High power mixing at large scale
An overview of the Xcellerex™ magnetic mixer system

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Abstract

We describe the benefits of the Xcellerex™ magnetic mixer 2000 L and 3000 L systems including experimental results highlighting the ability of the system to deliver high power at large scale and flexibility of use at lower volumes.

Hardware summary

- 2000 L and 3000 L compact systems
- Hexagonal shape
- Configurable hardware with customization
- Integrated 0.75 kW drive unit
- Sloped bottom to maximize recovery
- Insulated double jacket for thermal control
- Optional conductivity, pH and temperature sensing
- Integrated inflation
- Dosing pumps available with remote control
- Automation:
  – Remote control via DCS or SCADA
  – Optional local control with touch screen HMI
  – Siemens PLC
  – OPC UA communication
  – 21 CFR 11 / Annex 11 compliance possible when controlled remotely

2.99 m
2.10 m

Fig 1. Xcellerex magnetic mixer 3000 L system and height in operation.

Powerful mixing

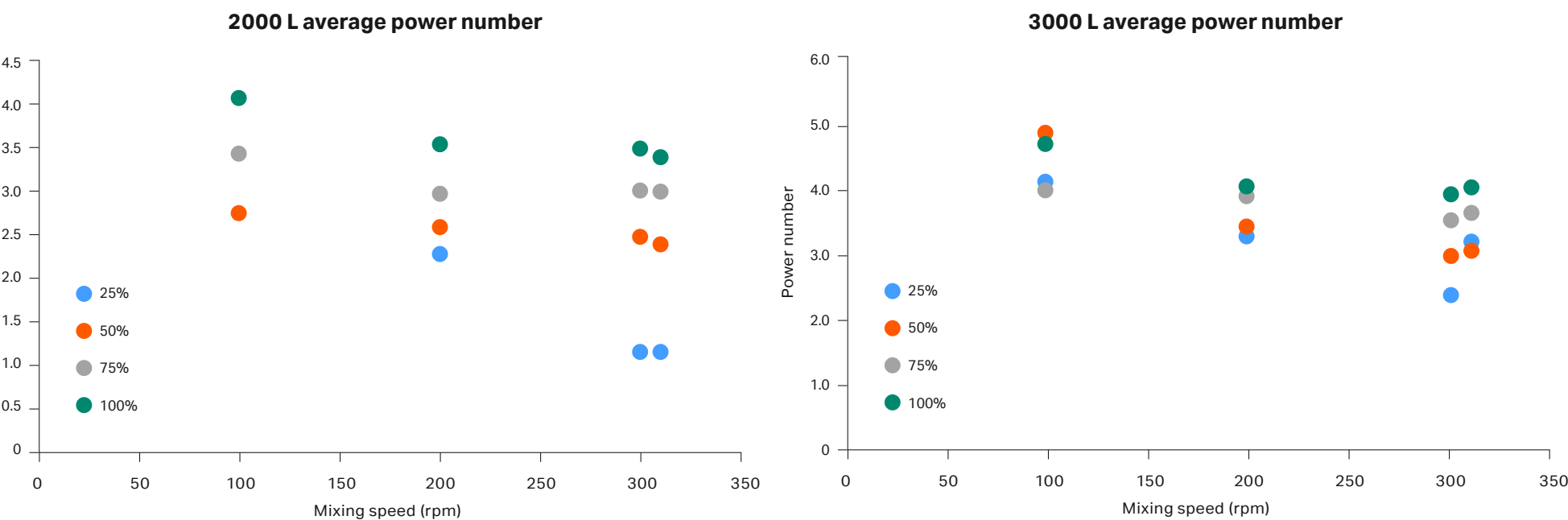Vortex generation at all volumes, ideal for floating powder dissolution

