

APPLICATION NOTE No. 436

From Shaker to Pilot/Production Bioreactor: How *Scale Up Assist* Using the BioFlo® 720 Bioreactor Control System Can Help Your Antibody Production Workflow.

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Abstract

To transfer the productivity from R&D to production, an effective scale-up strategy is required to ensure the reproducibility of both cell culture growth and antibody yields at large working volumes, ideally with little or no additional optimization. The approach using constant power-input is a successful method for matching bioreactor yields at different scales. This study details the use of the new *Scale Up Assist* feature of the BioFlo 720 Bioreactor Control System to scale CHO batch cultures from 3 L over 10 L stirred-tank, rigid-wall BioBLU® Single-Use Bioreactors (SUBs) to either 50 L or 250 L stirred SUB-bags. Using a built-in constant power software algorithm, the Scale Up

Assist specified what agitation and gassing set points to use for different vessel sizes.

We cultivated Chinese Hamster Ovary cells (CHO) using BioBLU Single-Use Bioreactors and Thermo Scientific™ HyPerforma™ 50 L and 250 L SUBs. Our results demonstrated that the parameters provided by the new Scale Up Assist software resulted in similar cell growth and monoclonal antibody (mAb) production yields for all three vessel sizes. Adoption of the controller's Scale Up Assist function can decrease process development time while also helping to ensure consistent mAb yields across vessel sizes and bioreactor platforms.

Introduction

Bioprocess development is often done at small or bench scale to save production costs, optimize ideal conditions for cultures, and shorten time to market.

An effective strategy is required during scale-up to ensure matching cell growth in cultures and similar mAb or other protein production yields from small, bench, and pilot scale. However, sometimes these strategies to scale-up cell culture processes are not as straightforward as we would like.

Many strategies have been established to streamline the scale-up of protein and mAb production. These strategies

include keeping a constant tip speed across bioreactors, matching oxygen volumetric mass transfer coefficients ($k_L a$), and maintaining constant impeller power per unit volume (P/V). We have previously utilized the Constant Power approach, manually calculated, for scale-up in both fermentation [1] and cell culture [10] applications. This method involves calculating impeller power dissipation per unit volume using Equation 1:

$$P/V = \frac{Np \times \rho \times N^3 \times d^5}{V}$$

N_p is the dimensionless impeller power number or Newton number [2], ρ is the density of water (kg/m^3), N is the impeller speed (rps), d the impeller outer diameter (m), and V is the working volume of the culture (m^3). This strategy has proven to be an effective method to maintain similar bioreactor yields from bench to pilot scale.

Our goal was to test the constant P/V based on the Scale Up Assist feature to automatically match mAb production yields from our CHO culture using BioFlo 320 and BioFlo 720 bioreactor control systems. The BioFlo 720 is a new bioprocess controller that is compatible with Thermo Scientific's existing line of SUBs. This controller introduces an innovative new feature termed *Scale Up Assist*, a built-in software algorithm that automatically calculates controller set-points for bioreactor/process setup. This greatly simplifies the process of scaling-up bioreactor mAb production processes. We used the new *Scale Up Assist* feature to successfully scale our CHO culture from 3 L to 10 L BioBLU bioreactors, and from 10 L to 50 L SUB, and from 10 L to 250 L SUB.

To succeed in bioreactor scale-up a healthy and robust inoculum is needed. We used the Eppendorf New Brunswick S41i CO_2 Incubator Shaker to prepare the initial suspension CHO inoculum, and seeded our bioreactor with log-phase cells at the highest quality level, > 98.9 % viability.

Furthermore, an economical way for medium preparation supports an effective mAb production. We used a novel method consisting of a modified BioBLU 50c Single-Use Vessel, which yielded substantial savings in both costs and resources such as additional equipment needs.

Materials and Methods

In these experiments, we used the BioFlo 720 Scale Up Assist to calculate the process parameters needed to scale-up from 3 L to 10 L and from 10 L to either 50 L or 250 L. We cultured our CHO cells using the BioFlo 320 and BioFlo 720 bioreactor control systems (Appendix Table 1A and B).

Procedure / mAb Production Workflow

mAb Production workflow overview

Our workflow begins when we thaw our cells. This can typically take less than a day between flask and media preparations to introducing the cells into their new environment in the incubator (Figure 1).

We then move ahead to routine passaging and seed train or flask culture scale up. This step in our workflow can typically take anywhere from 2 to 3 weeks of culturing depending on the inoculation density we are targeting (Figure 1).

