



Deluxe Benchtop Bioprocess Controller

PERFUSION

PRODUCT SUMMARY

.....

The Perfusion Model of our Deluxe Benchtop Bioprocess Controller (BPC) is an innovative solution designed to meet the demands of cell culture applications. Powered by your choice of automation and control software, this controller provides comprehensive regulation and direction for the cell culture process. It offers advanced features with integrated equipment and instrumentation, including precise pH, DO, and temperature control, accurate gas mixing through mass flow controllers and agitation, and precise liquid delivery with variable speed pumps with totalizer and dosing capabilities. With the addition of ATF control, the system ensures dynamic management of retentate flow, optimizing the overall cell culture process. The open-architecture mechanical design and flexible hardware options ensure seamless integration and customizable operating ranges to meet

specific process requirements. This perfusion controller allows for manual and semi-automated operation, offering unparalleled control, flexibility, and efficiency in cell culture processes.

APPLICATIONS:

The Perfusion Model of our Deluxe Benchtop BPC precisely controls agitation, aeration, and perfusion processes for cell retention, ensuring optimal growth conditions for your cell culture. This ATF perfusion controller is ideal for various processes, allowing users to maximize their productivity and achieve optimal results in a variety of perfusion applications, including:

- Cell & Gene Therapy
- Monoclonal Antibody (mAb) Production
- Biosimilar Development
- Protein Expression and Purification
- Vaccine Production
- Continuous Perfusion Culture

BENEFITS OF THE DELUXE PERFUSION BENCHTOP BPC:

- Integrates seamlessly and scales from process development to advanced manufacturing, offering versatility for various perfusion applications.
- Optimizes cell culture by precisely controlling agitation, aeration, pH, DO, and temperature, ensuring maximum productivity and efficiency with minimal repeated runs.
- ATF control dynamically manages media and retentate flow, enhancing filtration efficiency and ensuring optimal cell culture, ideal for continuous perfusion processes.
- Maximizes benchtop space and minimizes footprint with its modular design, making it ideal for labs with limited space while offering robust functionality.
- Standard integration with Rockwell™, with deluxe options for DeltaV™ or your preferred DCS.

SCALABILITY:

This perfusion controller is a versatile and robust piece of equipment, offering exceptional functionality for process development and seamless integration with advanced manufacturing processes. Its dedicated perfusion mode controls vessel weight, allowing optimal cell culture conditions and enhanced productivity. The controller's vessel geometry, gas transfer capabilities, and mixing performance adhere to industry standards. Whether you're involved in technology transfer, process troubleshooting, or development, this controller is the ideal tool to drive innovation and efficiency.

regulated environment's rigorous demands and standards if required. In addition, this piece of equipment is GMP compliant and can be incorporated to meet 21 CFR Part 11 compliance regulations.