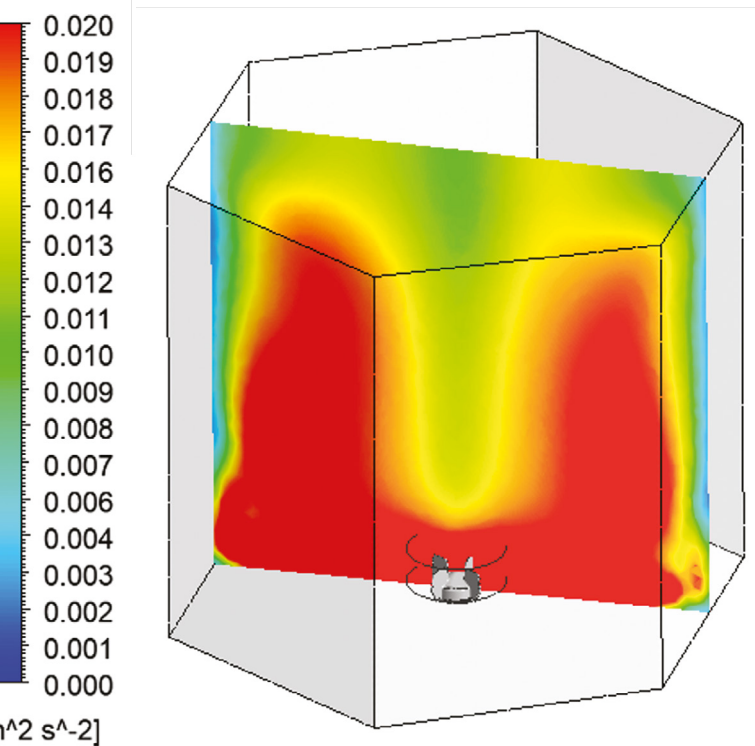**Fig 2.** Calculated power numbers in 2000 L and 3000 L mixing tanks[1].

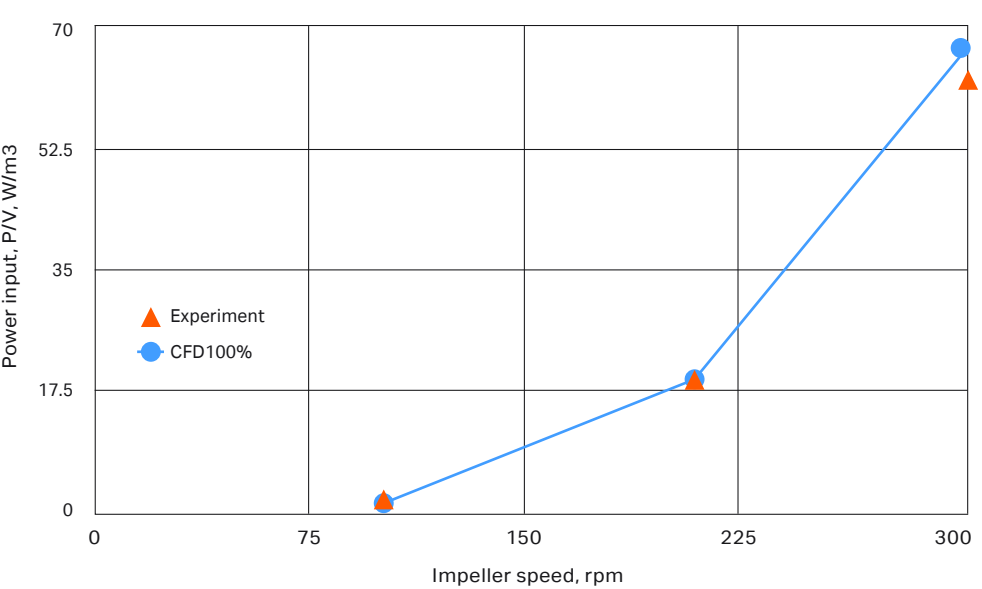**Fig 3.** Time-averaged contour plot of turbulent kinetic energy 3000 L at 310 rpm.

