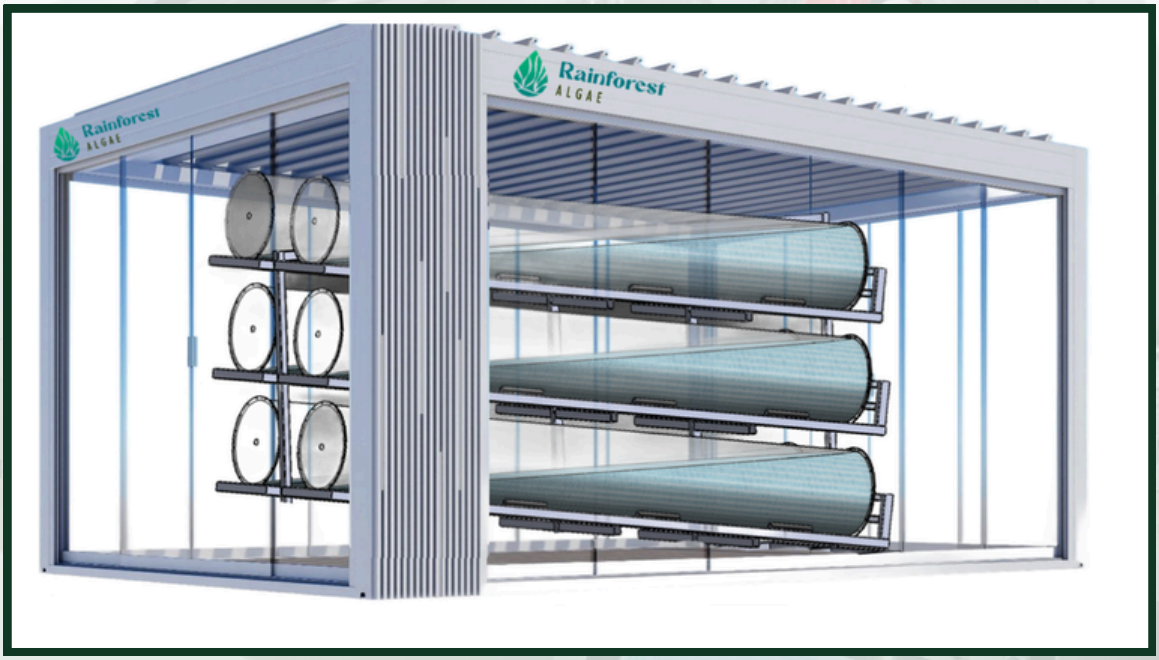
Rainforest
ALGAE

Rainforest Technologies Product Brochure



Calgary, AB Canada
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Photobioreactor Models and Culture Capacity Overview

REACTOR MODEL		CULTURE CAPACITY (L +/- 20%)		PAGE
Minnow	**RF-2L**	2		**5**
Chinook	**RF-10L**	10		**6**
Dolphin	**RF-420L**	420		**7**
Beluga	**RF-1250L**	1,250	1.25 m^3	**8**
Beluga-IT	**RF-1250L-IT**	1,250	1.25 m^3	**9**
Beluga Calf	**RF-1250L-C**	1,250	1.25 m^3	**10**
Minke	**RF-4300L**	4,300	4.3 m^3	**Info available on request**
Orca	**RF-10m^3**	10,000	10 m^3	**Info available on request**
Bowhead	**RF-28m^3**	28,000	28 m^3	**Info available on request**
Fin	**RF-100m^3**	100,000	100 m^3	**Info available on request**
Blue	**RF-1000m^3**	1,000,000	1,000 m^3	**Info available on request**
Reactor Enclosure				**11**
Accessories				**12**

INTRODUCTION

Thank you for your interest in Rainforest Algae Corp. and the technologies that we have developed. The company was founded on a vision to create a positive impact on the global climate change challenge. Algae is the fastest-growing plants on the earth, with the potential to double its biomass within 24-48 hours and dependent on environmental conditions and genetics found within 100,000+/- species that exist. Algae is responsible for 60-70% of the oxygen that we breathe. Algae is the source of many compounds that sustain us, from food that we and all animals, fish and birds eat, to fuels and anything else that is derived from petroleum products and so much more.

Where algae are so prevalent around the world, the primary challenges to cultivating it for commercial purposes rest in the driving down the cost associated with producing the algae, dewatering and drying the biomass and minimizing the associated environmental impacts. We refer to these as the “techno-economics” (the capital and operating costs) and the “life-cycle-assessment” (adding up all of the components of construction and ongoing operations - that end up causing CO_2 emissions to be released and subtracting the amount of CO_2 that is sequestered in the biomass).