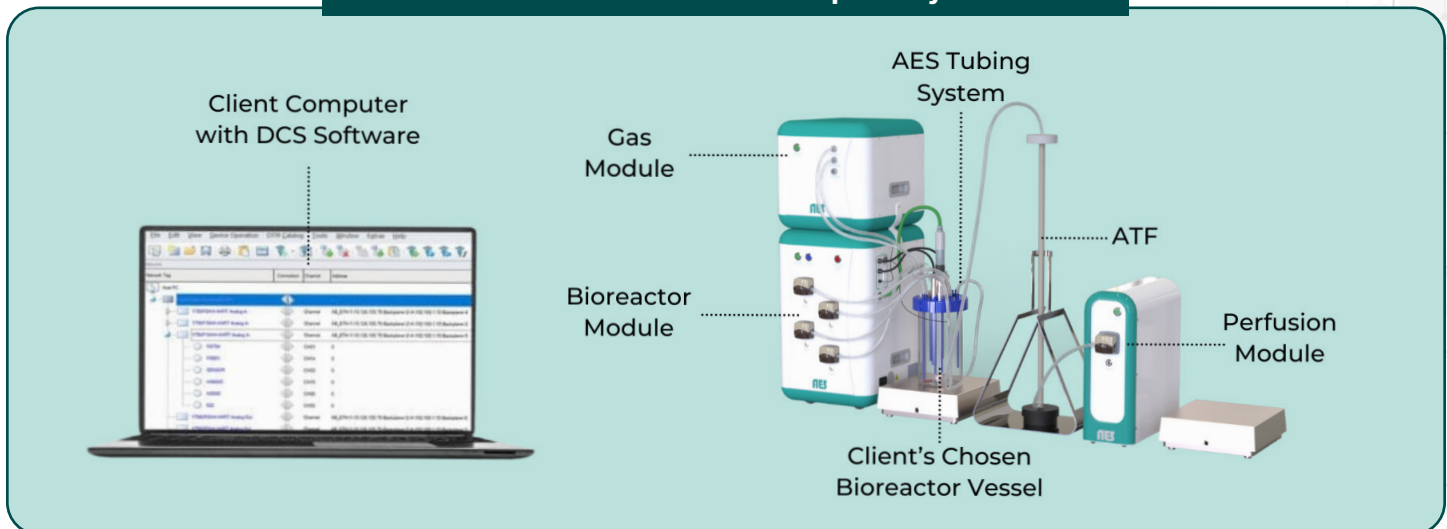
SYSTEM OVERVIEW

Users can customize the Perfusion Model of the Deluxe Benchtop BPC to meet their needs due to its flexibility and adaptability. The system includes a bioreactor, a gas module, and a perfusion module, with the option to add additional pumps via the auxiliary pump module. The system is designed to minimize footprint with stackable enclosures, and all components are made of industrial, powder-coated panels to resist corrosion and ensure long-term use. The system can choose their preferred DCS system, which allows easy control and monitoring from their computer. In addition, users can customize their cell process culture process to meet specific requirements by setting up manual or semiautomated sequences.

BIOREACTOR MODULE:

The system's main component is the bioreactor module, which controls agitation, liquid management, temperature, pH, DO, weight measurement, and biomass. Due to its high-powered direct and magnetic drive motor assemblies, it can rotate clockwise and counterclockwise and operate four integrated pumps with variable speed modes. This control system monitors real-time data from pH and DO probes.

The Perfusion Deluxe Benchtop BPC System



AUTOMATED PROCESS MONITORING & REMOTE CONTROL:

Users have the flexibility to configure alerts and set points, tailoring them specifically to their unique application requirements. Monitor trend reports for these process values, gaining valuable insights into the performance of their system. Create, edit, and save methods, enabling them to optimize cell culture protocols according to their needs. This comprehensive suite of features empowers users to effectively manage their operations and identify deviations from the defined culture parameters.

DESIGNED FOR A REGULATED ENVIRONMENT:

This perfusion controller can be designed to meet a

Liquid Management:

The bioreactor module is equipped with four onboard pumps (with three additional pumps via the included auxiliary pump module). These pumps control liquid flow rates and volumes, enabling accurate dispensing and sampling of liquids. The peristaltic pump head design ensures gentle handling of shear-sensitive materials, while the bi-directional stepper motor provides excellent accuracy and precision. The perfusion controller effectively monitors and controls both in bioprocessing applications.

Measurement of pH & DO:

The bioreactor module's pH and DO probes provide real-time monitoring and control of pH and DO levels

throughout the bioprocessing application. The pH probe uses industry-proven technology and utilizes an optical DO probe with a stainless steel body. The digital probes work with the perfusion controller, enabling real-time monitoring and control of pH and DO. The system's software allows for easy visualization and analysis of the data collected from the pH and DO probes, providing greater insight into the bioprocessing application.

Temperature Control:

The bioreactor module offers precise temperature control, which is essential for cultivating temperature-sensitive cells or producing heat-sensitive proteins. An optional custom heating jacket is available for the bioreactor vessel, providing even heating for optimal cell growth and chemical reactions. Cooling systems can also be combined with the heating jacket to create a temperature-controlled environment within the vessel.