Lastly, we focus on our bioreactor process. The bioreactor phase of our workflow can vary depending on our bioprocess procedure. For example, our batch run typically lasts a week, our fed-batch runs can last 2 to 3 weeks and our perfusion can be three or more weeks long. For these experiments, we chose batch runs.

Now that our cell culture bioprocess workflow has been defined, we will break down each step further for each batch run in our experiments.

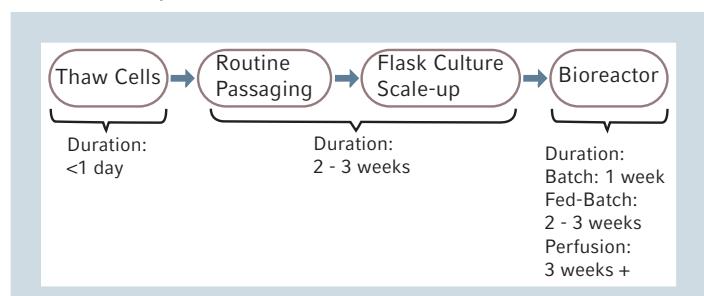


Fig. 1: Overview of a typical cell culture mAb production workflow

Thawing cells: Inoculum

For all experiments, we used a proprietary suspension CHO cell line producing a human monoclonal antibody (hmAb) from TPG Biologics, Inc., cultivated in Dynamis™ AGT™ Medium (Thermo Fisher Scientific®). The medium was supplemented with 8 mM L-glutamine, 1 % Antibiotic Antimycotic solution, and 1 % Gibco® Anti-Clumping Agent (Thermo Fisher Scientific) for a complete medium [3].

We prepared our cell culture inoculum by cultivating our cells in single-use, baffled bottom shake flasks (Corning®) with a 20 % maximum fill volume. We first thawed our cells from a previously cryopreserved vial and inoculated them into a 125 mL flask at a seeding density of 3×10^5 cells/mL. After our shake flask was seeded, we placed it into our New Brunswick S41i CO_2 Incubator Shaker. We set our shaking speed to 125 rpm and our CO_2 to 8 %.

Achieve the perfect inoculum!

A critical aspect to designing any cell culture bioprocess, especially regarding scale-up, is to achieve matching growth curves and production yields from shaker to pilot scale.

Reducing shock factors such as temperature fluctuations can greatly reduce negative impact on your culture.

The New Brunswick S41i CO₂ Incubator Shaker combines precise temperature and CO₂ control with one of the best laboratory shakers available, resulting in high cell yields and viability (Figure 2).

An important feature of the S41i is the high temperature disinfection option. With a few simple clicks, your shaking incubator is clean and ready to go for your next bioprocessing challenge!



Fig. 2: New Brunswick S41i CO₂ Incubator Shaker

Routine passaging and seed train/flask culture scale-up workflow

After the initial thaw we allowed our cells to grow for a few passages before scale-up, in order to acclimate them to their environment. We determined that under our conditions the optimal passage schedule is every other day. After monitoring our cell growth and viability (determined to be >95 %), we increased our culture volume from 125 mL to 250 mL, and finally, to 1 L shake flasks. During this scale-up, flask inoculation density, percentage fill and other parameters remained the same. Using this culture method, each bioreactor in this experiment was inoculated with cells that were approximately at the same passage and duration of the culture post-thaw [3].

For each experiment, the number of flasks per scale-up step varied, based on the amount required for optimal target inoculation and working volume of each bioreactor. For all experiments, our target inoculation density was 5×10⁵ cells/mL. We also prepared additional extra flasks in case of suboptimal performance. After enough cells were obtained, we took the amount of culture that was needed from our 1 L flasks and combined them into a 2 L addition bottle (Eppendorf) that was prepared and autoclaved. We used this bottle method to inoculate our BioBLU 3c and 10c Single-Use Bioreactor.

For our 50 L SUB run, we needed a larger volume of inoculum. To reach this goal, we inoculated a BioBLU 10c Single-Use Vessel with a working volume of 10 L. Once growth in our bioreactor reached approximately 2×10⁶ cells/mL, we then welded our harvest line on to our BioBLU 10c and inoculated our 50 L SUB (Figure 3).