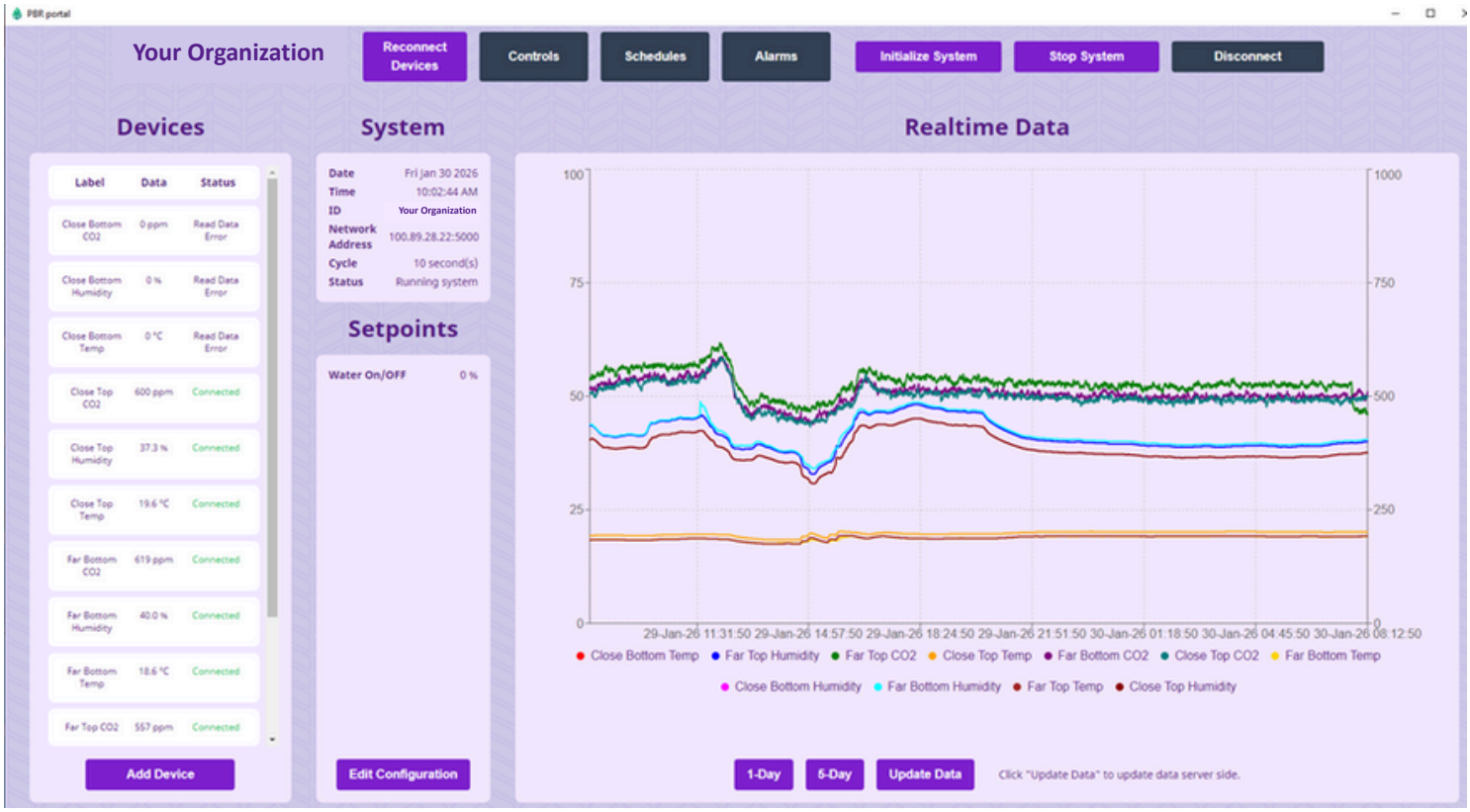
It used to be that raceway ponds provided the most economic and environmental results. Especially in Canada and other colder climates, we don’t have warm climates that would sustain cultivation year-round. So, although raceway ponds work, a more controlled cultivation environment provides more consistent and much higher algae yields/unit culture volume. **When compared with raceway ponds, Rainforest reactors require a fraction of the space and are designed to utilize sunlight where available, i.e., within greenhouses, even in cold climates.**

Since 2020, Rainforest Algae Corp. has been working to develop the most advanced bioreactor system available, **taking advantage of the extraordinary advancements in culture mixing and mass transfer of gases between the liquid and gas phases** that are essential to optimizing reaction yields, whether these involve chemical, photosynthetic, or fermentation reaction kinetics. **To reduce algae cultivation operating costs, there is a need to integrate renewable energy sources. The sun offers us free solar energy to promote algae growth. It is important that, where possible, photobioreactors should utilize this energy when it is available. This is why Rainforest promotes the use of an ENCLOSURE system (pg 10) for smaller commercial systems and the use of greenhouse enclosures for larger systems.**