Weight Measurement:

The bioreactor module revolutionizes perfusion applications with integrated vessel, media feed, and harvest scales. This advanced benchtop BPC is explicitly designed for perfusion cultures and delivers precise control for antifoam, feed, and media applications. Notably, the system goes beyond conventional setups by incorporating the ability to control the vessel weight through the permeate pump and the associated flow rate from the permeate flowmeter. This innovative approach ensures a dynamic and responsive feedback loop, allowing real-time adjustments to maintain the desired weight and flow conditions. Customize your controller by seamlessly integrating hanging load cells and platform scales into the bioreactor module for accurate and continuous weight measurement. This enables optimal liquid control via gravimetric feed control. Seamlessly interfacing with your preferred DCS software, the controller automatically feeds the required addition, ensuring comprehensive control across all cell culture applications while streamlining workflows and enhancing efficiency.

Biomass Measurement:

The bioreactor module has a capacitance probe input, enabling real-time monitoring and control of critical parameters, such as glucose feed rate. With a proven track record in optimizing cell culture, vaccine, and viral vector production processes, this cutting-edge instrumentation provides comprehensive, real-time insights into live cell density and viable biovolume profiles. By harnessing PAT principles, our biomass measurement solution enhances process monitoring, automation, and control. This indispensable tool for biopharmaceutical manufacturing improves productivity and efficiency in continuous production processes.

CO₂ Measurement (Optional Instrumentation):

Real-time monitoring and control of CO₂ levels are made possible by the advanced CO₂ measurement capabilities in the perfusion controller. This feature ensures optimal conditions for cell growth and chemical reactions throughout your process. What sets this controller apart is its on-board CO₂ measurement capabilities, which eliminate the need for external equipment, streamlining the setup process and enhancing user-friendliness.

GAS MODULE:

The gas module offers efficient communication through Ethernet/IP protocol, enabling seamless connectivity between the system, mass flow controllers (MFC), and other devices. It comes with four MFCs that allow precise control of Clean Compressed Air (CCA), O₂, CO₂, and N₂ flow rates. Gas flow to Bioreactor HEADSPACE, SPARGE A, or SPARGE B is managed through a triple output manifold, with each MFC having independent shutoff valves. The system can accommodate up to six MFCs, facilitating the integration of additional gases for diverse overlay and sparging strategies. By leveraging MFCs and agitation, the gas module ensures reliable and accurate bioprocess control, guaranteeing superior outcomes.

PERFUSION MODULE:

The Deluxe BPC equipped with the Perfusion Module is engineered to elevate bioprocessing precision by effectively managing media flow throughout the system. This sophisticated setup integrates a dedicated pump for permeate and waste, complemented by two clamp-on flow sensors—one for monitoring retentate flow and another for monitoring permeate flow downstream of the pump.



Alternative Tangential Flow (ATF) Control:

A key feature of this Perfusion Module is its incorporation of ATF control, marking a significant advancement in bioprocessing capabilities. The perfusion module utilizes a bi-directional MFC that harnesses compressed and vacuumed air to control the diaphragm pump. This MFC seamlessly transitions between deflation and inflation, optimizing filtration by pulling retentate through the filter during deflation and pushing it back into the reactor upon inflation. Simultaneously, the bi-directional pump precisely manages retentate flow between the bioreactor and the ATF filtration filter. This dynamic control mechanism ensures optimal filtration, resource efficiency, and a seamless bioprocessing experience.

FLUID HANDLING:

Explore our seamlessly integrated solutions for fluid management, encompassing both our meticulously designed single-use tubing system and a range of vessel options tailored to your processes.

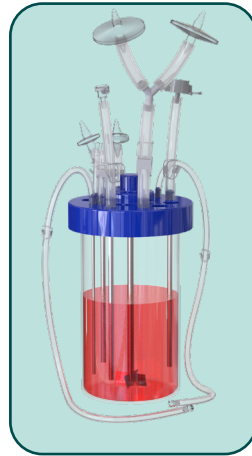
Vessel Selection:

Select from our array of vessel options tailored to your processes. Choose the convenience of single-use

consumables, eliminating the need for cleaning and sterilization, or opt for the durability of autoclavable vessels suitable for long-term use or specific experimental terilization, or opt for the durability of autoclavable vessels suitable for long-term use or specific experimental conditions. Regardless of your choice, our commitment to supporting your needs with consumables and expertise remains steadfast. Please ensure your vessel is compatible to optimize your processes effectively. Together, our integrated solutions create a seamless workflow, ensuring precision and efficiency in your laboratory endeavors.