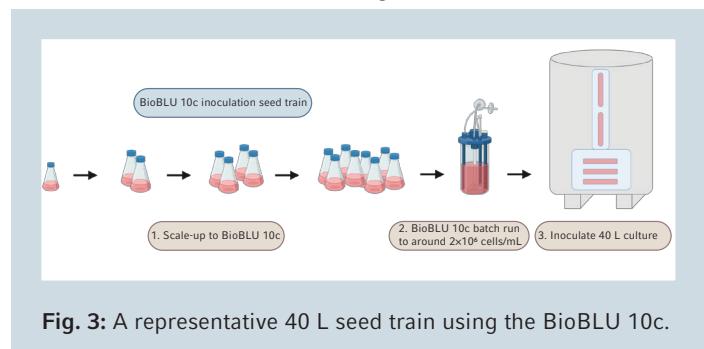


Fig. 3: A representative 40 L seed train using the BioBLU 10c.

Our scale-up seed train strategy used for the 40 L run can be applied to larger vessel sizes. By seeding a BioBLU 10c vessel and allowing culture density to reach approximately 2×10⁶ cells/mL, we were able to inoculate our 50 L SUB, with a working volume of 40 L, at 0.5×10⁶ cells/mL.

For our 250 L run, we followed a similar seed train process flow by inoculating 2x BioBLU 10c's to reach enough cell density to inoculate our 250 L SUB with a working volume of 150 L.

Using this approach, we could inoculate the 500 L vessels in a similar seed train process flow (Figure 4). For example, to inoculate a 500 L run, we would prepare our initial culture in our S41i shaker. We would then scale-up our flask culture to inoculate a BioBLU 10c vessel. We would allow our culture to grow for a few days to achieve the calculated density needed to inoculate a 50 L SUB. We could then incorporate our 50 L SUB culture into our seed train by allowing the culture to grow for an additional few days to reach a high enough density to inoculate our 500 L SUB run.

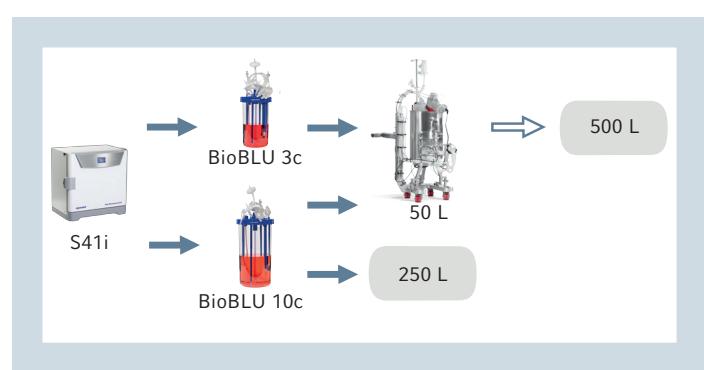


Fig. 4: Seed train strategy for larger vessels.

Bioreactor control and process parameters

Vessels

The BioBLU 3c and 10c Single-Use Vessels were operated by a BioFlo 320 bioprocess controller. Our BioFlo 320 was also used at the 10 L-scale to prepare the amount of inoculum needed for the 40 L culture. The BioFlo 320 controller was set up according to the previously published application note [4].

A Thermo Scientific HyPerforma 50 L Outer Support Container was used for the 40 L CHO culture and was controlled by the BioFlo 720 bioprocess control system. A LAUDA® VC1200 water-cooled temperature control unit (TCU) was connected to the support container to provide heating to the jacket.

For our 250 L SUB run, a Thermo Scientific HyPerforma 250 L Outer Support Container and a LAUDA VC2000 TCU was used.

We used a Thermo Scientific HyPerforma 50 L and 250 L Bioprocess Container (BPC) with a 5:1 turndown ratio and drilled hole sparger (DHS) for our CHO cultures. Our internal BPC pressure was measured using a PendoTECH® Single Use Pressure Sensor™ and monitored by our BioFlo 720 bioprocess controller.

50 L and 250 L SUB preparation and bag inflation

The Thermo Scientific BPC was inflated using the BioFlo 720's *Auto Inflate* software feature. The auto inflation function automatically introduces a specified amount of air into the BPC until it is fully inflated. The *Auto Inflate* program also has a built-in safety feature that will automatically shut down all gases in the event of high pressure being detected in the bag. Our pressure sensors were connected before inserting the bag into the outer support container by using the aseptic pressure sensor connector (Thermo Scientific).

