

Customized Perfusion Single-Use-Bioreactor



Semi-Continuous Biomanufacturing

August 2018



Per Stobbe

Please let me explain ...

I PR - Intellectual-Property-Right's



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

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C12M 1/00 (2006.01)
C12M 1/34 (2006.01)

(52) International Application Number:
PCT/US2016/01000

(54) Title: STORBE, PER: Via Light Harvesting 12, 4000 Chino (US)

(57) Abstract: The present invention relates to a flowable dispersion system consisting of a single-use bioreactor, a single-use pump and a single-use microorganism-based mass transfer for harvesting cells from a liquid media of high microorganism concentration in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor. The pump system is a single-use pump connected to a valve to the bioreactor of the single-use bioreactor through a liquid connecting port. The pump system is connected to a valve to the bioreactor through a liquid connecting port to a single-use bioreactor in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor.

(51) Int. Cl. C12M 1/00 (2006.01)
C12M 1/34 (2006.01)
C12M 1/36 (2006.01)

(52) Int. App. No. 2016/01000

(54) Title: DISPENSABLE BIOPROCESS SYSTEM SUPPORTING BIOLOGICAL ACTIVITY

(57) Abstract: The present invention relates to a flowable dispersion system consisting of a single-use bioreactor, a single-use pump and a single-use microorganism-based mass transfer for harvesting cells from a liquid media of high microorganism concentration in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor. The pump system is a single-use pump connected to a valve to the bioreactor of the single-use bioreactor through a liquid connecting port. The pump system is connected to a valve to the bioreactor through a liquid connecting port to a single-use bioreactor in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor.

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(19) World Intellectual Property Organization
International Bureau

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01 February 2018 (01.02.2018)

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WO 2018/022661 A1

(51) International Patent Classification:
B01D 1/34 (2006.01)
B01D 1/36 (2006.01)
B01D 1/38 (2006.01)

(52) International Application Number:
PCT/US2017/017307

(54) Title: DISPENSABLE BIOPROCESS SYSTEM SUPPORTING BIOLOGICAL ACTIVITY

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(12) United States Patent
Shelvit

(49) Patent No.: US 6,544,424 B1
(51) Date of Patent: Apr. 8, 2003

(54) FLUID FILTRATION SYSTEM

(57) Abstract: A filtration system for fluids, particularly biological fluids, comprising a filter connected to one end of a storage vessel and to the other end to a diaphragm pump. The filter comprises a hollow fiber membrane or a screen filter. The vessel serves as a storage container for a process stream to be filtered. The diaphragm pump provides the means for generating rapid, alternating low and high pressure flow between the vessel and pump and through the hollow fibers or screen filter. The system allows easy removal of waste from the filter and the addition of fresh fluid to replenish the filtered fluid.

(51) Int. Cl. B01D 1/36 (2006.01)
B01D 1/38 (2006.01)
B01D 1/34 (2006.01)

(52) Int. App. No. 2002/01212
(54) Title: DISPENSABLE BIOPROCESS SYSTEM SUPPORTING BIOLOGICAL ACTIVITY

(57) Abstract: The present invention relates to a flowable dispersion system consisting of a single-use bioreactor, a single-use pump and a single-use microorganism-based mass transfer for harvesting cells from a liquid media of high microorganism concentration in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor. The pump system is a single-use pump connected to a valve to the bioreactor of the single-use bioreactor through a liquid connecting port. The pump system is connected to a valve to the bioreactor through a liquid connecting port to a single-use bioreactor in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor.

31 Claims, 8 Drawing Sheets

(12) United States Patent Application Publication
STORBE

(43) Pub. No.: US 2018/0112600 A1
(45) Pub. Date: Jun. 7, 2018

(54) REFERENCE SYSTEM

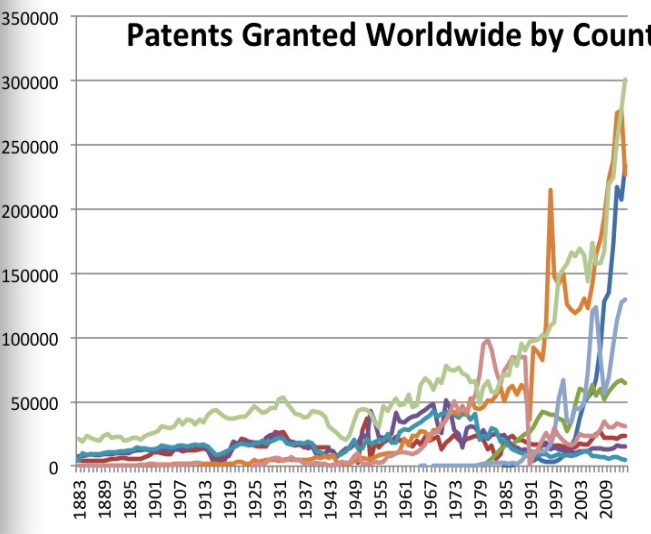
(57) Abstract: The present invention relates to a system consisting of a single-use pump and a single-use microorganism-based mass transfer for harvesting cells from a liquid media of high microorganism concentration in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor. The pump system is a single-use pump connected to a valve to the bioreactor of the single-use bioreactor through a liquid connecting port. The pump system is connected to a valve to the bioreactor through a liquid connecting port to a single-use bioreactor in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor.

(51) Int. Cl. C12M 1/00 (2006.01)
C12M 1/34 (2006.01)
C12M 1/36 (2006.01)

(52) Int. App. No. 2016/01000

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(57) Abstract: The present invention relates to a flowable dispersion system consisting of a single-use bioreactor, a single-use pump and a single-use microorganism-based mass transfer for harvesting cells from a liquid media of high microorganism concentration in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor. The pump system is a single-use pump connected to a valve to the bioreactor of the single-use bioreactor through a liquid connecting port. The pump system is connected to a valve to the bioreactor through a liquid connecting port to a single-use bioreactor in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor.



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24 June 2010 (24.06.2010)

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WO 2010/069321 A2

(51) International Patent Classification:
B01D 1/34 (2006.01)
B01D 1/36 (2006.01)
B01D 1/38 (2006.01)

(52) International Application Number:
PCT/US2009/000251

(54) Title: ELECTRONICALLY CONTROLLED DIAPHRAGM PUMP

(57) Abstract: An electronically controlled diaphragm pump system is provided. The pump system comprises a pump housing with a drive gas chamber and a fluid chamber separated by a diaphragm. The drive gas chamber is connected to one or more gas ports for injecting and/or sucking a gas into and out of the gas chamber. The fluid chamber is connected to a gas inlet port for fluid inlet and a gas outlet port for fluid outlet, where the fluid inlet has a valve adapted to open for fluid inlet when a selected inlet gas pressure is maintained and the outlet port has a valve adapted to open for fluid outlet when gas is injected into the gas chamber. The pump system further has a pressure means connected to a gas inlet port for providing a drive gas pressure in response to a control signal, and a gas inlet pressure means connected to a gas outlet port for providing a gas inlet pressure and the gas underpressure means. It is preferred that the displacement sensor for determining the displacement or position of the diaphragm and adapted for supplying the control signal to the gas pressure means and the gas underpressure means. It is preferred that the means for providing a drive gas pressure comprise a gas pressure proportional control valve being connected to the gas inlet and the control circuit, whereby the drive gas pressure is varied as a function of the control signal supplied by the control circuit. Also, the means for providing a gas underpressure means comprise a gas underpressure proportional control valve being connected to the gas outlet and the control circuit, whereby the gas underpressure is varied as a function of the control signal supplied by the control circuit.

(51) Int. Cl. B01D 1/34 (2006.01)
B01D 1/36 (2006.01)
B01D 1/38 (2006.01)

(52) Int. App. No. 2009/000251

(54) Title: DISPENSABLE BIOPROCESS SYSTEM SUPPORTING BIOLOGICAL ACTIVITY

(57) Abstract: The present invention relates to a flowable dispersion system consisting of a single-use bioreactor, a single-use pump and a single-use microorganism-based mass transfer for harvesting cells from a liquid media of high microorganism concentration in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor. The pump system is a single-use pump connected to a valve to the bioreactor of the single-use bioreactor through a liquid connecting port. The pump system is connected to a valve to the bioreactor through a liquid connecting port to a single-use bioreactor in a perfusion mode continuous process for expression of a protein of interest in a single-use bioreactor.

Ready to use
"right out of
the box"

The building block's for **Perfusion-SUB's**

1 SUB Single-Use- Bioreactor

A SUB specifically designed for your application.

Adaptable Working Volume, special impeller and aerator, desired length and hose brand, fit your existing PCS, etc.



2a Clio Single-Use-Pump

Clio in an One-way-Single-Use-Pump (O-SUP) combining the HFF and SUB into the P-SUB.

Clio is a true Positive Displacement liquid pump fully computer controlled.



2b Thalia Single-Use- Exchanger

Thalia is an Alternating-Single-Use-Exchange (A-SUE) connecting the HFF with the SUB.

Thalia is a true Positive Displacement broth exchanger fully controlled.



2c Aglaea Single-Use- Exchanger

Aglaea is an Alternating-Single-Use-Exchange (A-SUE) connecting the HFF with the SUB.

