

Fluidnatek® LE-500

Pilot-scale electrospinning/-spraying machine



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The Fluidnatek® LE-500 Pilot-scale electrospinning machine provides all of the capability needed to develop a product from initial concept to pilot-scale manufacture.

Specification	
Operating modes	Batch or semi-continuous system for fibers or particles
Volume per batch	from <1ml up to 4 l
Run time per batch	up to several days (depending on solution). The controls allow the user to program the machine to automatically switch off after a set time.
Typical fiber/particle diameters	from 20 nm up to 10 µm

Fluidnatek® LE-500: standard platform [LE-500BS]

The Fluidnatek® LE-500 Pilot-scale electrospinning machine comes as standard with the following features and can be upgraded with optional extras as shown in the next section:

Stainless steel, aluminium and glass frame and enclosures

The airtight and thermally insulated cabinet is chemically resistant to organic solvents, enabling proper solvent cleaning. It is designed with a focus on the creation of sterile conditions.

Special safety-encapsulated diffuse LED lighting

To enable proper visualization of the process.

Control from touch screen

The tool is controlled from a touch screen interface through which the user can interact with intuitive software, controlling all the parameters and functionalities. The software can be provided with admin and user access levels.

Ethernet remote diagnostics

Equipped with an Ethernet connection that will permit remote diagnosis and maintenance activities.

Two HV power supplies (up to 30 kV / -30 kV, 0.5 mA)

Equipped with two high voltage power supplies, up to +30 kV and -30 kV for the emitter and the collector, respectively, capable of generating a maximum emitter-collector electrical voltage drop of 60 kV. This feature allows the accurate control of the process and improves the collection of atomized particles/fibers, avoiding them sticking to undesired grounded locations. Optionally, these can be upgraded to biopolarity HV power supplies, each -30 to +30kV.

One semi-continuous liquid feeding system with one each 250 ml, 1 l and 2 l vessel

Solution delivery system ideal for semi-continuous high-throughput production. This system is provided with one each 250 ml, 1 l and 2 l solution reservoirs for connection to compressed air supply. Solution flow rates are controlled by automated pressure regulation.

One single-phase single emitter spinning head with mount

Single emitter spinning head for small-scale research activities. For use with any size of Luer lock needle (reusable or disposable), which enables extremely fast removal and replacement. Needles supplied are 22GA-1/2" (disposable stainless steel with PP hub) by default. Other sizes available upon request.

One single-phase parallel multi-emitter spinning head with mount

Multi-emitter spinning head consisting of either (to be selected by customer): 24 parallel emitters in circular array (recommended for spraying of particles), or 28 parallel emitters in linear array (recommended for spinning of fibers), all fed from the same solution feed. For use with any size of Luer lock needle (reusable or disposable), which enables extremely fast removal and replacement. Needles supplied are 22GA-1/2" (disposable stainless steel with PP hub) by default. Other sizes available upon request.

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Flat plate collector

Flat stainless-steel plate collector with dimensions: 602 mm x 644 mm.

Automated regulation of emitter-collector distance

Automated Z-axis adjustment for the regulation of the distance between the spinning head and collector. Range: 0-300 mm. Accuracy: 1 mm.

Temperature and humidity display

Equipped with temperature and RH monitors within the spinning chamber that display the real-time environmental conditions on the control panel.

Special castors

Allowing easy positioning of the equipment and then secure solid placement on the floor.

Actively regulated exhaust system

Ventilation module to properly exhaust evaporated solvents from the experimental chamber. Pressure sensors at the inlet and exhaust monitor the air pressure differential and ensure optimum ventilation is maintained, whilst also operating a slight negative pressure within the chamber to maximize operator safety. If the ventilation is stopped for any reason, the system safely shuts down to prevent build-up of hazardous vapor. The actively regulated exhaust system is required for use with the optional air conditioning modules to maintain balanced airflow through the system.

Safety features

Fluidnatek® equipment is CE compliant, fulfilling all the corresponding EU Directives (2006/42/EC, 2004/108/EC, 2006/95/EC). Supplied with a certificate of CE compliance from an independent 3rd Party auditor (SGS). This means that the user is completely protected against electrical discharges, despite the high voltages used.