Furthermore, reactor monitor, log, and control systems continue to be advanced to not only optimize yields but also move us toward a fully automated platform. The sealed reactor vessel can be cleaned in place (CIP) to ensure culture remains contamination-free. Depending on reaction requirements, the system can be configured with controllable lighting systems, temperature, gas exchange, nutrient additions, harvesting pumps, parameter sensors, etc. The control system may be configured to respond to reaction kinetics and/or AI/ML algorithms. Furthermore, whether dealing with cellular agriculture, algae, fermentation cultures, the Rainforest reactor systems are rapidly scalable from 2L through 100’s and potentially 1000’s m^3. Reaction schedules can be set for batch, semi-batch, or continuous operations. All reactor systems may be cleaned in place (CIP) or autoclaved (2L, 10L).

Because of the reactor design, considerable customization is possible, whether to meet space constraints or to achieve reactor volume objectives. Essentially, scaling is related to increasing diameters and lengthening reactor vessels to increase/decrease culture volumes. However, for the purposes of this document, multiple scaled bioreactor culture capacity possibilities are provided.

The Rainforest reactors can be monitored and controlled via WiFi on board, on your desktop or even on your smart device with graphing. You can also monitor your culture in real-time via a flow-through microscope/camera adapter. **Because of the multiple reactor tube configuration of the reactors, you have built-in redundancy, risk mitigation, or segregation to be able to simultaneously run multiple different reactions/cultures in the system**. The larger systems are generally constructed with 6 tubular reactors. Importantly, because the mass gas transfer relies on the rotating reactor vessels rather than dispersion of gases by bubbling from the bottom of a reactor vessel (sparging), there is a significant reduction in foaming that occurs within the reaction vessel.



If objectives include Net Zero carbon emissions, this may be achieved in relation to energy requirements by 1) cultivating under ambient light conditions and/or 2) coupling with renewable energy sources. This can be achieved within "greenhouse" types of environments, including high-profile glass enclosure systems that we are able to integrate with, as seen on the cover page of this document.

We look forward to partnering with you to achieve your research, environmental, social, and/or commercial project objectives.

Let's begin the conversation soon!
Stan Pankratz, PhD, MBA, BSc
President & CEO
Rainforest Algae Corp.
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*NOTE: Specifications in this document are subject to change as systems continue to be advanced.

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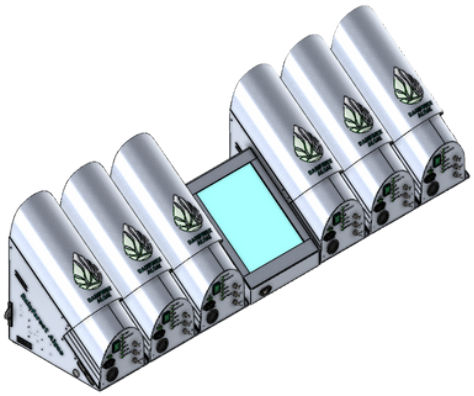
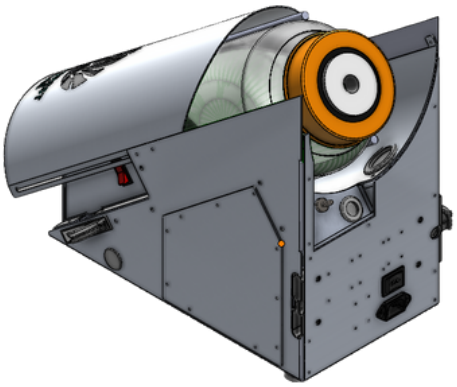
Minnow RF-2L





Specifications

Culture Volume	2 L / 0.5 US gal +/- 20%	
Reactor Vessel (Food Grade PET / borosilicate) Sealed with LED lighting	4 L / 1.1 US gal	**RF-2L-RV-PET / RF-2L-RV-Bor**
Power	50 W	
Power with 6 units	300 W	
Available voltage	110-120 VAC	
Available Frequencies	50 / 60 Hz	
Dimensions	Length 450-520 mm / 17-21 in (closed / open) Width 210 mm / 8.5 in Height 380-485 mm / 15-19 in (open / closed)	
Weight	8.5 kg / 19 lbs.	
Power cord	1 m / 3.3 ft	
Peristaltic pumps (variable speed up to 0.5L/min)	2	
Air pump with HEPA filter (0.2um)	1	
On board microcomputer with monitor / control / data logging / graphing software / WiFi enabled.	**Included**. User interface app may be installed on laptop / desktop / smart devices or using the Rainforest optional Control Module. **Controls include**: temperature / LED light intensity / rotation speed / peristaltic pumps / parameter and component scheduling	
Culture Monitoring Equipment	1 K-Type Thermocouple and 1 pH Probe	
**Other probes available on request*		

Control and Monitoring System (CMS) with touch screen. Will control up to 6 ea. RF-2L reactors.	
Dimensions	Length 350 mm / 14 in Width 250 mm / 10 in Height400 mm / 16 in
Weight	4.5 kg / 10 lbs.