Aglaea is controlled by C-24.



3 SUS Single-Use- Sensor's

Single-Use-Sensor's which fit your existing Process-Control-System connections.

Parameters measured with VisiFerm, OneFerm, PICO biomass and level.



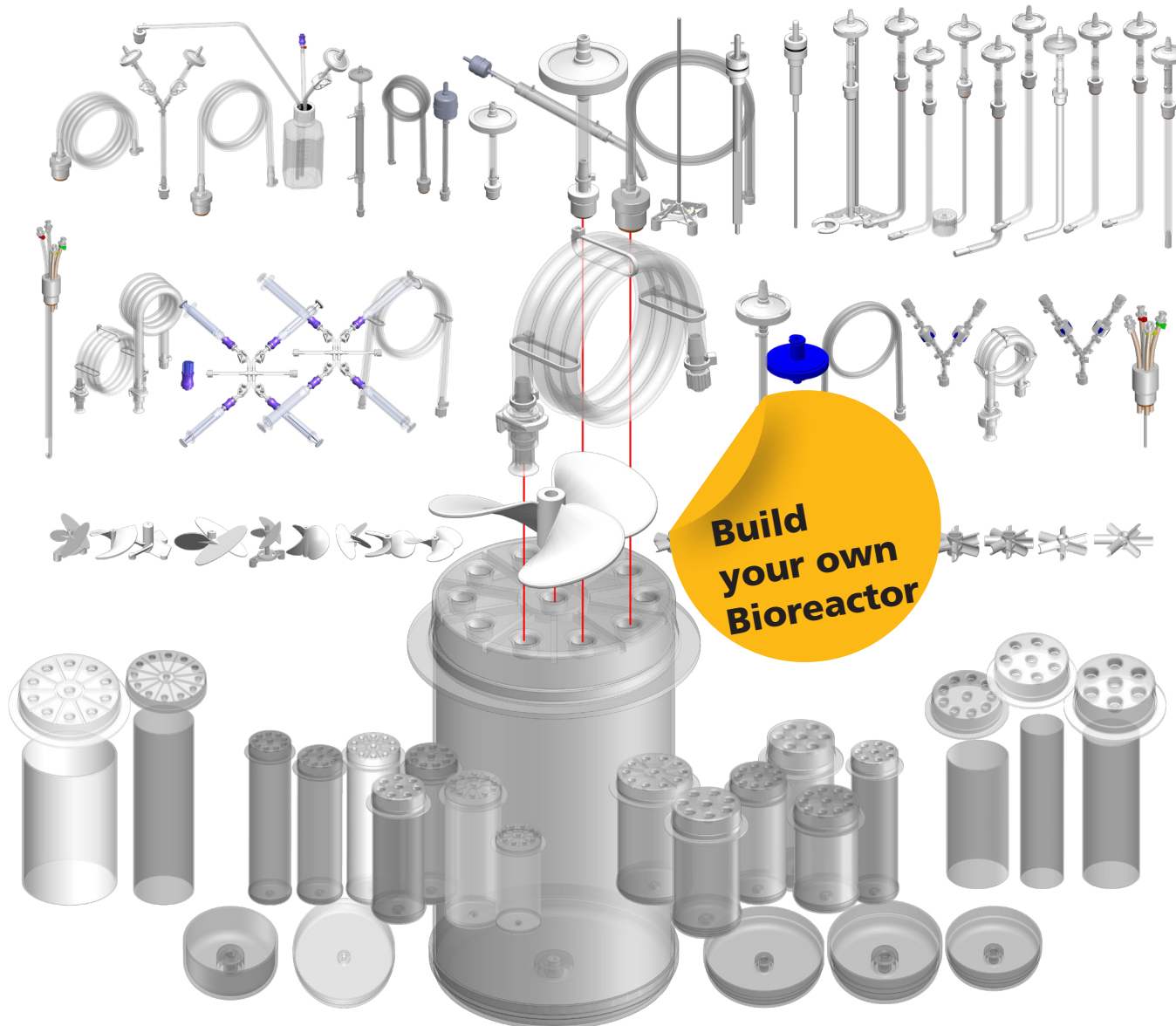
4 HFF Hollow-Fiber- Filter

Choose your preferred size Hollow-Fiber-Filter combined with the O-SUP or A-SUE and the SUB.

Any type, number and brand of HFF can be added.

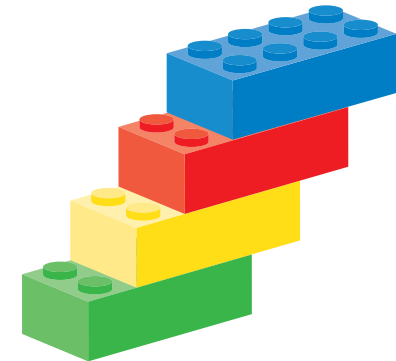


① What does “Customized” really mean?



Build your next
Perfusion-SUB
exactly to your
needs ...

We have more than 5.000 components
designed to fit each other. That's
millions of combinations !



If you know Lego® you will like to
build with us.

It's all Plug & Play!

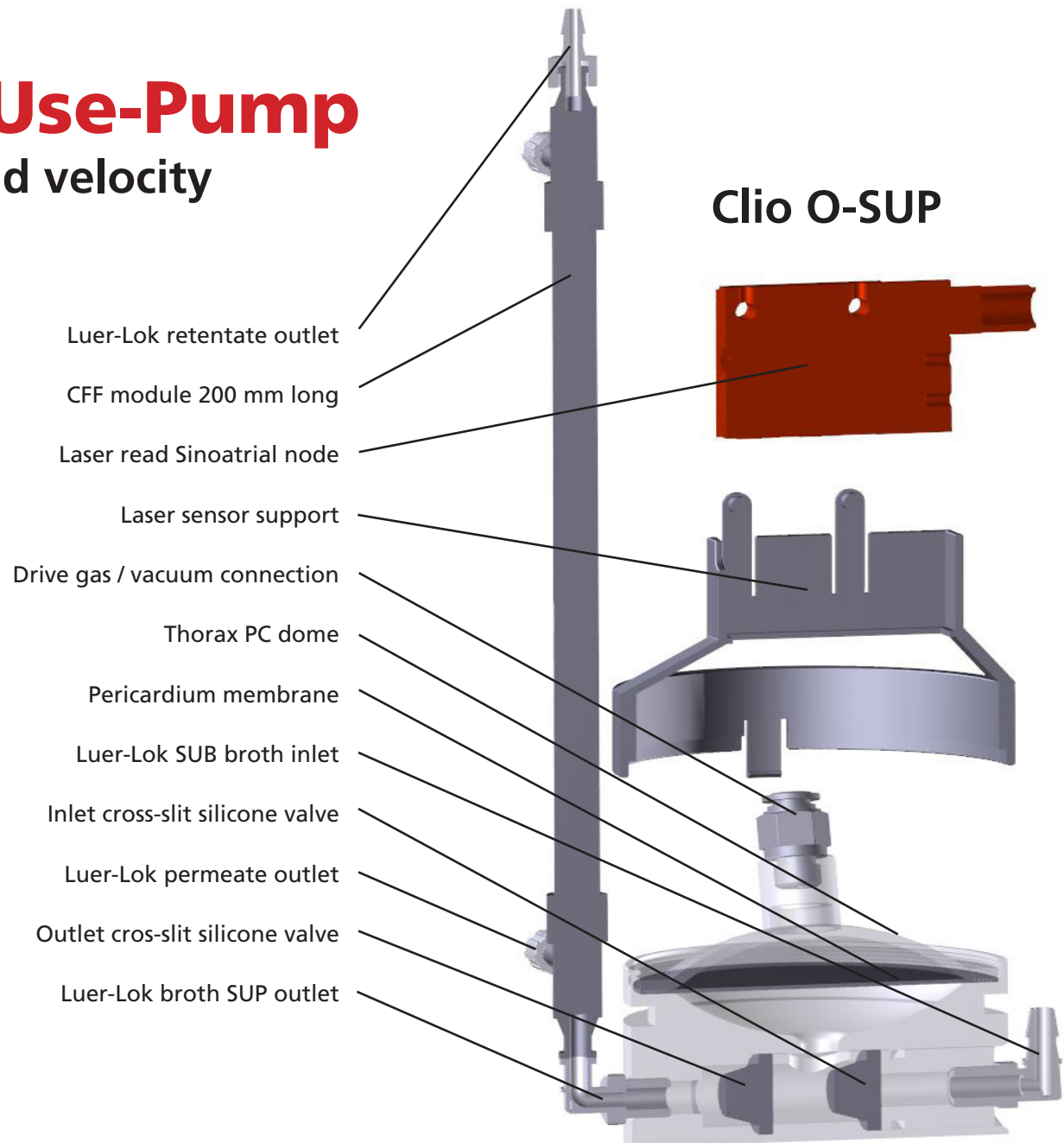
2a **Clio**
One-way-Single-Use-Pump
Measures accurate volume and velocity

The O-SUP is a pump arranged inside a Polycarbonate housing with a set of passive liquid conveying valves.

The 1,0 mm thick silicone Pericardium membrane separates the drive gas pressure and / or vacuum from the broth.