Media filling process

Sterile medium was pumped into the BioBLU 3c and 10c vessels directly through a top addition line by welding onto the addition line with a Terumo tube welder and using one of the pumps located on the BioFlo 320 control station.

Prepared medium was pumped into the 50 L and 250 L BPC through their top addition line using the 520R2 pump head integrated on the BioFlo 720 cabinet. The medium for our 50 L SUB run was sterilized by pumping it through Polycap TC filters after being prepared as described above. After 30 L were pumped into the 50 L BPC, we switched on the temperature loop to warm the medium at 37°C for a minimum of 12 hours prior to inoculation.

For our 250 L run, we sterilized our medium by pumping it through Durapore Opticap XL capsule filters. We filtered 130 L of medium and allowed for the medium to warm for a minimum of 12 hours prior to inoculation, as described for our 50 L run. We volume adjusted our vessels accordingly based on our inoculation density and desired working volume of our vessels.

Process parameters for all runs

For all cultures, we measured dissolved oxygen (DO) by using Mettler Toledo® ISM® DO sensors. Our DO setpoint was set to 50 % for all experiments and was controlled at setpoint using 3 - gas auto mixing (Table 1). The P and I values selected for these experiments were optimized by using a dissolved oxygen simulation as previously described [8].

Table 1: Overview of process configurations and setpoints for all cell culture runs.

| Parameters | Setpoints | | | |
|----------------------------|--|-----------------------|---------------------------|-------------------------|
| | 3c | 10c | 50 L | 250 L |
| Controller | BioFlo 320 | BioFlo 320 | BioFlo 720 | BioFlo 720 |
| Working volume | 3 L | 10 L | 40 L | 150 L |
| Agitation | 151 rpm | 126 rpm | 169 rpm | 99 rpm |
| Temperature | | | 37 °C | |
| DO Sensor | | polarographic sensor | | |
| DO Setpoint | 50 %, (P= 2; I= 0.09) | 50 %, (P= 2; I= 0.09) | 50 %, (P= 2.5; I= 0.09) | 50 % DO, (P= 1; I= 0.1) |
| pH Sensor | potentiometric sensor | | | |
| pH Setpoint | 7.0 (deadband = 0.1), cascade to CO ₂ (acid), cascade to 0.45 M sodium bicarbonate (base) | | | |
| Target Inoculation Density | 0.5 x 10 ⁶ cells/ mL | | | |
| Gas strategy | 3 – gas auto mixing | | | |
| Gassing range | 0.04 SLPM – 1 SLPM | 0.04 SLPM – 1 SLPM | 0.04 SLPM – 13.33 SLPM | 0.04 SLPM – 50 SLPM |

We used an analog pH sensor for all of our experiments. Our pH setpoint was set to 7.0 with a deadband of 0.1 and was controlled via a cascade to CO₂ (acid) and 0.45 M sodium bicarbonate (base). For our 3 L culture, we sterilized our pH sensor after calibration in a sterilizing pouch and inserted the sensor aseptically into a spare Pg 13.5 port on the BioBLU 3c vessel in our Biosafety cabinet. Our pH sensor was calibrated based on the protocol in the BioFlo 320 manual [5]. For the 50 L and 250 L culture, all sensors were inserted into probe assembly sleeves (Thermo Scientific) and

autoclaved. The sensors were then inserted into the BPCs via the front sensor quick connectors, after inflation but prior to liquid filling. DO sensors were calibrated as previously described [6].

Dissolved CO₂ was monitored using a Mettler ISM CO₂ sensor that was also aseptically inserted in the Biosafety cabinet into a spare port on the BioBLU vessels after being sterilized separately. For our 50 L run, the sensor was sterilized using the SUB probe assembly and aseptically inserted into the SUB.

For all experiments, temperature was controlled at 37°C and remained constant for the duration of the runs.

Scale Up Assist feature

The BioFlo 720 bioreactor control system was designed to save time and to mitigate risks. (Figure 5). The well-known BioFlo software has been enriched with a variety of new features to automate the workflow, saving time and simplifying repetitive tasks, such as the Scale Up Assist. Whether scale-up strategy is based on constant P/V or constant tip speed, the Scale Up Assist calculates all critical parameters needed, including gas flow rates and agitation with vessel specific data automatically populated in the software.