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Chinook RF–10L

Specifications

Culture Volume	10 L / 2.6 US gal +/- 20%	
Reactor Vessel (Food Grade PET / borosilicate) Sealed with LED lighting.	24 L / 6 US gal	**RF-10L-RV-PET / RF-10L-RV-Bor**
Power	350 W	
Available voltage	110-120 VAC	
Available Frequencies	50 / 60 Hz	
Dimensions	Length 965 mm / 38 in Width 430 mm /17 in Height 710-1090 mm / 28-43 in (closed / open)	
Weight	34 kg / 75 lbs.	
Power cord	1 m / 3.3 ft	
Peristaltic pumps (variable speed up to 0.5L/min)	4	
Air pump with HEPA filter (0.2um)	1	
Control and Monitoring System (CMS) with touch screen, monitor / control / data logging / graphing software / WiFi enabled.	**Included.** User interface app may be installed on laptop / desktop / smart devices or using the Rainforest optional Control Module. **Controls include:** temperature / LED light intensity / rotation speed / peristaltic pumps / parameter and component scheduling	
Culture Monitoring Equipment	1 K-Type Thermocouple and 1 pH Probe	
**Other probes available on request*		

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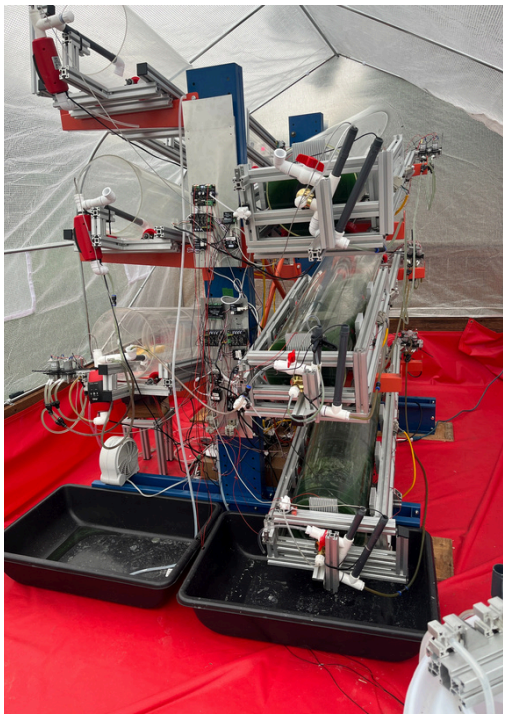
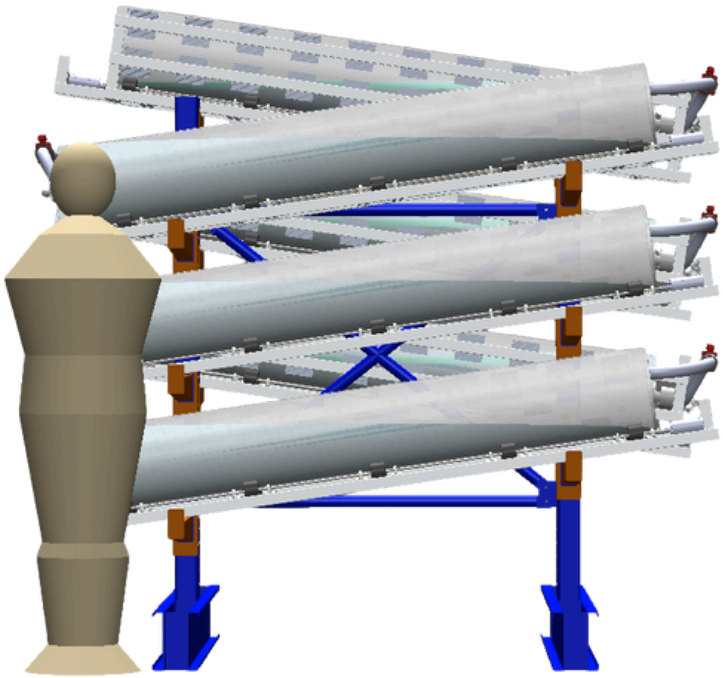
Dolphin RF-420L