The red tri-angular laser sensor read the membrane position with 0,1 mm accuracy at any time. Pressure sensors inside Clotho Drive Unit help calculating online the drive gas pressure. Clotho control via proportional valves and PID loop the wanted membrane position.

Clio can easily be programmed to pump fluids in 1:1000 range over time or by conveyed amount of fluid. Clio is a true Positive Displacement (PD) pump where every stroke is measured accurately independent of the ever dynamic stroke volume. Each stroke duration can vary between seconds and multiple minutes.




Thalia

Alternating-Single-Use-Exchanger

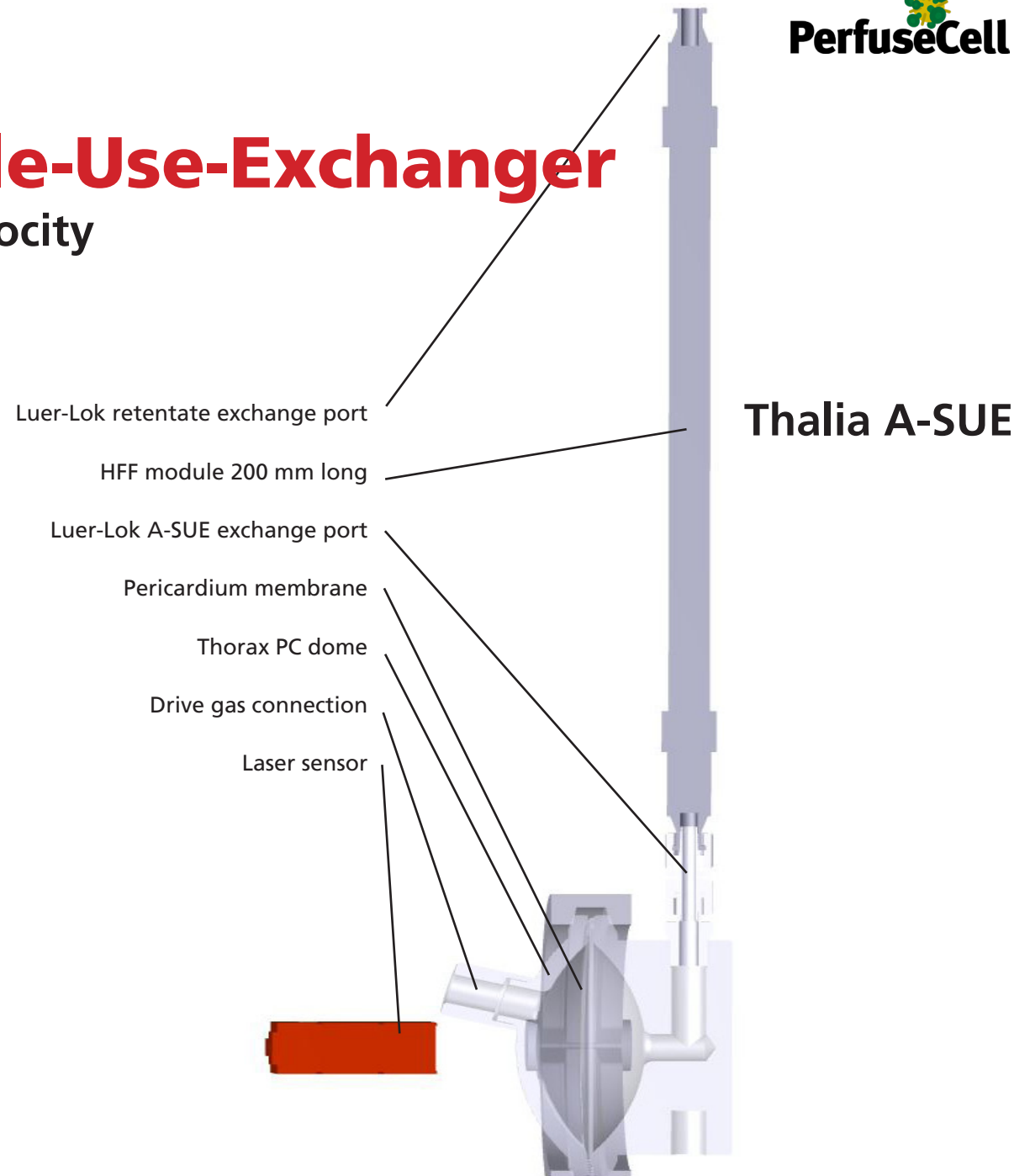
Measure both volume and velocity

The A-SUE is arranged inside a Polycarbonate housing with no liquid valves. The A-SUE exchange liquid forth and back.

The 1,0 mm thick silicone Pericardium membrane separates the drive gas pressure and vacuum from the broth.

The red tri-angular laser sensor read the membrane position with 0,1 mm accuracy at any time. Pressure sensors inside Clotho Drive Unit participate in online calculation of the needed drive gas pressure. Clotho control proportional valves and hereby in PID loop the wanted membrane position.

Thalia can easily be programmed to convey fluid in 1:1000 range over time or by exchanged amount of fluid. Thalia is a true Positive Displacement (PD) exchanger where every stroke is measured accurately independent of the ever dynamic stroke volume. Each stroke duration can vary between seconds and multiple minutes.





Aglaea

Alternating-Single-Use-Exchanger

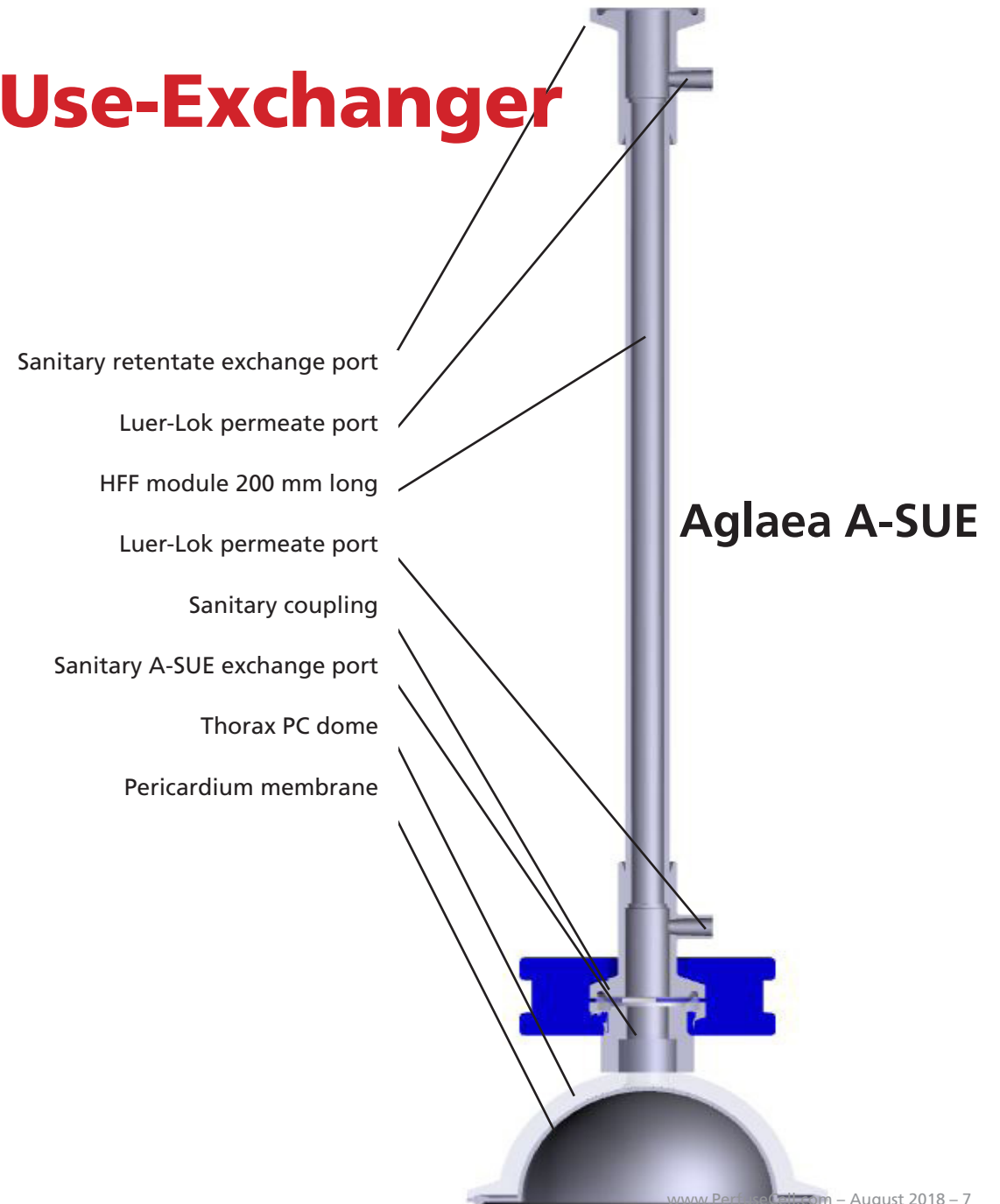
Alternating-Single-Use-Exchanger

The A-SUE diaphragm is arranged inside a Polycarbonate housing with no connected liquid valves. The A-SUE exchange liquid broth forth and back.