Critical parameters for our experiments, including agitation and gas flow rates, were calculated by the new Scale Up Assist function on the BioFlo 720 (Figure 6). We used a constant power/volume (P/V) ratio of 20 for our scale-up calculations. Using this P/V ensured all bioreactors could be operated at reasonable tip speeds for their vessel size and geometry. The power numbers used for these calculations were determined experimentally for our BioBLU vessels in the Eppendorf applications laboratory and were provided



Fig. 5: BioFlo 720 bioprocess control station

Technical Features

In this study, the BioFlo 720's integrated software assistants were used for efficient bioprocess setup. Get to know more about their use for sensor calibration, bag inflation and process scale-up on www.eppendorf.group/bioflo720

by Thermo Scientific for the 50 L and 250 L BPC [7]. These values have been programmed into the BioFlo 720 and are automatically activated when the corresponding vessel is selected in the Scale Up Assist screen (Figure 6).

Sampling and analytics

We took two samples from each bioreactor daily, one in the morning and one in the evening, to check offline values such as cell density, viability, glucose, ammonia (NH₃), lactate, and hmAb concentration. To collect the highest quality sample from the growing culture in our BioBLU bioreactors, we connected a sterile 5 mL syringe to the sample port Luer Lock and removed a dead volume of 3 mL. We then collected a second 3 mL sample in a new syringe to provide a fresh, viable sample for analytics [3].

For our 50 L and 250 L SUB runs, we used sterile 50 mL Labtainer™ BioProcess Container bags as our sampling bags and welded them onto our sampling line using our Terumo tube welder. We first welded on a fresh bag, used to remove a dead volume of 20-30 mL from our sampling

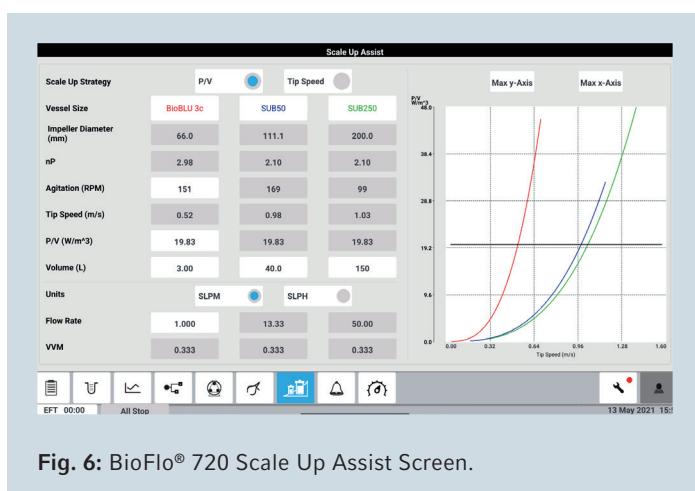


Fig. 6: BioFlo® 720 Scale Up Assist Screen.

line. We then welded this bag off and welded on a new bag to our sampling line. We took roughly the same amount of sample for our cell count and analytics. Lastly, we welded on a final bag so that we could weld off the bag needed for our sampling. This is designated as the next sample time's dead volume bag.

We measured cell density and viability (via the trypan blue exclusion method) using a Vi-Cell® XR Viability Analyzer (Beckman-Coulter®). We confirmed our pH values offline using an Orion Star™ 8211 pH-meter (Thermo Fisher Scientific). Using the offline pH value, we restandardized the pH calibration on the controller daily, to prevent any discrepancy between online and offline measurements. We measured glucose, ammonia, glutamate, lactate, and hMAb using a Cedex® Bio Analyzer (Roche Diagnostics®) [3].

Results

Throughout our experiments, we monitored our metabolic profiles twice a day, to observe how our culture was growing and to intervene if we detected any changes in growth or the health of our cells. Our metabolic profile for our 50 L SUB run is shown in Figure 7 as an example.

The actively growing cultures depleted the initially supplied glucose by day 5. Lactate remained under 2.5 g/L for the duration of the run. Ammonia concentrations rose every day to a toxic level of 10.2 mmol/L by day 6. We reached 164 mg/L of IgG by day 6 (Figure 7).

Cell growth comparisons

The cell growth curves for all four vessel sizes are shown in Figure 8. By using the parameters calculated by the BioFlo 720 Scale Up Assist feature, we were able to match the growth profiles across all platforms in multiple batch runs.

These results demonstrate that the new Scale Up Assist feature can decrease process development time while maintaining cell yields across vessel sizes and bioreactor platforms. Antibody production is shown for all runs in Figure 9.