Specifications

Culture Volume – comprised of 6 rotating reactor vessels - Culture Volume	420 L / 110 US gal +/- 20%	**RF-420L-RV-SYSTEM**
Reactor Vessel (Acrylic) – Sealed w LED Lighting		
Individual reactor vessel - Culture Volume	70 L / 18 US gal	**RF-70L-RV**
Power	2 kW *(when using sunlight ~500W)*	
Available voltage	110-120 VAC	
Available Frequencies	50 / 60 Hz	
Dimensions	Length 2.4 m / 8 ft Width 1.6 m / 5.25 ft Height 2.1 m / 7 ft (closed/ open)	
Recommended working space around reactor	1 m / 3.3 ft	
Operating Weight	1350 kg / 3000 lbs.	
Peristaltic pumps (variable speed up to 6L/min)	13	
Air pump with HEPA filter (0.2um)	1	
Control and Monitoring System (CMS) with touch screen monitor / control / data logging / graphing software / WiFi enabled.	**Included.** User interface app may be installed on laptop / desktop / smart devices or using the Rainforest optional Control Module. **Controls include:** temperature / LED light intensity / rotation speed / peristaltic pumps / parameter and component scheduling	
Culture Monitoring Equipment	1 K-Type Thermocouple and 1 pH Probe per tube	
**Other probes available on request*		

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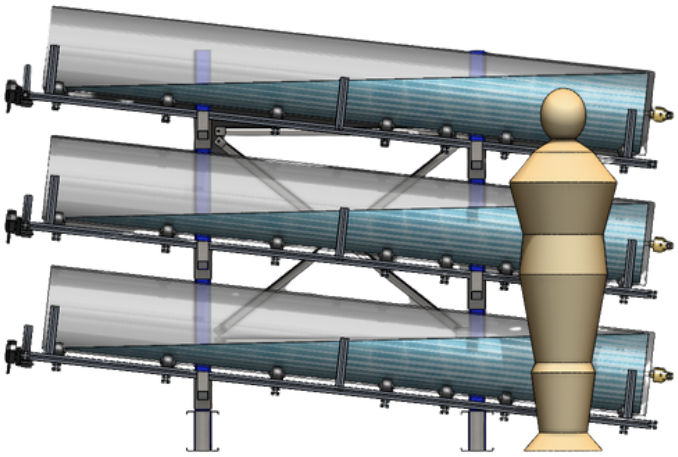
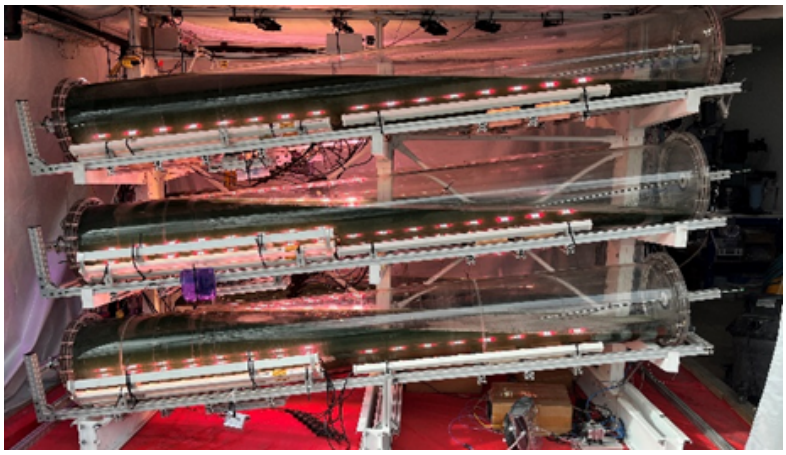
Beluga RF-1250L





Specifications

Culture Volume – comprised of 6 rotating reactor vessels	1250 L / 330 US gal +/- 20% **RF-1250L-RV-SYSTEM**
Reactor Vessel (Acrylic) – Sealed w LED lighting	
Individual reactor vessel - Culture Volume	208 L / 55 US gal **RF-208L-RV**
Power	3.5 kW *(when using sunlight ~800W)*
Available voltage	110-120 VAC
Available Frequencies	50 / 60 Hz
Dimensions	Length 3.3 m / 11 ft Width 1.6 m / 5.25 ft Height 2.25 m / 7.4 ft
Recommended working space around reactor	1 m / 3.3 ft
Operating Weight	2500 kg / 5500 lbs.
Peristaltic pumps (variable speed up to 6L/min)	13
Air pump with HEPA filter (0.2um)	1
Control and Monitoring System (CMS) with touch screen monitor / control / data logging / graphing software / WiFi enabled.	**Included.** User interface app may be installed on laptop / desktop / smart devices or using the Rainforest optional Control Module. **Controls include:** temperature / LED light intensity / rotation speed / peristaltic pumps / parameter and component scheduling
Culture Monitoring Equipment	1 K-Type Thermocouple and 1 pH Probe per tube
**Other probes available on request*	