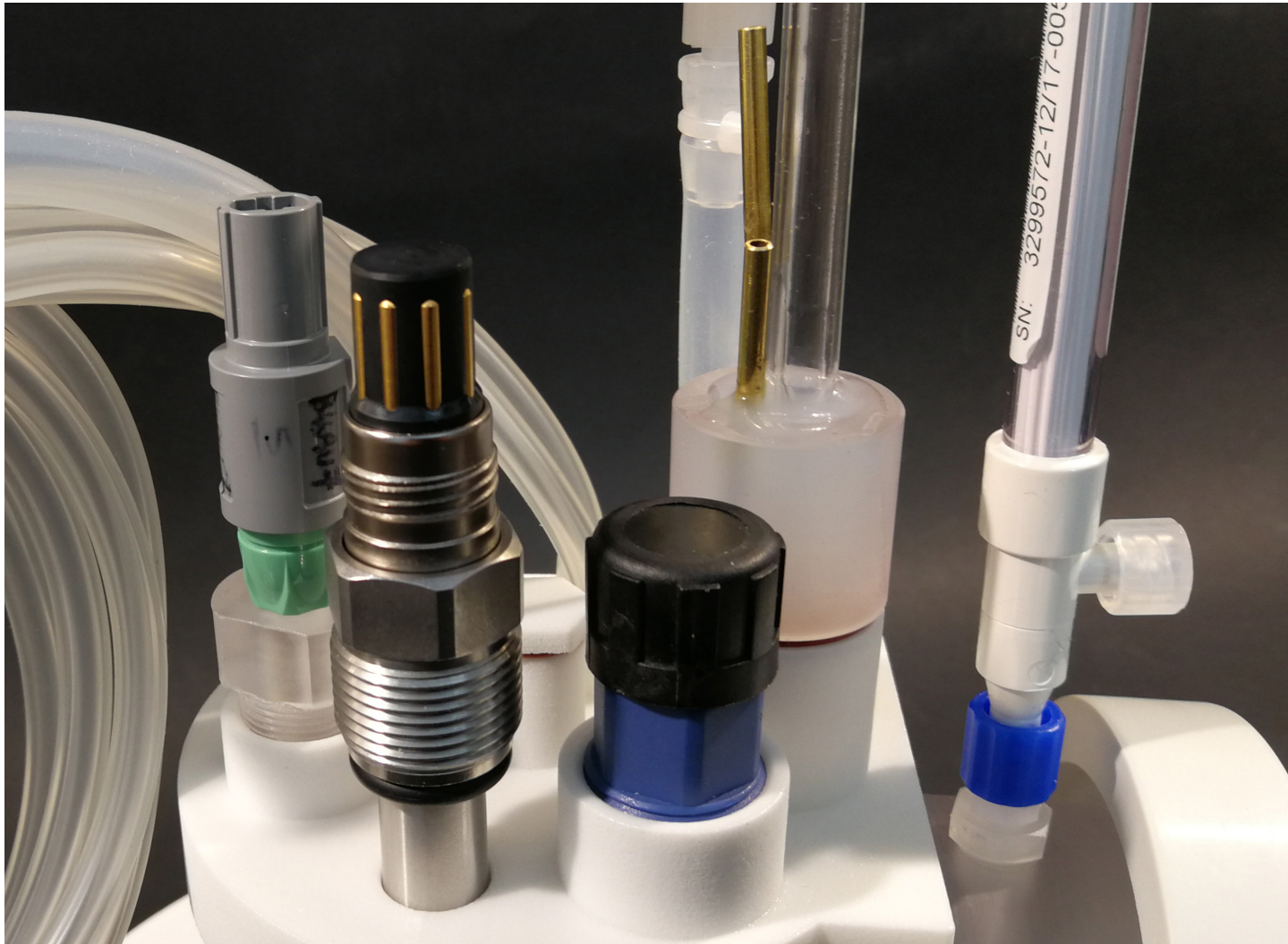
The 1,0 mm thick silicone Pericardium membrane separates the drive gas pressure / vacuum from the broth.

Aglaea with the sanitary flange and standard dimensions fit onto the ATF stainless steel foot.

Pressure sensors inside C-24 drive dnit controls the drive gas pressure.



③ The unique **Single-Use-Sensor's** measures DO, pH, bio-mass, level



The complete P-SUB family as standard include through the head-plate vertically mounted pre-installed Single-Use-Sensor's (SUS) for DO, pH, and level.

Depending on P-SUB size bio-mass SUS mounted vertical through head plate or horizontal at bottom.

For accurate DO measurements we pre-install either VisiWell or PolarWell. Use the optical or polarographic Re-Usable-Sensor supplied with your PCS.

For pH measurements standard PCS cabling with either AK9 or AS8 connector coupled to the pre-installed pH SUS is recommended.

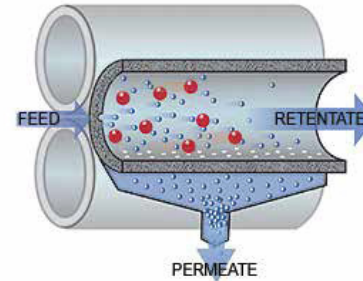
PICO Futura SUS capacitance as standard.

④ The Hollow-Fiber-Filter separates at only 200 nm

Cross Flow Filtration is an efficient method for filtration and separation of solutions containing biomolecules, or particles such as viruses, bacteria or cellular material. It is a process whereby product flow (broth feed) is directed inside the multiple straw / tube shaped membranes with most of the solution as retentate circulated back into the SUB. A minimum of the broth feed pass tangentially across the membrane as permeate.

The rapid flow of broth along the membrane acts to 'sweep' the surface, reducing concentration polarization. It also prevents build-up of foulants that can plug the pores at the membrane surface. The rapid cross flow creates a pressure drop, which forces some of the feed solution and dissolved molecules that are smaller than the pores in the membrane, through the membrane filter as permeate.

The solution that passes through the membrane is referred to as filtrate or permeate. Molecules or particles larger than the membrane pores are retained in the feed, broth and effectively concentrated in the SUB.



Mini P-SUB

integrated Single-Use-Pump,
Single-Use-Sensor's and
Hollow-Fiber-Filter

CellMembra-500

Miniature P-SUB for cell retention in perfusion cultivation setup in a fully single-use setup. CellMembra-500 integrates a customized CellVessel Single-Use-Bioreactor (SUB) and a One-way-Single-Use-Pump (O-SUP) and 4 Single-Use-Sensor's combined with the HFF (Hollow-Fiber-Filter).

Features of CellMembra-500:

- CellVessel SUB designed for your applications and setup.
- Supplied with Single-Use-Sensor's (SUS) being DO, pH, bio-mass, and level.
- Pumped volume and obtained velocity accurately measured – no guessing.
- The complete and pre-assembled unit packed in dual film bags and precision irradiated – forget the autoclave.
- Working Volume (WV) range from 100 ml to 400 ml.



