrane in dead-ended mode decreases with time, the UTF process requires *thin channels* to obtain a practical flux: at the end of the Load Step the boundary layer almost completely fills the channel. UTF channels are microfluidic channels with channel heights on the order of 50~100 µm.

UTF can also be used for buffer exchange. In this case the UTF Process comprises an additional Washing Step between the Load and Recovery steps. After the boundary layer is built during the Load Step, a wash buffer is fed to the UTF channel to displace the feed buffer *through* the concentrated boundary layer.

Similarly to Single-pass TFF, the UTF modality is a single-pass process with all the advantages of single-pass operation: simpler system and low residence time (low protein exposure time). However, in contrast to Single-pass TFF, UTF processes are simpler having only a single degree of freedom – the load time. Furthermore, UTF modules are more versatile than Single-pass TFF modules – the same UTF module can be used for many applications.

The UTF module and process are covered by US Patent 9,511,326 "Cycling ultra-thin channel filtration" and pending international patents.