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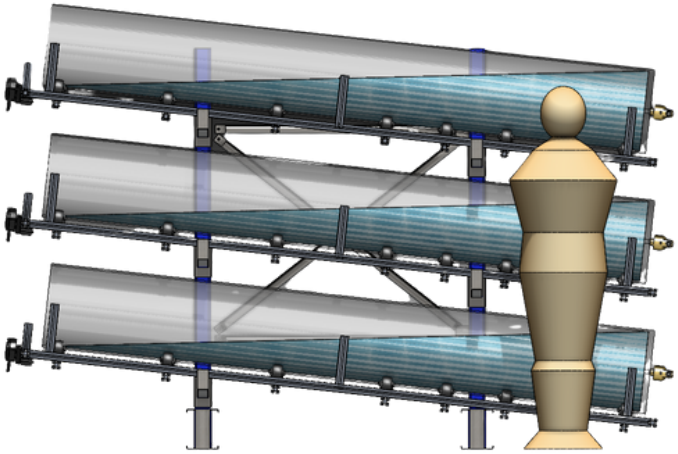
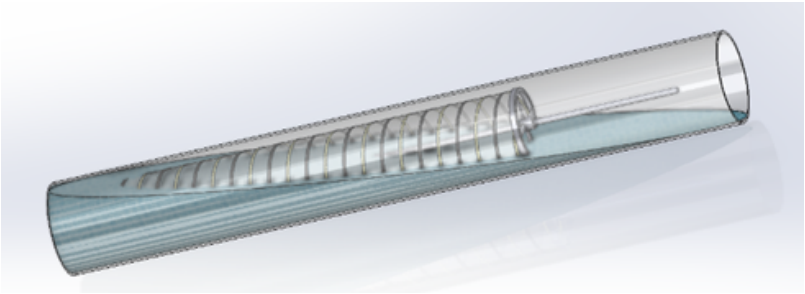
Beluga RF-1250L-IT - Beta





This is our most recent and most advanced photobioreactor system.

Where the BELUGA RF-1250L rotates each reactor vessel, with the BELUGA RF-1250-IT, there is a secondary reactor vessel that rotates inside of a stationary outer shell of the reactor system. This design significantly reduces the number of moving parts, which in turn reduces maintenance. The rotation of the inner vessel significantly reduces the amount of rotational energy that is required. An even greater amount of energy is reduced due to the incorporation of the lighting system into the inner rotating reactor vessel, which also benefits from much more efficient and effective dispersion of light within the algae cultures. Meanwhile, the culture remains thoroughly mixed while maintaining excellent mass gas transfer to optimize culture growth.

Specifications

Culture Volume – comprised of 6 rotating reactor vessels	1250 L / 330 US gal +/- 20% **RF-1250L-IT-SYSTEM**
Reactor Vessel (Acrylic) – Sealed w LED lighting	
Individual reactor vessel - Culture Volume	208 L / 55 US gal **RF-208L-IT-RV**
Power	2.5 kW est. *(when using sunlight ~800W)*
Available voltage	110-120 VAC
Available Frequencies	50 / 60 Hz
Dimensions	Length 3.3 m / 11 ft Width 1.6 m / 5.25 ft Height 2.25 m / 7.4 ft
Recommended working space around reactor	1 m / 3.3 ft
Operating Weight	2500 kg / 5500 lbs.
Peristaltic pumps (variable speed up to 6L/min)	13
Air pump with HEPA filter (0.2um)	1
Control and Monitoring System (CMS) with touch screen monitor / control / data logging / graphing software / WiFi enabled.	**Included.** User interface app may be installed on laptop / desktop / smart devices or using the Rainforest optional Control Module. **Controls include:** temperature / LED light intensity / rotation speed / peristaltic pumps / parameter and component scheduling
Culture Monitoring Equipment	1 K-Type Thermocouple and 1 pH Probe per tube
**Other probes available on request*	