Mini P-SUB

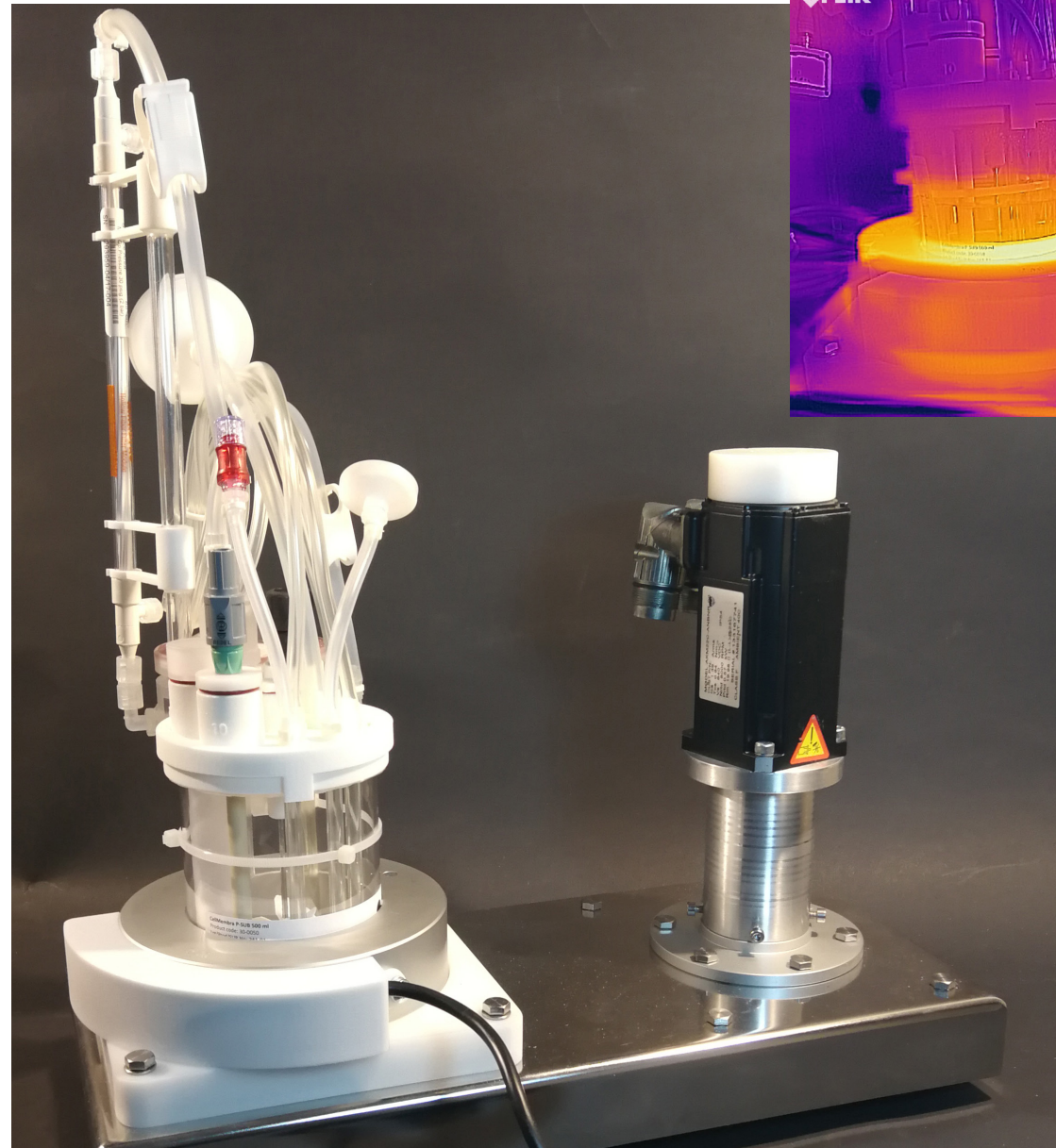
driven by standard PCS

CellMembra-500

Mini CellMembra™ P-SUB's may easily be driven by traditional Process-Control-System's (PCS) servo motor's. The high thermal mass Heating-Support-Foot (HSF-E) insure good PCS PID algorithm regulation. Select either electrical or water thermal control.

Features of CellMembra-500:

- Select the impeller for operation with your application and PCS setup.
- Single-Use-Sensor's (SUS) as currently available (DO, pH, bio, level).
- 500 ml Vessel Volume (VV) for Working Volume (WV) ranging from 100 ml to 400 ml.
- The complete and pre-assembled unit packed in dual film bags and precision irradiated – forget the autoclave.



Mini P-SUB

with Single-Use-Exchanger,
Single-Use-Sensor's,
Hollow-Fiber-Filter

CellRetention-500

Miniature P-SUB for cell retention in perfusion cultivation setup in a fully single-use setup. CellRetention-500 integrates customized CellVessel Single-Use-Bioreactor (SUB), Alternating-Single-Use-Exchanger (A-SUE), and 4 x Single-Use-Sensor's with the HFF (Hollow-Fiber-Filter).

Features of CellRetention-500:

- CellVessel SUB designed for your applications and setup.
- Supplied with 4 x Single-Use-Sensor's (SUS) being DO, pH, bio-mass, and level.
- Exchanged (alternating) volume controlled and obtained velocity accurately measured and displayed – no guessing.
- The complete and pre-assembled unit packed in dual film bags and precision irradiated – forget the autoclave.
- Working Volume (WV) ranging from 100 ml to 400 ml.



**100 ml
mini P-SUB**



Parallel P-SUB's

designed for any Process-Control-System

Perfusion-SUB-500

Do you need like 4 or 8 or 16 P-SUB's operating in parallel? Mix freely between the 500 or the 3200 size P-SUB's and even CellVessel SUB's? Do you already have 4 or more Process-Control-System's (PCS) available in your lab. Straight forward with all the accessories available from PerfuseCell.

Its all Plug & Play!

- Whatever servo motor you may have the MST can adapt – with agitation for both 500 ml and 3.200 ml VV P-SUB's.
- The width of 4 x P-SUB's mounted in HSF on MST is less than 0,8 meter space on your lab table.
- This setup fits in particular well the DasGip Parallel PCS system with RE30 or RE40 servo motors (PCS pn 76DG04CC or 76DG08CC or 76DG16CC).

Customized
to your
wish



Medium size P-SUB with Single-Use-Pump, Single-Use-Sensor's, Hollow-Fiber-Filter

The 3,2 liter Vessel Volume (VV) P-SUB is a fully customizable CellVessel expanded into the CellMembra concept

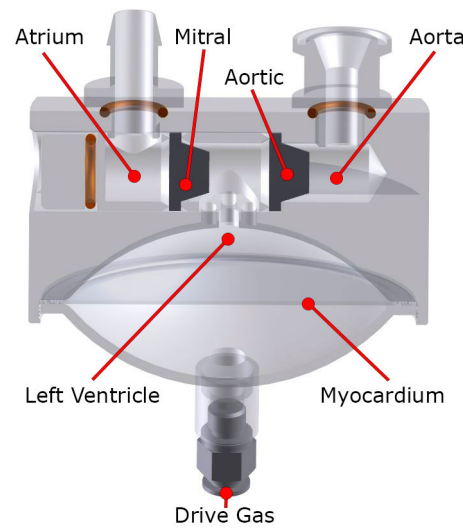
CellMembra-3200

- CellVessel SUB with 3,2 liter Vessel Volume (VV)
- CellVessel SUB ranging 0,4 – 2 liter Working Volume (WV)
- Integrated Clio-100 O-SUP with fully controlled and measured 0 – 100 ml volume per stroke
- Any available HFF can be specified and pre-installed and as many as needed
- SUB with any type of impeller and as many as needed
- Agitation from top (HPD) facilitates RE30, RE40, P100 servo motor with ID25-A adaptor, or Biostat with ID39-B adaptor
- Agitation by Magnetic-Bottom-Drive (MBD) by PerfuseCell Magnetic-Stirrer-Table (MST) by any servo motor. Such as Biostat servo motor with ID39-B adaptor
- Single-Use-Sensor's with connectors which fit your PCS



Medium size P-SUB

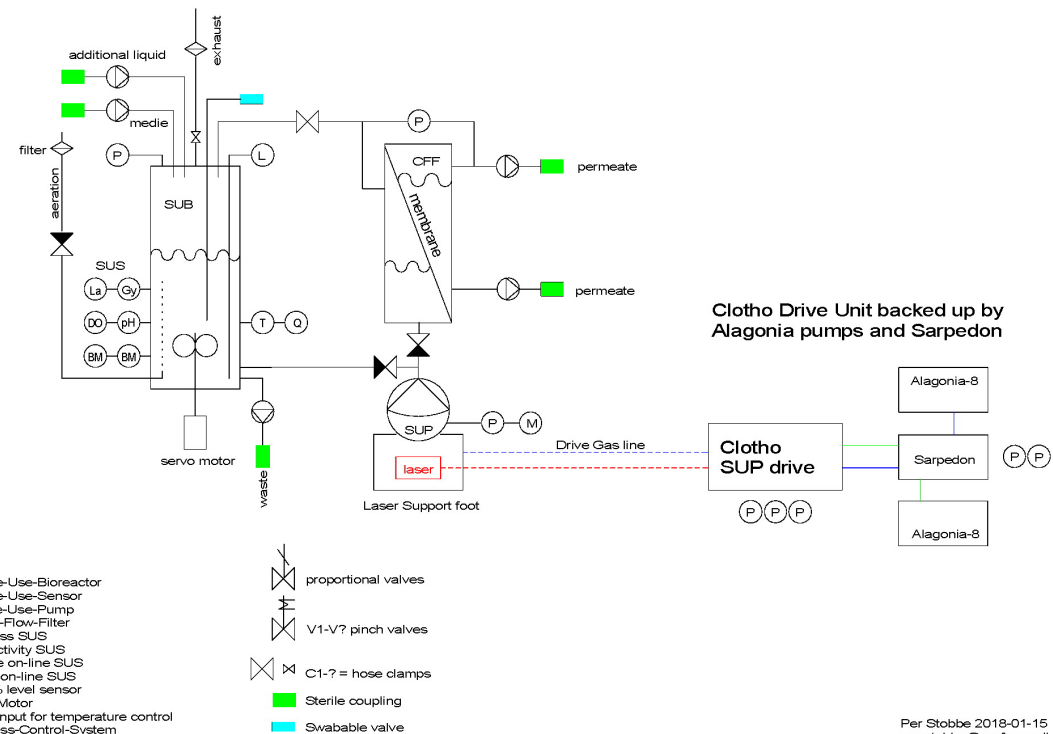
with Single-Use-Pump,
Single-Use-Sensor's,
Hollow-Fiber-Filter



CellMembra-3200

- CellMembra-3200 is all pre-assembled and ready to use
- O-SUP is Clío-100 with selectable 0-100 ml volume per stroke
- O-SUP fully controlled volume and velocity by Clotho
- Fully customized setup and any HFF mono or dual
- Single-Use-Sensor's (SUS) as required (DO, pH, bio-mass, level)
- Compact Clotho Drive Unit is needed
- Alternatively Alagonia-8 pumps and perhaps Sarpedon
- Drive Unit is available in both a single channel and dual channel version within the same U2 cabinet

