

BIOFLO 4500[®]

Fermentor/Bioreactor

**Benchtop
20 & 30 Liter
System
For Process
Development
through
Small-Scale
Production**



NEW BRUNSWICK SCIENTIFIC

Where Quality and Innovation Have Become Tradition

BIOFLO[®] 4500 FERMENTOR

The BioFlo 4500 is an industrial fermentor/bioreactor with the power, versatility and advanced controls for microbial, insect and mammalian cell culture, in applications ranging from research through small-scale production. A wide array of options enable configuration to your individual process requirements, without the high cost and delays normally associated with purchasing a custom fermentor. The system's most powerful feature is its advanced control capability, driven by NBS' ML-6100™ multi-loop controller with touch-screen interface. With the ML-6100, on-screen entry of process control loops, sterilization cycles and calibration routines is remarkably intuitive, making the BioFlo 4500 exceptionally easy to operate. Almost any auxiliary process device, from sensors to biochemical analyzers, can be integrated with the fermentor without need for additional hardware, software or a service technician. In fact, every facet of this compact system has been designed with efficiency in mind. An open-frame design provides easy access to all piping, valves, regulators and filters; and assignable, peristaltic pumps with Easy-Load[®] pump heads speed tube loading. The system is fully cGMP compliant. For process flexibility and operating simplicity the BioFlo 4500 has no equal.

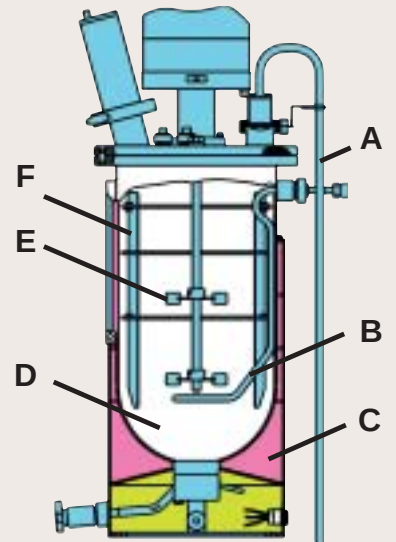
UNIQUE ADVANTAGES

- Multiple options allow for process-related configuration
- Available with an embedded or external ML-6100 controller, or customer-specified SCADA system. The ML-6100 provides an intuitive user interface for fermentation operation and system configuration
- For scale-up studies, the ML-6100 allows emulation of much larger bioreactors through programmable heating, cooling, and pre- and post-sterilization protocols
- Capable of rapid temperature shifts in growth phase, to allow for heat induction (1°C/minute in range of 30°C to 45°C); with slower temperature rises also programmable
- High oxygen transfer rates (OTR) of 350 mM O₂/L/Hr minimum, attainable
- Optional 2-gas, 3-gas and 4-gas mixers available for oxygen enrichment and cell culture applications
- Capable of remote control, data logging and process programming using optional AFS-BioCommand[®] software
- Only NBS has an in-house ASME-accredited vessel shop, microbiology and cell culture labs, software and instrumentation development group, and integrated cGMP bioprocess area to provide added customer support
- Set-up and start-up assistance provided, with optional validation and training packages available. Process development and scale-up assistance can also be provided