Fig 4. Power input of Xcellerex magnetic mixer 3000 L (Empirical data Vs. CFD).

Single-use summary

- Allegro™ film; low-density polyethylene (LDPE) contact layer
- Single impeller (Figure 7)
- Risk control by design:
  – Rigid base and top-hat protects against damage during shipping and storage (Figure 5)
  – Easy installation to reduce risk of damage and operator error (installation wizard available when using controller) (Figure 6)
- Biocontainer deployment using air inflation
- Standard configurations with customization option
- Single-use inflation set required
- Optional single-use dosing lines available
- Gamma irradiated (25 to 50 kGy)
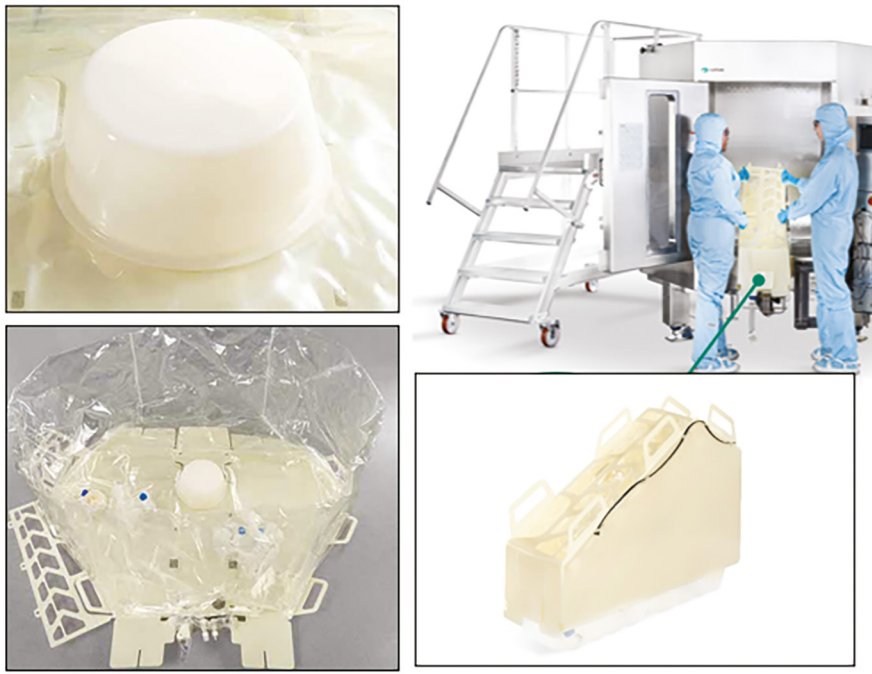- 2-year shelf life
- Regulatory dossier documentation package