CellMembra Perfusion-SUB integrating Clío O-SUP pump, sensors, valves
Perfusion, cell retention, one direction pulsating flow through CFF



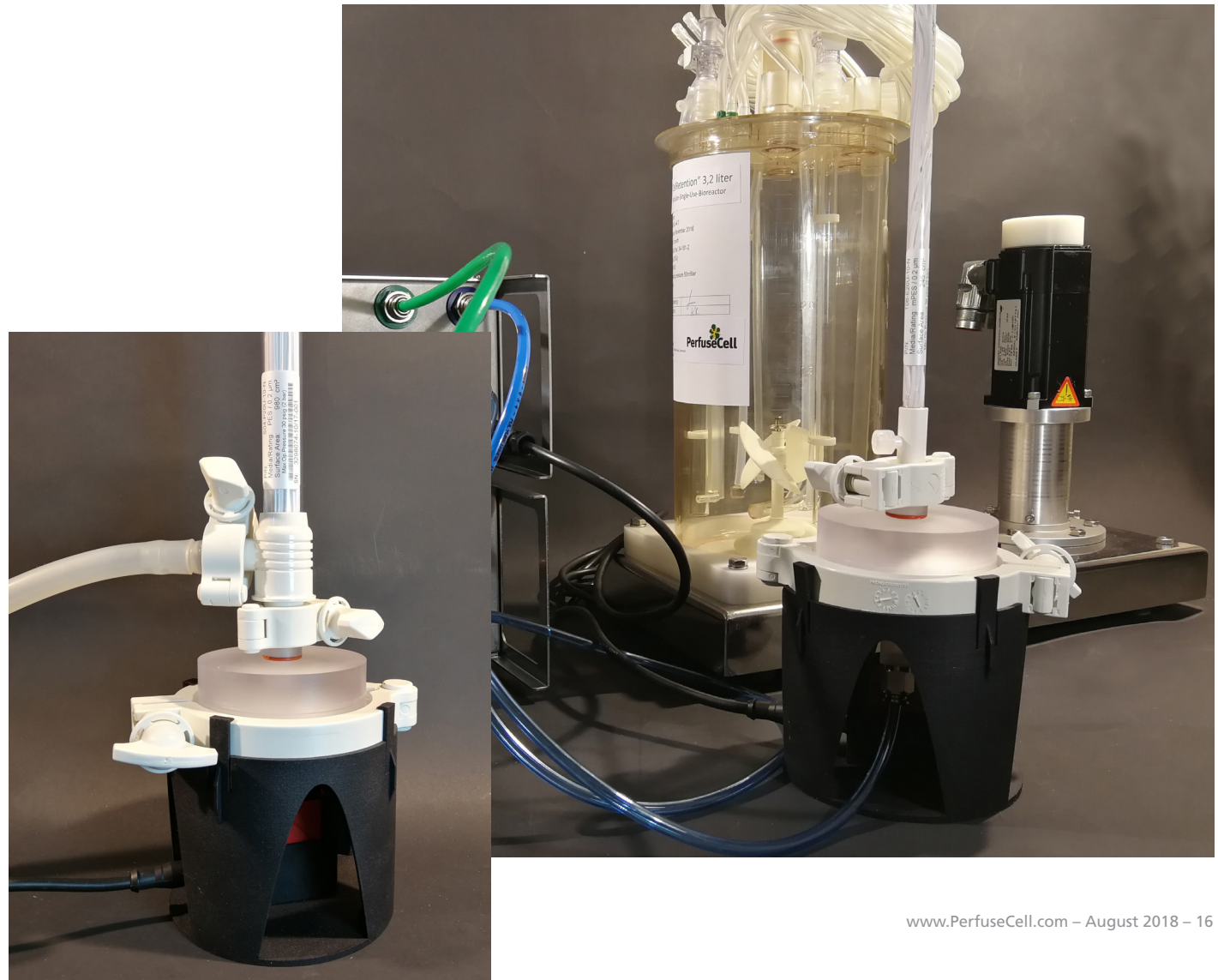
Per Stobbe 2019-01-15
per.stobbe@perfusecell.com

Medium size P-SUB

integrates Single-Use-Exchanger,
Single-Use-Sensor's,
Hollow-Fiber-Filter

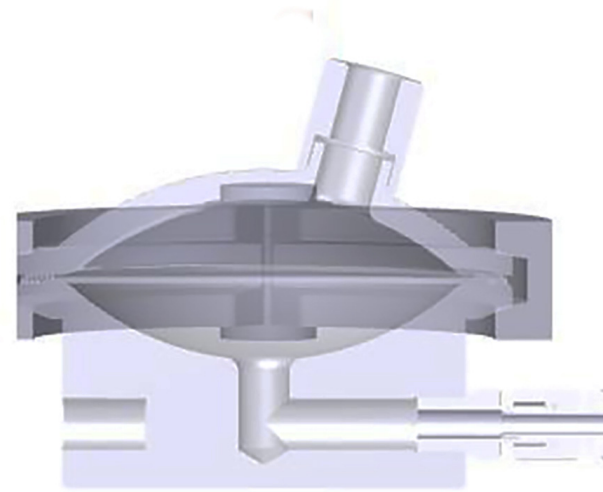
CellRetention-3200

- CellVessel SUB with 3,2 liter Vessel Volume (VV)
- CellVessel ranging 400-2.000 ml Working Volume (WV)
- Integrated Thalia-100 A-SUE fully controlled and measured 0-100 ml volume per stroke
- Any available HFF can be specified and pre-installed and as many as needed
- SUB with any type of impeller single or dual
- Agitation by Magnetic-Bottom-Drive (MBD) by PerfuseCell Magnetic-Stirrer-Table (MST) with any servo motor
- Range of Single-Use-Sensor's with connectors which fit your PCS
- Check out thermal control below



Medium size P-SUB

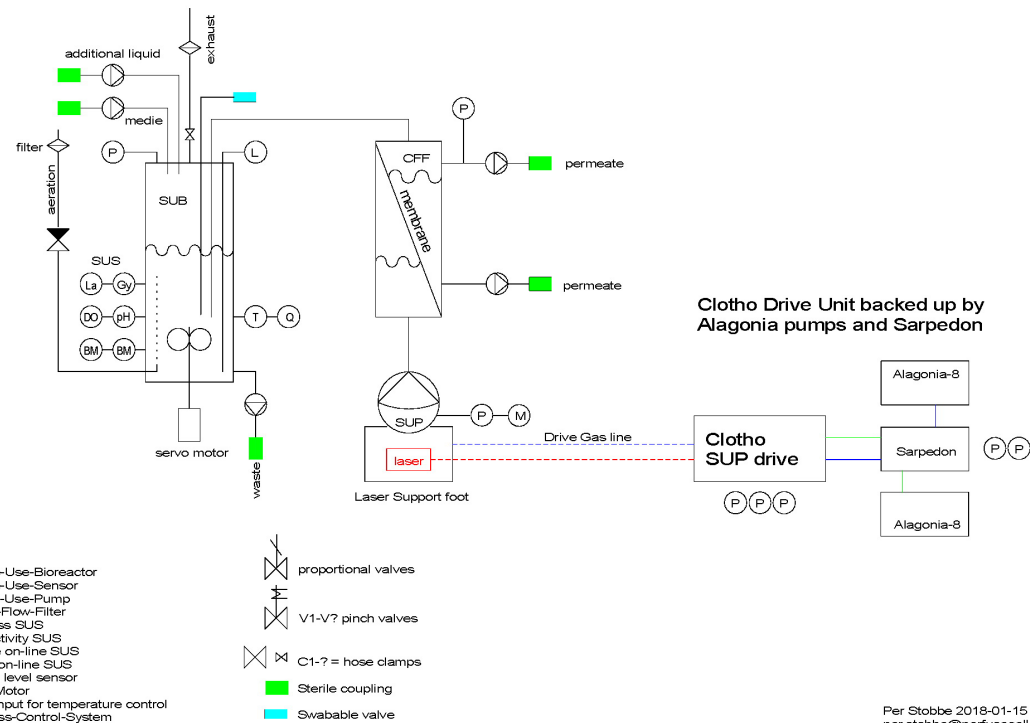
with Single-Use-Exchanger,
Single-Use-Sensor's, single-use
Hollow-Fiber-Filter



CellRetention-3200

- CellRetention-3200 is all pre-assembled and ready to use right out of the box
- A-SUE is Thalia-100 offering 0-100 ml per stroke accurately programmed
- A-SUE fully controlled volume and velocity
- Fully customized setup and any or multiple HFF
- Single-Use-Sensor's (SUS) as required (and available)
- Clotho Drive Unit is needed
- Alternatively Alagonia-8, Alagonia-12 drive gas pumps and Sarpedon

CellRetention Perfusion-SUB integrating Thalia A-SUE, Single-Use-Sensors, Cross-Flow-Filter for alternating pulsating flow through CFF



Medium size P-SUB

with Single-Use-Exchanger,
Single-Use-Sensor's, single-use
Hollow-Fiber-Filter



CellTernate-2 Perfusion-SUB

- CellTernate-2 is all pre-assembled and ready to use right out of the box
- Aglaea-100 A-SUE offer 0 – 100 ml broth flow per stroke
- Aglaea-100 connects to the 2,5" ATF-2 foot and hereby fully controlled by C-24
- Fully customized setup and any or multiple HFF as to your wish
- Single-Use-Sensor's (SUS) as required (and available)
- Your own C-24 drive unit is needed
- Check out thermal control below



Ultra compact Clotho-2 Drive Unit

for CellMembra and CellRetention



The portfolio of CellMembra and CellRetention Perfusion-SUB's are all driven by the green Clotho software for super accurate control and comprehensive data acquisition.