All of our runs had similar results in IgG production when they reached completion.

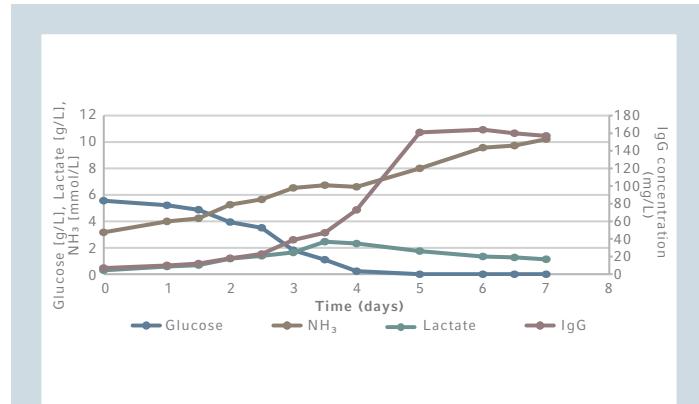


Fig. 7: 40 L run metabolic profile.

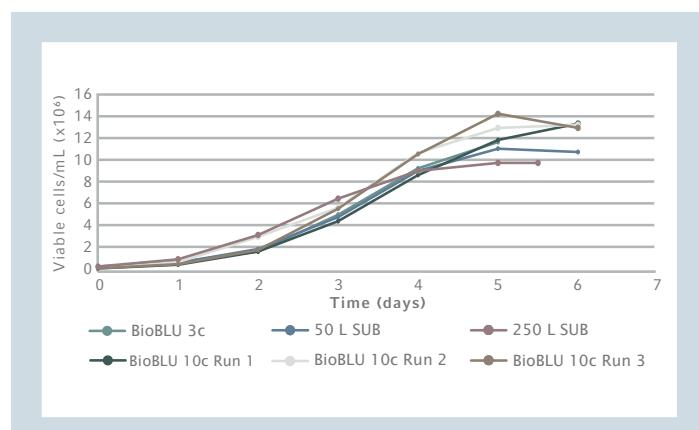


Fig. 8: Cell culture comparison of BioBLU's to 250 L SUB runs.

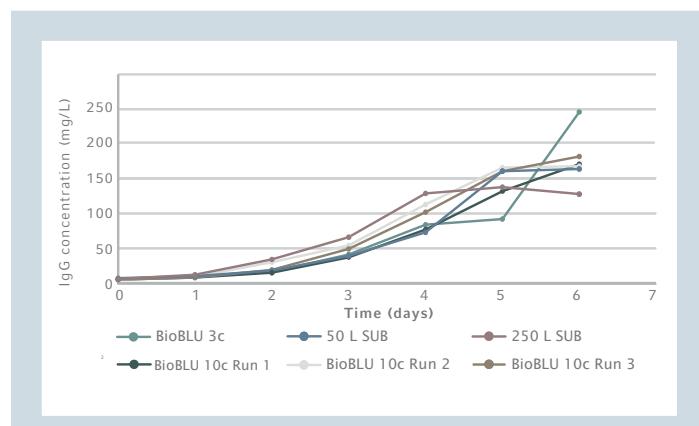


Fig. 9: Antibody production for scale-up runs.

Conclusion

There are several possible strategies for scaling up bioreactor cultures. Matching $\kappa_L a$ coefficients is one method that has been utilized with great success. This method requires extensive measurements of oxygen transfer under several different conditions. Gas flow, agitation, temperature, and bioreactor configuration can all impact $\kappa_L a$ constants and must be taken into account. Matching impeller tip speeds is an option that simplifies the scale-up process. However, this strategy may result in reduced mixing performance in larger vessels [9]. Maintaining constant power is another straightforward scale-up strategy. All that is required is a measurement of vessel power number to calculate Equation 1. Eppendorf and Thermo Scientific have measured the power numbers for a variety of their vessels, simplifying the use of the new Eppendorf Scale Up Assist feature to scale from their Eppendorf bench-scale single-use vessels to Thermo Scientific's pilot and production scale single-use vessels.

The BioFlo 720 Scale Up Assist application is convenient and straight forward to use. The Scale Up Assist feature allows operators to tailor their processes using constant power or tip speed. This allows users to pursue either strategy, or compare them to determine which one works best for their application. Users then select their vessels from the drop-down menus. Vessel characteristics, such as impeller diameter and power numbers, are automatically programmed. These steps are facilitated through a user-defined vessel option that can be manually adapted. The Scale Up Assist then automatically calculates the critical parameters, such as agitation and maximum gassing, to successfully scale their culture from one vessel to another.