Dimensions [w x d x h]	
Fluidnatek® LE-500	1250 mm x 1600 mm x 2200 mm
Climate control unit	900 mm x 1100 mm x 1950 mm

In addition, the Fluidnatek® LE-500 Pilot-scale electrospinning machine can be configured with a variety of optional upgrades, which provide additional functionality and enable the system to be tailored to the requirements of your application.

Second semi-continuous pressurized liquid feeding system (up to 2 l)** [LE-500V2]

Solution delivery system ideal for semi-continuous high-throughput production. This system is provided with a second solution reservoir (250 ml, 1 l or 2 l volume) for connection to compressed air supply. Solution flow rates are controlled by pressure regulation. The Fluidnatek® LE-500 can accommodate two reservoirs with pressurized liquid feed systems, allowing either up to 4 l of a single solution to extend the production run time, or two separate solutions (250 ml or 1 l or 2 l each) to be used for coaxial electrospinning or electro-spraying. This system requires a feed of dry compressed air.

Syringe pump/s with single-phase, coaxial, or triaxial emitter** [LE-500P]

Provides accurate control of liquid infusion for small-scale production and R&D activities.

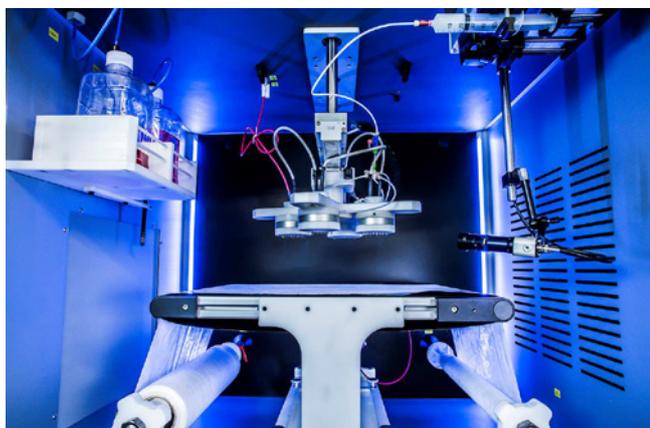
Syringe specification	
Minimum dead volume	to < 0.1 ml
Syringe volume	up to 140 ml
Min-max flow rates	0.1 µl/h – 6000 ml/h (depending on syringe size: e.g. from 9.5 µl/h to 1240 ml/h for a 5 ml BD plastic syringe)
Linear force	100 – 200 N

The Fluidnatek® LE-500 can accommodate up to three syringe pumps. The first syringe pump is to be used with the single-phase emitters (single and multi) included with the platform, the second syringe pump includes a coaxial single emitter, for the spinning of core-shell fibers or particles, and the third syringe pump includes a triaxial single emitter, for spinning 3-layer fibers or particles. Capillary needles can be easily replaced and interchanged, allowing the use of a broad range of dimensions (OD: 0.15 – 3.2 mm; ID: 0.08 – 2.6 mm). Other emitter geometries can be custom designed.

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Roll-to-roll semi continuous collecting system** [LE-500R2R]



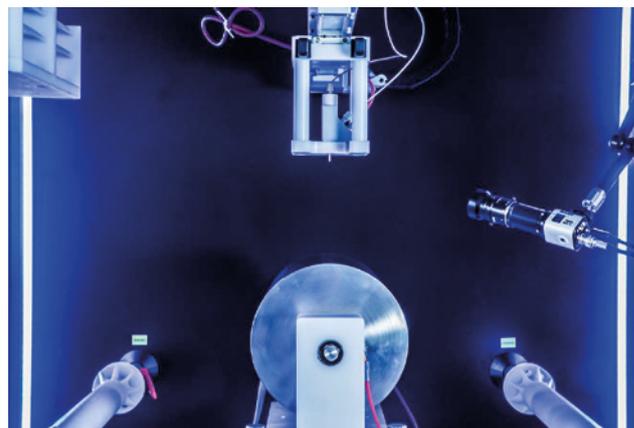
Internally mounted roll-to-roll collection system for semi-continuous collection. The roll-to-roll can move forward and backwards (bidirectional motion). The roller mounts can accommodate a range of core diameters using spacer collars

Spacer collar specs	
Internal core diameter range	50 – 70 mm
Maximum roll width	500 mm
Maximum roll diameter	200 mm
Minimum linear speed	0,1 mm/s
Maximum linear speed	100 mm/s

Universal rotating collector platform** [LE-500RA]

Allows the easy mounting of interchangeable rotating drum, mandrel, or disc collectors up to 300 mm length. Motor provides collector rotation speed from 200 rpm up to 2000 rpm (up to 20 m/s linear speed with 200 mm diameter drum), enabling collection of randomly oriented or circumferentially aligned fibers. Please discuss your specific requirements and Bioinicia may be able to provide a customized solution. Note: Rotating collectors provided by Bioinicia are carefully balanced for eccentricity.