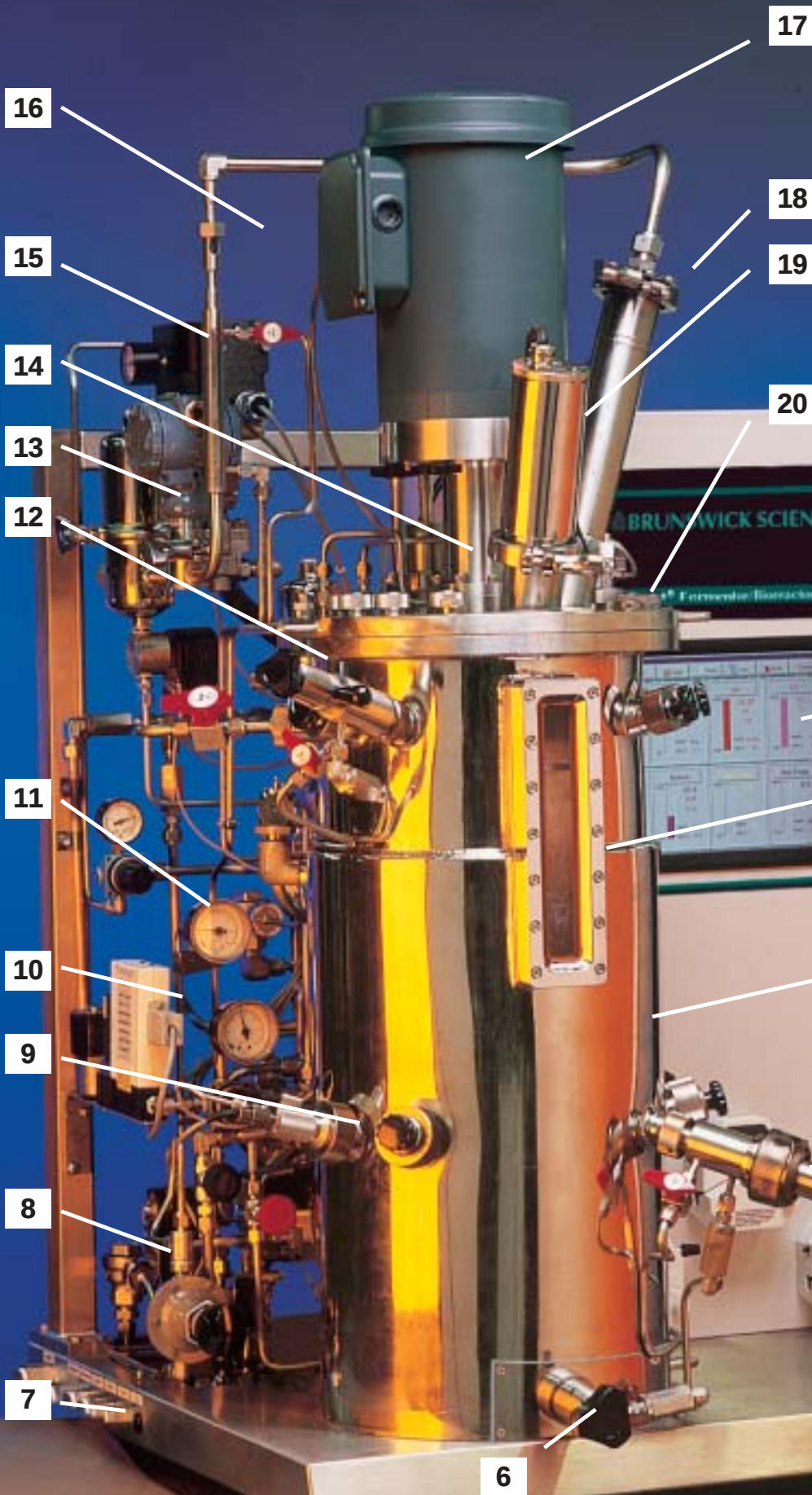
ADVANCED FEATURES (As Shown at Right)

- 1 ML-6100 Embedded Controller** with touch-screen interface, optional
- 2 Viewing Window**, 8.5" x 1.25" (21.6 x 3.2 cm), allows viewing the culture above and below liquid level
- 3 Sterilizable-In-Place Vessel**, ASME coded, available in 20 or 30 L capacities. Type 316L stainless steel polished to an internal finish of 15 - 20 Ra eases cleaning and prevents residue build-up
- 4 Resterilizable Sample Valve**, 19 mm, variable flow with quick-connect fitting, optional
- 5 Peristaltic Pumps**, up to three assignable pumps, optional. (One switched, auxiliary outlet for optional remote pump, not shown, is standard)
- 6 Resterilizable Harvest/Drain Valve**, 19 mm with quick-connect fitting. Easy access through removable vessel panel
- 7 Services** for water, air, clean and house steam, water return and drain can be connected from *either side* of the base for easy installation
- 8 Steam Traps**, multiple steam traps guarantee the sterilization temperature is maintained in all process lines
- 9 Ports**, multiple 19 & 25 mm Ingold-type ports allow addition of RTD, pH, D.O. and other sensors
- 10 Thermal Mass Flow Controller** provides precise, automatic control of air flow
- 11 Open Frame Piping** facilitates access for cleaning, maintenance and servicing
- 12 Resterilizable Inoculation/Addition Valves**, up to 4 19 mm valves, with quick-connect fitting, optional
- 13 Filters**, sterilizable-in-place in 316L stainless steel housings accommodate various-brand filter cartridges. (Exhaust filter shown, air inlet not visible)
- 14 Rupture Disk** safety device of 316L stainless steel prevents over-pressurization of vessel; includes discharge tube to convey liquid to bottom of console
- 15 Automatic Back-Pressure Regulator**, optional. Manual Back-Pressure is standard
- 16 Exhaust Line** with heat exchanger and view glass. Heat exchanger heats gas above dew point and prevents filter clogging
- 17 Motor**, top-drive provides agitation for both microbial and mammalian cell culture
- 18 Exhaust Condenser**, high-efficiency, with Tri-Clamp fittings, optional
- 19 Combination Light and Fill Port** provided, with sanitary Tri-Clamp fittings
- 20 Headplate Ports**, (7) 28 mm ports (I.D. 19 mm) allow addition of sensors, sampling and addition devices

Vessel Interior



- A Rupture Disk with Discharge Tube
- B Multi-Orifice Ring Sparger
- C Electrically-Heated Water Jacket
- D Hemispherical Bottom
- E Impellers, (Two)
- F Removable Baffles, (Four)



ML-6100 — THE POWER OF PROCESS

The advanced ML-6100 bioprocess controller has been designed specifically to meet the unique demands of fermentation and cell culture operations. Using this advanced system, you can add, name, change or delete control loops and protocols, quickly and conveniently. And when it's time to scale-up, you can move from research through production without changing controllers - the ML-6100 handles it all.