In conclusion, we believe that these results demonstrate the effectiveness of the Constant Power strategy. Results that are shown using this strategy, indicate that it is possible to match yields from a 3 L BioBLU vessel to a 250 L Thermo Scientific SUB by way of Scale Up assist without optimization.

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References

- [1] Li, B and Sha, M. Scale-Up of Escherichia coli Fermentation from Small Scale to Pilot Scale Using Eppendorf Fermentation Systems. Eppendorf Application Note 306. 2016.
- [2] Löffelholz C., Husemann U., Greller G., Meusel W., Kauling J., Ay P., Kraume M., Eibl R., Eibl D. "Bioengineering Parameters for Single-Use Bioreactors: Overview and Evaluation of Suitable Methods." Chemie Ingenieur Technik. 85(1-2):40-56. 2013.
- [3] Suttle, A and Sha, M. Next Generation Bioprocess Controller: SciVario twin. The flexible controller for all your bioprocess needs. Eppendorf Application Note 432. 2020.
- [4] Suttle, A and Sha, M. CHO Cell Culture in Eppendorf BioBLU® 10c Single-Use Vessels. Eppendorf Application Note 361. 2018.
- [5] Eppendorf BioFlo 320 Operating Manual, Eppendorf. Inc.
- [6] Willard, S. A Guide to Calibration on the BioFlo® 120 and BioFlo® 320: Dissolved Oxygen Sensors. Eppendorf Short Protocol 40. 2017.
- [7] Fradin, S, Heln, K, and Kewes H. rAAV Production in Suspension. CAP GT® Cells in BioBLU® 3c and 10c Single-Use Vessels. Eppendorf Application Note 407. 2018.
- [8] Longsworth, J, Schillings, N, Ma, S. Dissolved Oxygen Control PID Tuning for Cell Culture Applications. Eppendorf Short Protocol 34. 2020.
- [9] Löffelholz C, Kaiser S.C., Kraume M., Eibl R, Eibl D. "Dynamic Single-Use Bioreactors Used in Modern Liter and m3 Scale Biotechnological Processes: Engineering Characteristics and Scaling Up." Adv Biochem Eng Biotechnol. 138:1-44. 2014.

Appendix

App. Table 1A: Materials and equipment used for all cell culture runs in this study.

| Material/Equipment | Supplier | Order No. |
|--|--------------------------|--------------|
| Cell Line | | |
| Suspension CHO cell line with mAb | TPG Biologics, Inc | Proprietary |
| Cell Biology Workflow | | |
| New Brunswick S41i CO ₂ Incubator Shaker | Eppendorf | S41I120010 |
| 125 mL VWR® Erlenmeyer Flasks, Polycarbonate, baffled, Sterile | VWR International | 89095-262 |
| 250 mL VWR Erlenmeyer Flasks, Polycarbonate, baffled, Sterile | VWR International | 89095-270 |
| 1 L VWR Erlenmeyer Flasks, Polycarbonate, baffled, Sterile | VWR International | 89095-286 |
| Vi-CELL XR Cell Viability Analyzer | Beckman Coulter | 731050 |
| Cedex BIO analyzer | Roche Diagnostics | 06395554001 |
| ThawSTAR® CFT2 Instrument | MedCision® | MCS-601 |
| Orion Star A211 pH meter | Thermo Fisher Scientific | STARA2116 |
| Media Preparations | | |
| BioFlo 120 Bioreactor Control System | Eppendorf | B120ACS008 |
| BioBLU 50c Single-Use Vessel, Macrosparger | Eppendorf | M1363-0129 |
| Dynamis AGT medium | Thermo Fisher Scientific | A2617504 |
| Anti-Clumping Agent | Thermo Fisher Scientific | 0010057DG |
| Antibiotic Antimycotic | Thermo Fisher Scientific | 15240062 |
| L-Glutamine | Thermo Fisher Scientific | 25030164 |
| Polycap TC 36 Capsule Filter, 0.2/0.2 µm, sterile | Cytiva | 6714-3602 |
| C-Flex®, Opaque White, 1/8" ID x 1/4" OD; | Cole Parmer® | EW-06424-67 |
| C-Flex® Tubing, 1/4" ID 3/8" OD | Fisher Scientific | 50-153-9381 |
| Silicone Tubing 1/4" ID 3/8" OD | Eppendorf | M0740-2542 |
| Silicone Tubing 3/16" ID, 5/16" OD | Eppendorf | M0740-2505 |
| 520U/R Pump | Watson-Marlow | 050.7141.10A |