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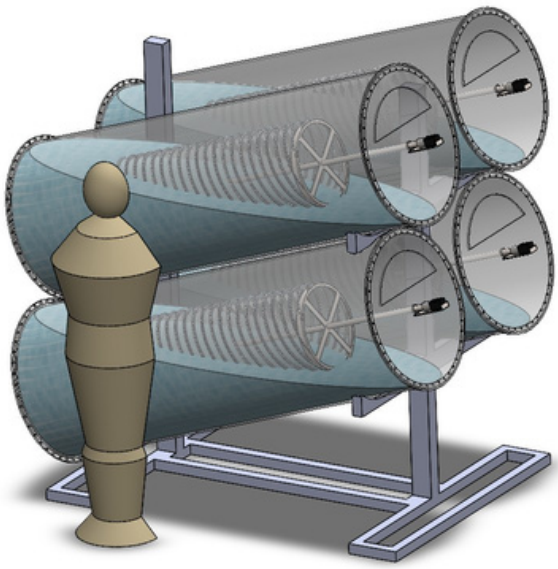
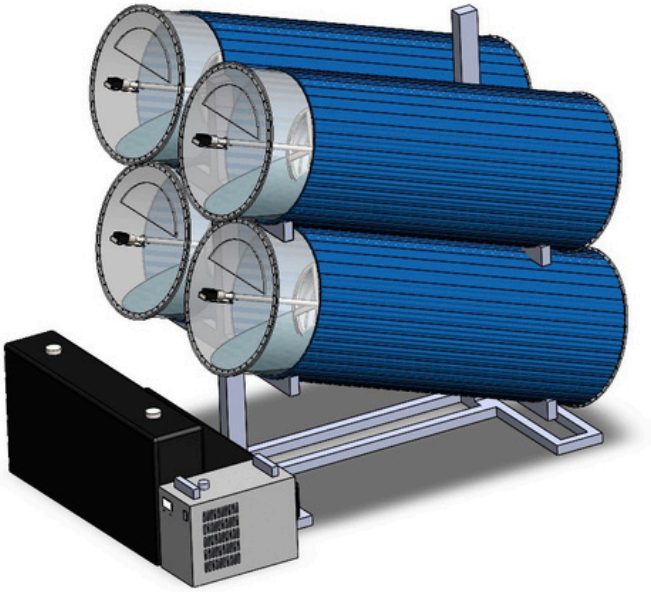
Beluga Calf





Specifications

Culture Volume – comprised of 4 rotating reactor vessels	1250 L / 330 US gal +/- 20%	**RF-1250L-C-SYSTEM**
Reactor Vessel (Acrylic) – Sealed w LED lighting		
Individual Reactor	312 L / 82 US gal	**RF-312L-C-RV**
Power	2.5 kW est.	
Available voltage	110-120 VAC	
Available Frequencies	50 / 60 Hz	
Dimensions	Length 2.6 m / 8.53 ft Width 1.95 m / 6.4 ft Height 2.25 m / 7.4 ft	
Recommended working space around reactor	1 m / 3.3 ft.	
Operating Weight	2200 kg / 4500 lbs.	
Peristaltic pumps (variable speed up to 6L/min)	9	
Air pump with HEPA filter (0.2um)	1	
Control and Monitoring System (CMS) with touch screen monitor / control / data logging / graphing software / WiFi enabled.	**Included.** User interface app may be installed on laptop / desktop / smart devices or using the Rainforest optional Control Module. **Controls include:** temperature / LED light intensity / rotation speed / peristaltic pumps / parameter and component scheduling	
Reactor Vessel Heating / Cooling "Jacket"	Advanced culture temperature control	
Culture Monitoring Equipment	1 K-Type Thermocouple and 1 pH Probe per tube	
**Other probes available on request*		

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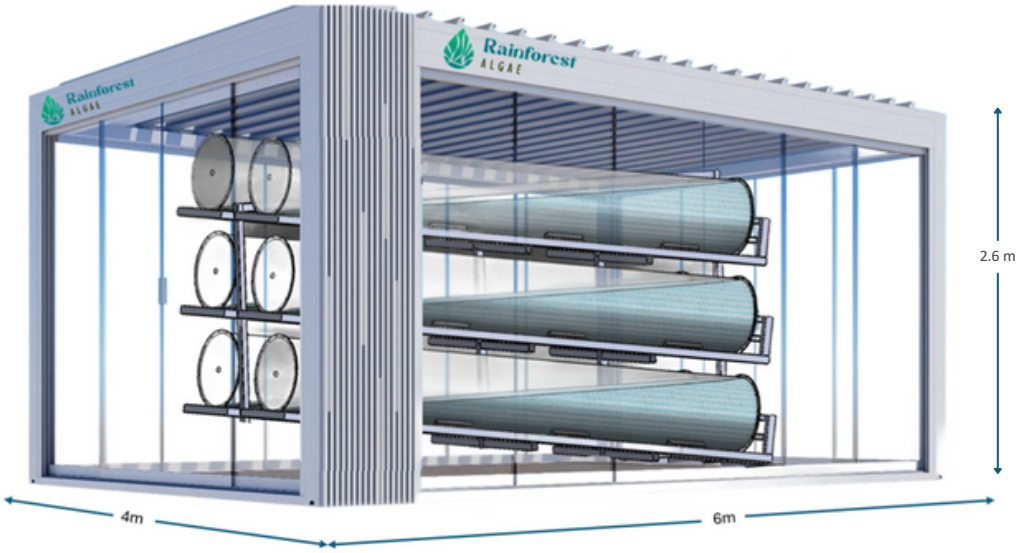
Rainforest Photobioreactor Enclosures RF-ENCL