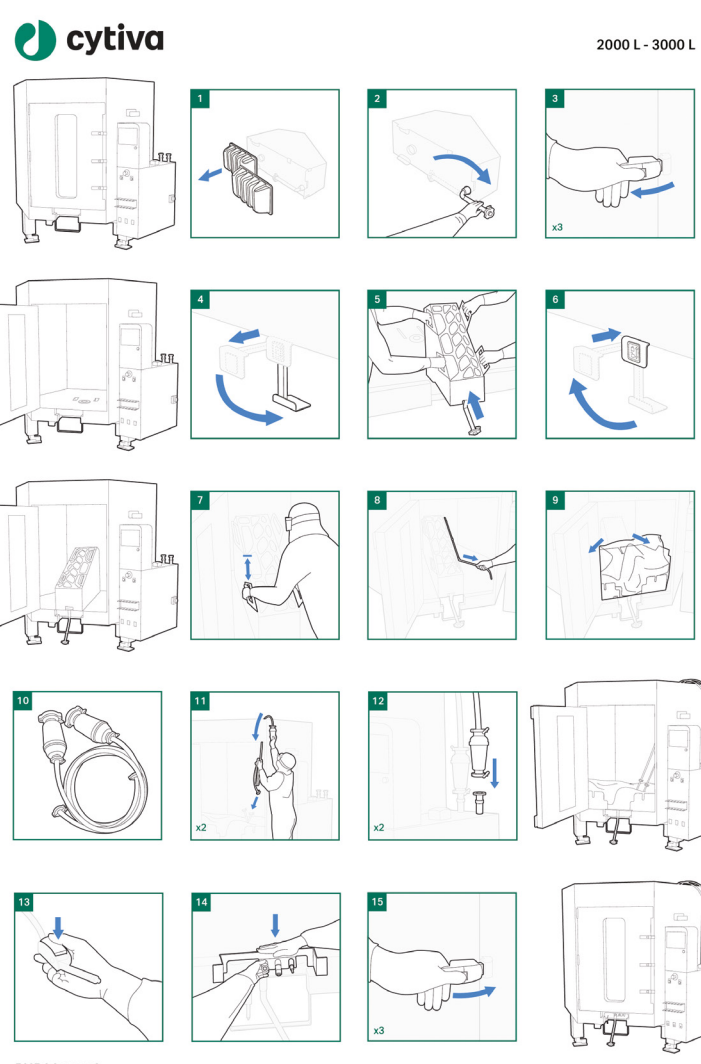
Fig 5. Compact single-use system with top hat.

Fig 6. Instructions for easy installation.

Fig 7. Xcellerex magnetic mixer impeller design.

Performance

Difficult-to-mix media (powder/liquid)

Materials and methods:

3000 L of Tryptic Soy Broth (TSB) at 23.5 g/L were prepared.

- Impeller speed: 310 RPM
- Filling volume prior to powder addition: 90% (2700 L)
- Powder addition time: 17 min
- Powder addition method: Cytiva single-use powder transfer vessels (PTV)

Mixing times:

- Visual: 37 min 52 s (including powder addition)
- $T_{99\%}$ (pH and conductivity): 4 min

Volume flexibility:

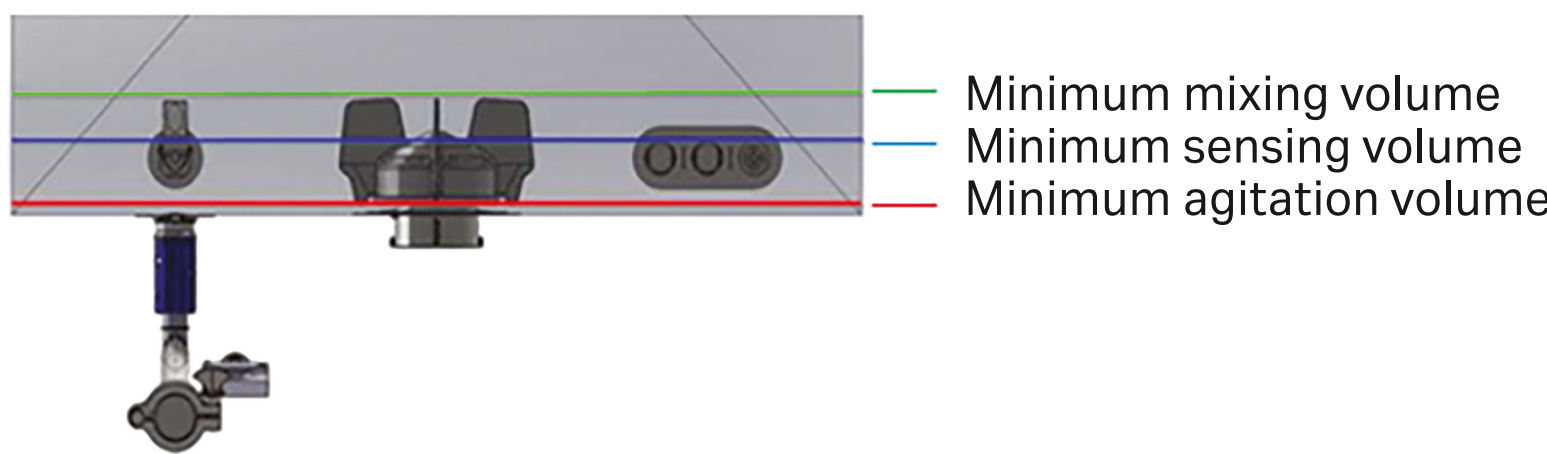The system geometry and impeller design facilitates high turn down ratios