Drum collector* [LE-500DRC]



Cylindrical anodized aluminium collector for mounting into the Universal rotating collector platform [LE-500RA]. Standard drum size supplied: 200 mm diameter x 300 mm length. Other materials and diameters available on request. When combined with the Y-Axis automated scanning emitter motion [LE-500YSM], this also allows for the fabrication of uniform coatings or sheets of electrospun fiber (up to 300 mm x 620 mm).

Mandrel collector* [LE-500MC]

Anodized aluminium rod collector for mounting into the Universal rotating collector platform [LE-500RA]. Allows for the fabrication of nanofiber-walled tubular structures. Multiple diameters available from 1 mm-15 mm. Maximum length: 300 mm. Other materials available on request. Standard mandrel size supplied: 5 mm diameter x 300 mm length.

Disk collector* [LE-500DC]

Sharp-edged stainless-steel disc collector for mounting into the Universal rotating collector platform [LE-500RA]. For collection of aligned fiber bundles onto disc edge. Standard disk size supplied: 200 mm. Other diameters available upon request.

Y-Axis automated scanning emitter motion** [LE-500YSM]

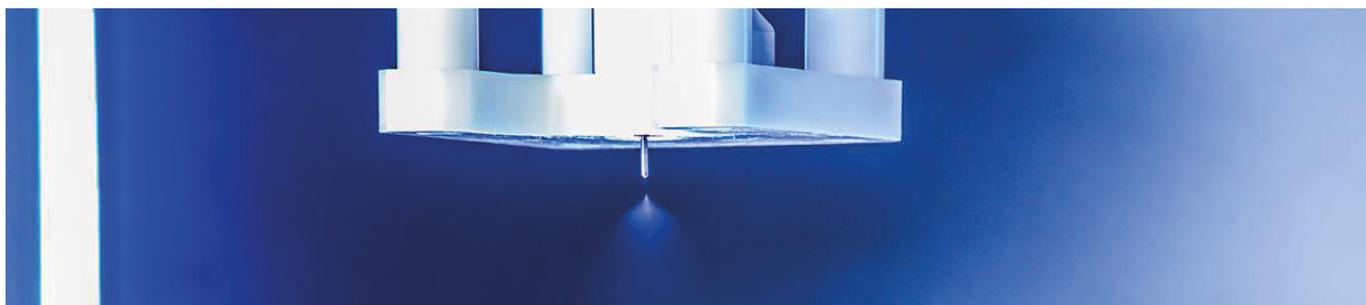
Linear automated motion of the spinning head to create wider, homogeneous samples. In combination with the rotating drum collector this enables the fabrication of homogenous nano/micro-fibrous sheets or coatings up to 300 mm x 620 mm. Maximum stroke: 300 mm. Minimum speed: 1mm/s. Maximum speed: 100mm/s.

Upgrade of automated regulation of emitter-collector distance (Z-Axis) [LE-500AZ40]

Upgrade of the automated regulation of emitter-collector distance in order to increase the working distance up to 400 mm.

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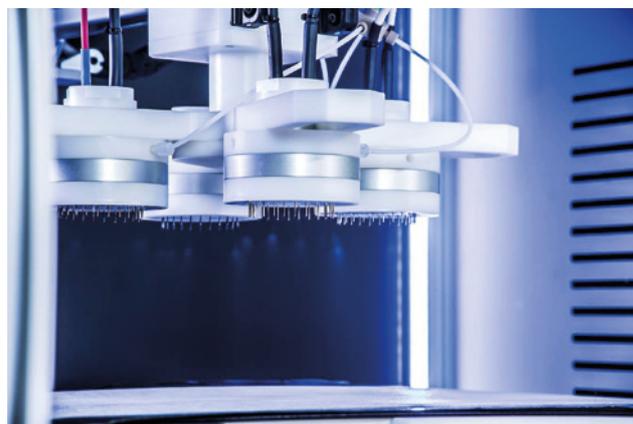
Linear single-phase multi-emitter spinning head (28 emitters)* [LE-500M28L]