AES Tubing Set:

Optimize your bioprocessing operations with our versatile Tubing Sets, engineered for seamless integration with our Perfusion Model of the Deluxe BPC. These tubing sets are designed to be compatible with your chosen vessel, ensuring that no matter your specific requirements, we have the right solution for you. Crafted from premium materials, these tubing sets deliver consistent and reliable performance in bioprocessing applications. Assembled and packaged in a controlled cleanroom environment, they meet the highest standards of sterility and quality. With advanced sterilization methods ensuring safety and biocompatibility, our Tubing Sets are the ideal solution for maintaining the integrity of your bioprocessing workflows.



AUTOMATION & CONTROL SYSTEMS:

The Perfusion Model of the Deluxe Benchtop BPC’s automation and control options offers flexible integration into your setup, supporting DCS or ‘stand alone’ control

as well as Industrial Ethernet communication standards.. The standard offering for the perfusion controller is DeltaV, providing real-time data acquisition and enabling accurate process control. Convenient trend analysis further enhances the capabilities of this controller. With streamlined tech transfer, scale-up, and recipe sharing, this controller simplifies research and facilitates seamless automation across different stages of the product development process.

DATA & COMMUNICATION:

The Perfusion Model of the Deluxe Benchtop BPC offers robust data and communication capabilities for precise control and insightful analysis. Its user-friendly interface displays real-time and historical data, which can be customized to suit your specific needs. This perfusion controller ensures efficient and reliable operation with remote monitoring, data logging, and alarm notifications. This controller can seamlessly integrate with external systems and tools for enhanced process analysis. Choose from local/removable media storage options to easily access historical data and control parameters.

AES Historian Database (Optional):

The optional DCS layer includes AES Historian, a comprehensive database for historical storage, retrieval, and integration into your bioprocess control system. AES Historian offers the following features:

- Fully integrated history configuration and data collection
- Status collection for every value
- Fully functioning historian on each DCS workstation
- Scalable plant historian for all BPS units in the system
- Integrated tools for viewing historical data, including Excel-based reporting and analysis
- Open connectivity for integration with third-party Historians
- Historical data accessible in operator displays

TECHNICAL SPECIFICATIONS

Bioreactor Module	
Enclosure Specifications	
Benchtop Footprint (H x W x D)	25" x 15" x 20"
Power Requirements	120-230 VAC, 50/60 Hz, 1200 Watts
Vessel Compatibility	Eppendorf**, Sartorius**, Applikon**
Agitation	
Agitation Direction Control	Bi-Directional
Motor Speed (Maximum Range)	600 RPM – Mammalian Cell Culture Applications 1200 RPM – Microbial Fermentation Applications
Liquid Control	
On-Board Pumps	(4) pumps with 24VDC Bi-Directional Stepper Motors
Pump Head Type	Peristaltic, Flip-Top Pump Heads
Pump Speed Range	0.2 - 200 RPM
Tubing Compatibility	AES Tubing Set or L/S -13, -14, -16, -25, -17, -18
Process Analytics	
Temperature	0 – 100 °C ± 0.15°C

*Optional Instrumentation if configured
** Speak with your Sales Rep to Determine Specific Compatibility

pH	2 – 12 pH
DO	0 – 100% Air Saturation ± 1% reading
Biomass Permittivity	0 – 100 pF/cm ± 2-3% reading
CO₂ Gas Saturation*	0 – 50% ± 10% reading

Weight Measurement

Vessel Scale Capacity	60 Kg, ± 0.001 kg readability, 0.03% FS error
Vessel Scale Communications	Digital Ethernet/IP

External Equipment and Instrumentation Specifications*

Weight Measurement

Vessel Scale Communications	Digital or Analog*
Platform Scales	3 kg ± 0.05 g, 6 kg ± 0.1 g or 60 kg ± 0.1 kg
Platform Scale Communications	Digital Modbus RS232 communication
Hanging Load Cells	3 kg ± 0.05 g readability