Minimum mixing volume
Minimum sensing volume
Minimum agitation volume

Fig 8. Schematic drawing with minimum operating volumes.

	Xcellerex magnetic mixer system	
Feature	2000 L	3000 L
Minimum agitation volume	26 L	53 L
Minimum sensing volume	76 L	114 L
Minimum mixing volume	258 L	387 L
Residual volume (no manipulation)	<2.5 L	<3.4 L
Residual volume (manipulation)	<0.3 L	<0.3 L

Table 1. Minimum operating volumes in the 2000 L and 3000 L Xcellerex magnetic mixers.
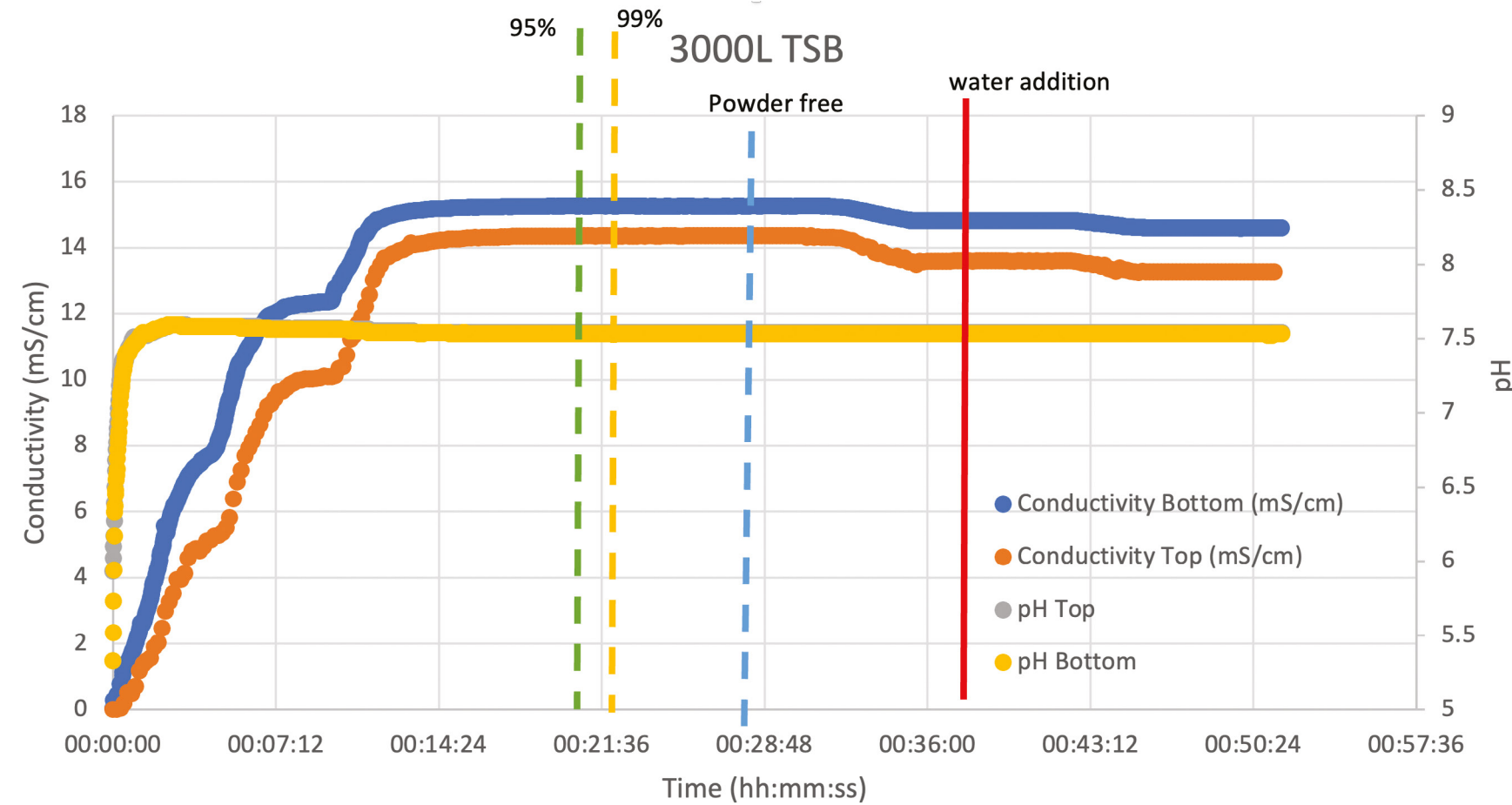