Stainless steel multi-emitter spinning head consisting of 28 parallel emitters in a linear array, to provide optimum deposition uniformity across the width of a roll-to-roll collector or drum. Recommended for increasing production rate when electrospinning of fibers. All emitters are supplied from the same solution feed. For use with any size of Luer lock needle (reusable or disposable), which enables extremely fast removal and replacement. Needles supplied are 22GA-1/2" (disposable stainless steel with PP hub) by default.

Other sizes are available upon request.

Up to four linear spinning heads can be mounted into the LE-500, although the optimum number of emitters will be dependent on the properties of the spinning solution. Includes holder for 1-4 linear single-phase parallel multi emitter spinning heads. For the deposition of two different polymers onto a drum or roll-to-roll collector to achieve a uniform two-component membrane, two linear multi-emitter heads can be supplied from individual solution feeds and connected to separate HV power supplies to allow for independent control of flow rate and applied voltage for each material. Requires second liquid feeding system pressurized or syringe [LE-500V2] or [LE-500P] and secondary spinning stage with independent HV power supply [LE-500PHV2].

Circular single-phase multi-emitter spinning head (24 emitters)* [LE-500M24N]



Multi-emitter spinning head consisting of 24 parallel emitters in a circular ring array, all fed from the same solution feed. Recommended for increasing production rates when electro spraying of particles. For use with any size of Luer lock needle (reusable or disposable), which enables extremely fast removal and replacement. Needles supplied are 22GA-1/2" (disposable stainless steel with PP hub) by default. Other sizes are available upon request. The Fluidnatek® LE-500 can be used with up to four circular multi-emitter spinning heads (requires [LE-500H] for more than 1 head).

Circular coaxial multi-emitter spinning head upgrade (24 emitters)* [LE-500C24N]

Multi-emitter spinning head consisting of 24 parallel emitters in a circular ring array, to enable both single-phase and coaxial electrospinning or electro spraying. Emitters can be easily removed and replaced to enable a broad range of capillary needle sizes to be used (OD: 0.15 – 3.2 mm; ID: 0.08 – 2.6 mm). The Fluidnatek® LE-500 can be used with up to four coaxial multi-emitter spinning heads (requires [LE-500H] for more than 1 head).

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Holder for 1-4 circular multi-emitter spinning heads* [LE-500H]

Mounting holder to allow for more than one (up to 4) multi-emitter spinning heads to be mounted in the LE-500 at the same time. Required for use with two or more circular multi-emitter spinning heads (single phase or coaxial).

Secondary spinning stage with independent HV supply** [LE-500PHV2]

An additional positive HV power supply (0 to +30kV, 0.5mA) and an adjustable holder provides for independent control of spinning voltage and distance of a second solution, to enable the deposition of composite structures consisting of two different components (fibers or particles) onto the rotating or roll-to-roll collectors. Includes second single-emitter spinning head. Multi-emitter spinning of two components requires two linear multi-emitter spinning heads [LE-500M28L]. Requires second liquid feeding system (pressurized or syringe, [LE-500V2] or [LE-500P]).

Upgrade to bipolar HV power supply** [LE-500BHV]

Any or all of the HV supplies can be upgraded from single polarity supplies, i.e. 0 to +30 kV or 0 to -30 kV, to bipolar supplies providing easy control of voltage between -30 kV to +30 kV using the integrated touch-screen control.

Gas-assisted electrospinning head (single emitter)** [LE-500GA]

Specially designed emitter and gas flow controller for gas-assisted electrospinning or electro-spraying. This combines electrostatic stretching with conventional blow spinning, to provide further control of the spinning jet and allow for increased flow rates compared with electrospinning or electro-spraying alone. Also available with heater to heat the air/gas supply [LE-500GAHA] for a more powerful blow spinning - please specify if this is required.