App. Table 1B: Materials and equipment used for all cell culture runs in this study.

| Material/Equipment | Supplier | Order No. |
|--|--------------------------|--------------|
| Bioreactor Workflow | | |
| BioFlo 720 Bioreactor Control System | Eppendorf | 1385200111 |
| BioBLU 3c Single-Use Vessel, Macrosparger | Eppendorf | 1386000300 |
| BioBLU 10c Single-Use Vessel, Macrosparger | Eppendorf | 1386141000 |
| 50 L Single-Use Outer Support Container | Thermo Fisher Scientific | SUB0050.9004 |
| Bioprocess Container (BPC) for HyPerforma™ 5:1 Single-Use Bioreactor | Thermo Fisher Scientific | SH31074.01 |
| Thermo Fisher HyPerforma 50 L Bioprocess Container, 5:1 turn-down ratio, drilled hole sparger | Thermo Fisher Scientific | SH31073.01 |
| Thermo Scientific Labtainer Bio-Process Container (BPC), 50mL with 2 Ports, Luer Lock, 2D BPC | Thermo Scientific | SH3065711 |
| Vi-CELL XR Cell Viability Analyzer | Beckman Coulter | 731050 |
| Cedex BIO analyzer | Roche Diagnostics | 06395554001 |
| Sterile Tube Fuser Dry | Cytiva | 28999602 |
| Terumo SCD® IIB Welder | Terumo BCT | 3NCC986 |
| DO Sensor (ISM), 220 mm | Mettler Toledo | P0720-6653 |
| DO Sensor (ISM), 320 mm | Mettler Toledo | P0720-6654 |
| pH Sensor, 225 mm | Mettler Toledo | P0720-5584 |
| pH Sensor, 325mm | Mettler Toledo | P0720-5580 |
| CO ₂ Sensor (ISM), 220 mm | Mettler Toledo | P0720-6664 |
| 520U/R Pump | Watson-Marlow | 050.7141.10A |
| Sodium Bicarbonate | Fisher Scientific | S631-3 |
| Antifoam C Emulsion | Millipore Sigma | A-8011 |
| Durapore Opticap XL capsule filters - 0.22µm - Length 4 inches – Hydrophilic, Hose Barb Inlet and Outlet | Millipore Sigma | KVGLA04HH3 |
| SUB Probe Assembly | Thermo Scientific | SH30720.02 |
| Aseptic Connector to Pressure Sensor | Thermo Scientific | SH31134.01 |
| PendoTECH® Single Use Pressure Sensor™, 1/4" Hose Barb | Cole Parmer | UX-19406-21 |
| C-Flex, Opaque White, 1/8" ID x 1/4" OD; | Cole Parmer | EW-06424-67 |
| C-Flex Tubing, 1/4" ID 3/8" OD | Fisher Scientific | 50-153-9381 |
| Silicone Tubing 1/4" ID 3/8" OD | Eppendorf | M0740-2542 |
| Silicone Tubing 3/16" ID, 5/16" OD | Eppendorf | M0740-2505 |
| Addition bottle kit, 2 L | Eppendorf | M1362-9902 |
| Addition bottle kit, 5 L | Eppendorf | M1362-9903 |

Ordering information

| Description | Order no. |
|--|------------|
| BioFlo® 720 Control System with 3 integrated Watson-Marlow® 314 peristaltic pumps | 1385200011 |
| BioFlo® 720 Control System with 3 integrated Watson-Marlow® 314 and 2 integrated Watson-Marlow® 520R2 peristaltic pumps | 1385200111 |
| Bioprocess Container (BPC), Thermo Scientific® | |
| 50 L | 0045890089 |
| 100 L | 0045890090 |
| 250 L | 0045890091 |
| Outer Support Container (OSC), Thermo Scientific® | |
| 50 L | 0045890041 |
| 100 L | 0045890044 |
| 250 L | 0045890042 |
| Temperature Control Units (TCU) | |
| TCU VC1200 (Recommended for 50L, 100L) | 0045530001 |
| TCU VC2000 (Recommended for 250L) | 0045530002 |



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