Fig 9. Dissolution of TSB with pH and conductivity data recording.
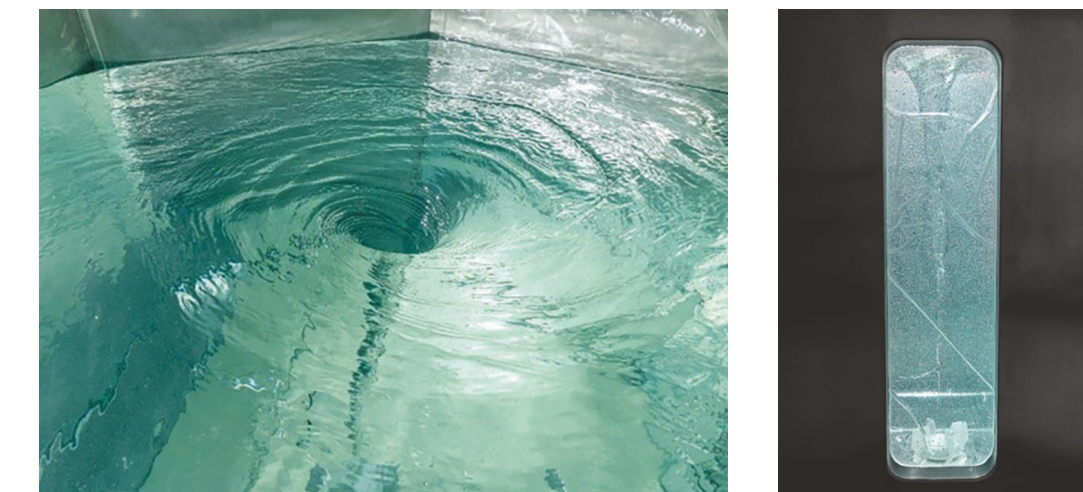
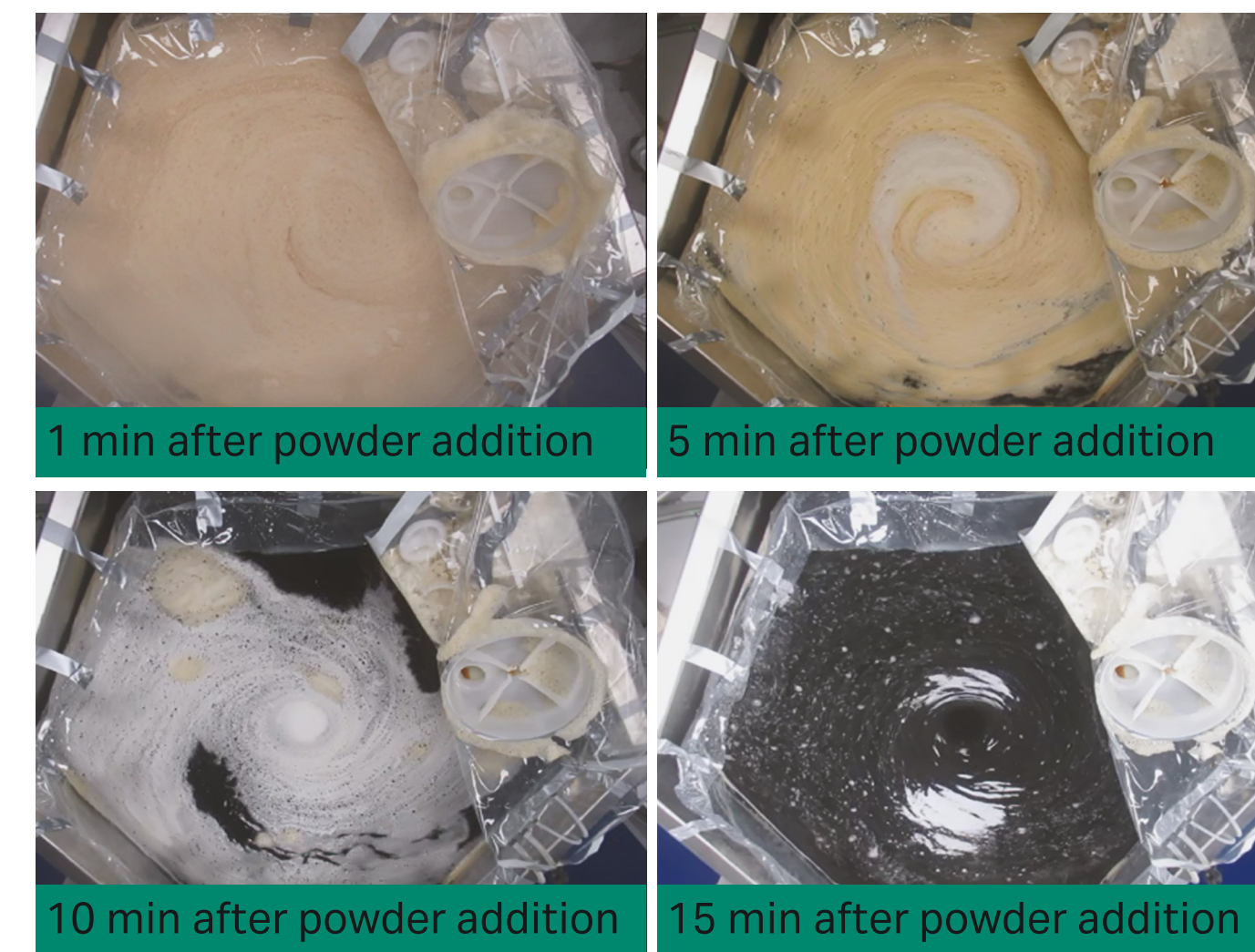**Fig 10.** Vortex formation from top and front view (through system window).

1 min after powder addition
5 min after powder addition
10 min after powder addition
15 min after powder addition

Fig 11. Dissolution of TSB over time with top mixing view and vortex formation.

Conclusions

The Xcellerex magnetic mixer demonstrates powerful mixing up to 3000 L with less than 10% deviation between CFD calculated power numbers and experimental values. The system design also addresses the main existing challenges encountered with mixing at this scale. This includes controlling the risk of leaks through the thoughtful design of the single-use system and attention to the ease of operation to reduce operator errors.

Where currently lab and cleanroom space is a challenge in the industry, the compactness of the Xcellerex magnetic mixer system brings a notable balance between performance, flexibility in operation and overall system size. The balance between height and footprint allows for easy operation within most typical cleanrooms and facilitates flexibility with high turn-down ratios.

1 https://www.cytivalifesciences.com/en/us/solutions/bioprocessing/knowledge-center/determining-the-power-numbers-for-xcellerex-magnetic-mixer

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