Solvent-gas-jacket* [LE-500SGJ]

System to regulate a solvent vapour-saturated gas flow around the emitter tip/s, to reduce the risk of tip drying, which can lead to needle blockage. This system will enable a steady and robust electrospinning/electro-spraying process for solutions with volatile solvents. Requires supply of compressed dry air (or alternative gas if preferred) as well as a coaxial spinning head or Linear multi-emitter spinning head with solvent gas jacket [LE-500M28LSGJ] for multi-emitter spinning of fibers.

Linear multi-emitter spinning head with solvent gas jacket fitting* [LE-500M28LSGJ]

Multi-emitter spinning head consisting of a linear array of 28 Luer lock emitters, with a solvent gas jacket fitting that allows connection to the Solvent gas jacket system [LE-500SGJ] to surround each emitter with a flow of solvent-saturated gas and thereby reduce the risk of tip drying. Up to four linear spinning heads with solvent gas jacket can be mounted into the LE-500, although the optimum number of emitters will be dependent on the properties of the spinning solution. Includes holder for 1-4 linear multi-emitter spinning heads with solvent gas jacket. Requires Solvent gas jacket system [LE-500SGJ].

Tubeless solution dispensing system* [LE-500TS]

Modified solution feeding system to eliminate dead-volume in syringe and tubing to minimize solution waste. Particularly suited to applications requiring the incorporation of expensive or difficult to obtain active ingredients. Also recommended, in combination with the syringe heater, to avoid solution cooling when spinning solutions that require elevated temperatures.

Syringe heater for tubeless solution dispensing system** [LE-500SH]

Heating collar to regulate temperature of the spinning solution within the tubeless liquid feeding system. Controls integrated into machine touch panel so that temperature can be set and modified from outside the spinning chamber. Suited to hot solution electrospinning, but not intended for melt electrospinning. Max temperature: 120 °C. Requires tubeless solution dispensing system [LE-500TS] to avoid solution cooling within spinning head.

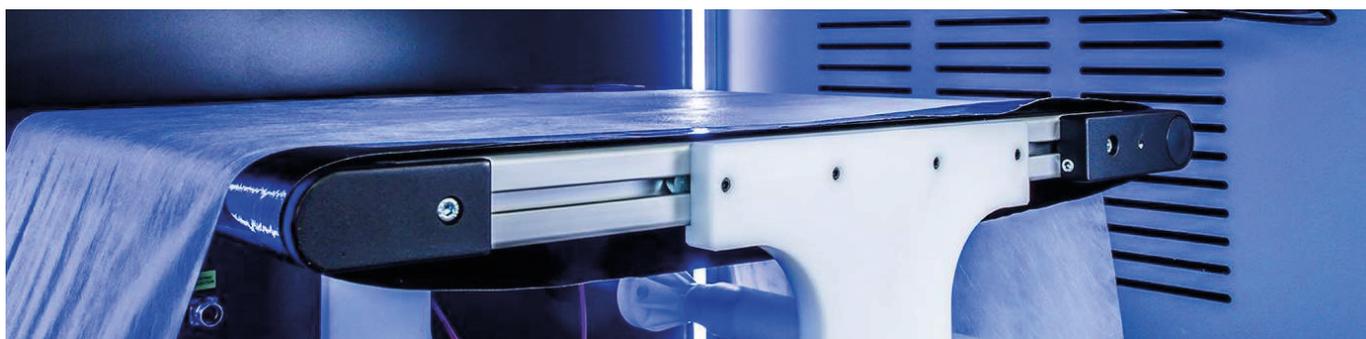
Taylor Cone visualization system** [LE-500C]

Integrated video camera, objective lens and monitor to display the Taylor Cone and initiation of the spinning jet (only one emitter can be displayed). Especially recommended for use with the coaxial



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Inlet fan filter unit (HEPA or ULPA)** [LE-500IF]

Fan unit with HEPA or ULPA filter on the air inlet eliminates the risk of chamber contamination through the air supply, to create an ultra-clean spinning environment.

Exhaust filter (HEPA or ULPA)* [LE-500EF]

HEPA or ULPA filter unit on chamber exhaust. Prevents contamination of surrounding facilities. Suitable for clean-room installation.

UV-C germicidal lamps** [LE-500GL]

UV-C germicidal lamps within the spinning chamber to further minimize contamination risk and ensure ultra-clean spinning conditions. Intended for sterilization of spinning chamber before/after processing.