ADVANCED FEATURES & BENEFITS

- The ML-6100 is a validatable process controller for research through cGMP applications
- Add ancillary equipment, from simple pumps to complex analyzers, right on screen without factory installation or added cost
- Control and display up to 16 parameters on a large color SVGA display
- One ML-6100 incorporates up to 60 inputs and outputs
- Display live trend graphs without using additional software (up to four hours)
- User-set alarms provide early notification of process deviations
- Menu-driven prompts simplify calibration of D.O., pH and other parameters
- Programmable sterilization screen automates sterilization and facilitates scale-up by duplicating thermal conditions of industrial pilot-scale systems
- Multiple controller configurations can be easily recalled to accommodate different microbial and cell culture processes
- Password feature ensures process security
- LAN (Ethernet) port provided for network connectivity
- Touch-screen interface available embedded or remote
- Intuitive Control -- Graphic touch screen simplifies all controller functions. Easy to learn, easy to use
- Cascade Control -- Easily cascade any parameter to up to 5 loops -- create powerful control schemes
- Trend Graphs -- Show process values in real time right at the controller for complete process information
- Security and Convenience -- Users can add, delete, change controller functions through the touch screen; Passwords prevent accidental changes



The menu-driven ML-6100 controller is designed for simplified control using on-screen programming of Loop Configuration, Pump and Sensor Calibration, Display Configuration, Trend Graphs, Cascade Control, Sterilization, and Alarms. Adding or changing control loops, sterilization cycles or calibration routines is remarkably straightforward. Just touch the appropriate gauge on the monitor to bring up the display for that parameter, then simply key in the new values.

CONTROL RIGHT AT YOUR FINGERTIPS

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(1) **Process Status Screen:** Uses bar graph gauges to display up to 16 process loops on 2 screens, presenting an on-line panorama of the process.

(2) **The Sterilization Menu:** To enhance scale-up capability you can program the bioreactor to perform the same as an industrial pilot-scale system. This menu permits the selection of heat-up, sterilization and jacket drain time, as well as valve operating sequences, to duplicate the thermal conditions of larger fermentors.

(3) **Alarm Shutdown Selection Menu:** With this menu a selection of parameters can be programmed to shut down in the event an alarm condition is reached, and continued operation would have an adverse effect on the process.

(4) **Trend Graphs:** Up to four on-line graphs may be displayed at one time.

(5) **Loop Configuration Screen:** Displays precise configuration of each loop, showing exactly where the appropriate connections are to be made, and allowing the user to create optional loops electronically without extra cost.