Heating Applications*

TCU	5 °C to 40 °C, accuracy ± 0.1 °C
------------	----------------------------------

Auxillary I/O

External Turk BLCND I/O Module	4 x Analog Input Channels
Configuration Types per Input Channel	0 – 10 VDC, 0 – 20 mA, or 4 – 20 mA

Gas Module

Enclosure Specifications

Benchtop Footprint (H x W x D)	15" x 15" x 18"
Power Requirements	120-230 VAC, 50/60 Hz, 550 Watts

Mass Flow Controller Specifications

Standard Model

MFC Quantity & Gas Type	(3) to (6) MFCs: O ₂ , CO ₂ , N ₂ *, CCA (Clean Compressed Air)*, O ₂ *
Instrument Range	0.003 – 50 SLPM (operating ranges and flowrate units are user-configurable)
Communication Protocol	Digital – RS485 communication

High-Performance Model*

MFC Quantity & Gas Type	(3) to (6) MFCs: O ₂ , CO ₂ , N ₂ *, CCA (Clean Compressed Air)*, O ₂ *
Instrument Range	0.003 – 50 SLPM (operating ranges and flowrate units are user-configurable)
Communication Protocol	Digital – Ethernet/IP communication

*Biotech Upgrade available for a higher 250:1 turn-down ratio and other performance enhancements**

Perfusion Module

Enclosure Specifications

Benchtop Footprint (H x W x D)	22" x 9" x 25"
Power Requirements	120-230 VAC, 50/60 Hz, 550 Watts

Mass Flow Controller Specifications

MFC Quantity & Gas Type	(1) Bi-Directional MFCs: CCA (Clean Compressed Air), AIR
Instrument Range	0 – 20 SLPM (operating ranges and flowrate units are user-configurable)
Communication Protocol	Modbus RS45 or Ethernet/IP communication*

*Optional Instrumentation if configured

Pressure Specification	
On-Board Pressure Sensors	(1) Pressure Sensor
Pressure Range	-14.5psi to +29psi
Liquid Control	
On-Board Pumps	(1) pump with 24VDC Bi-Directional Stepper Motors
Pump Head Type	Peristaltic, Flip-Top Pump Heads
Pump Speed Range	0.2 - 200 RPM or 0.2 - 300 RPM*
Permeate Flow Meter	(1) Flow Meter
Permeate Flow Range	0 to 8000 mL/min \pm 16 mL/min
Retentate Flow Meter*	(1) Flow Meter
Retentate Flow Range*	0 to 70,000 mL/min \pm 140 mL/min 7,000 - 70,000 mL/min \pm 2% of the reading
ATF Vacuum Pump	
On-Board Vacuum Pump	(1) Diaphragm Pump
Auxiliary Pump Module*	
Enclosure Specifications	
Benchtop Footprint (H x W x D)	19" x 7" x 15"
Power Requirements	120-230 VAC, 50/60 Hz, 1440 Watts
Liquid Control	
On Board Pumps	(3) Pumps
Pump Head Types	Peristaltic, Flip-Top Pump Heads
Pump Speed Range	0.2 - 200 RPM
Tubing Compatibility	AES Tubing Set or L/S -13, -14, -16, -25, -17, -18
Automation & Control Software	
Standard Offering	Rockwell™
Deluxe Offering	AES Library DeltaV™, Process Sequence Model functionality DeltaV™ based Perfusion control
Optional Features	DeltaV™ configuration of auxiliary I/O signals or custom ancillary equipment/instrumentation

*Optional Instrumentation if configured

TUBING SPECIFICATIONS

Production Specifications	
Tubing Materials	Platinum-cured Silicone, Thermoplastic Elastomer
Adapter Materials	Polypropylene
Pinch Clamp Materials	Polypropylene
Sanitary Materials	Gasket: Polycarbonate Clamp: Nylon End Cap: Polypropylene
Environmental Requirement	ISO 14644-1 Class 7 Cleanroom Environment
Shelf Life	2 Years from the Date of Manufacture
Sterilization Method	Gamma Irradiation
Compliance/Biocompatibility	USP Class VI and ISO 10993 Standards