Data logging and export function* [LE-500DL]

All processing parameters and spinning conditions can be automatically recorded and exported onto any USB drive connected to the machine. The data is recorded as CSV files, which can be easily opened in Microsoft Excel or equivalent software.

Multi-user level access with recipe database* [LE-500RDB]

Enables different levels of operator access, to ensure that only authorized personnel have access to modify processing parameters. Basic operator login only allows access to pre-set "recipes" of parameter set-ups, which can be saved into a database of optimized recipes associated with the processing of individual materials. This will increase standardization and simplify the workflow for repeat processing.

Programmable sequential multi-step recipe function* [LE-500PSMR]

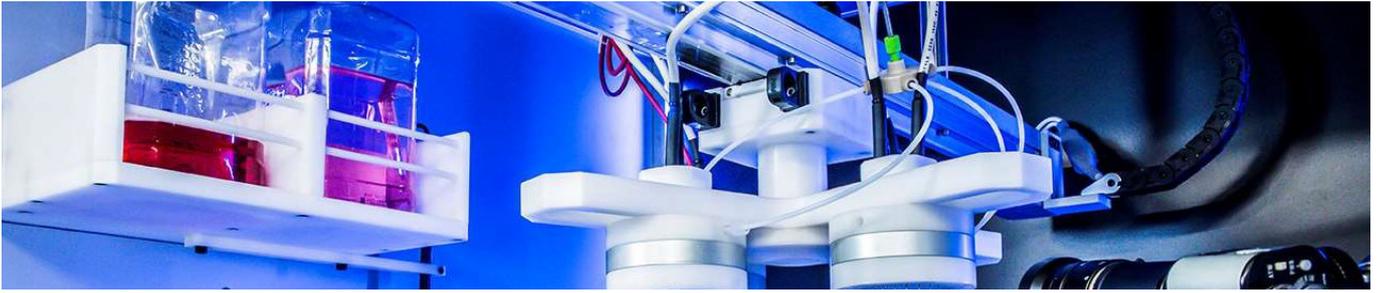
Allows the processing parameters (e.g. voltage, distance, flow rate, drum rotation speed etc.) to be programmed and automated as a function of time. Sequential programmes can be created, saved and loaded via the touch-screen interface.

Air conditioning: Temperature and RH control unit** [LE-500AC]

External system that introduces a conditioned air stream into the cabinet. The temperature of the air can be controlled from 18 °C to 45 °C (± 1 °C). Relative humidity can be controlled from 10% to 80% (± 3 %), depending on temperature. For example at 25 °C the achievable RH range will be 30%-80% (more information can be provided on request). Importantly, this climate control system conditions the air before it enters the spinning chamber and works together with the actively regulated exhaust system to provide high air exchange rates to ensure the spinning environment remains stable during production with no build-up of solvent vapours. The air passes through a HEPA filter before entering the spinning chamber. This HEPA filter can be easily replaced – typically in a standard lab, the filter will need replacing after 3-5 years, in clean-room facilities it will last for at least 10 years without the need for replacement. This air conditioning system is self-contained and can be purchased separately from the LE-500 electrospinning machine and easily installed at the customer facility. Room conditions from 20 °C - 25 °C and from 35%-75% RH. This system requires a supply of demineralized water (TDS <30 ppm, EC <47 μ S/cm). Where this is not already available, Bioinicia recommends the installation of an in-line reverse osmosis water purifier and can assist you further if needed. Note: an ion-exchange water softener should not be used without further purification.

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Voltage for the air conditioning unit: 480Vacc**
[LE-500ACAD]

Modification on the air conditioning unit to work under 480V, 60Hz, 15A, 3-phase + N + PE. Voltage conditions mostly required in USA.

Machine qualification (for ISO or GMP processes)*
[LE-500GMP]

The Fluidnatek® LE-500 can be provided with qualification documentation for ISO or GMP validation compliance. Alternatively, Bioinicia can provide full IQ/OQ validation on site, or FAT/SAT service. Please enquire if this is of interest to you.

* The LE-500 unit can be user-upgraded anytime with these PLUG & PLAY accessories.

** The LE-500 unit can be manufacturer-upgraded anytime with these accessories. Incurs additional on-site engineer installation charge.