Specifications

Ceiling louvers 0 – 120°	Electric meter	Clear view 360°
Connect battery / grid inverter	Misting	Footprint 4m x 6m (13 in. x 20 in.)
Sliding 12mm sliding glass doors	Rain sensing	Handles snow load
Smart controls	Wind sensing	All-weather 3-4 season use
Air conditioning (-20°C to 40°C)	Blinds	220V connect, Comm port
Ambient lighting	Solar panels 14kW	Dim: 4m x 6m x 2.6m

The photobioreactor enclosures can be coupled together to create enlarged spaces. A single enclosure may be configured to enclose a reactor system with a culture capacity of $4m^3$. The value of this system is that it allows ambient light (360° + ceiling) to be used for cultivation, while enclosure temperature can be maintained via AC / misting for cooling or enclosure heating to sustain close to optimized environmental conditions. Where direct sunlight may provide too much light intensity or heating within the enclosure, motorized blinds on the outside of the enclosure may be lowered. In the event of severe wind, blinds will automatically be raised. Louvers on the ceiling allow for opening for both more light and ventilation. If the rain sensor senses rain, the louvers automatically close.

Of importance is that for photobioreactors relying on LED lighting, this can represent 80+ % of the operating energy of the reactor system. Utilizing ambient light will significantly reduce or even eliminate the need for additional lighting. The photovoltaic louver panels may also cover much of the other operating energy requirements of the Rainforest reactor systems. 5kW battery storage may reside within the enclosure, and / or the electrical system may be connected to grid . Renewable energy / light significantly reduces the environmental impacts of the system.

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ACCESSORIES

OPTIONS & Replacement Parts

RF-2L-RV-PET	2L Food Grade PET Reactor Vessel
RF-2L-RV-Bor	2L Borosilicate Reactor Vessel
RF-10L-RV-PET	10L Food Gr PET Reactor Vessel
RF-10L-RV-Bor	10L Borosilicate Reactor Vessel
RF-AAP	Absolute Air Pressure
RF-AP-10 Air pump	(10 LPM) with 0.2μm air filter
RF-APG	Analogue Pressure gauge
RF-C	Current
RF-CH-HT	5000W Heater / Chiller
RF-CMS	Control Monitor System
RF-CMS-CP	Controllable Plug AC
RF-CMS-CP(Adj)	Controllable Plug - Variable AC
RF-CO2	CO2 conc (ppm) / RH / Temp
RF-DAP	Differential Air Pressure
RF-DO	Dissolved oxygen (%)
RF-EC	Electrical Conductivity
RF-GVS	Gas Valve Solenoid (on/off)
RF-GVS-Adj	Gas Valve Solenoid (Adjustable)
RF-IMx Series	
RF-IMx-NH3	Ammonia
RF-IMx-NO2-	Nitrite
RF-IMx-NO3	Nitrate
RF-IMx-PO4	Phosphate
RF-LVS	Liquid Valve Solenoid (on/off)
RF-LVS-Adj	Liquid Valve Solenoid (Adjustable)

RF-FM-*xx*	Flowmeter (acrylic) 0.1 - 30 LPM
RF-NB-10S	Nanobubble generator (10L Fixed)
RF-NB-20F	Nanobubble gen (20L/min Flow Thru)
RF-NB-100F	Nanobubble gen (100L/min Flow Thru)
RF-NOx	Nitrous oxide compounds
RF-ORP	Oxygen reduction potential
RF-PH	pH (0.0 -14.0) between 0C - 80C
RF-PM	Particulate matter (airborne)
RF-PP-0.5	Peristaltic pump 0.5L/min
RF-PP-6	Peristaltic pump 6 L/min
RF-PO4	Phosphate
RF-PRx Series	
RF-PRx-MC	Microscope / Camera w flow cell
RF-PRx-OD	Optical Density for cell counting
RF-PRx-V	Viable Cell Count
RF-PRx-TB	Turbidity
RF-PWR	Power(AC)
RF-RTD	Resist. Temp (-50℃ to +500℃)
RF-TDS	Total Dissolved Solids
RF-TK	Temp. K-Type (-40℃ to +400℃)
RF-V	Voltage
RF-VOC	Volatile organic compounds

*Other probes / sensors / solenoids by request