BIOFLO 4500 FERMENTOR/BIOREACTOR SPECIFICATIONS *

VESSEL	Total Capacity	20 Liters		30 Liters
	Working Volume	5 - 15 Liters		7 - 22.5 Liters
	Aspect Ratio (H:D)	1.98 : 1		2.03 : 1
	Geometry	Cylindrical with hemispherical bottom dish		
	Pressure Rating	Vessel is ASME-coded, rated for 40 psig (2.8 kg/cm ²) Jacket rated for 50 psig (3.5 kg/cm ²)		
	Viewing Window	Rectangular window, sidewall mounted above and below the maximum working level. Area of visibility is 8.5" High x 1.25" Wide (21.6 x 3.2 cm)		
	Baffles	(4) 316L stainless steel removable baffles		
MATERIALS & FINISH	Dimensions	9.48" I.D. x 18.8" H (24.08 x 47.78 cm)		10.79" I.D. x 22" H (27.41 x 55.88 cm)
	Vessel	316L stainless steel, polished to an internal finish of 15 - 20 Ra and an external finish of 25 - 30 Ra. Electropolishing optional		
	Process Piping	316L stainless steel, orbitally welded. All valves and associated components are of 316L stainless steel		
IMPELLERS	Gaskets/O-Rings	Gaskets of Silicone; O-Rings of EPDM		
	Outer Diameter	3.75" (9.53 cm)		4.31" (10.95 cm)
NOZZLES	Type	(2) Six-bladed 316L stainless steel, Rushton blade, standard. Marine blade, pitched blade, spin filter and basket impeller, optional		
	Headplate	(7) 28 mm ports, 19 mm I.D. plugged; (1) exhaust port, tri-clamp; (1) combination filling/light port, tri-clamp; (1) bearing housing; (1) rupture disk 316L stainless steel, 40 psi (2.7 bar) piped to bottom of console, tri-clamp		
	Upper Side Wall	(4) 19 mm Ingold-type ports, plugged; (1) overlay port, plugged; (1) sparge port, with multi-orifice ring sparger		
	Lower Side Wall	(2) 19 mm Ingold-type ports, plugged; (1) Thermowell, 19 mm; (3) 25 mm Ingold-type ports, plugged		
	Jacket Bottom	(1) Jacket water in; (1) Jacket water out; (1) Jacket pressure relief valve (1) 19 mm harvest/drain valve poppet-type with .25" (0.63 cm) quick connect		
AGITATION	Drive	1 HP, AC motor, top-entry		
	Sensor	Fiber optical photo interrupter		
	Range	50 - 1,000 rpm, ± 1 rpm		
	Control	PID regulation of speed via microprocessor feedback circuit		
	Bearing Housing	Single mechanical seal, standard. Double mechanical seal optional		
TEMPERATURE	Sensor	Platinum RTD in thermowell		
	Control	(4) Cartridge heaters at the bottom of the vessel. Cooling water is admitted to the jacket through the temperature control valve and the flow control valve. PID regulation, with PWM		
	Range	5°C above coolant supply temperature to 85°C, $\pm 0.2^\circ\text{C}$		
	Shift	1°C/minute in growth phase in a range from 30°C to 45°C		
AIR FLOW	Inlet Filter	Sterilizable-In-Place (SIP) absolute 0.2 μ filter with 316L stainless steel housing		
	Outlet Filter	SIP depth filter with 316L stainless steel housing. Absolute 0.2 μ filter optional		
	Control	Thermal Mass Flow Controller, PID regulation		
	Range	5 - 50 SLPM (10:1 Turndown), optional for 0.2 - 10 SLPM (50:1 Turndown)		
PRESSURE		Manual back-pressure, standard. Automatic back-pressure regulator, optional		
STERILIZATION		Fully automatic sterilization and cool down, sterilization programmable from 0 to 500 minutes, 121° - 130°C		
CHART RECORDER SIGNAL		A recorder output may be assigned to any available 0 - 20 mA output. Recorder optional		
COMMUNICATIONS PORTS		LAN (Ethernet) port, RS422 AFS-BioCommand port for automatic data logging and control		
ANALOG INPUTS		(3) Sets of 0 - 20 mA		
ALARM BUZZER & CONNECTOR		Audible alarm standard, external alarm output via relay contacts		
WEIGHT	Net	300 lbs. (136 kg)		420 lbs. (191 kg)
	Gross	425 lbs. (193 kg)		545 lbs. (247 kg)
DIMENSIONS, OVERALL	Inches	35" Wide x 29.7" Deep x 47" High		35" Wide x 29.7" Deep x 51" High
	cm	89 Wide x 75.4 Deep x 119.4 High		89 Wide x 75.4 Deep x 129.5 High
ELECTRICAL		220/240 V, 50/60Hz, single phase, 30 A. Meets UL, CSA, VDE & British standards		
UTILITIES		Requires appropriate utilities for utility steam, clean steam, air, water, exhaust, water return, drain and optional gasses		

OPTIONAL ACCESSORIES

- **Controller** - ML-6100 embedded or remote, or third party controller
- **Gas Overlay**
- **Exhaust Condenser**, water-cooled installed in headplate to minimize evaporation of culture medium
- **Resterilizable Inoculation/ Addition Valves**, 19 mm
- **Syringe/Septum Addition Port Assemblies**
- **Resterilizable Sampling Valve**, 19 mm, variable flow
- **Diaphragm Drain Valve**
- **Aerosol Containment System** to prevent aerosol formation when sampling
- **Steam Generator** for utility and clean steam
- **Pre-Filter Kits** for air, water and steam for removal of particulates or impurities
- **2, 3, or 4-Gas Controller** for oxygen supplementation and gas mixing
- **Impellers**, Marine Blade, Pitched Blade, Spin Filter or Basket
- **Pumps**, Up to (3) built-in assignable Easy-Load® feed/harvest pumps
- **Auxiliary Pump**, assignable peristaltic pump
- **Double Mechanical Seal** for agitator bearing housing
- **Foam/Level Kit** for addition of chemical defoamer or level control
- **High Foam Kit** to alert for high-foam in exhaust line
- **pH Probes**, Ingold or Broadley James
- **D.O. Probes**, Ingold or Broadley James
- **Chart Recorder**
- **cGMP Validation**, IQ, OQ packages

(*) Specifications subject to change without notice. Easy-Load is a registered TM of Cole-Parmer Instrument Co.



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