The ultra compact Clotho-2 Drive Unit is able to control both the Clio One-way-Single-Use-Pump's (O-SUP) and / or the Thalia Alternating-Single-Use-Exchanger (A-SUE) over distances up to 2 meter with 1% accuracy.

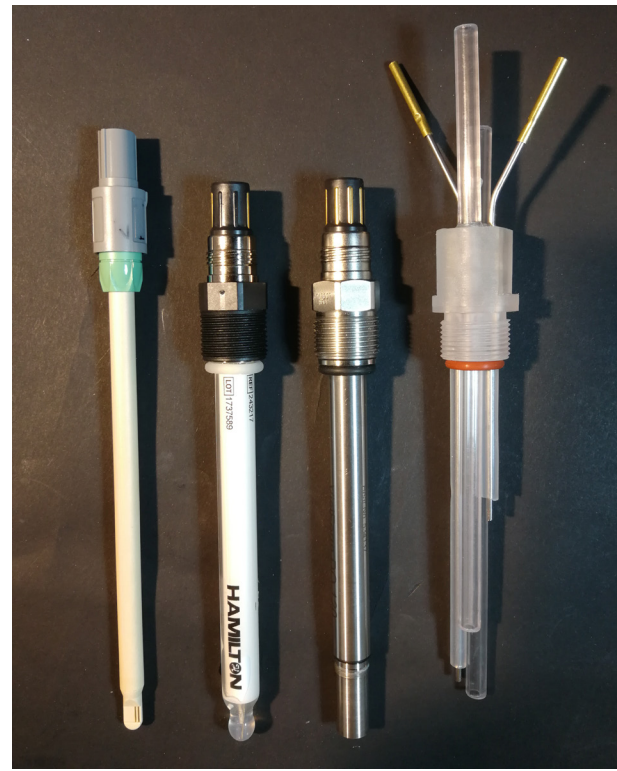
The all stainless steel and stackable Hephaestus U2 cabinet measures (in mm):

- W: 230
- D: 230
- TD: 295
- H: 110

③ The unique **Single-Use-Sensor's** measures DO, pH, bio-mass, level

All pre-installed:

- Capacitance bio-mass
- Customized high quality pH
- Customized high quality DO
- Customized high quality level
- All Single-Use-Sensor's



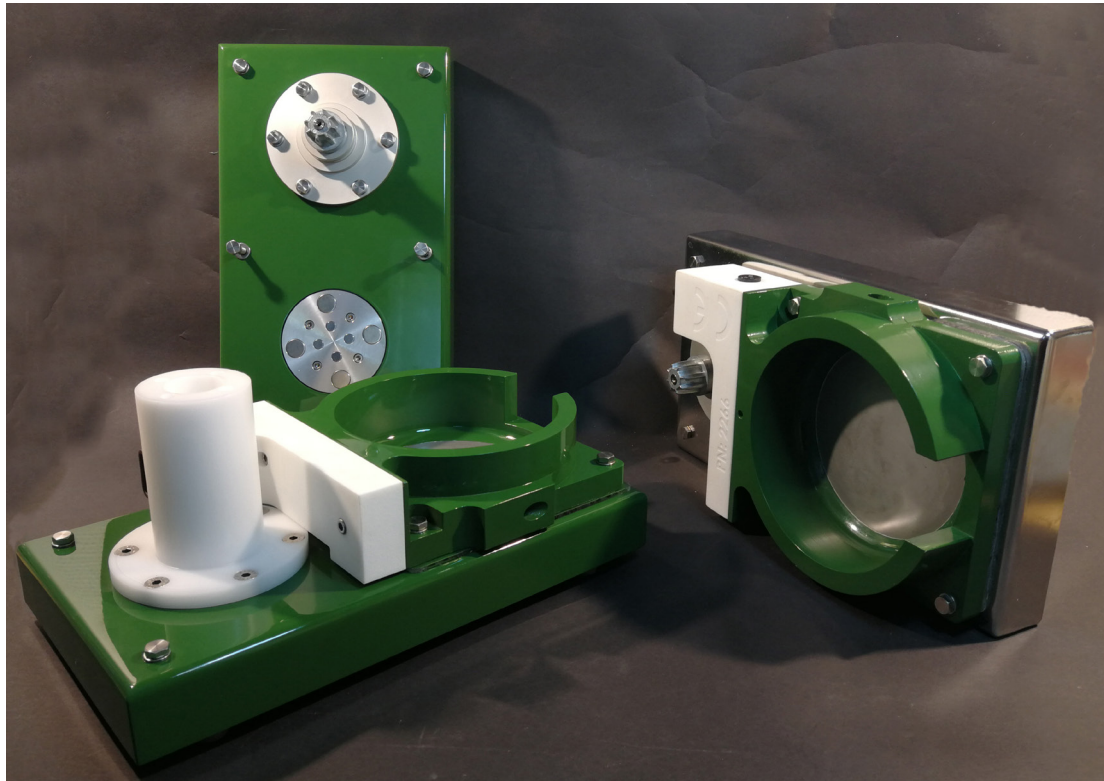
Thermal control

The best thermal control for all 3.200 ml size P-SUBs

Its all Plug & Play!

Heating-Support-Foot (HSF) that fits any of the 3.200 ml vessel's. Able to operate with small volumes starting from few hundred ml up to 2.000 ml.

Allow installation of 3.200 ml Vessel Volume sizes like CellTernate-2 with horizontal mounted PICO bio-mass Single-Use-Sensor.



Whatever happens – you can run the P-SUB dry, forget media, thermo couple fall out, PCS breaks down ... this advanced HSF will newer destroy the P-SUB and leak out media or burn your fingers when trying to solve the problem!

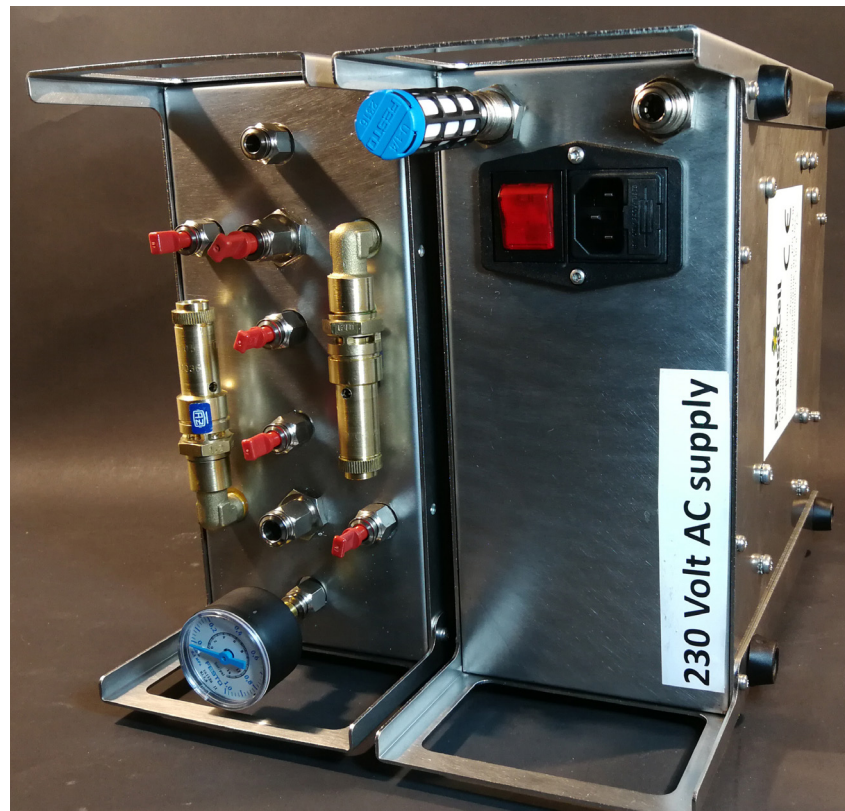


Clotho Drive Unit accessories

Clotho Drive Unit is housed in ultra compact stainless steel Hephaestus size U2 cabinet.

Clotho-2 facilitate two (red) Laser sensor input and several internal pressure sensors. For independent control of two in parallel and selectable size operating Single-Use-Pump's and / or Single-Use-Exchanger's.

For simple, low noise, ultra compact and fast setup – Alagonia drive gas pump's and Sarpedon manifold / reservoir.



Clotho software

drive both O-SUP and A-SUE

Clotho Drive Unit's contain a webserver displaying online information on the build-in display. The webserver allow the enduser with a smartphone or a PAD to connect to the webserver for programming. Linux runs on a 900 MHz quad-core ARM Cortex-A7 CPU. Clotho software is based on CodeSys PLC platform on top of Linux firmware.

