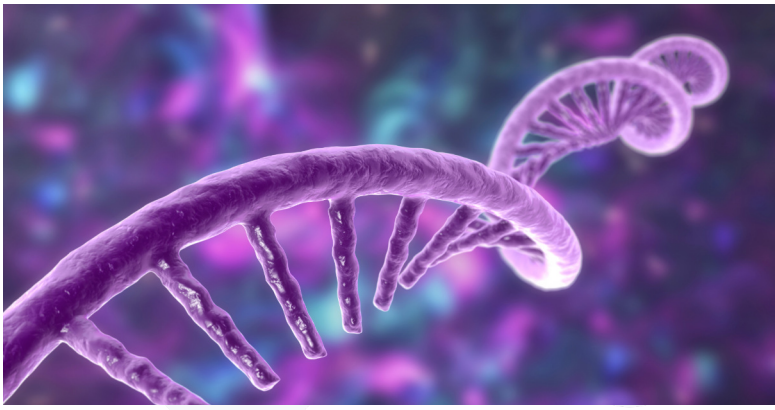
Single-Pass VMF: mRNA Concentration

SANI Membranes

Single-Pass, Continuous Concentration of mRNA Using Vibro® Membrane Filtration (VMF)

Single-Pass VMF significantly enhances the performance of single-pass membrane filtration in the downstream concentration and purification of mRNA constructs. It provides > 3× the sustainable flux rates reported for conventional TFF, enabling efficient single-pass continuous concentration and purification at high concentration factors within a single module.



Intensified Downstream mRNA Processing With Vibro®

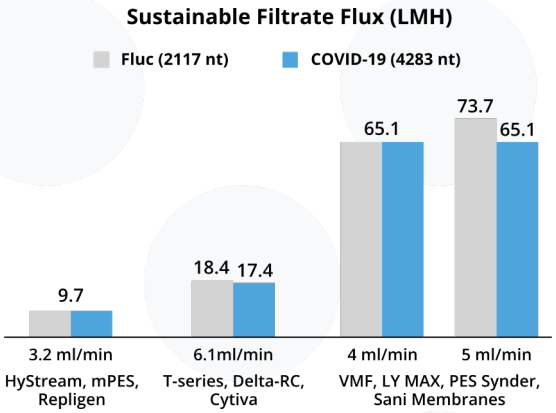
Conventionally, single-pass tangential flow filtration of mRNA requires very low flux rates to allow stable operation. VMF, however, uses vibrations to mitigate fouling and can thus operate at much higher flux rates, enabling efficient concentration and purification of mRNA in a compact design. This study concludes that it would be possible to process **100 L of in vitro transcription (IVT) crude in 24 h** with **< 0.1 m² of membrane area** – demonstrating VMF's huge potential for intensified, continuous processing.

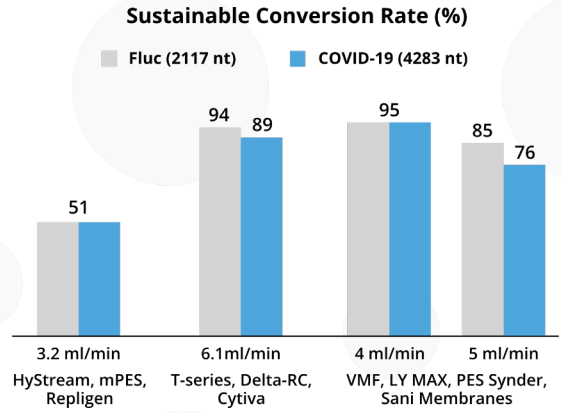
> 3× Sustainable Flux Compared to Conventional TFF

In flux stepping experiments, a 35 cm² VMF unit showed:

- **4 ml/min feed flow:** Sustainable flux of 65.1 LMH at a conversion rate of 95% / 20× concentration for two different mRNA constructs
- **5 ml/min feed flow, Fluc (2117 nucleotides):** Sustainable flux of 73.7 LMH at a conversion rate of 85% / 6.67× concentration
- **5 ml/min feed flow, Covid-19 (4283 nucleotides)** Sustainable flux of 65.1 LMH at a conversion rate of 76% / 4.17× concentration

This corresponds to more **> 3× the sustainable flux** rates conventional systems achieved under similar conditions and better or comparable conversion rates **using less membrane area**.





Figures 1 and 2: *In flux stepping experiments, VMF achieved similar or better results than conventional technologies in another study by Javidanbardan et al. at much higher sustainable flux and thus on less membrane area.*

Read the Article

Ali Behboudi, Amin Javindanbardan, Ziqiao Wang, Luolin Zhou, Andrew L. Zydney: *Vibration-assisted ultrafiltration dramatically improves mRNA purification.* Separation and Purification Technology 363 (2025) 132179.

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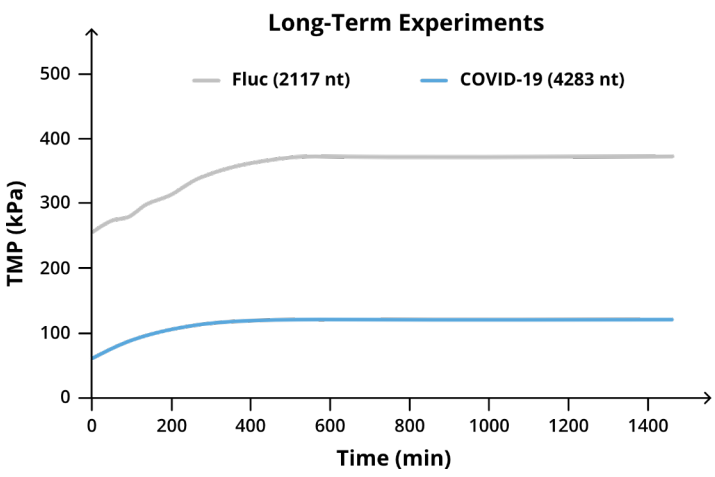
Single-Pass VMF: mRNA Concentration

Stable, Long-Term Process Technology



Extended continuous runs (24 h) confirmed VMF's robustness and high efficiency. At a feed flow of 4 ml/min and flux of 61.7 LMH, intentionally kept slightly below critical flux for long-term operation, VMF demonstrated:

- **90 % conversion / 10× concentration**
- **Stable operation** at low TMP (125 kPa for Fluc / 375 kPa for Covid-19)
- No indication of protein degradation / aggregation

The stable TMP in the last 15 h indicates that much **longer operation may be possible.**

Figure 3: *After an initial slow increase of < 0.25 kPa/min, TMP stabilizes in long-term operation.*

Improved Purification

In addition to concentrating the mRNA, ultrafiltration also serves to reduce any impurities (e.g. RNA polymerase) in the IVT crude. VMF removed **63% of all proteins** for Covid-19 and **88% for Fluc** at a conversion rate of 90%, plus **100% of all residual nucleotides** under all conditions, significantly reducing the burden on later chromatography steps.

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