When Clotho is connected to a supply of drive pressure and vacuum source with sufficient capacity, then the spec is:


- Stroke frequency, per minute: 0,5-15
- Stroke duration, seconds: 1-60
- HFF broth velocity, m/s: 0,1-12

Ver. C.70

Cleaning/Harvest relation	Set point conveyed volume	Velocity calc straws & diameter		Configuration
1 : 5	200 ml/min	1	1.0 mm	Close
Automatic device control		Manual device control		
Run	Stop	Vacuumize	Pressurise	

Clotho-2

Year Month Day Hour Min. Sec.
Time: 2018 2 12 14 21 22



Adjust Time

Wanted 0 Y 0 M 0 D 0 h 0 m 0 s

Set Time

Device selection:

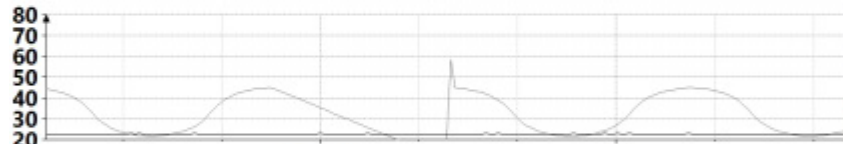
O-SUP

A-SUE

Thalia-30

Clio-30

Clio-100



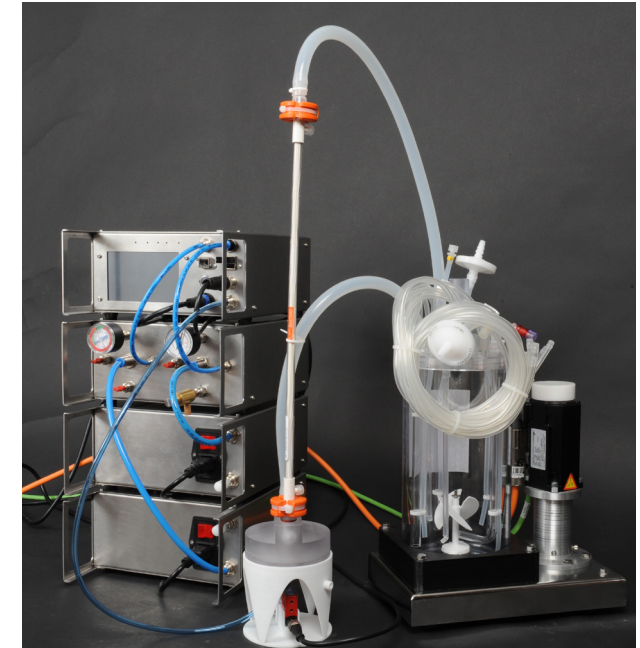
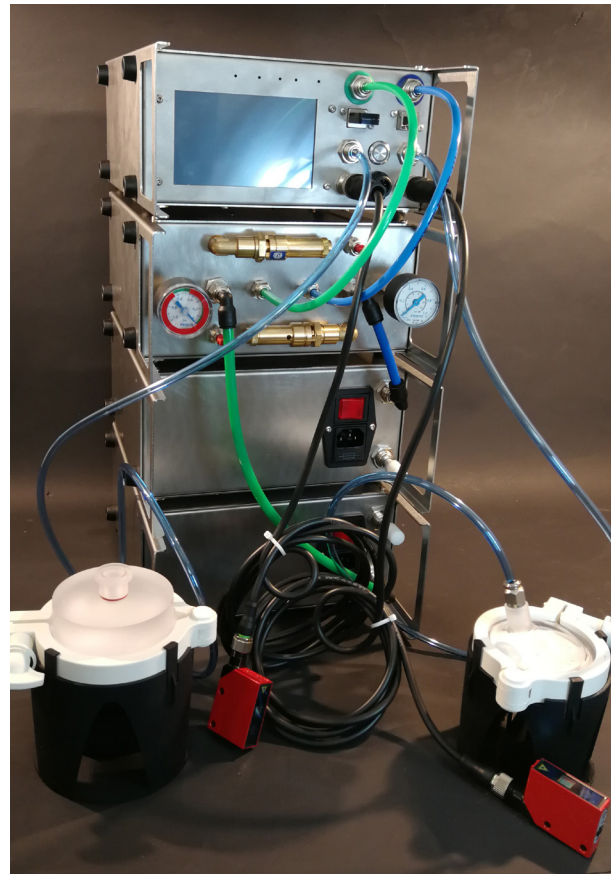
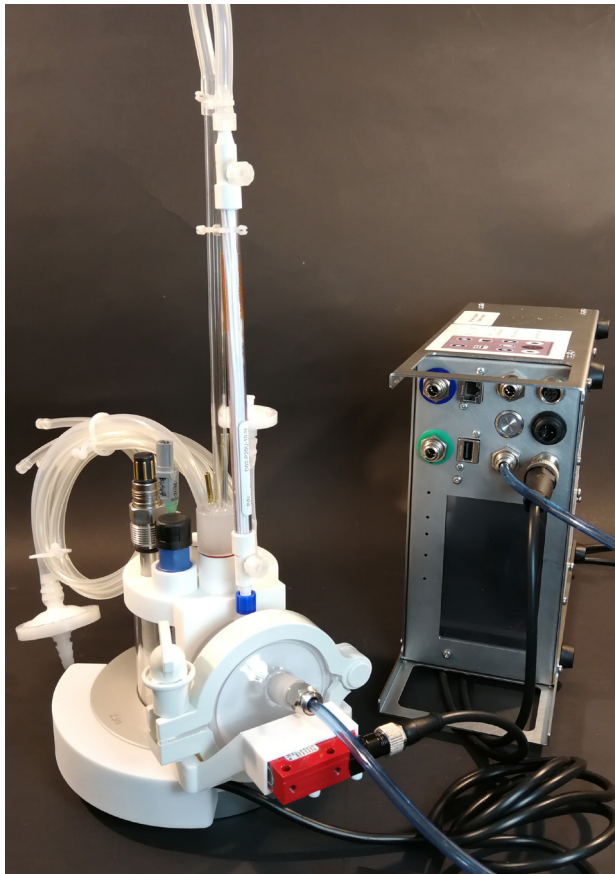
	3m30s	4m	
Drive Gas▲P	Real time vol. (ml/min sec)	Device stroke per min	Last harvest avg. velocity:
-0.011 Bar	2.2 ml/min	5	- 0.0 m/s
Supply▲P	Avg. volume conveyed	Device stroke before cleaning:	Last cleaning avg. velocity:
-0.012 Bar	59.3 ml/min	3	- 0.0 m/s
Vacuum▲P	Total volume conveyed	Total device stroke:	Total run time:
-0.014 Bar	13.0 ml	31	4.2 min

Clotho-2 Drive Unit **setup** for CellMembra & CellRetention

Dual channel fully independent operated by Clotho-2 Drive Unit.

Clotho-2 designed for control of two in parallel operating Single-Use-Pump's and / or Single-Use-Exchanger's.

Shown with Alagonia-8 drive gas pump's and Sarpedon manifold / reservoir – all in the same ultra compact Hephaestus U2 cabinet's.

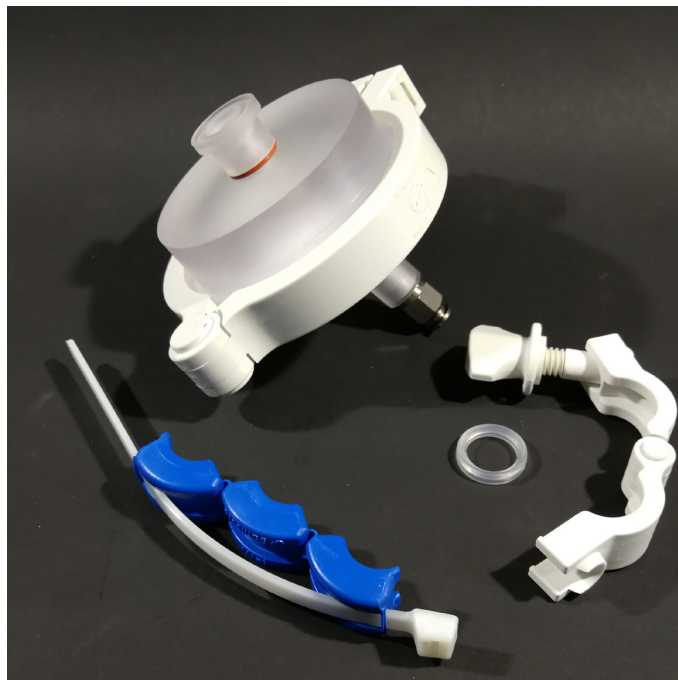


Selectable accessories for P-SUB's

Connecting the HFF with sanitary coupling to the O-SUP or the A-SUE outlet / inlet port and the SUB ports is easy. PerfuseCell as well as other suppliers offer various connection devices.

HFF – harvest continuously a cell free permeate. Choose from one of your preferred suppliers, such as:

- www.spectrumlabs.com
- www.watersep.net
- www.parker.com/dh-bioprocessing
- www.gelifesciences.com



Thank you for your attention

